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Mangrove in Ecuador: Conservation and Management Strategies

Fausto López-Rodríguez

Abstract

In Ecuador, 100% of the mangroves are protected through different mechanisms: protected areas, community mangrove concessions, and protective forests. However, there is still deforestation of the mangroves, even in protected areas, which is caused mainly by the construction/expansion of shrimp pools. Shrimp is currently Ecuador's first non-oil export product. The Sustainable Use and Mangrove Custody Agreements are very important because they cover an area almost similar to that of protected areas. This mechanism is effective because it allows the sustainable extraction of resources from the mangrove, but forces the "custodians" to protect this ecosystem. This chapter includes a case study on the management of the "mangrove concessions" of the province of El Oro, southern Ecuador, in which the management effectiveness of these areas is analyzed. We found that despite the limited resources that these mangrove concessions have, the level of management is "satisfactory", which means that most of the management objectives are met. However, these areas should receive more support, both from the state and private organizations, as they conserve more than 40% of Ecuador's mangrove.

Keywords: mangrove, mangrove concessions, local communities, sustainable, management, protected areas, shrimp pools

1. Introduction

Mangrove forests have a great relevance for the world, they are resilient to the adverse effects exerted by both natural and anthropic factors and play a fundamental role in the strategy for adaptation to climate change. They are also the basis for food security for ancestral communities and traditional users.

At a global level, it is calculated that mangrove forests cover an area of about 15'000,000 hectares, 11% ($\approx 1'650,000$ hectares) of which is found on the Pacific and Caribbean coasts of South America. In Ecuador, there are an estimated 161,000 hectares of mangroves. Regarding mangrove losses, annual values of 0.16% have been estimated worldwide between 2000 and 2012, with South America having the lowest rates of deforestation compared to Asia, Africa, North and Central America [1]. Ecuador had the highest deforestation in the 1970s with 27% deforestation going from 300,000 ha in the 1960s to 145,000 ha in the 1980s. The mangrove conservation efforts in Ecuador were based, originally, on the issuance of policies and laws and the creation of state protected areas [2]. A new mechanism was created in 1999, which recognized the rights and traditional uses of the communities

that lived in these ecosystems or that depended on their resources for their survival: The Custody and Sustainable Use of Mangrove Agreements (AUSCM).

This conservation mechanism plays a key role in the conservation of the mangrove in Ecuador, since it occupies almost the same extension as the mangrove that is found in the protected areas of the National System of Protected Areas (SNAP). It complements government conservation efforts, with community conservation activities.

The main objectives of this study are to show the key role of the AUSCM in the conservation of the mangrove in Ecuador, since it occupies almost the same extension as the mangrove that is found in the protected areas of the National System of Protected Areas (SNAP) as well as the effective management that local communities give to this ecosystem.

2. Current situation of mangroves in Ecuador

Ecuador has a land area of 256,370 km² and an estimated population, as of 2018, of 17'096,789 inhabitants. It limits to the north with Colombia, to the south and east with Peru and to the west with the Pacific Ocean. In addition, on the maritime border of the Galapagos Islands, it borders the Cocos Island of Costa Rica [3]. The Ecuadorian territory includes, in addition to the land area, 1'092,140 km² of maritime area, which is equivalent to 4.3 times the continental territory. The extension of the continental coast is 1200 km [4] (Figure 1).

In the coastal of Ecuador, several economic, social and environmental activities are developed, with diverse interests that cause that the Coastal region is a highly conflictive region. This region has several marine-coastal ecosystems, one of the most important is the mangrove. This ecosystem is considered one of the most productive in the world, however, it is one of the most threatened. In the case of Ecuador, in the span of 40 years, 27% of the mangrove were lost as a consequence, mainly, of the construction of shrimp pools and urban expansion [2].

Figure 1. Coastal and insular region of Ecuador.

The mangrove swamp in Ecuador is located mainly in six estuaries. CLIRSEN and PMRC (2007) determined that in 1969 the mangrove area in Ecuador reached 203,624 hectares, which, by 2006, was reduced to 146,971 hectares, a loss of 56,653 hectares, equivalent to 22,8% [2].

The highest annual rate of deforestation occurred between 1991 and 1995 (2.35% per year); on the contrary, between 1995 and 1999 a recovery of the mangrove cover was observed and between 1999 and 2006, the annual rate of deforestation was 0.13% [2]. For its part, in the decade from 2006 to 2016, a mangrove recovery of 14,864 hectares was observed again [2, 5] (**Table 1**).

The current mangrove area in Ecuador is 161,835 ha. This mangrove coverage gain was the result of reforestation programs implemented by different institutions and communities that have mangrove use and custody agreements, as well as the natural regeneration of the ecosystem [6, 7].

At the policy and legal level, these marine-coastal ecosystems have received significant support. In the first place, there is the 2007 Constitution of Ecuador that recognizes mangroves as “fragile and threatened ecosystems” which gives them a special “status” in relation to other types of ecosystems. The Organic Environment Law (2017) confirmed earlier regulations that, in Ecuador, all mangrove forests are property of the State. Another important regulation, based on the economic valuation of ecosystem services of mangroves, is the resolution No. 056 of the Ministry of the Environment of 2011, based on which fines for mangrove deforestation of up to USD 89,273 are established [8]. According to a study carried out by the Charles Darwin Foundation (CDF), Galapagos National Park Directorate (GNPD) and the Scripps Institute of Oceanography at the University of San Diego, each hectare of mangrove in Galapagos has at least a value of \$ 27.852, because the 3,700 hectares store more than 778.000 tons of carbon. Its conservation is considered a measure of adaptation and mitigation to climate change.

On April 4, 2019, the National Action Plan for the Conservation of Mangroves in Ecuador was approved. This Plan seeks to promote the protection, recovery and sustainable use of mangroves, with a focus on improving the quality of life of ancestral and traditional users [9].

Estuaries	1969	1984	1987	1991	1995	1999	2006	% of mangrove lost comparted to1969
Cayapas Mataje	23.677	23.653	23.507	22.863	21.947	22.057	21.400	9.6
Muisne	3.282	2.701	2.445	1.340	830	1.187	1.187	52.5
Cojimías	13.123	9.917	8.466	6.028	3.651	1.921	2.742	79.1
Chone	3.973	1.673	1.040	784	391	705	932	76.5
Guayaquils Gulf	124.320	119.277	115.784	109.608	102.108	104.715	105.130	15.4
Jambelí Archipelago	34.712	24.592	23.570	21.092	17.697	19.111	19.111	56.2
Total	203.624	181.815	174.815	161.718	146.628	149.699	146.971	27.6

Source: [2].

Table 1.
Mangrove loss by estuary (in hectares). Period 1969–2006.

3. Causes of mangrove loss in Ecuador

Anthropogenic activities are the main causes of the destruction of mangroves. These activities substantially alter the composition, structure and function of mangroves, reducing the ecosystem services they provide. In Ecuador, the transformation of the mangrove into shrimp pools and urban development are the main factors in the loss of this ecosystem.

3.1 Shrimp activity

Ecuador is currently one of the main producers of farmed shrimp in the world. Although the shrimp industry is of great importance to the country, it has also been the main cause of the destruction of the mangroves.

According to the National Chamber of Aquaculture of Ecuador, in 2015 there were 213,000 hectares assigned to shrimp production, of which 181,000 hectares are located in an area that was originally mangrove. The province of Guayas has the highest coverage of shrimp farms, with approximately 140,000 hectares, which represents 66% of the total production followed by the province of El Oro with 18% [10]. In addition to the deforestation of mangroves that the construction of the pools implies, during the activity itself, effluents rich in organic and inorganic particles are released that deteriorate the resources of the estuaries [11].

Shrimp is currently Ecuador’s first non-oil export product. The Ministry responsible for the fishery sector estimated that, in 2013, 66% (6,192 ha) of the shrimp ponds in the province of Esmeraldas were illegal, in the province of El Oro 39% (12,576 hectares), and Manabí 59% (8,434 hectares) and Guayas 18% (17,437 hectares) [12]. Even protected areas have not been exempted from the presence of this activity since in 4 out of 6 coastal protected areas there were shrimp farms installed or expanded after the creation of the area.

CLIRSEN and PMRC (2007) determined that the main loss of mangrove coverage occurred between 1969 and 1995, a period in which more than 56,000 hectares were deforested. Since 2006, mangrove coverage has remained relatively stable while the area covered by shrimp farms increased to 210,000 hectares [2]. The evolution of areas dedicated to shrimp farming is showed in **Table 2**.

The loss of mangroves up to 2000 occurred at the same time that shrimp farming was developing. A slight increase in the mangrove area is observed as of 2000, which allows us to deduce that the conservation strategies and the regulations created generated favorable impacts for the conservation of this ecosystem (**Figure 2**).

	Year								
	1969	1984	1987	1991	1995	1999	2000	2006	2016*
Shrimp farms (ha)	0	89,368	117,728	145,998	178,071	175,253	175,253	175,748	210,000
Mangroves (ha)	203,695	182,157	175,157	162,186	146,938	149,556	127,690	148,230	161,835

*2018 data do not show a significant increase in the area of shrimp farms.
Source: [2].

Table 2.
Evolution of areas dedicated to shrimp farming and mangrove conservation in the 1984–2016 period.

Figure 2.
Relationship between mangrove loss and shrimp farm area growth.

3.2 Urban development

Many coastal cities are located in areas that were once occupied by mangroves. It is estimated that until 1994 approximately 3,000 to 5,000 hectares of mangroves were destroyed to make way for the growth of cities such as Guayaquil, Machala, and Esmeraldas [13].

4. Strategies for mangrove conservation in Ecuador

The accelerated transformation of the mangroves of continental Ecuador led to the generation and implementation of different strategies to protect them, thereby achieving that, at present, 100% of the mangrove is protected. The first measures focused on establishing laws and regulations to protect the mangrove. In 1986, the entire mangrove was classified as a protective forest, providing governmental institutions with a basic set of instruments to punish its deforestation. Later, in 1994, a mangrove deforestation ban was established, and the expansion and construction of new shrimp ponds was prohibited.

The main conservation strategies are:

- Mangroves declared as Protective forests
- Mangroves declared Protected areas
- Sustainable use and Custody Agreements of mangrove forests
- Governmental incentive program for forest conservation: Socio Manglar

4.1 Protective forests

All mangroves were declared as Protective forests in 2003, is a figure that in addition to conservation, allows the development of certain activities like deforestation, contamination etc. [14].

4.2 National system of protected areas (SNAP)

The first formal strategy to stop the rapid loss of mangroves in Ecuador was declaration of protected areas covering mangrove forests. In 1979 the Churute Mangrove Ecological Reserve was established, located in the Guayas province and 16 years later the following was established: Cayapas Mataje Ecological Reserve (Esmeraldas). The most recent protected area with mangrove ecosystem, the Area Nacional de Recreación Isla Santay, was created in 2010 [15]. Today, Ecuador has 19 marine and coastal protected areas, which together represent about 8% of the total coverage of the SNAP. Nine of these areas contain (totally or partially) 72,523.48 hectares of mangrove [15] (Table 3).

In 2017 the Network of Marine and Coastal Protected Areas of Ecuador (Red de AMCPs) was created, as a mechanism for political-administrative interaction to enhance institutional resources and manage the areas in an articulated and synergistic manner. Coastal marine protected areas. The aim of this network is to guarantee biological connectivity between ecosystems by creating connectivity corridors and conserving the biodiversity of the National System of Protected Areas in the marine-coastal zone [16].

However, even though the laws forbid deforestation and degradation of protected areas, the mangrove coverage reduced even in the most recent year (2010 to 2018) by 150.34 hectares due to conversion to shrimp farms, which shows a weakness in the control, surveillance and monitoring of these areas and an illegality on the part of the shrimp farms [17].

4.3 The mangrove sustainable use and custody agreements (AUSCM)

In Ecuador, all mangrove forests are property of the State, with the Ministry of the Environment (MAE) being the institution responsible for their management [18].

The AUSCM are the management tool contemplated in the Ecuadorian legal framework [18, 19], under which mangrove forests are handed over to ancestral users to custody these areas. The AUSCM guarantee the “custodians” exclusive access to the mangrove areas with the right to sustainably use bio-aquatic resources,

	Protected area	Month/Year it was created protected area	Total Extention (ha)
1	Reserva Ecológica Manglares Churute	Julio 1979	49,389
2	Reserva Ecológica Cayapas Mataje	Octubre 1995	51,300
3	Reserva Ecológica Arenillas	Mayo 2001	13,170
4	Refugio de Vida Silvestre Islas Corazón y Fragatas	Octubre 2002	2,811
5	Reserva de Producción de Fauna Manglares El Salado	Noviembre 2002	10,635
6	Refugio de Vida Silvestre Manglares Estuario del Río Muisne	Marzo 2003	3,173
7	Refugio de Vida Silvestre Manglares El Morro	Septiembre 2007	10,030
8	Refugio de Vida Silvestre Estuario del Río Esmeraldas	Junio 2008	242
9	Área Nacional de Recreación Isla Santay	Febrero 2010	2,215

Source: <http://areasprotegidas.ambiente.gob.ec>.

Table 3.
State protected areas with partial or total mangrove coverage.

but in turn have the obligation to realize control and surveillance of mangrove and report the progress of its management to the [19]. These agreements, also called “mangrove concessions,” are important because they protect 42.85% of the Ecuadorian mangrove (almost the same extent as the protected areas) and are the livelihood for thousands of families living in the coast. In the province of El Oro, the AUSCM cover about 80% of this ecosystem [7].

Currently in Ecuador there are 59 community organizations with custody agreements with an area of 69,369 hectares (**Figure 3**).

The fact that the mangrove area under AUSCM is almost equal to that occupied by the protected areas of the National System of Protected Areas (SNAP) is relevant (**Table 4**).

4.4 Socio Manglar, incentive for mangrove conservation

The Socio Bosque Program has a special incentive for mangrove protection named “Socio Manglar”, which provides an economic incentive to “custodies” (communes, associations, etc.) of mangrove forests. The mangrove conservation incentive was created in 2014 to support the management of the Sustainable Use and Custody of Mangrove Forests Agreements (AUSCM). As of 2020, there are 27 signed agreements covering 34,160 hectares, for which they receive USD 413,481 each year, with which 1,635 families benefit. In the province of El Oro, the 11

Figure 3.
Evolution of the AUSCM since 2000.

Distribución del manglar	Cobertura (ha)	%
Protected Areas (SNAP) (2020)	72.523	45.15
Sustainable Use and Custody of Mangrove Forests Agreements (2020)	69.369,48	42.86
Protection Forest (2020)	19.943	11.99
TOTAL	161.835	100

Source: www.ambiente.gob.ec.

Table 4.
Mangrove distribution according to conservation status.

beneficiary organizations of Socio Manglar receive approximately USD 113,092.54 for the conservation of 5,343.18 hectares of mangroves [20].

5. The AUSCM in the province of El Oro

The mangrove ecosystem in the El Oro province (southern Ecuador) covers 19,318 hectares that represent 4% of the provincial surface. The area covered with mangrove forest is located on the coastal zone and the Jambelí Archipelago in which there are six small fishermen villages, which depend on the resources they extract from the mangrove, particularly the collection of black shell (*Anadara tuberculosa* and *A. similis*) and red crab (*Ucides occidentalis*), and artisanal fishing [21].

It is estimated that originally the mangrove coverage in the El Oro province occupied 35,144 hectares, having been reduced, by 2006, to 16,152 hectares, which is equivalent to a loss of 56.2% [2]. According to the Ministry of Environment and Water, there is a recovery of 2,866 hectares between 2006 and 2018. **Figure 4** shows the evolution of mangrove coverage in the El Oro Province.

There are currently 24 AUSCM in the province of El Oro that comprise 15,666.34 hectares, which means that 81% of the mangrove swamp is protected in these areas. The Arenillas Ecological Reserve, with an area of 13,170 hectares, has only 1,239 hectares of mangroves, which makes the role of the AUSCM in the conservation of the mangroves in this province even more relevant. These custody areas benefit 1,323 families.

Figure 4.
Evolution of mangrove coverage in the El Oro Province. Period 1969–2018. Source: [2].

6. Main drivers of mangrove degradation in the El Oro province

6.1 Population growth

The constant growth of the population of the El Oro province has been the consequence of a series of factors, mainly associated with the development of economic activities, among which are: the banana industry, shrimp farming and mining. Between 1974 and 2018, the population almost tripled, currently reaching a

population of around 700,000 inhabitants. Only five of the 14 cantons in the province of El Oro have mangroves, but 413,299 people live there, representing 68.8% of the total population. 49% of these inhabitants reside in the Machala canton, where Puerto Bolívar is located, the main axis of development of this province. Urban and industrial development has caused the deforestation of mangrove forests in the El Oro Province [7].

6.2 Aquaculture development policy (shrimp farming)

The development of shrimp farming in Ecuador began in 1970. It had a rapid growth due to the issuance of a series of favorable public policies and the endowment of economic resources from international organizations such as the World Bank, the International Monetary Fund and the Inter-American Development Bank [22]. The felling of the mangrove for the construction of the shrimp ponds is the most important impact, but during the shrimp cultivation process other environmental impacts are generated, such as discharges (biocides, fertilizers, antibiotics, etc.) that are released into the estuaries and sea without any treatment [7, 10]. The province of El Oro is the second with the largest extension of shrimp farms in the country, with an estimated area of 35,576.6 hectares, which represents 19.05% of its territory. The shrimp concessions are superimposed on the mangrove that is under Sustainable Use and Custody Agreements, in 333.3 hectares, that is, 2.3% of the area with AUSCM [21].

6.3 Agricultural development policy (banana and cocoa)

Bananas was, for decades, Ecuador's first non-oil export product, which is why it has received important support from the State, through subsidies, tax benefits and other incentives designed to consolidate its production and export. In the province of El Oro, banana plantations cover more than 58,000 hectares, which represents more than two-thirds of the permanent crop area of the province (68%). This monoculture uses various chemicals that pollutes the waters that go to the estuaries [23].

6.4 Mining development policy

Mining activity has received a great boost, particularly in the last 12 years, during which the legal and political framework was reformed to promote mining activity, especially large-scale mining. The approval of a new Mining Law and its respective regulations stand out here. In the province of El Oro there are 853 mining concessions, which cover 154,785 hectares, equivalent to 28.4% of its surface. In 11 of the 14 cantons of this province there are concession areas. The problem is that most of the mining concessions are located in the upper part of the watershed basins polluting rivers that later deposit their contaminated waters in estuaries and mangroves [7].

6.5 Climate change and El Niño phenomenon

Another important driver at the global scale is the El Niño phenomenon that is increasing due to climate change. The "El Niño Phenomenon" (ENSO-El Niño-Southern Oscillation) is a climatic event that occurs approximately every 2–7 years and is related to short-term climate variability. It results in the appearance of warmer (El Niño) or colder (La Niña) surface waters than normal in the central and eastern tropical Pacific [24]. It has been determined that among the most important changes caused by El Niño are the increase in sea temperature and sea level that can produce more intense rains than normal. The decrease in salinity due to the

contribution of fresh water from the rains, can interfere in the development and growth of the species *Rhizophora mangle* and *R. harrisoni* (they need and are tolerant to high levels of salinity) and in that of mollusks and crustaceans that depend on the habitat of these species, particularly the black or brown shell (*Anadara tuberculosa* and *A. similis*) and the red crab (*Ucides occidentalis*) [25].

7. Evaluation of the management of the AUSCM

Evaluating the effectiveness of the management of protected areas or other conservation measures is key because it allows, in addition to knowing the management problems and their causes, to identify and apply, in a timely manner, strategies and measures to improve their management. There are several methodologies to evaluate the management of protected areas or other conservation measures. In Ecuador, the principal method used to evaluate the effectiveness of management conservation measures is the Hockings Reference Framework proposed by the IUCN (2000) and the 360° performance evaluation [26].

In the case of the 20 AUSCM in the province of El Oro in force in 2017, the methodology known as 360° Performance Evaluation was applied with some adaptations which allows verifying compliance with the inherent obligations of the organizations involved, as well as the factors that affect their actions [27]. The 17 indicators that were used are divided into four groups:

- a. Current state of the mangrove. Evaluates aspects such as mangrove coverage and pollution.
- b. Compliance with the agreement. It includes compliance with the Management Plan, the delivery of semi-annual reports and complaints, etc.
- c. Custodian performance. It includes compliance with the implementation of control and surveillance programs, sustainable use, participation of fishermen, economic contributions, commercialization, etc.
- d. Performance of support entities. It includes the MAAE and other institutions of the national and local government, academy, etc.

For the rating and weighting of this evaluation, the Likert scale was used with four rating levels (from 0 to 4) associated with a percentage that reflects the respective management levels. This method is based on a method used by De Faría (1993) and later incorporated by WWF, GIZ and IUCN in the Manual for Evaluating the Management Effectiveness of Protected Areas [28, 29]. Ulloa et al. (2012) applied it in the evaluation of the management effectiveness of five coastal marine protected areas [30]. **Table 5** shows the levels of qualification of management effectiveness of the areas under custody.

The results indicated that the management effectiveness of the 20 mangrove custody areas analyzed is in ranges between 46.7% and 93.5%, which means that none of these areas has an unsatisfactory management (**Figure 5**).

At the individual indicator level, the highest corresponds to the maintenance and increase of the mangrove coverage and the lowest to “Direct sale/added value of crabs and shells” which shows that most of the fishermen still work with intermediaries who are in charge of commercialize bioaquatic products [26].

The perceptions of the custodians regarding to the recovery of the mangrove were verified through a multi-temporal analysis in three periods: 1985–1999–2018

Level I. Unsatisfactory. ($\leq 25\%$). Indicates that the protected area has not guaranteed its long-term permanence
Level II. Slightly Satisfactory. (26–50%). Means that the protected area is highly vulnerable to conjunctural factors and its permanence is not guaranteed in the long term
Level III. Satisfactory. (51–75%). Indicates that the protected area has deficiencies which prevent an effective management, but the management objectives are partially met
Level IV. Very Satisfactory. (76–100%). Indicates that the permanence of the protected area is guaranteed and management objectives are fully meet.

Source: [28, 30].

Table 5.
Management effectiveness levels of areas under AUSCM.

Figure 5.
Management effectiveness of the 20 mangrove custody [26].

on the Jambelí Archipelago. The multi-temporal analysis agrees with the perception of organizations and institutions that mention that the massive felling of mangroves has stopped since the creation of the custody agreements (AUSCM).

The mangrove cover in the Jambelí archipelago in 1985 was 13,084.17 hectares, while in 1999 it was reduced to 8,978.43 hectares. For 2018 the mangrove cover was 9,454.47 hectares. While between 1985 and 1999 in the Jambelí archipelago 4,106 hectares of mangroves were deforested, between 1999 and 2018, 476 hectares were recovered precisely at the time when mangrove concessions began to be awarded to local communities (**Figure 6**).

There are small clearings, mainly in the areas adjacent to the shrimp ponds, for the maintenance of its walls. On the other hand, they perceive mangrove recovery in sites far from shrimp farms, which they attribute to the control and surveillance and reforestation activities carried out by the organizations [31].

The Socio Manglar incentive has contributed to improve the management effectiveness of the mangrove custody agreements, as well as the organizational strengthening. However, the overexploitation of bioaquatic resources and contamination still persist, requiring greater support and inter-institutional coordination from control entities such as the Ministry of Environment and Water of Ecuador (MAAE), Ministry of Production, Foreign Trade, Investments and Fisheries (MPCEIP) and the Public Prosecutor's Office [26].

Figure 6.
Mangrove cover on Jambelí Archipelago in three periods: 1985–1999–2018.

8. Key elements in the management of community areas

Several key elements have been developed to strengthen the management of the AUSCM in the province of El Oro. Among the most prominent are:

Capacity building program for beneficiaries of the AUSCM

This training included the topic of organizational, administrative-financial strengthening and management of marine-coastal resources.

Capacity building program for Technical Advisors of the AUSCM

It is a series of 6 modules aimed both for partners of organizations in charge of technical aspects and for organizations that provide.

ManglarApp

The ManglarApp mobile application is a digital tool that is part of the global trend of electronic government and digital citizenship, and that allows complaints, notifications and early alerts of anomalies in mangroves through a smartphone. This application was created in order to improve communication between the partners of organizations with AUSCM and the control entities in matters of mangroves like the Ministry of Environment and Water of Ecuador¹, Ministry of Production, Foreign Trade, Investments and Fisheries and Prosecutor’s Office) [32].

¹ On March 4, 2020, through executive decree 1007, President of Ecuador ordered the merger of the Ministry of the Environment (MAE) and the Secretariat of Water (SENAGUA) creating the Ministry of Environment and Water. With this change, the Undersecretary of Marine and Coastal Management, an entity that was decentralized, disappeared, and now operates from Quito (the capital of Ecuador). The functions now fulfilled by the Under Secretariat of Natural Heritage.

9. Conclusions and recommendations

Few evaluations of management effectiveness have been performed in the AUSCM. The last evaluation was made in 2008 [33]. One of the main differences in the results of this study was the mangrove cover. While the 2008 assessment reports a loss of mangroves in the custody areas, the present investigation found a recovery of this ecosystem. Likewise, this research found greater compliance in the execution of management plans than the 2008 study. Another important difference is found in the Socio Manglar incentive, which did not exist in 2008 which is an important support for the management of the AUSCM.

The declaration of the mangroves of Ecuador by the Organic Environment Law (2017) as a national asset is an important milestone in mangrove ecosystem conservation because it gives this ecosystem a high-level legal protection, which is complemented by the recognition given by the Constitution of Ecuador as a “fragile and threatened” ecosystem.

Although all mangroves in Ecuador are protected through different mechanisms (protected areas, AUSCM and protective forests), it has been identified that, even within the areas protected by the State, the loss of mangroves continues, as shrimp farms convert mangrove forests into shrimp pools.

Both in the protected areas of the SNAP and in the areas under AUSCM, a land occupation by shrimp farming is observed, which shows that the monitoring systems of these areas is lacking behind, hence the convenience of strengthening monitoring systems through the use of satellite images, as well as other community monitoring mechanisms is evident.

Shrimp farming continues to be a factor in the loss of mangroves both in the State’s protected areas (SNAP) and in the custody areas.

The elimination of the Under Secretariat of Marine and Coastal Management could imply a weakness in the support of the Ministry of the Environment and Water to the management of the AUSCM.

Organizations with custody areas, government and technical assistance entities, agree that Sustainable Use and Custody Agreements are an effective tool for the conservation and for the economy of ancestral communities and traditional users of the mangrove. It has been effective in curbing mangrove logging (as demonstrated by the multitemporal study), although overexploitation of bioaquatic resources and contamination of water and sediment persists, threats for which greater support and inter-institutional coordination are required by the authorities. Control entities (MAE, MPCEIP, Prosecutor’s Office).

Mangrove Custody and Sustainable Use Agreements are an important and effective conservation strategy for the conservation of mangroves in the province of El Oro. The recovery of mangrove coverage and effectiveness of the mangrove management is “Satisfactory”.

The Socio Manglar program has supported the organizations, providing financial means to improve their control and surveillance, pay basic organizational costs (office, material), however not all organizations receive this incentive, so it is necessary to seek new sources of financing to improve the success of the AUSCM without the Sociomanglar incentive.

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