Mangrove Concessions: An Innovative Strategy for Community Mangrove Conservation in Ecuador

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Fausto Lopez
Universidad Técnica Particular de Loja

Mangrove Concessions: An Innovative Strategy for Community Mangrove Conservation in Ecuador

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Fausto Vinicio López Rodríguez

Abstract

The sustainable use and custody agreements of mangrove forests (Mangrove forest concessions) emerged in 1999 as a complementary strategy to the national protected area policy strategy. This innovative strategy supports the conservation of mangrove forests by providing legal security to traditional mangrove users, conceding them land rights concessions and thereby promote the participation of local communities in the conservation of mangroves, allowing the sustainable capture of biodiversity mainly of sea shells and crabs. This chapter includes a case study of the association of artisanal fishermen and related activities named "Costa Rica", located in the province of El Oro. This association obtained in 2000 a mangrove forest concession, being one of the first in the country. After 17 years of signing the agreement with the National Government, in spite of anthropogenic pressure, mainly from the shrimp industry, the area maintained its mangrove forest cover and the association has been able to sustainable use the mangrove resources, especially the black ark or blood cockle *(Anadara tuberculosa).*

Keywords

Mangroves · Mangrove concessions · Participatory management of mangroves · Mangrove deforestation · Shrimp industry · Black arch production

F. V. L. Rodríguez (✉)
Departamento de Ciencias Biológicas, Research Group: Gobernanza, Biodiversidad y Áreas Protegidas, Universidad Técnica Particular de Loja, Loja, Ecuador
e-mail: fvlopezx@utpl.edu.ec

25.1 Introduction

Mangrove forests are a type of tropical forest of great importance for the livelihoods of millions of people around the world. Globally, mangroves cover about 152,360 km^2 (15′236.000 ha) in 123 countries (Spalding et al. 2010). More than 100 million people worldwide live within 10 km of mangroves, benefiting on a permanent basis from a wide variety of ecosystem goods and services provided by the mangrove forests (UNEP 2014).

Communities directly benefit from goods such as wood (used for construction, furniture, firewood, etc.) and aquatic fauna (mollusks, fish, crustaceans, etc.), which is crucial for their food security (UNEP 2014). Mangroves are among the most productive source of renewable resources on the planet. The primary production levels of mangroves surpass those of many agricultural systems, producing about 10 g/m^2 per day of organic material which amounts up to 37 metric tons per hectare per year (Center for Integrated Natural Resource Mapping by Remote Sensing et al. 2007). These ecosystem goods and services are estimated to amount up to US $33.000–57.000 annually per hectare for the national economies of the developing countries that possess mangroves (UNEP 2014).

The economic potential of mangroves comes from three key sources: forestry products, estuary and littoral fishing and ecotourism. Mangroves also play a key role in the protection of coasts and the management of habitats for species that are threatened and critically endangered (FAO 1994). This means that in addition to the important ecosystem services provided to human beings, mangroves are key for the conservation of species that are threatened due to anthropogenic activities.

In addition to the benefits mentioned above, mangrove ecosystems are capable of storing about 1.000 tons of CO_2 per hectare in their biomass and subsoil. This fact makes of mangroves one of the richest ecosystems in terms of carbon

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in the planet. Consequently, the greenhouse gas emissions from mangrove deforestation are among the highest produced by land use changes in the tropics. Greenhouse gas emissions due to mangrove deforestation represent up to 1/5 of the global emissions produced by deforestation (UNEP 2014).

Despite its importance, mangroves are disappearing worldwide by 1–2% per year, a deforestation rate greater than tropical rainforests. It is estimated that nearly 35% of global mangrove forests no longer exist (World Wildlife Fund 2015). Losses are occurring in almost every country that has mangroves, especially in developing countries, where more than 90% of the world's mangroves are located. The economic cost of mangrove deforestation is US $42 billion per year (UNEP 2014). Fragmentation and deforestation put the long-term survival and essential ecosystem services of mangroves at great risk (Polidoro et al. 2010). Main drivers of mangrove loss are aquaculture (shrimp farming), coastal development and logging for timber and fuel production (Kavanagh 2014; Polidoro et al. 2010).

World catch of shrimp is about 3.4 million tons per year. China, together with four other Asian countries, accounts for 55% of the world catch. Globally, 40% of shrimp production comes from shrimp farming. Annual export of shrimps is currently worth more than US$10 billion, or 16% of all fishery exports (FAO 2015_1). Although it's a very important industry, shrimp fisheries are the major source of fisheries conflict and problems in the mangrove forests (Gillett 2008).

Mangroves are critically endangered and approaching extinction in 26 out of the countries having mangroves (Polidoro et al. 2010). Eleven of the 70 mangrove species (16%) are at elevated threat of extinction, particularly in the Atlantic and Pacific coasts of Central America, where as many as 40% of mangroves species present are threatened with extinction (Polidoro et al. 2010; Kavanagh 2014).

Ecuador is the smallest of the mega diverse countries in the world, and perhaps the most diverse of the planet according to the number of species per hectare. This amazing biodiversity is represented at the genetic, species and ecosystem level and is due to factors such as: its equatorial location, presence of the Andes and Coastal mountains, multiple climates and the circulation of ocean currents: the cold Humboldt current and the warmer El Niño current (García et al. 2015). Thus, in Ecuador exist 24 of the 27 globally recognized marine and coastal ecosystems.

Of the 13 globally recognized coastal ecosystems, 12 can be found in Ecuador, amongst this is the mangrove ecosystem (Hurtado-Domínguez et al. 2012; Ministerio del Ambiente and GIZ 2012; FAO 2012).

Of the South Pacific countries, Colombia has the largest area of mangrove forests with 370.000 ha (more than two-thirds are located in the Pacific) (CPPS et al. 2013). Ecuador has 161.835 ha of mangrove forests (Ministerio del Ambiente de Ecuador 2017_1) while Peru has around 6.000 ha of mangroves (CPPS et al. 2013). The mangrove surface related to country surface in Ecuador is 0.60%, followed by Colombia with 0.31% and Peru with 0.01% (Yáñez–Arancibia; Lara–Domínguez 1999).

Approximately, 39% of Ecuador's territory lies within 100 km of the coast. 58% of the Ecuadorian population lives in this area, and depends on the services provided by marine and coastal ecosystems, such as mangroves (FAO 2012; Terán et al. 2006).

In spite of the importance of this ecosystem, in Ecuador, in the late 1970s, mangroves were considered unproductive areas, leading to aggressive deforestation causing the loss of 27.7% of its coverage. In 2006, the mangrove land coverage was 147228.6 ha (Bravo 2013), an extension that increased by 14,067 ha in 2016, recovery attributed to reforestation and natural regeneration of mangrove forests (Ministerio del Ambiente de Ecuador 2017_1).

This chapter presents the historical and current situation of mangroves in Ecuador, their importance and main threats, and the conservation efforts taken to combat mangrove deforestation, including policies and regulations, the creation of protected natural areas and, upon request of ancestral communities[1] and traditional mangrove users,[2] the creation of the innovative conservation mechanism called: Sustainable Use and Custody Agreements of Mangrove Forests also called Mangrove Forest Concessions.

25.2 Mangrove Forests in Ecuador

25.2.1 Distribution and Coverage of Mangrove Forests

Located in the Eastern South Pacific, the coast of continental Ecuador has a length of about 2500 km (excluding the Galapagos Islands). Within 15 km from the coast there are 345 human settlements with a total population of 3,943,912 people, equivalent to 32.44% of Ecuador's population (Ministerio del Ambiente S.f.). Many of the coastal communities depend on marine and coastal resources for their livelihood (Ministerio del Ambiente and Conservación Internacional-Ecuador 2017). Fishing, aquaculture and coastal tourism are some of the main economic activities. (See Fig. 25.1)

[1] Ancestral communities are human groups that historically lived in a specific geographical area in which they have coexisted with their ecosystems, obtaining benefits from the natural resources for their subsistence (Ministerio del Ambiente de Ecuador 2017_1).

[2] Traditional users are human groups that over a long period of time have benefited of the natural resources of a specific geographical area for their subsistence (Ministerio del Ambiente de Ecuador 2017_1).

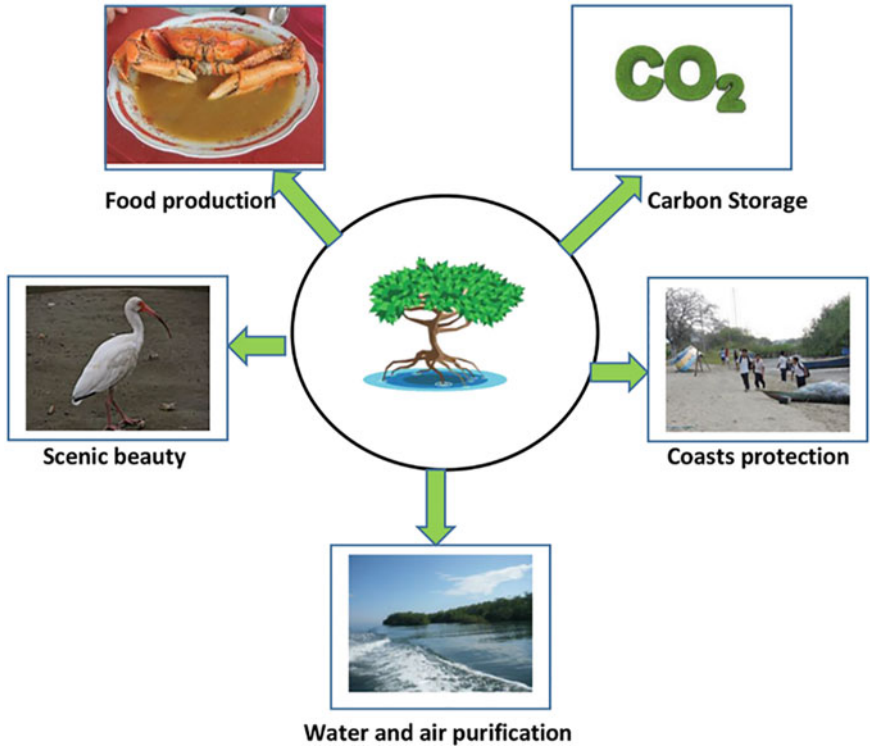

Fig. 25.1 Five key environmental services provided by mangrove forests. Mangroves help build and maintain the integrity of coastal areas, are highly productive and maintain a complex network of ecological interactions. They are the breeding grounds for a wide variety of fish, mollusks and crustaceans and a food source for many vertebrate and invertebrate species. It is estimated that at least two-thirds of edible species of fish need the mangrove to survive. In Ecuador, thousands of artisanal fishers depended on mangroves for generations onwards, for subsistence fishing, as well as a principal source of income. Ecuador determined the economic cost of the loss of environmental goods and services due to mangrove destruction and its restoration cost per hectare on USD 89,273.01 (Gobierno de la República del Ecuador 2011a, b; CPPS et al. 2015; Beitl 2010)

In Ecuador, mangrove forests are distributed along the coast from the province of Esmeraldas in the north of Ecuador to the province of El Oro in the south of the country (Quizhpe 2008).

In 1969, the surface covered by mangroves in Ecuador was 203.624 ha. According to the Center for Integrated Natural Resource Mapping by Remote Sensing et al. (2007), by 2006, this area had been reduced to 147.228,60 ha, that is a reduction of 56.395,9 ha or 27.7% of the mangrove present in 1969. Ecuador's Ministry of Environment, states that currently there are 161.835 ha of mangroves in the country. This increase in mangrove cover is likely to be a result of reforestation programs and natural regeneration (Ministerio del Ambiente de Ecuador 2017_1).

According to a study carried out by Center for Integrated Natural Resource Mapping by Remote Sensing et al. (2007), 99.8% of remaining mangroves are found in six key estuaries: Cayapas Mataje (21.400 ha), Muisne (1.558 ha), Cojimies (2.742 ha) and Chone (933 ha), all in the north of the country; and the Gulf of Guayaquil (105.130 ha) and the Jambelí Archipelago (15.208 ha) both in the south of the country. (See Fig. 25.2)

The Cojimies estuary (79.1%), the Chone estuary (76.5%) and the Jambelí Archipelago estuary (56.2%) have lost most of their mangrove coverage, caused mainly due to land use change related to shrimp farming and urban development (Bravo 2013). (See Table 25.1)

25.2.2 Flora of Mangrove Forests

Mangrove forests are mainly composed by the following mangrove species: *Rhizophora mangle, R. racemosa, R. x harrisonii, Laguncularia racemosa var. racemosa, L. racemosa var. Glabriflora y Avicennia germinans* (MAE and FAO 2014). A recent study by Cornejo (2014) recorded 179 species of vascular plants in the country's mangroves (Cornejo ed. 2014). The red mangrove (*Rhizophora mangle L.*) is the most abundant species found in Ecuador (Bravo 2013). (See Fig. 25.3)

25.2.3 Fauna of Mangrove Forests

Although the diversity of plant species in mangrove forests is relatively low compared to other ecosystems, the diversity of animals is much higher. In Ecuadorian mangroves there are 52 species of birds, 15 species of reptiles, 19 species of mammals, approximately 100 species of fish, 20 of crustaceans and 70 of mollusks. These animals can be found in this ecosystem primarily due to its importance as an area for shelter, food and / or reproduction (MAE and FAO, 2014).

Many of the animal species found in the mangroves, whether visitors or residents, are of food and commercial importance for nearby communities because of their nutritional value and abundance, among which we can

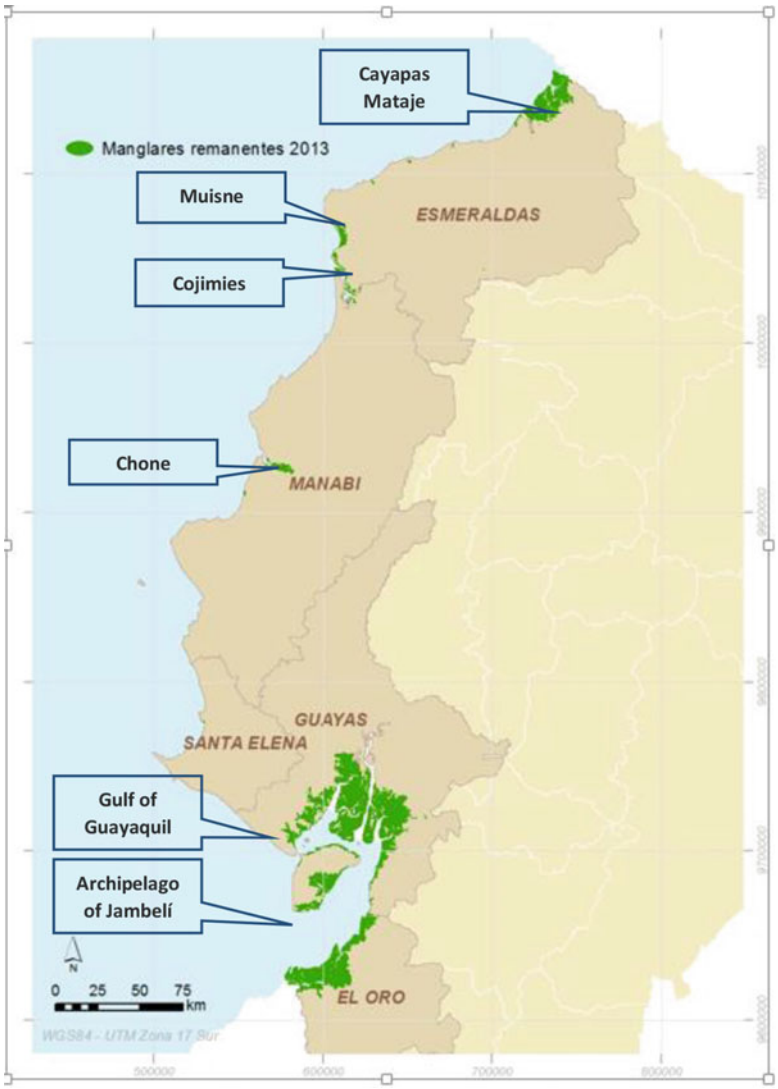

Fig. 25.2 Location of main mangrove areas of the continental territory of Ecuador. The Gulf of Guayaquil estuary is the largest area of mangrove forest (105,130 ha) followed by the Cayapas Mataje estuary with 21,400 ha and the Jambelí Archipelago estuary with 15,208 ha. The Chone estuary (933 ha) is the smallest of all (Center for Integrated Natural Resource Mapping by Remote Sensing et al. 2007). (Map: Conservacion Internacional-Ecuador 2016)

Table 25.1 Mangrove coverage in the five main estuaries of Ecuador

Estuary	1969	1984	1987	1991	1995	1999	2006	% of coverage loss (using data from 1969 and 2006)
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
Cojimíes	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
Golf of Guayaquil	124.320	119.277	115.784	109.608	102.108	104.715	105.130	15,4
Archipelago of Jambelí	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

The highest absolute annual deforestation rate occurred in the period from 1991 to 1995 (2.35% per year), and in the period from 1995 to1999 a mangrove recovery was observed. For the period from 1999 to 2006, the deforestation rate is 0.13% per year (Center for Integrated Natural Resource Mapping by Remote Sensing et al. 2007). On the contrary, in the decade from 2006 to 2016 there is again a mangrove recovery of 15,835 ha (Ministerio del Ambiente de Ecuador 2017[1])

mention the crabs *(Ucides occidentalis, Callinectes arcuatus, C. toxins)*, shrimp *(Litopenaeus stylirostris, L. vannamei),* black ark *(Anadara tuberculosa)*, mussels *(Mytella guyanensis)*, oysters *(Crassostrea columbiensis),* clams *(Protothaca sp., Chione subrugosa)* and dozens of fish species like Lily *(Mugil cephalus),* corvina *(Cynoscion albus),* sea bass *(Centropomus spp.)*, Snapper *(Lutjanus sp.)* etc. (Castellanos-Galindo et al. 2012).

Fig. 25.3 Roots of red mangrove (*Rhizophora mangle* L.) during low tide in the Costa Rica Island, Archipelago of Jambelí. This specie is characterized by its large stilt-like roots that accumulate sediments, making up the habitat of mollusks and crustaceans that play a key role in the local economy of nearby communities. This mangrove species developed physiological and anatomical adaptation strategies as a marked tolerance to high concentrations of salt and adaptations to deal with unstable soils. Due to its high resistance in saline environments, the red mangrove wood has been used in the construction sector as columns on docks and in the construction of houses. It is also used to make hammocks and crafts. The red mangrove is currently the most used mangrove species in reforestation programs in Ecuador (MAE and FAO 2014). Photo credit: Adrián Orihuela

Mangrove productivity, which is reflected by the presence, abundance and status of the populations of its species, is directly related to the extent, state and quality of conservation efforts of mangrove forests (Castellanos-Galindo et al. 2012; Bravo 2013).

Amongst the mangrove fauna in Ecuador, there is also a tiny species of mite *(Hattena rhizophorae*), a visitor to the flowers of the red mangrove. This species has been discovered in the country's mangroves in 2006, being its genus unknown to the American continent (Cornejo and González 2015).

The most relevant bird species found are the Magnificent Frigatebird (*Fregata magnificens*), Blue-footed booby (*Sula nebouxii*), Neotropic Cormorant (*Phalacrocorax brasilianus*), Brown Pelican (*Pelecanus occidentalis*), Black-crowned Night-Heron (*Nycticorax nycticorax*), Roseate Spoonbill (*Platalea ajaja*) amongst others. These bird species are attracted to mangroves due to the abundance of prey and nesting places. Only in the Jambeli Archipelago (El Oro province), 115 bird species have been recorded (A. Orijuela, personal communication, May 22, 2017). This number is relatively high given the previous high rates of mangrove deforestation of the 70s and the 80s. Due to this fact, Birdlife International has included the remaining mangrove forest of the Jambelí Archipelago among its 108 important bird areas (IBAs) in Ecuador (BirdLife International and Conservation International 2005) (Fig. 25.4).

Many of these bird species are abundant and can be easily seen perching and nesting on the mangroves or flying overhead making them an important ecotourism attraction (Bravo 2013).

In terms of reptiles, the once abundant American crocodile (*Crocodylus acutus*) is rarely seen in the mangroves of Ecuador. Green marine turtles (*Chelonia mydas*) are common in the Jambeli Archipelago. Similarly, researchers have been able to track Hawksbill (*Erytmochelys imbricata*) nesters and juveniles in the estuaries of the archipelago (García et al. 2015). This is very important reason for mangrove conservation given the endangered status of these marine turtle species.

Fig. 25.4 The Roseate Spoonbil (*Platalea ajaja*) is a very large pink colored bird with an unmistakable long flattened and spatulate beak. It measures from 71 to 79 cm and feeds on small fish and crustaceans. Photo credit: Adrián Orihuela

25.2.4 Threats to Mangrove Forest in Ecuador

Anthropogenic activities are the main drivers of mangrove destruction around the world. The destruction of mangroves is related to habitat destruction, over exploitation of resources, lack of urban planning, shrimp farming, cattle ranching, agriculture, aquaculture, urban solid waste, industrial pollution, pesticide and fertilizer pollution, oil spills, and alteration of hydrological conditions (Spalding et al. 2010). Anthropogenic activities substantially alter the composition, structure and function of mangroves reducing the ecosystem services these provide.

In Ecuador, changes in land use from mangroves to shrimp farms and urban development are the main factors of mangrove forest loss. Mangroves are increasingly threated by aquaculture activities and especially by shrimp farming. (See Fig. 25.5)

Although the shrimp industry is of great importance for the country, this industry is the principal cause of mangrove destruction in Ecuador. This activity encourages mangrove forest fragmentation and results in a reduction of goods and services provided by the mangrove ecosystem (Polidoro et al. 2010; Aschenbroich et al. 2015). In Ecuador, before the development of shrimp farms, the subsistence economy of coastal inhabitants was based on a traditional use of the mangrove ecosystem that included the extraction of mollusks and crustaceans and the production of vegetable coal (Latorre 2014).

After the startup of the first shrimp farms in the 1960's, the Ecuadorian government started to see mangroves as a source of economic development and promoted shrimp farming. This is how Ecuador became one of the major producers of farmed shrimp in the world, which caused a consequent loss of a significant area of mangrove forest.

According to Ecuador's National Chamber of Aquaculture, in 2015 there were 213,000 ha allocated to the production of shrimp, out of which 181,000 ha were originally mangrove ecosystems. There are around 3000 shrimp farms in Ecuador (Revista Líderes 2015). The Guayas province had the most shrimp farming activity with about 140,000 ha of shrimp pools and generating 66% of Ecuador's total shrimp production. The provinces of El Oro, Manabí, Esmeraldas and Santa Elena followed with 18%, 9%, 6% and 1% of Ecuador shrimp production respectively (Cámara Nacional de Acuacultura 2017).

In addition to the direct loss of mangrove forests during the construction of a shrimp farm, these also liberate effluents rich in organic and inorganic particles causing destruction to nearby mangroves due to contamination (Hurtado-Domínguez et al. 2012; FAO 2015_2).

The deforestation of mangroves in Ecuador coincides with the growth of the shrimp farming industry. Recent studies have shown that 80% of the loss of mangrove carbon in Ecuador is due to the direct displacement of mangroves by shrimp farms (Hamilton and Lovette 2015).

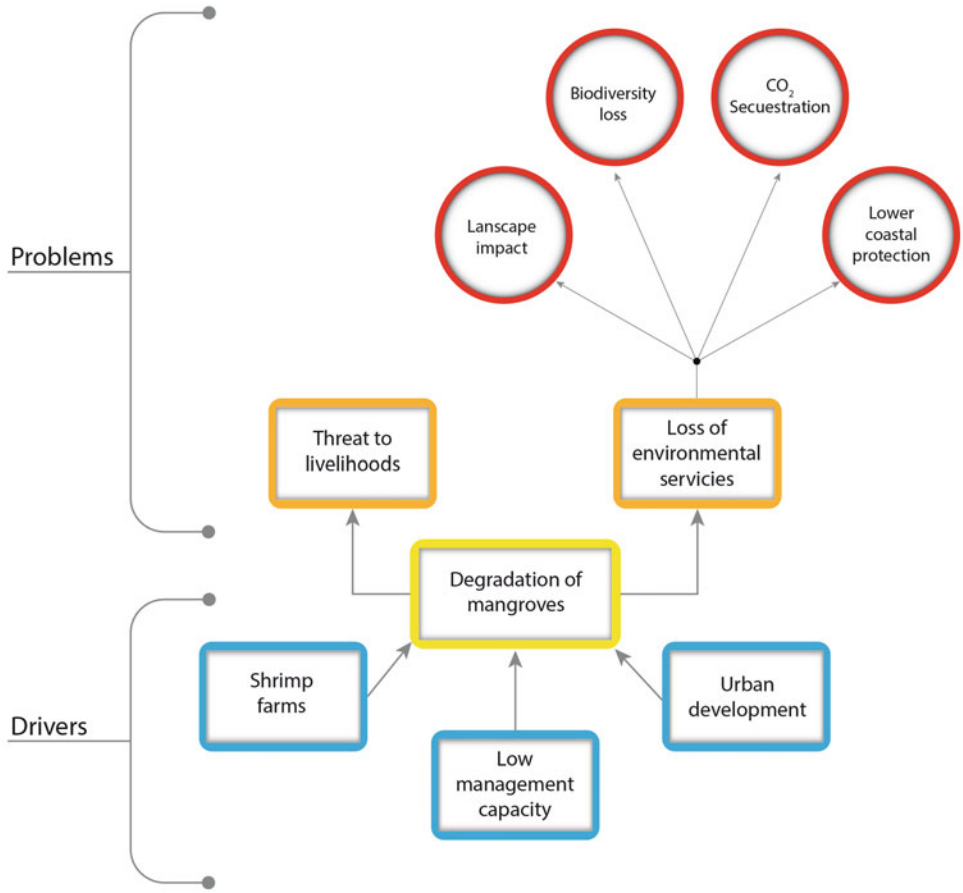

Fig. 25.5 Drivers of mangrove degradation in Ecuador. This generates a series of problems for the human being: the loss of food that is extracted directly from the mangrove s and the loss of environmental services provided by this ecosystem. Many cities on the Ecuadorian coast are located in areas that were mangrove areas in the past. In 1994 it was estimated that approximately 3000–5000 ha of mangrove forests have been destroyed by uncontrolled growth of cities (Guayaquil, Machala and Esmeraldas). Guayaquil, the country's largest city, is located in what was used to be a mangrove area (Spurrier 2012)

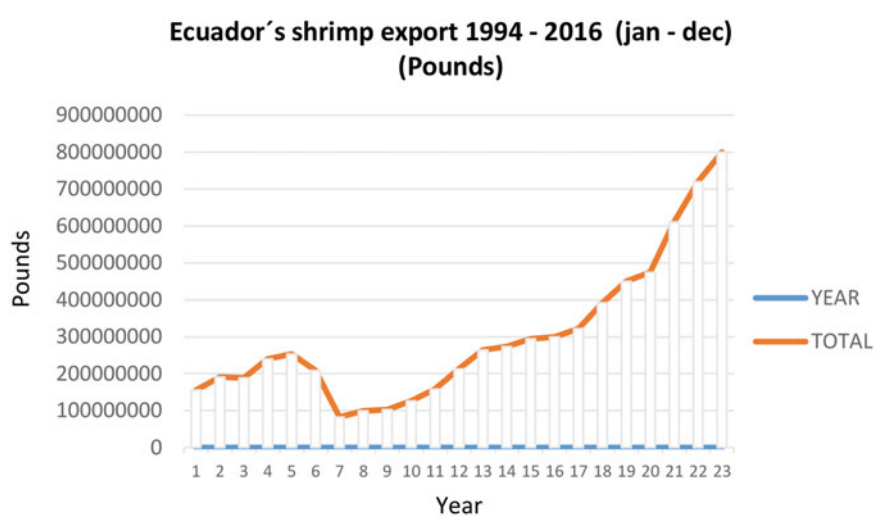

Fig. 25.6 Ecuador's shrimp export during the period 1994–2016. While in 1994, Ecuador exported 156 million pounds of shrimp equivalent to more than US $514 million, in 2016 the country exported close to 800 million pounds (US $2.5 billion), the highest amount of income since 1994 (Cámara Nacional de Acuacultura 2017)

25.2.5 Shrimp Farming in Ecuador

Ecuador is one of the major producers of shrimp around the world. The provinces with the most shrimp farming activity are Guayas, El Oro and Esmeraldas (IUCN and CI Ecuador 2016). In 2016, Ecuador sold close to US $2.5 billion of shrimps, 13% more than in 2015, making shrimp the second major non-petroleum export product according to Ecuador's Central Bank. According to Ecuador's National Chamber of Aquaculture, 20% of non-petroleum exports are generated by the shrimp industry. The growth of the shrimp industry has been progressive over the last 20 years (Cámara Nacional de Acuacultura 2017). (See Fig. 25.6)

The principal export market for Ecuadorian shrimps is the Asian continent, receiving 58% of its export volume in 2016 (and 61% in 2015). The United States and Africa were second with 19% each in 2016. It is estimated that the shrimp industry generates 180.000 direct and indirect jobs and that together with the fishing industry it makes up 5% of Ecuador's employment (Bernabé-Argandona 2016).

It is important to mention that the growth of the shrimp sector in Ecuador has been related to some illegitimacy issues. Even though, article 54 of Ecuador's Secondary Environmental Law (Texto Unificado de Legislación Ambiental Secundaria-TULAS), (Gobierno de la República del Ecuador 2003) states that: "*no government institution or entity will authorize the construction of new shrimp farm pools or the extension of existing shrimp farms located in the mangrove ecosystem and its buffer zone.*", many shrimp farms were built since this legislation entered into force in 2003. Ecuador's Aquaculture Sub-Secretariat (Subsecretaria de Acuacultura) estimated that in 2013, 66% (6.192 ha) of the shrimp farms in Esmeraldas province were illegal. Similarly, in El Oro, Manabí and Guayas provinces, illegal shrimp farms made up to 59% (8434 ha), 39% (12,576 ha), and 18% (17,437 ha) of the shrimp farming land respectively (Government of the Republic of Ecuador 2008).

The executive decrees No. 1391 (Government of the Republic of Ecuador 2008) and No. 852 (Government of the Republic of Ecuador 2016) describe the regulation of shrimp enterprises and establish that shrimp enterprises created after 1999 are illegal when they occupy areas that belong to the State or are located within protected areas. It also defines the maximum extension of shrimp concessions: for natural persons up to 250 ha and for legal persons up to 1000 ha. In these executive decrees the period of concessions was increased from 10 to 20 years, period

Fig. 25.7 Shrimp pond. The construction of shrimp farms has been directly linked to mangrove destruction, the main cause of the decline in the reproduction of mollusks and crustaceans (shell and crab). In addition, a study carried out by the UnderSecretariat of Marine and Coastal Management of the Ministry of Environment (MAE-SGMC) determined that in 4 out of 6 analyzed protected areas that belong to the National Protected Area System there were new shrimp farmers installed or old ones expanded their area after the date of the declaration of the protected area. On the other hand, and in compliance with Decree 1391, the MAE-SGMC, until October 2012, had approved 745 reforestation plans submitted by shrimp farmers. Most of these plans belonged to the province of El Oro (263) and Guayas (221) (Ministerio del Ambiente 2017_2). The Ministry of Environment estimate that between 2008 and 2017, 2614 ha of deforested mangroves where reforested. Photo credit: Javier Vásquez

Table 25.2 Evolution of the shrimp areas in the period of 1984–2006

	Year							
	1969	1984	1987	1991	1995	1999	2006	2016
Shrimp farms (ha)	0	89.368	117.728	145.998	178.071	175.253	175.748	210.000

The main expansion of the surface of shrimp pools in Ecuador occurred during the first two decades after its first introduction to the country. Since 1995 the expansion of this industry stabilized (Center for Integrated Natural Resource Mapping by Remote Sensing et al. 2007)

Table 25.3 Evolution of the mangrove area in the period 1969–2016

	Year								
	1969	1984	1987	1991	1995	1999	2000	2006	2016
Mangrove (ha)	203.695	182.157	175.157	162.186	146.938	149.556	127.690	148.230	161.835

Since the period 1995–1999 the negative deforestation rate changed into a situation of mangrove recovery of 0.23, becoming again negative for the period 1999–2006, with 0.025% per year (Fig. 25.8)

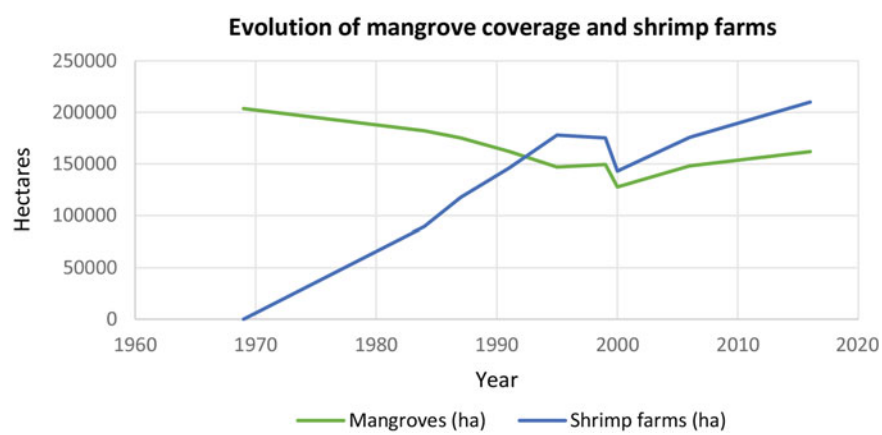

Fig. 25.8 Comparison of mangrove coverage (ha) and extension of shrimp farms (ha) between 1969 and 2016. Since 2006 the coverage of mangroves has remained relatively stable, while the area covered by shrimp farming has increased to 210,000 has. The main loss of mangrove coverage occurred between 1969 and 1995 (Center for Integrated Natural Resource Mapping by Remote Sensing et al. 2007)

that can be renewed, but obliges the concession holders to reforest mangrove forests being cut until 2015. In compliance with this regulation, between 2010 and 2012, 40 shrimp farms have been evicted adding up to 2495.86 ha of shrimp farms (Government of the Republic of Ecuador 2016) (Fig. 25.7).

In addition, the Ministry of Environment's resolution 056 establishes fines up to US$89,273 per hectare for cutting down mangroves (Gobierno de la República del Ecuador 2011a, b).

According to the Center for Integrated Natural Resource Mapping by Remote Sensing et (2007) the evolution of the surface of shrimp pools from 1984 to 2006 is as follows. (see Table 25.2):

25.2.6 Environmental and Socio-economic Impacts of Shrimp Farming in Ecuador

Despite the economic importance of the shrimp industry, it is the main cause of the destruction of the mangrove forest in Ecuador, and related to the reduction of ecosystem services of mangroves (Latorre 2014; Revista Líderes 2015) (Table 25.3).

Latorre (2014) indicate that in Ecuador, before the development of the shrimp farming industry, traditional uses (mainly collection of crab and shellfish, along with coal production) played an important role in the subsistence economy of the inhabitants living along the Ecuadorian coast. With the expansion of shrimp farming at the end of the 1960's, the situation changed, and mangrove areas were seen by the Ecuadorian State as a potential source of economic development through the promotion of the shrimp industry.

The destruction of mangroves and degradation of the associated biodiversity had multiple negative impacts on the communities and traditional users who benefited from resources and ecosystem services provided by mangroves. Increased effort is required to collect biodiversity species that provide food security and income to the local population. Unemployment rates increased amongst traditional mangrove users, losing their traditional work, as shell and crab collection (Bravo 2013). Mangrove conversion has caused the overexploitation of the mangrove cockle (*Anadara tuberculosa* and *A. similis*), a bivalve mollusk harvested from the roots of mangrove trees, locally known as concha prieta (Beitl 2010). Another social impact caused by mangrove deforestation are community displacement, the decrease of resource rights, the reorganization of local economies, increase in economic

Table 25.4 State managed protected areas with mangrove forests coverage

	Name of the protected areas	Month/year of creation	Total extension (ha)
1	Mangroves of Churute ecological reserve	July 1979	49,389
2	Cayapas Mataje ecological reserve	October 1995	51.300
3	Esmeraldas River wildlife refuge	June 2008	242
4	Mangroves Muisne River wildlife refuge	March 2003	3173
5	Islas Corazón y Fragatas wildlife refuge	October 2002	2811
6	Mangroves El Morro wildlife refuge	September 2007	10.030
7	Mangroves of El Salado Reserve for Fauna	November 2002	10,635
8	Isla Santay national recreation area	February 2010	2215
9	Arenillas ecological reserve	May 2001	13,170

Source: http://areasprotegidas.ambiente.gob.ec
These nine protected areas all belong to the *State managed natural protected areas system (PANE in Spanish),* one of the four subsystems that make up the *National System of Protected Areas* (SNAP). Mangrove areas under the Sustainable Use and Custody agreement have an important conservation role due to its close distance to natural protected areas of the SNAP, some are even located within the protected areas

Table 25.5 Distribution of mangroves according to their legal status

Mangrove distribution	Surface coverage (ha)	%	Source
Protected areas (SNAP) (2012)	73.071	46,5	Astudillo et al. (2014)
Mangrove concessions (2014)	65.933	42,0	SGMC
Mangrove forests without conservation status (to 2014)	18.020	11,5	Astudillo et al. (2014)
TOTAL	157.024	100	

Protected areas contain 73.071 ha of mangrove forests or 46.5% of the total existing mangrove forests in Ecuador. 42% of the mangrove forest is protected through sustainable use and custody agreements or mangrove concessions. The remaining 18.020 ha of mangroves are protected according to law, but are not covered by the national protected area system or mangrove concessions (see Table 25.5)

disparity and social conflict (Beitl 2010; C-CONDEM 2007; Martinez-Alier 2001; Stonich and Vandergeest 2001).

In addition to the direct loss of mangroves due to shrimp pool construction; shrimp farms also impact neighboring mangroves by releasing large quantities of effluents rich inorganic and inorganic particles and nutrients (Páez-Osuna 2001). Shrimp production in pools requires the use of antibiotics, in addition to fertilizers, pesticides and other chemicals for the treatment of water and soil, causing the indirect destruction of nearby mangroves due to water pollution by the above mentioned chemicals.

After leaving the shrimp farming activity the soil is unsuitable for any other productive activity due to soil salinization and soil contamination (Bravo 2013).

25.3 Mangrove Forest Conservation Efforts in Ecuador

25.3.1 Protected Areas

The first strategy to stop rapid loss of mangroves in Ecuador was the creation of protected areas. In 1979 the Manglares Churute Ecological Reserve was created, located north of the equator in the province of Esmeraldas, followed by the Cayapas Mataje Ecological Reserve in 1995.

Nowadays, Ecuador has 14 marine and coastal protected areas, together accounting for about 8% of all total coverage of protected areas in the country. Nine of these areas contain (total or partially) mangroves forest. (See Table 25.4)

25.3.2 The Mangrove Sustainable Use and Custody Agreements (Mangrove Forest Concessions)

The term "traditional or ancestral communities" is enshrined in the Constitution of the Republic of Ecuador. It recognizes the existence of indigenous peoples and Afro-Ecuadorians who define themselves as nationalities with ancestral roots, which are part of the Ecuadorian State. These are groups of people who live according to organizational traditions established prior to the emergence of the modern state (National Constituent Assembly 2008). The Unified Text of Secondary Environmental Legislation (TULAS), establishes that ". . . the ancestral communities may request to be granted the sustainable use of mangroves for subsistence, development and marketing of fish, mollusks and crustaceans, among other species, which grow in this habitat." Such requests of ancestral users and communities is agreed upon by a "Sustainable Use and Custody Agreements of the mangrove forest (Gobierno de la República del Ecuador 2003).

The idea of these "Sustainable Use and Custody Agreements for the of the mangrove forest" already emerged in 1994, due to recognizing the need to defend mangrove

forests from logging and the consequent loss of biodiversity associated with mangrove (Bravo 2013).

Formally, the "*Acuerdos para el Uso Sustentable y Custodia del Manglar* ¨ (In English: *Sustainable Use and Custody Agreements for mangrove forests),* also known as "Mangrove Forest Concessions", were introduced in 1999 in order to prevent the clearing of mangrove forests and to provide legal land use rights to ancestral communities and traditional users of the mangrove forests. They aim to promote community participation in the defense and conservation of the ecosystem and to maintain the traditional use of fish, mollusks and crustaceans by local communities. These agreements give ancestral communities and traditional users the exclusive use of mangrove resources for 10 years, in turn, they are requested to protect the ecosystem. Thereby, these agreements complement the national conservation strategies of the nine protected areas of Ecuador containing mangrove forests (Gobierno de la República del Ecuador 1999).

Already before various efforts had been made to stop the felling of mangrove forests, such as the modification of the *Forestry and Conservation of Natural Areas and Wildlife Law* in 1990, through which it was legislated that: "mangroves, even those existing in particular properties, are considered State property and cannot be, they are not susceptible to possession or any other means of appropriation and may only be exploited by concession.

To establish the regulatory framework for the *Sustainable Use and Custody Agreements* for mangrove forests the following executive decrees and ministerial agreements were emitted.

Executive decrees and ministerial agreements

Executive Decree No. 1102.

Released in 1999, gave ancestral communities the right to apply for concessions for the sustainable use and custody of mangrove areas. This Executive Decree was revoked in 2002, and included as a chapter on mangroves in the Unified Text of Secondary Environmental Legislation of Ecuador (Coello et al. 2008).

Ministerial Agreement No. 172.

Issued in 2000, this agreement established the instructions for the granting of agreements of sustainable use and custody of mangroves, and started the issuing of concessions of mangrove forests to the ancestral communities and traditional users settled along the coastal line (Coello et al. 2008).

Ministerial Agreement No. 024.

Through this agreement in 2009, the Sub-Secretary for Marine and Coastal Management (of the Ministry of Environment), was given the responsibility to issue and monitor the Agreements of mangroves use to ancestral communities and traditional users (Coello et al. 2008).

Ministerial Agreement No. 129.

This agreement issued in 2010, specified and detailed the instructions for conceding the agreements of sustainable use and custody of mangroves in favor of ancestral communities and traditional users (Coello et al. 2008).

Ministerial Agreement No. 144.

This Agreement, issued in 2011 reformed the Ministerial agreement No. 129. It particularly addresses the minimum content of the Management Plans of the Mangrove Concessions (Coello et al. 2008).

Ministerial Agreement No. 198.

This agreement, issued in 2014, specified instructions for a governmental incentive to ancestral communities and traditional users for the conservation and sustainable use of mangroves, named Mangrove Partner (Socio Manglar), which seeks to contribute to the consolidation of mangrove areas to which concessions have been issued (Coello et al. 2008).

Socio Manglar (Mangrove Partner)

This program provides a direct economic incentive to organizations that hold agreements for sustainable use and custody of mangroves. The amount of the incentive depends on the area of the concession and is aimed at strengthening local organizations through supporting the implementation of their mangrove management plans. The incentive is set up for 10 years, it supports the development of the following activities:

- Control and Monitoring
- Administrative Management
- Technical Assistance for the implementation, monitoring and/or evaluation of management plans.
- Organizational strengthening.
- Financing of productive and social projects, that benefit partners.

The amount of the economic incentive depends on the area of the concession and is transferred in two installments per year. The amount is calculated according to the following table:

Categoría	Rango de Has en Acuerdo	Incentivo Fijo Anual
1	100 a 500 has	$7.000 USD
2	501 a 1.000 has	$10.000 USD
3	Mayor a 1.000 has	$15.000 USD
Más un incentivo variable de $3USD/Ha		

By 2017, 24 associations with more than 23,000 ha of mangrove are receiving funds from Socio Manglar.

Outline of Requirements for Sustainable Use and Custody Agreements

The concession of a certain area of mangroves can be issued to ancestral communities and traditional users, organized in legally constituted cooperatives or association registered by the Sub-Secretary for Marine and Coastal Management, to whom they have to present a Management Plan. The Ministerial Agreement No. 144 (Gobierno de la República del Ecuador 2011a, b) defines the minimum content of these

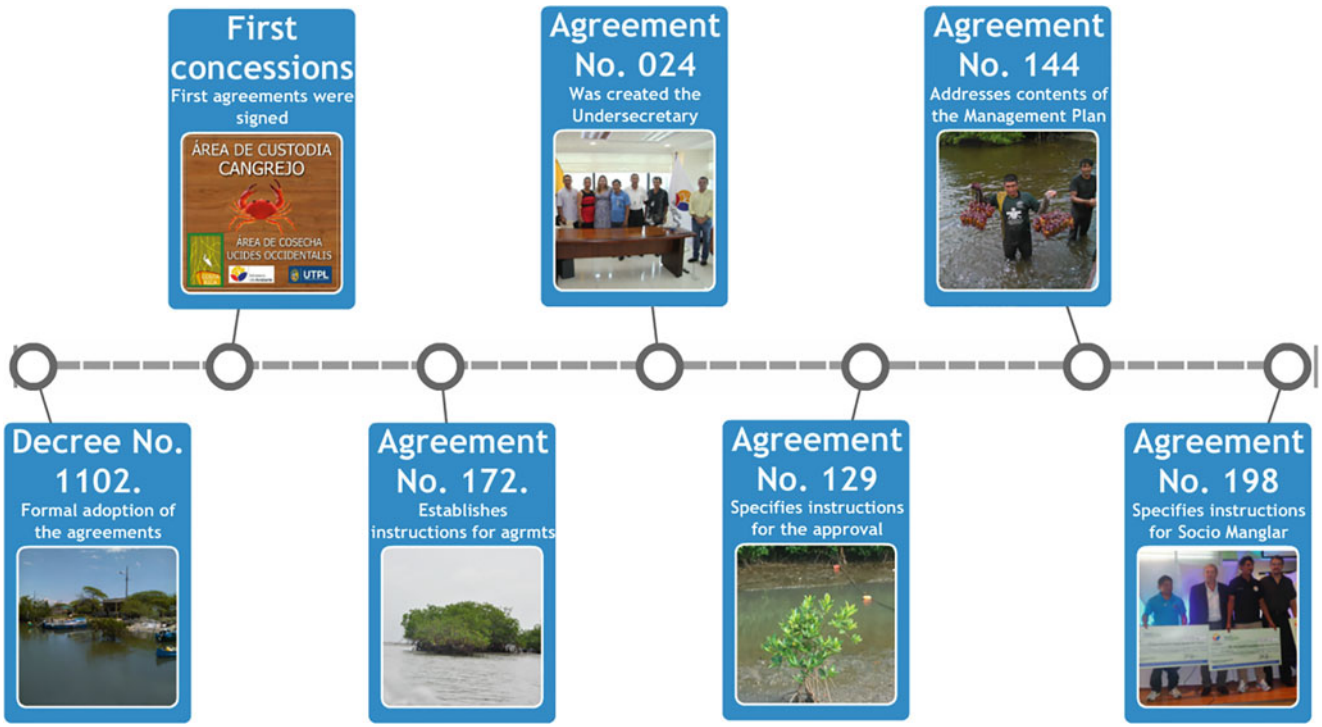

Fig. 25.9 Even though, sustainable use and custody agreements of mangrove forests were established from 1999, it was from the beginning of the decade of the 90s that social organizations and NGOs began promoting the issuance of mangrove areas in favor of ancestral and traditional users. The last stage of the policy framework for community mangrove conservation consisting in the Mangrove Partner Incentive sets the beginning of the consolidation of mangrove concessions

Management Plan. The Plan should contain three programs: Sustainable Use or Resources, Control and Surveillance and Monitoring and Evaluation. These programs have to contain activities and well defined indicators.

The application must be accompanied by a technical assistance agreement with a university, research institute, NGO or governmental institution.

The activities permitted in the area of the custody agreement correspond only to sustainable activities and non-destructive use of the mangrove areas: Catching of fishes and invertebrates; Aquaculture of fish, invertebrates, mammals, reptiles or other species of native wildlife through practices that do not affect the coverage of mangroves or the dynamics of the water bodies; mangrove reforestation; eco-tourism and non-destructive mangrove recreation activities, education and scientific research.

From 2000 to 2015, 66 agreements for sustainable use and custody of mangroves had been issued to fishermen's organizations allocated in 5 coastal provinces: El Oro, Guayas, Santa Elena, Manabí and Esmeraldas. By 2017, 47 Associations have mangrove concessions with a total of 59.208 ha (Ministerio del Ambiente de Ecuador 2017$_1$). (See Fig. 25.9)

Evaluation of Use and Custody Agreements

In 2008, the Ministry of Environment, CI and IUCN, performed an evaluation of 27 of the existing sustainable use and custody agreements of mangrove forest, during which 27 management plans were assessed. This evaluation indicated that in general terms, the planned activities of the management plans were implemented successfully. While there were organizations that achieved 100% compliance with the implementation of the management plans there were others that have failed to comply all activities. The most relevant conclusions of this evaluation were: mangrove agreements are a positive tool for the conservation of mangroves and have served as a legal instrument to guarantee ancestral mangrove users exclusive access to these areas, generated social and economic benefits and improved living conditions; contributed significantly to stop the felling of mangrove. On the other hand, control and monitoring have been the most difficult tasks as well as the administration of areas. Technical assistance provided by NGOs, universities, among others was a very important support (Coello et al. 2008).

25.3.3 Other Legislation for Related to Mangrove Conservation

Until the end of the 70s, mangroves were considered unproductive areas by the Ecuadorian government, without representing economic benefit for the country. As a result, concessions for using the beach and mangrove forests to

establish shrimp farms were emitted, due to the production value generated by this activity, causing the destruction and felling of large areas of mangrove. From the 1980s onwards, the recognition of the importance of mangrove forests to society led to the development of mechanisms for conservation and protection of mangroves, being included in the Constitution of Ecuador.

Several laws, executive decrees and ministerial agreements have incorporated elements related to the protection and conservation of the mangrove. Among the most important are:

Constitution of the Republic of Ecuador (2008)

Article 405 states that in the areas of the National System of Protected Areas (SNAP), the State will promote the "Participation of communities, peoples and nationalities that have traditionally inhabited areas protected in their administration and management". While article 406, mentions that the State shall regulate the conservation, management and sustainable use, recovery, and domain limitations of the fragile and threatened ecosystems; among which is the mangrove.

National Plan for Good Living (2013)

This plan refers to the mangrove in different sections. It is commanded to strengthen the conservation and sustainable use of biodiversity, it will recognize, respect and promote knowledge and ancestral knowledge, innovations, and sustainable traditional practices of communities, peoples and nationalities with their full and effective participation (Gobierno de la República del Ecuador 2013).

Environmental Organic Code (2017)

Several articles of this Code mention the importance of the knowledge of the communities of their ancestors and the priority to conserve fragile ecosystems such as mangroves. Furthermore, it emphasizes that the conservation of mangroves and other fragile ecosystems it in the public interest as well as the establishment of areas of custody and sustainable use of mangrove and the creation of economic incentives for the conservation of fragile ecosystems (Government of the Republic of Ecuador. 2017).

Ramsar Convention

The Ramsar Convention is an intergovernmental Treaty adopted on 2 February 1971, signed in Ramsar, Iran; it serves as the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. Ecuador is one of the 168 Contracting Parties to this Convention, and entered into force in Ecuador on January 7, 1991. Ecuador currently has 18 sites designated as wetlands of international importance (Ramsar sites), with an area of 290,815 hectares. Five of these Ramsar Sites have some percentage of mangrove cover (Echeverría 2008).

25.4 Case Study: Mangrove Concessions at Costa Rica Island

25.4.1 Archipelago of Jambelí

The archipelago of Jambelí is located at the southern end of the Ecuadorian coast, in waters of the Gulf of Guayaquil. It belongs to the canton of Santa Rosa, province of El Oro. It has an approximate area of 41,706 ha. The archipelago of Jambelí is comprised of five island communities: Bellavista, Costa Rica, Las Huacas, Las Casitas and Pongalillo. (See Fig. 25.10)

In the province of El Oro, until 2016, there were 26 mangrove agreements for sustainable use and custody of the mangroves, which cover an area of approximately 8328 ha, equivalent to more than 55% of the extent of mangrove in the province of El Oro. By 2017, there are 21 agreements with an extension of 11.318 ha (75,45%). From the point of view of conservation, the

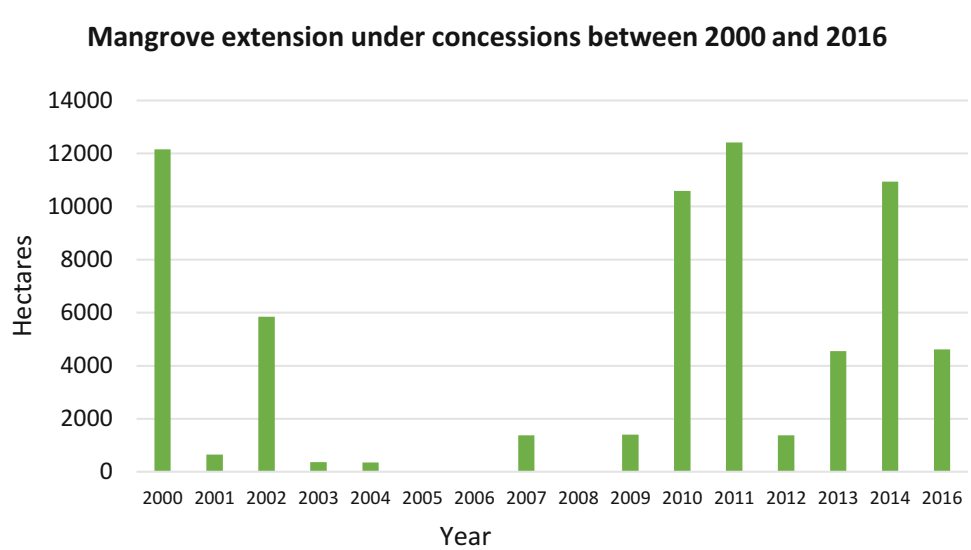

Fig. 25.10 Mangrove extension under concessions between 2000 and 2016. The periods between 2000–2002 and 2010–2014 recorded the highest number of agreements signed with beneficiaries mainly from El Oro and Guayas provinces (Ministerio del Ambiente de Ecuador. 2017[1])

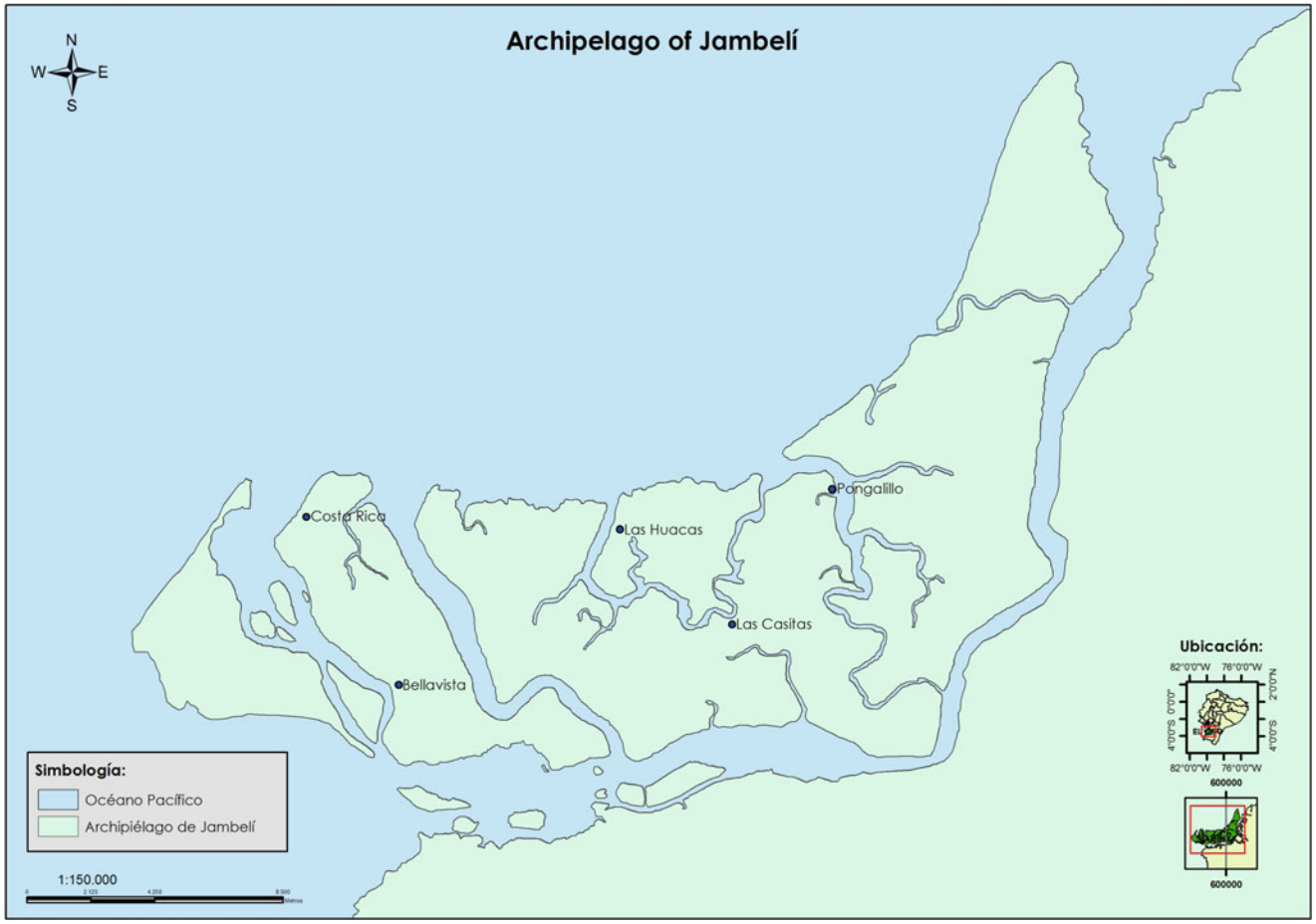

Fig. 25.11 The five islands of the archipelago of Jambelí, through their grassroots organizations made up of fishermen, black ark collectors ("concheros") and red crab collectors ("cangrejeros"), have been awarded mangrove concessions, since the same year that these were put into effect (2000). The concessions include more than 2.300 ha of mangrove forest (Gobierno Provincial Autónomo El Oro and Fundación Ecológica Arcoiris 2013)

area of mangroves protected through these agreements in this province is very important as the Arenillas Ecological Reserve, a State managed protected area, contains only 1.266 ha of mangrove forest (7.41% of the total area of the reserve).

The mangroves at the Archipelago of Jambelí are one of the mangrove ecosystems most impacted by human activity in Ecuador. The current landscape that can be seen in this area is a mosaic of shrimp farms, patches of mangrove forest, networks of canals and estuaries, settlements of small towns and the scene of traditional activities such as fishing and collecting of shells and crabs (Bravo 2010). (See Fig. 25.11)

The Island Costa Rica

Costa Rica is the urban capital of the rural Jambelí Parish, belonging to the Santa Rosa municipality, and the province of El Oro. Costa Rica has an approximate population of 86 families, with 165 men and 175 women. Its inhabitants collect shells and crabs, or work in the fishing and tourism sector.

25.4.2 The Management of the Mangrove Concession

The mangrove concession was granted to the Costa Rica Artisanal Fishermen Association (In Spanish: Asociación de Pescadores Artesanales y Afines "Costa Rica") on August 16, 2000 with an extension of 519 ha (Gobierno Provincial Autónomo El Oro and Fundación Ecológica Arcoiris 2013). The agreement of the Association was renewed in July, 2016, with the same extension. (See Figs. 25.12 and 25.13)

This Association has developed a successful management model which is based on four key activities (Fig. 25.14):

(a) *Sustainable harvesting of back ark*

The Costa Rica Association, as part of its management plan, promotes the sustainable use of the black ark (*Anadara tuberculosa*). They respect the minimum size for extraction

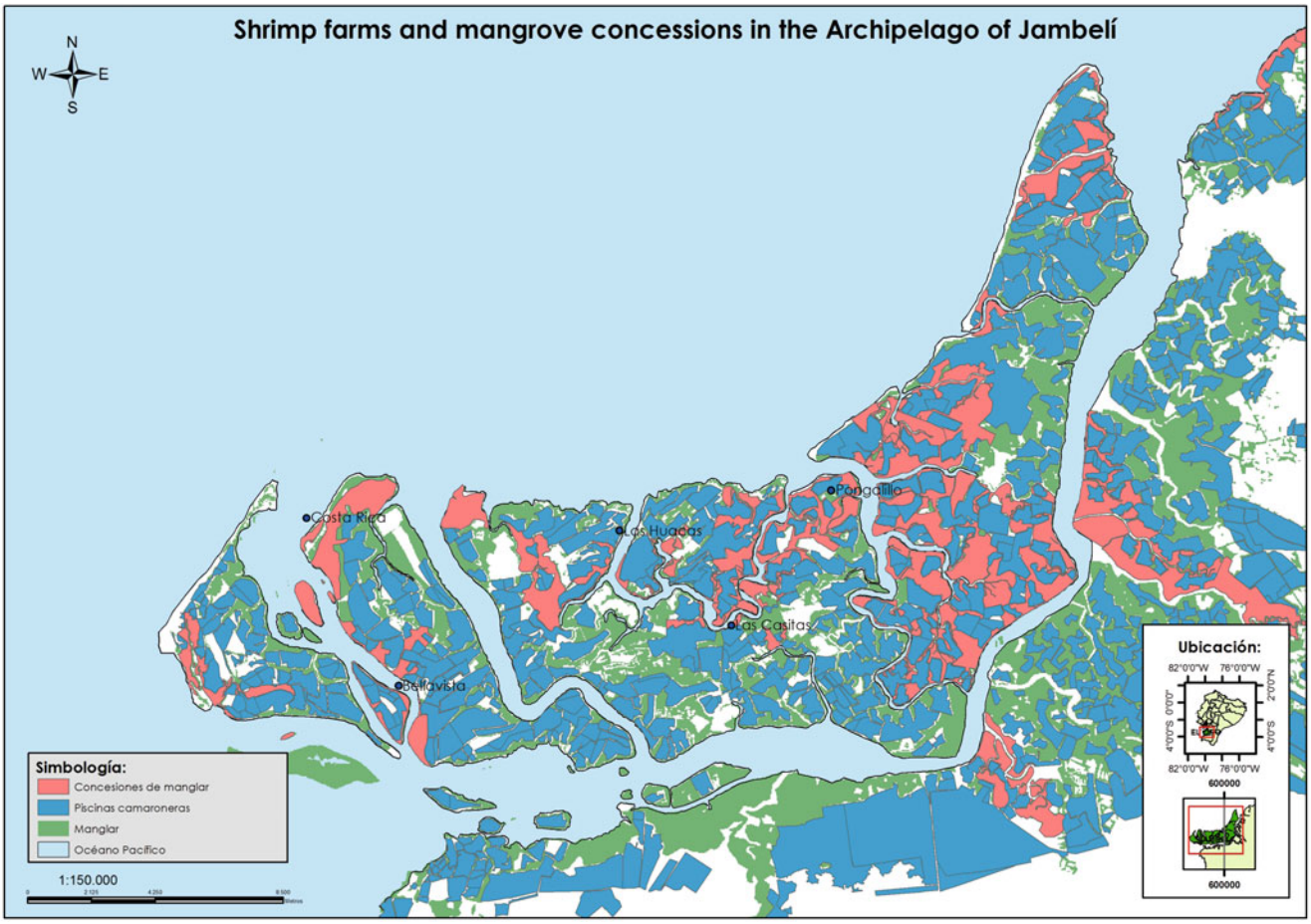

Fig. 25.12 Shrimp pools and concessions of mangrove forest in the Archipelago of Jambelí. The shrimp industry occupies most of the mangrove forest territory of this area. According to the Cámara Nacional de Acuacultura-National Chamber of Aquaculture (2017), El Oro is the second province dedicated to the production of shrimp, with more than 30,000 ha, i.e. 15% of the 210.000 ha of shrimp farms that currently exist in Ecuador. This activity was developed even in protected areas such as the Arenillas Ecological Reserve, where 500 ha of shrimp farms were identified

and commercialization, being 4,5 cm as regulated by the Ministry of Agriculture, cattle raising, aquaculture and fisheries (Gobierno de la República del Ecuador 2008). The Costa Rica Association gathers approximately 3000 shells per day, at an average of 100 shells by each partner of the association (Total of 30 currently active partners). There are five main collection sites mentioned below, which are harvested in a period of 10 days:

- **Encenada or Chupador**. A day of collection
- **Chalet**. Two days of collection
- **Los Chanchos**. Four days of collection
- **Diluvio**. Four days of collection
- **Costa Rica (in front of the town)**. Two days of collection

During the last two decades, the black ark has begun to show signs of overexploitation throughout the Ecuadorian coast. The smaller sizes and fewer catches indicate signs of stress (Beitl 2010) (Fig. 25.15).

(b) *Reforestation*

Although there is little area available for reforestation, the association reforested all spaces without vegetation within their area, which accounts to 55 ha approximately since the beginning of the concession.

(c) *Custody of the area*

The area is patrolled almost every day. The association organized patrol groups formed by two members of the association. The treat that limits the continuity of this activity is the lack of resources for fuel and the piracy danger.

(d) *Ecotourism*

The Costa Rica Association has a Committee of Ecotourism, which currently is promoting this activity on the island. A pristine beach, known as San Gregorio, is located very close to

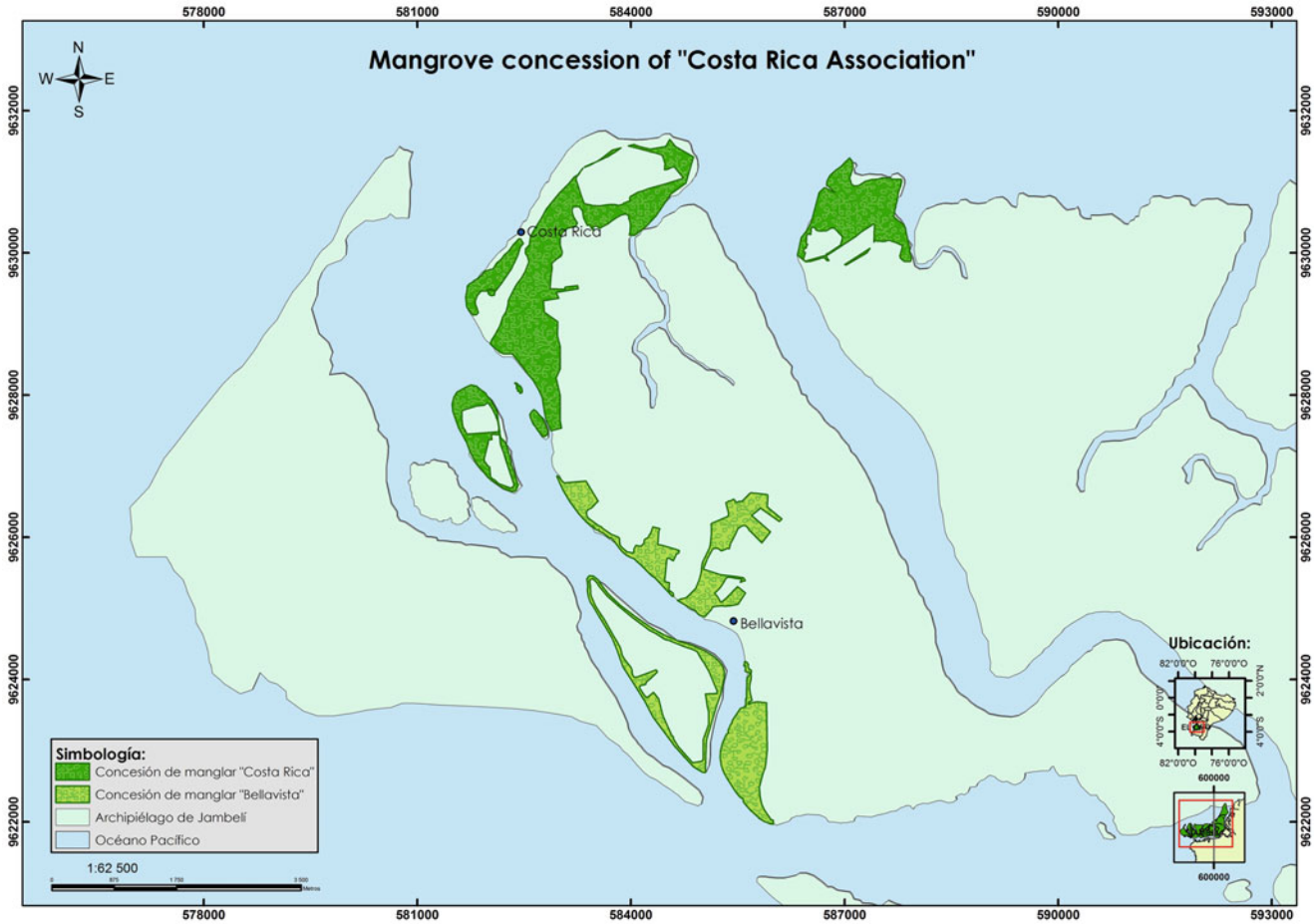

Fig. 25.13 Map of the mangrove concession "Costa Rica". The agreement expired in 2010 but it was renewed in July 2016 by the Sub-Secretary of Marine and Coastal Management after updating the management plan. The area of the Costa Rica Association is close to the area of the Bellavista Association a very important aspect for the biological connectivity

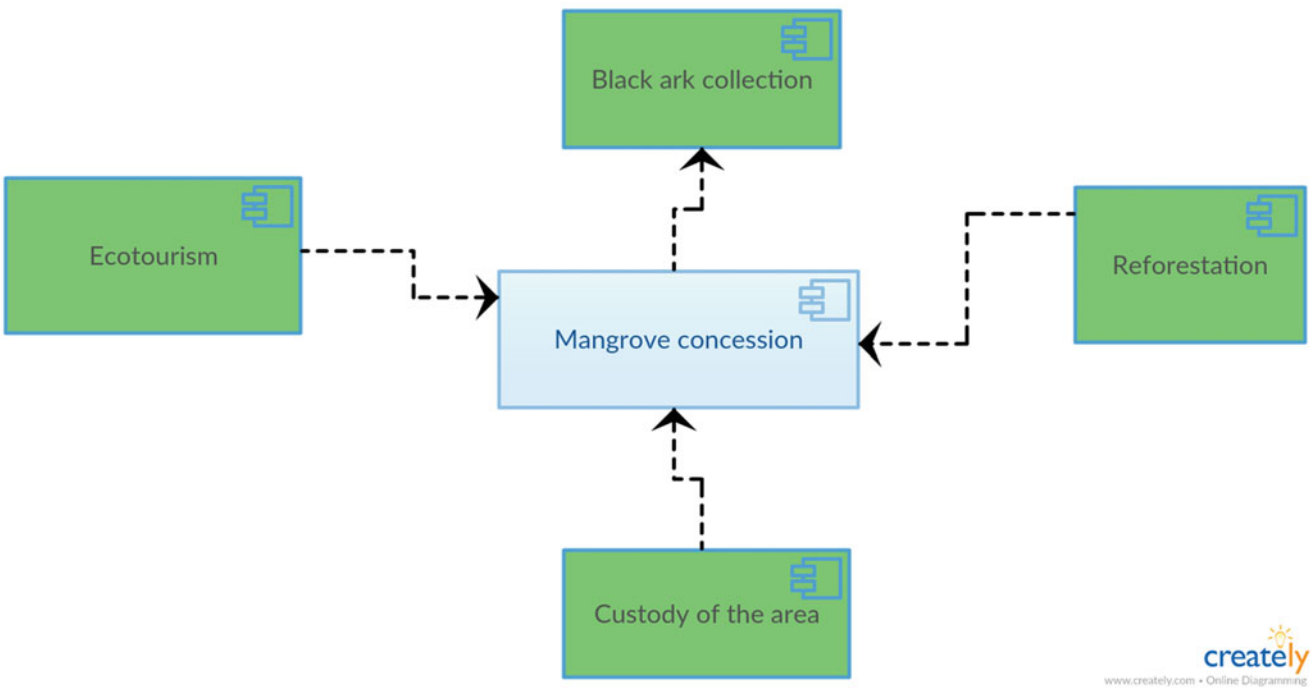

Fig. 25.14 The management model of the area mangrove concession of the Costa Rica Association. The Association of Costa Rica is one of the first organizations that received a mangrove concession. Originally it received technical and economic support from the Fundación Ecológica Arcoiris (Rainbow Foundation) and the UNDP – GEF Small Grants Program to implement activities such as reforestation, reproduction of black ark in captivity, ecotourism, among others

Fig. 25.15 Black Ark (*Anadara tuberculosa*). This species lives in the mangrove sludge (associated with the roots of *Rhizophora mangle*), buried from the root zone up to about 5 cm deep, or on soft bottoms between 15 and 50 cm deep (IMARPE n.d.). This mangrove resource has suffered a significant decrease in numbers due to the deterioration of the mangrove forests and overexploitation. The National Fisheries Institute-INP (2017) estimates that around 25'000.000 shells are extracted annually by about 3.000 fishermen, although at present they collect 50% less than previous years. C-CONDEM estimates that at present each fisherman is able to collect 100 shells per day unlike previous years when they collected up to 1000. There is a permanent prohibition to collect shells up to 4.5 cm, established by law. To reach this size, the shell requires between 12 and 18 months, period in which it has reproduced at least once. At this rate of collection it is estimated that in 10 years this species might disappear since more than 50% of the collected shells do not meet the minimus size of 4.5 cm (in the province of El Oro is estimated at 59%) (Instituto Nacional de Pesca 2017). Photo credit: Javier Vásquez

the urban population. Besides the beach, bird watching and local gastronomy of the island are the main tourism attractions, receiving more and more visitors day by day.

25.4.3 State of Mangrove Forest Conservation of the Island Costa Rica

In order to determine the state of conservation of mangrove forest under the concession, multi-temporal analysis were implemented in 1991, 2000, 2013 and 2014, which took into consideration a 1 kilomenter buffer zone.

The main land use coverage's identified by this study include: mangrove, deforested areas and shrimp ponds; the coverage related to sea and sand banks were not analyzed as they were not considered relevant according to the mangrove concession system. (See Fig. 25.16)

Mangrove deforestation had a peak during the first year of the mangrove concession (2000) due to the deforestation caused mainly by shrimp farms, accounting up to 394.19 ha which represents a 13% of the analyzed extension; the deforestation rate reduced to 176.53 ha (5%) in 2013, but the following year it raised to 6% 182.19 ha.

The area covered by shrimp pools in the zone increased from 1991 to 2013, from 176 ha to 467 ha which accounts a 15,4% of the analyzed area. During 2014 a small reduction of shrimp pools was observed 463 ha (15,2%). See Tables 25.6 and 25.7

The data presented suggests that the main cause of mangroves forest loss during the last few decades is a result of deforestation due to the construction of shrimp-culture pools. Aschenbroich et al. (2015) states that mangroves are increasingly threatened by aquaculture development especially shrimp-culture fostering through this practice the fragmentation of the ecosystem, and consequently the reduction of goods and services it offers.

25.5 The Future of Mangrove Concessions in Ecuador

The economic, social and environmental importance of the areas under Sustainable use and custody agreements of mangrove forests is receiving recognition by governmental authorities, which is reflected in the political, technical and financial support. The Mangrove Partner program (Socio Manglar) for instance allowed the direct assignation of economic resources to beneficiaries of mangrove concessions during 10 years to support the management of areas, allowing a long term management model. At the moment, not all concession holders are participating in the programme, as funding is limited, hopefully in coming years all communities with concessions can enter in the programme, so that by having financial means for control activities their mangrove management can be improved.

Another fundamental aspect in mangrove long term conservation is put all mangrove forest under the direct involvement of local associations by providing new concessions or increase the areas of existing concessions, since it represent to them a legal framework to safeguard their food security and a source of stable economic income.

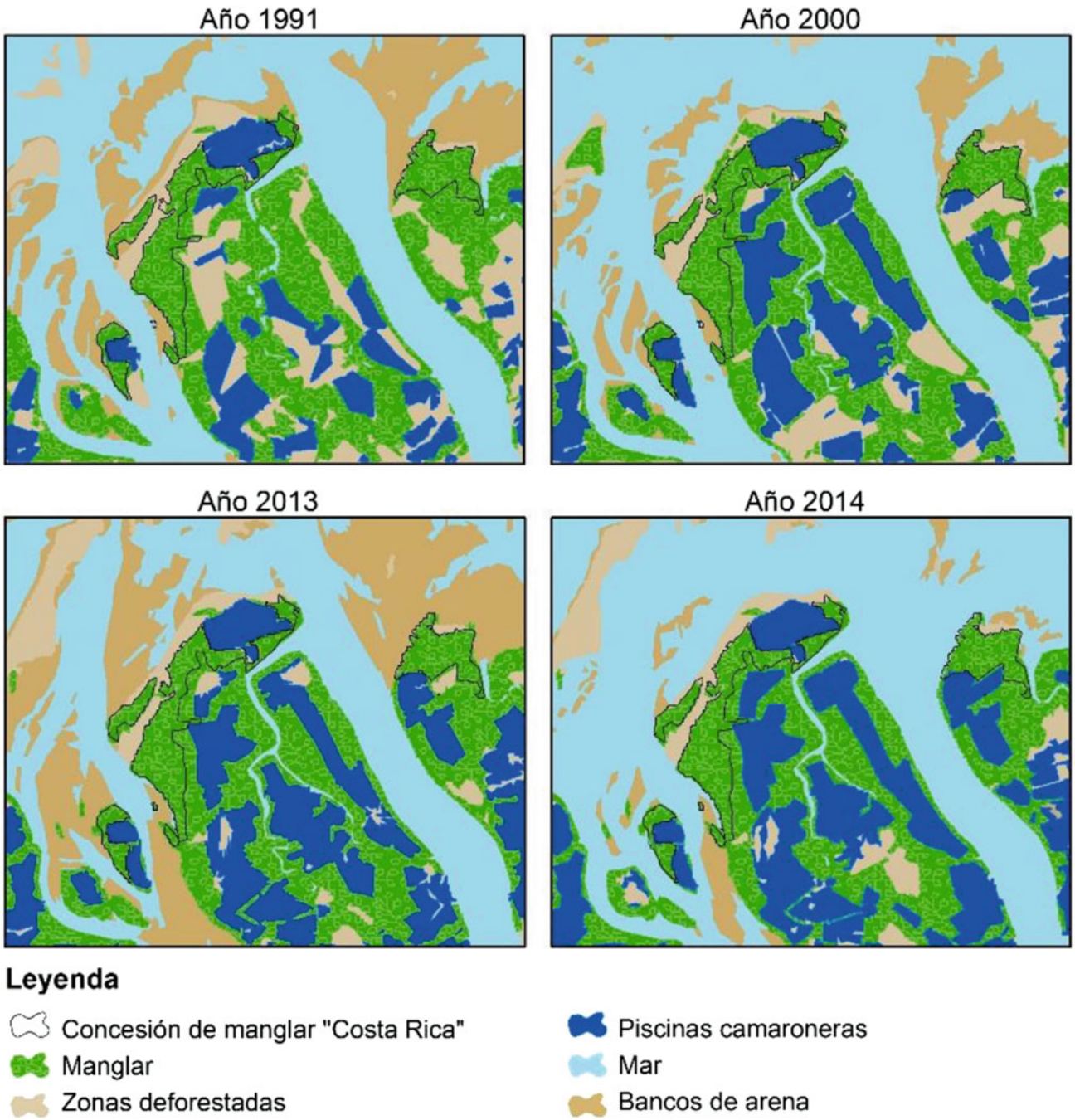

Fig. 25.16 Land use change in the Costa Rica Island. Images show the beginning of land use change due to mangrove deforestation by shrimp farms construction between 1991 to 2014

Even though there are persistent conflicts with shrimp farmers, there are recent examples of collaboration between shrimp farmers businesses and community associations, like joint control and surveillance activities, reforestation of degraded areas amongst other, which bring up important success factors for long term conservation of community mangrove areas. Include mangrove contamination into this dialogues, and search together for innovative measures to reduce water pollution is desired to guarantee the conservation of flora and fauna of the mangrove forests.

On the other hand, some associations or concessionaries show weaknesses related to the management of their mangrove areas, for instance, related to a good organizational structure and competences related to technical aspects, particularly related to monitoring and evaluation of the area under concession. Therefore, the agreements that are signed

Table 25.6 Surface in hectares of the different land uses on the Costa Rica Island considering 1 kilometer buffer zone

	1991		2000		2013		2014	
Land use extensions	Ha	%	Ha	%	ha	%	Ha	%
Mangrove	880.07	29.02	798.39	26.33	823.19	27.15	808.84	26.67
Deforested areas	394.19	13.00	242.76	8.00	176.53	5.82	182.19	6.00
Shrimp pools	176.21	5.81	413.82	13.64	467.02	15.40	463.02	15.27
Sea	1025.52	33.82	1208.49	39.85	785.77	25.91	1416.58	46.72
Sand banks	555.85	18.33	368.38	12.15	779.33	25.70	161.21	5.31
TOTAL	3031.86	100	3031.86	100	3031.86	100	3031.86	100

The mangrove coverage in 1991, of approximately 880 ha was reduced to 798,39 ha (26%) by 2000; later during 2013 and 2014 mangrove coverage changed from 823.19 ha (27%) to 808,84 (26%), respectively

Table 25.7 Analysis of the mangrove cover change rate

Period	Surface (ha) Year 1	%	Surface(ha) Year 2	%	Change Rate
1991–2000	880.07	29.02	798.39	26.33	−1.08
2000–2013	798.39	26.33	823.19	27.15	0.23
2013–2014	823.19	27.15	808.84	26.67	−1.75

The quantitative analysis of the data above, shows the surface occupied by mangrove coverage in periods: 1991–2000, 2000–2013 and 2013–2014. The deforestation and reforestation values are represented by the negative/positive sign respectively.The data shows a loss of mangroves in the period 1991–2000, a period in which there was a high increase in deforestation, corresponding to 81,68 has; whereas in the period 2000–2013 there was an increase in the mangrove coverage. The mangrove coverage increased partly due to reforestation of some areas, carried out by the Rainbow Foundation (Fundación Arcoiris in Spanish) jointly with community members of Costa Rica Island, which corresponds to 24.8 has. Moreover, in the last period a loss of mangroves was identified corresponding to 14.34 ha. This information might be related to having insufficient data available in comparison with earlier periods

should be supported by technical cooperation agreements with a university or non-governmental organization (NGO), which contributes to overcome these weaknesses. In this aspect, it is important to mention the support at organizational level that the Union Network of Organizations of Artisanal Fishery Production (Red Unión de Organizaciones de Producción Pesquera Artesanal de El Oro – UOPPAO) provides to most of concessionaries that are affiliated to this network.

Income diversification is another important aspect in which associations are working. It includes activities such as ecotourism and direct commercialization of red crab (*Ucides occidentalis*) and black ark (*Anadara similis* y *Anadara tuberculosa)* pulps, without intermediaries, as well as give added value to their product like crab pulp.

Recently (2017) conflicts arised between independent collectors (no legalized) pirates and mangrove concessionaries, however conflict solving meetings are taking place to find solutions to these problems.

25.6 Conclusions

In Ecuador, mangroves are protected by different strategies: national protected areas, mangrove concessions and by environmental law all mangroves, being fragile ecosystems are declared protected forests (by executive decree) although the latter have not been formally created (they do not contain management plans for example).

By the mangrove concessions strategy, through providing land rights, communities are involved in protecting 40% of the Ecuadorian mangroves against deforestation. Their control activities have proven to be effective. Therefore the Mangrove Agreements strategy is considered of great importance for the future of this ecosystem in Ecuador.

In the province of El Oro, 11,300 ha of mangroves are in the hands of ancestral communities and traditional users, which is equivalent to 75% of the mangrove that exists in this province. In contrast, only 08% of this ecosystem is within the Arenillas Ecological Reserve, an area that belongs to the National System of Protected Areas, therefore the Concessions strategy being of great importance in the El Oro Province.

Multi-temporal analysis of the forest cover in the mangroves of the Costa Rica Association and other areas showed that the main changes over time have been mainly due to the development of the shrimp industry. There is however evidence of mangrove recovery as an indicator of the effective functioning of the areas under community custody.

In the El Oro Province, mangrove deforestation has been reduced almost entirely in the areas covered by concessions, but contamination from shrimp farming has not been tackled by the concession strategy. Water pollution affects the flora and fauna of this ecosystem and alternative strategies should be implemented to reduce mangrove degradation due to contamination.

Although traditionally the relationship between shrimp farmers and mangrove concessionaires in the province of El Oro has been marked by conflicts, in recent years there has

been an improvement in relations between these two groups, therefor government institutions, communities with mangrove concessions, shrimp farmers and other supporting actors like Universities might, through dialogue find solutions to water pollution.

Although all mangrove concessions have important biological information, it is necessary to define basic indicators to design and implement a monitoring program that ensures scientific evidence for the positive impacts of mangrove conservation on flora and fauna, and define whether contamination impacts mangrove biodiversity.

The incentive of the Mangrove Partner Programme, has a positive impact on the management of the Mangrove concessions, providing financial means for buying equipment (boats, motor, etc.), as well as fuel for the control operations in the Mangrove to prevent invasive fisherman, detect mangrove deforestation and contamination activities etc. The Mangrove Partner Programme, also has a positive impact on the management of the Mangrove as it provides financial means for organizational strengthening. The mangrove concession of Costa Rica Association, for being a community protected area without funding from the Mangrove Partner Programme, has much less funds for its management, causing that the financial sustainability is one of the main weaknesses to exercise good management of the area.

The mangrove forests have several resources and attractions that could be used to develop ecotourism projects. However technical resources, transportation basic infrastructure, and improvement of the client service are still needed. Greater involvement of public and private institutions is required, to help strengthen social cohesion and promote community-based tourism, also the community requires inputs and resources required to strengthen them.

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