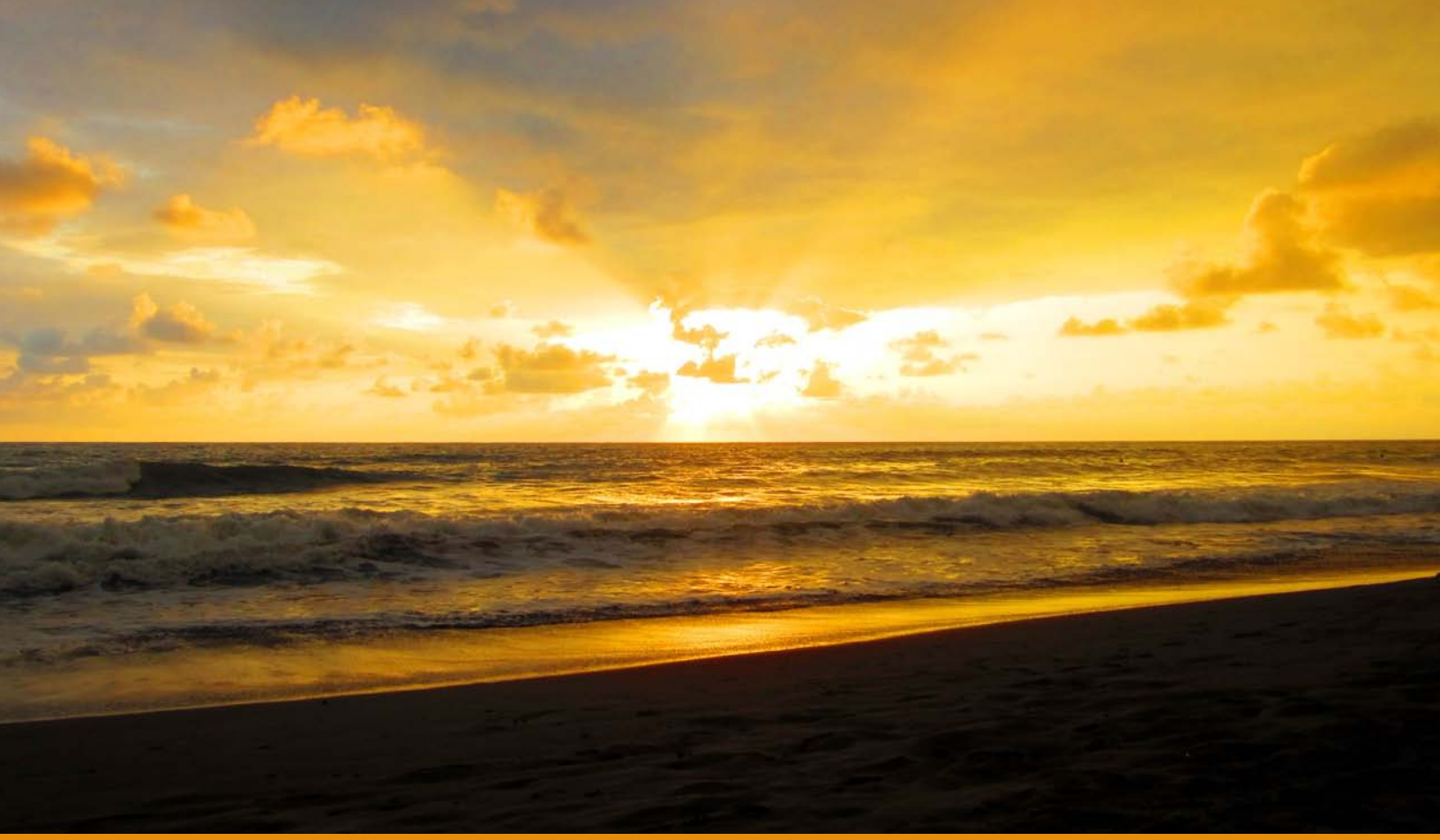

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Human dimension of the marine ecosystems of the Osa and Golfito Region

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August, 2014

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TABLE OF CONTENTS

ACRONYMS ..... **V**

OSA AND GOLFITO INITIATIVE OVERVIEW ..... **VII**

WHAT IS INOGO VII

THE INOGO STUDY REGION IX

EXECUTIVE SUMMARY **1**

CHAPTER 1. BIOLOGICAL FEATURES **2**

1.1. DESCRIPTION OF THE BIOGEOGRAPHY 2

1.2 HABITATS AND BIODIVERSITY 3

I. The Golfo Dulce: the only tropical fjord with an anoxic bottom *4*

II. Mangroves of the Golfo Dulce *5*

III. Coral reefs and coral communities of the Golfo Dulce and the Caño Island Biological Reserve *6*

IV. Térraba-Sierpe National Wetland: the largest mangrove estuary in the country and its biodiversity *7*

V. Wildlife aggregations *8*

Whale and dolphin aggregations 8

Sea Turtles 9

Nesting sites 10

Whale Shark aggregations, and other sharks and rays 11

VI. Human communities in the Osa and Golfito Region *11*

A general overview of the region's demography 11

CHAPTER 2. THE HUMAN DIMENSION **14**

2.1 MARINE ECOSYSTEM SERVICES AND HUMAN WELLBEING 14

I. Communities Livelihoods based on marine assets in the Osa and Golfito Region *17*

Tourism and recreation 17

Recreational fishing 18

Small scale fisheries 19

Cockle harvesting 22

II. Coastal communities characterization *23*

2.2 MARINE ASSETS GOVERNANCE AND STAKEHOLDER PARTICIPATION 28

I. Governance of the marine territory *28*

Marine Responsible Fishery Area 32

Terrestrial Maritime Zone (Zona Maritimo Terrestre, ZMT) 33

Marine Protected Areas 34

II. Citizen Stakeholders of the Osa and Golfito marine region *38*

III. Stakeholders Network and Linkages *44*

CHAPTER 3. MARINE ECOSYSTEMS HEALTH AND THE WELLBEING OF COASTAL COMMUNITIES: CHALLENGE AND THREATS **47**

3.1 LAND USE CHANGES AND DOWNSTREAM EFFECTS: A LONG STANDING THREAT IN THE OSA AND GOLFITO REGION 47

I. The Térraba-Sierpe National Wetland *48*

II. The Golfo Dulce *49*

3.2 UNSUSTAINABLE FISHERIES 52

I. Shrimp fisheries *52*

II. Large scale fisheries: the case of tuna fishing *53*

The case of tuna farm project 54

III. Shark finning *55*

3.3 CLIMATE CHANGE AND ITS CONSEQUENCES FOR THE REGION OF STUDY 56
I. The Warming Events: El Nino Southern Oscillation *56*
3.4 EMERGING THREATS 58
I. The Diquís Hydroelectric Project *58*
II. Crocodile Bay Marina Project *59*
The Crocodile Bay Marina, as described by Crocodile Bay representatives 60
The opposition to the Crocodile Bay Marina 60
Comparative analysis of opportunities and threats 63
CONCLUSIONS **66**
REFERENCES **69**

Tables

Table 1. Description of Costa Rica's South Pacific Ecological Units. 3
Table 2. Demography of the cantons of Osa and Golfito 12
Table 3. Coastal Communities Characterization. 24
Table 4. Allowed fishing fleets in the Golfo Dulce Marine Responsible Fishing Area. 33
Table 5. Comparison of Costa Rica's Marine Management Categories. 36
Table 6. Groups working in the coastal region of Osa and Golfito. 38
Table 7. Entities that provide support services for local stakeholder development. 41
Table 8. Stakeholders' main roles in the social networks of the South Pacific. 46
Table 9. Opportunities and Threats of the Crocodile Bay Marina Project. 64

Figures

Figure 1. Products of the Osa and Golfito Initiative's Phase 1. viii
Figure 2. Boundaries of the territory covered by the Osa and Golfito Initiative, INOGO. ix
Figure 3. Patrimonial maritime extension of Costa Rica. 2
Figure 4. Golfo Dulce trophic flux representation. 5
Figure 5. GPS points for rainy season sea turtle sightings.. 8
Figure 6. A) Percentage of population benefited by economic activity. B) Geographical distribution of the main socio-economic activities in the South Pacific.. 13
Figure 7. Beneficiaries of the Osa and Golfito marine ecosystem services. 15
Figure 8. Hierarchy of relations of Costa Rican environmental law. 29
Figure 9. Institutions with greatest involvement in management and use of marine resources. 30
Figure 10. Location of Costa Rica's EEZ.. 31
Figure 11. Institutional and social stakeholders linkages in the South Pacific AMUM. 44

ACRONYMS

ACOSA	Área de Conservación Osa / Osa Conservation Area
AMPR	Área Marina de Pesca Responsable / Marine Area for Responsible Fisheries
AMUM	Área Marina de Uso Múltiple / Marine Area for Multiple Uses
ATPC	Asociación Turística de Pesca Costarricense / Costa Rican Tourist Fishing Association
BID	Banco Interamericano de Desarrollo / Inter American Development Bank
CCAD	Comisión Centroamericana de Ambiente y Desarrollo / Central American Environmental Commission
CGR	Contraloría General de la República / Comptroller General's Office
CIMAR	Centro de Investigación en Ciencias del Mar / Marine Research Center
CIMAT	Comisión Institucional de Marinas y Atracaderos Turísticos / National Marina Authority
CNE	Comisión Nacional de Emergencias / National Emergencies Commision
COLAC	Consejo Local del Área de Conservación / Local Council for a Protected Area
CONAC	Consejo Nacional de Áreas de Conservación / National Conservation Areas Council
CORAC	Consejo Regional de Áreas de Conservación / Regional Council for a Conservation Area
ENOS	El Niño Oscilación del Sur
FAO	Food and Agriculture Organization
FECOP	Federación Costarricense de Pesca / Costa Rican Fisheries Federation
FENOPEA	Federación Nacional de Pescadores Artesanales y Afines / National Artisanal Fishermen Federation
HNTS	Humedal Nacional Térraba-Sierpe / Terraba-Sierpe National Wetland
ICE	Instituto Costarricense de Electricidad / Costa Rican Electrical Company
ICT	Instituto Costarricense de Turismo / Costa Rican Tourism Board
IDA	Instituto de Desarrollo Agrario / National Institute for Agrarian Development (now INDER)
IICE	Instituto de Investigaciones en Ciencias Económicas / Research Institute on Economic Sciences
IMN	Instituto Meteorológico Nacional / National Metheorology Institute
INCOPESCA	Instituto Nacional de Pesca y Acuacultura / National Fisheries and Aquaculture Institute
INDER	Instituto Nacional de Desarrollo Rural / National Institute for Rural Development
MIDEPLAN	Ministerio de Planificación Nacional y Política Económica / Ministry of Planning and Economic Policy
MINAE	Ministerio de Ambiente y Energía / Ministry of the Environment and Energy
MOPT	Ministerio de Obras Públicas y Transporte / Ministry of Public Works and Transportation

MPA	Marine Protected Area
PNC	Parque Nacional Corcovado / Corcovado National Park
PNMB	Parque Nacional Marino Ballena / Marino Ballena National Park
PNPB	Parque Nacional Piedras Blancas / Piedras Blancas National Park
PNUD	Programa de las Naciones Unidas para el Desarrollo / United Nations Development Programme
RBIC	Reserva Biológica Isla del Caño / Caño Island Biological Reserve
SETENA	Secretaría Técnica Nacional / National Environmental Technical Secretary
SICA	Sistema de Integración Centroamericana / Central American Integration System
SINAC	Sistema Nacional de Áreas de Conservación / National System of Conservation Areas
SNG	Servicio Nacional de Guardacostas / Coast Guard
TAA	Tribunal Ambiental Administrativo / Environmental Administrative Court
ZEE	Zona Económica Exclusiva / Exclusive Economic Zone
ZMT	Zona Maritimo Terrestre / Maritime Terrestrial Zone

Osa and Golfito Initiative Overview

What is INOGO

The Osa and Golfito Initiative, "INOGO", is an international collaborative effort to develop strategies for sustainable human development and environmental stewardship in the Osa and Golfito Cantons of Costa Rica. The effort's core is a collaboration between people and institutions in the US and Costa Rica, facilitated by the Stanford Woods Institute for the Environment at Stanford University.

INOGO is designed to build on the many previous efforts in the region, working hand in hand with Costa Ricans in local communities, in the public and private sector, and with NGOs to create shared visions and long-term strategies for a sustainable future for Osa and Golfito. The project integrates the social, cultural, and economic dimensions of the region with both its marine and terrestrial ecosystems.

In addition to producing new studies and reports, the goal of this initiative is to generate a living process for sustainable development led by Costa Ricans, especially the people from Osa and Golfito. It also aims to provide information and products that will be useful to stakeholders in the region for their ongoing decision-making processes. We envision a two-phase trajectory for INOGO, Phase 1: Development of a Strategies for Action, and Phase 2: Socialization and Implementation.

Phase 1 of INOGO features four key components for the study region:

- Synthetic Analyses, written to pull together and interpret existing information, plus fill a few holes, and thus create a baseline for future work;
- Case Studies to address timely issues, where it was clear that local actors needed more information to advocate for community and environmental wellbeing;
- Interactive Co-development with stakeholders of scenarios depicting possible alternative futures, a process which in itself has value as it gives leaders the space to think about long-term goals alongside potential collaborators
- Design of strategic pathways towards sustainable development.

The full INOGO process is described in a document titled "The Osa and Golfito Initiative, INOGO: Building a shared dream".

Listening and consulting with stakeholders

An important goal of the INOGO process is to maintain an inclusive, participatory process that engages actors at the local, regional, and national levels. Throughout the initiative, INOGO has been working to make sure that the local communities' concerns, aspirations and needs are heard, in particular those relevant for a more positive future, where families have a chance to improve their quality of life in healthy social and natural surroundings.

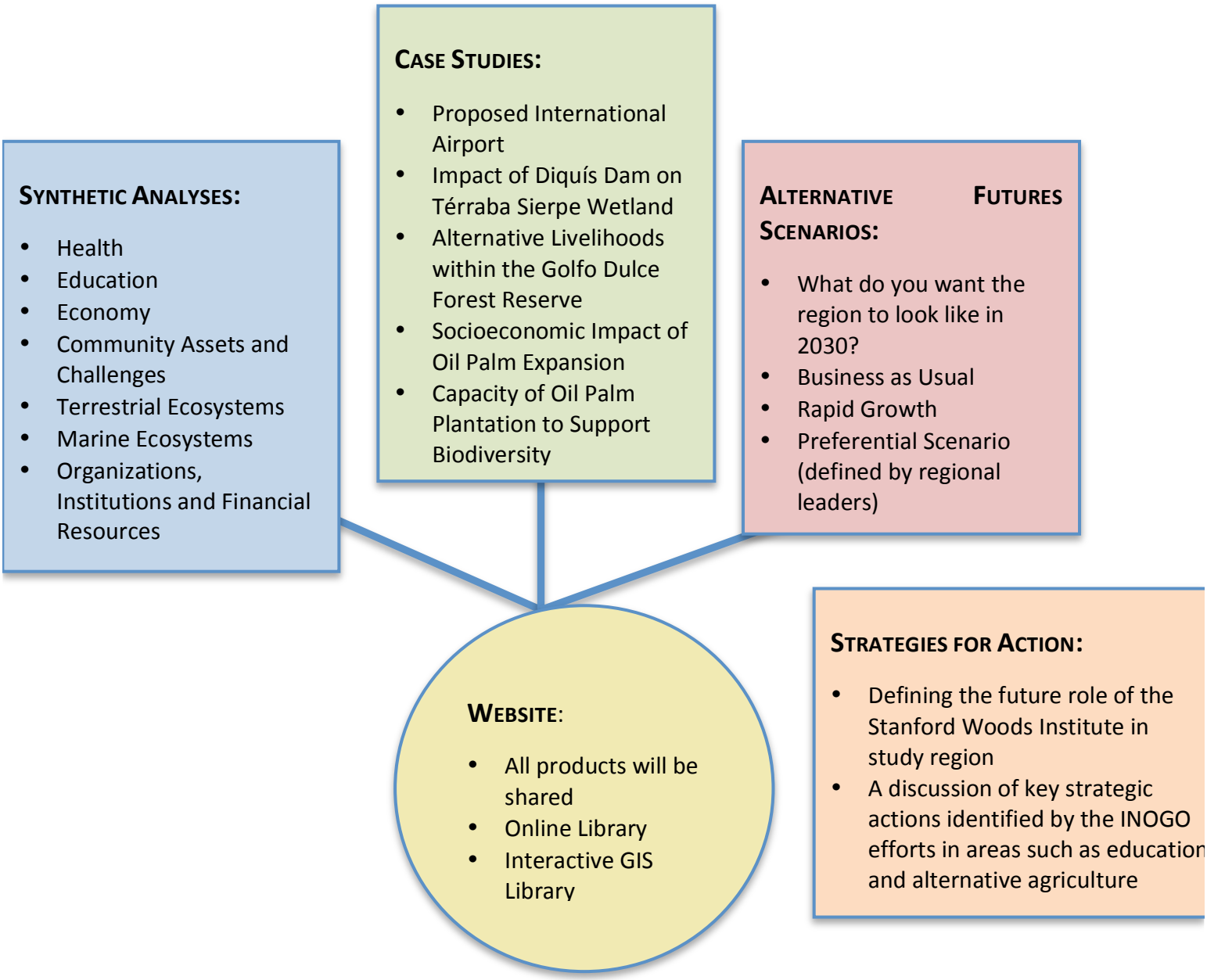


Figure 1. Products of the Osa and Golfito Initiative's Phase 1.

The INOGO Study Region

The study region of the Osa and Golfito Initiative was defined by ecological boundaries, plus the Pan-American Highway. Initially it was considered a focus on the Osa Peninsula, but reflected that the Golfo Dulce logically needed to be included because of its importance to both human and natural processes in the region. Once the Golfo Dulce was included, it became logical to include surrounding communities and as much of its watershed as we could.

These ecologically based boundaries include parts of the cantons of Osa and Golfito, and even include portions of some districts. While this provided a significant challenge in some data collection and analysis, it is recognized that all boundaries have their own challenges. The following map thus shows the initial boundaries of INOGO: as a living process it is anticipated that these boundaries may change over time.

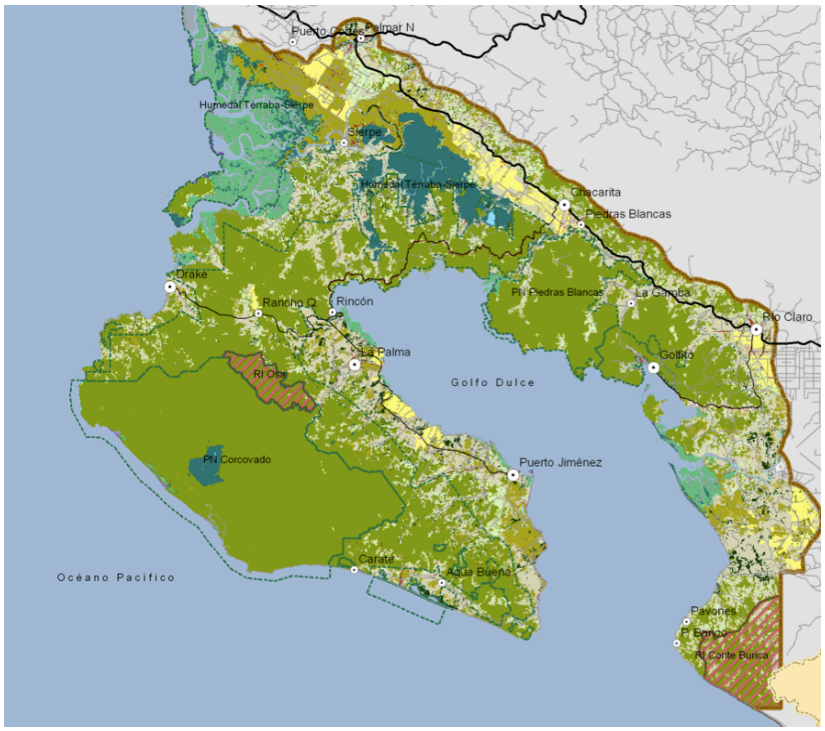


Figure 2. Boundaries of the territory covered by the Osa and Golfito Initiative, INOGO.

EXECUTIVE SUMMARY

The marine ecosystems of the Osa and Golfito Region provide high biological diversity and a flow of ecosystem services upon which traditional and emerging uses depend. The area is relatively lightly populated, but previous land use and resource use practices have shifted these ecosystems into a compromised state, which from a water quality and marine resources perspective are far less productive than they might be under different future planning scenarios. The region has been subject of extensive study, but remains threatened by fragmented approaches to development and lack of good data to link landscape development to impacts downstream in important productive marine ecosystems. New studies that link land use to hydrology and downstream impacts seem critically necessary. These ecosystems vary in terms of the level of degradation and stress they have already endured, so fully understanding impacts of human activities prior to expanding development is key. Large-scale landscape changes that alter hydrology and pollutant loading could have significant impacts on marine ecosystems and the ecological services they provide. Given the level of dependence on these services by local communities, development should proceed with solid plans to assess its impacts and to make adjustments adaptively to sustain services. The local governmental and non-governmental organizations provide a solid foundation on which to build this adaptive management framework.

Chapter 1. BIOLOGICAL FEATURES

1.1. Description of the Biogeography

Although Costa Rica is a relatively small country (land mass: 51,100 km^2), its marine area, including Territorial Seas and Exclusive Economic Zones (EEZ) is over ten times its land surface (589,683 km^2). As shown in the following figure, this marine territory is so large in proportion to the land due to the "Isla del Coco" off the Pacific coast, that significantly expands the 200-mile Exclusive Economic Zone of Costa Rica and extends this border to Ecuador and Colombia (Quesada-Alpízar & Cortés, 2006).

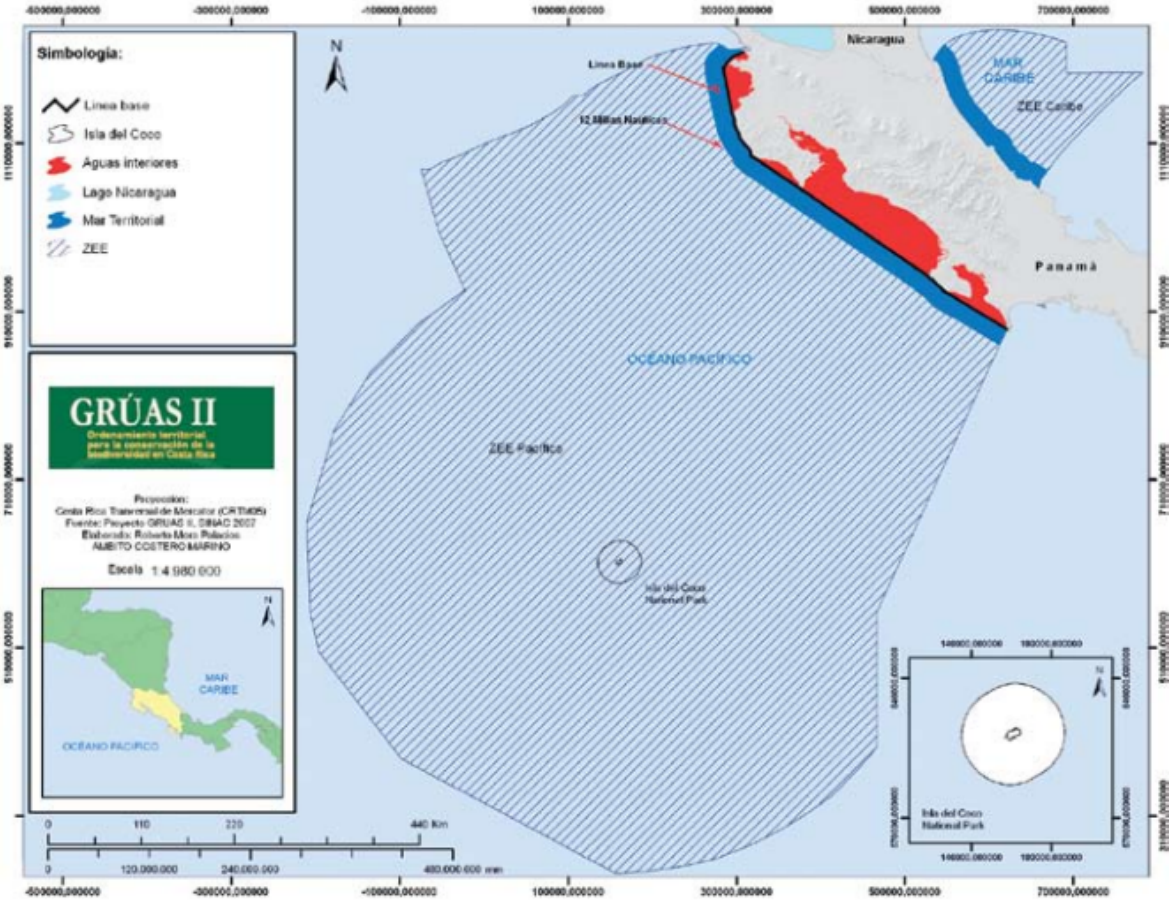


Figure 3. Patrimonial maritime extension of Costa Rica.

Due to Costa Rica's particular geography, more than 6,700 marine species have been reported in its waters, reaching a 3.5% of global marine biodiversity. The contrasting oceanographic conditions on either side of the Panamanian isthmus (in the Pacific and Caribbean), separated about three million years ago, has resulted in a flora and fauna with different characteristics on each side, including numerous geminate (sibling) species (Alvarado, Cortés, Esquivel, & Salas, 2012b).

Costa Rica is located between two biogeographical provinces[1] (Eastern Tropical Pacific and Northwest Atlantic Tropical). The area of study is part of the Eastern Tropical Pacific Province, which is divided into two ecoregions[2], Cocos Island and Nicoya. The Osa and Golfito area is within the Nicoya ecoregion. The focus area in the marine sector of the INOGO, extends within the boundaries of the marine and coastal ecological units described in Table 1.

Table 1. Description of Costa Rica's South Pacific Ecological Units.

Marine Ecological Unit	Toponymic limits	Area (km^2)	Bathymetric Interval (m)	Main features
Pacific Ocean		(543 842km^2)		
Ballena	Boca Coronado Boca Río Barú	1007	0-200	Low coast, interrupted by foothills. Large beaches alternating with a rocky shore and cliffs. Wide platform.
Térraba	Boca Río Sierpe Boca Coronado	2385	0-200	Tide controlled delta, mangrove swamps, sand and mud flats, estuaries. Wide platform.
Corcovado	Boca Río Piro Boca Río Sierpe	1329	0-200	Small alluvial flats surrounded by rocky cliffs, disperse mangrove swamps and coral reefs. Narrow platform.
Fjord	Bathymetric height of -100m	270	100-200	No shore, only deep waters. Anoxic basin with macro bacteria.
Golfo Dulce	Punta Banco Puntarenitas (Jiménez)	599	0-100	Alluvial flats partly surrounded by paleo-cliffs, cliffs, mangrove swamps, and coral formations, gravel beaches, reduced swells.
Burica	Burica Point Border Limit	656	0-200	Mountainous peninsula with rocky cliffs, abrasion platform, rocky beaches, oceanic influence, very narrow platform.

Source: (SINAC, 2009).

1.2 Habitats and Biodiversity

Costa Rica's Pacific coast is 1,160 km long and includes a series of gulfs, bays, rocky shores, beaches and islands, among other geomorphologic features that provide a diversity of marine

[1] The biogeographical provinces are large areas determined by the presence of distinctive biota with particular evolutionary elements, the result of historical isolation. This isolation can be the result of different geomorphologic, hydrographic or geochemical properties. Due to its length, the provinces contain significant levels of internal biogeographical heterogeneity which is the reason why they were therefore disaggregated into ecoregions (Spalding *et al*., 2007).

[2] The ecoregions are the smallest marine classification units representing "strongly cohesive units large enough to contain the ecological processes and life stories of most of its sedentary species " (Spalding *et al*., 2007).

habitats in which scientists have identified approximately 4,700 species (Wehrtmann, Cortés-Nuñez, & Echeverría-Sáenz, 2009). The INOGO study area contains several conservation targets:

- The "Golfo Dulce", a tropical fjord with a unique anoxic bottom.
- Mangrove communities at the Golfo Dulce.
- Coral reef formations and coral communities, particularly in the Caño Island Biological Reserve and Golfo Dulce.
- The Térraba-Sierpe National Wetland, the largest mangrove estuary in Costa Rica.
- Aggregation areas for cetaceans and sharks, and important sea turtle nesting areas.
- Human communities.

I. The Golfo Dulce: the only tropical fjord with an anoxic bottom

Golfo Dulce is the southern-most embayment along the Pacific coast of Costa Rica, centered on 8°30'N and 83°16'W, with an area of approximately 750 km^2. It is characterized as "fjord-like" in that it has a 50-70 m sill that separates the deep (>200 m) inner basin from the open ocean. The depth of the inner basin combined with this shallow sill limiting water exchange with the ocean causes anoxic conditions within the gulf to occur at depths of 60 m and below (Hebbeln *et al.* 1996 in (Quesada-Alpízar & Cortés, 2006). It is the only embayment with these hydrographic characteristics in the tropical Americas and one of only four known in all of the tropics (Richards, 1965 in (Quesada-Alpízar & Cortés, 2006). Surface salinity in the small estuaries within Golfo Dulce ranges from 0 to 25 ‰, lower on average than in the Gulf of Nicoya further north, due to higher annual rainfall in the south (200 mm/month Dec.-April and 500 mm/month May-Nov.).

With 1,028 species reported in the literature, Golfo Dulce contributes with 21.5% of the total of reported species (4,745) for the Pacific coast of the country. High diversity has been documented in marine worms, fishes, macro crustaceans, and mollusks. Following a linear biodiversity index, Golfo Dulce contains 5.24 species per linear km, a few less that the half of the value for the Pacific coast of Costa Rica (10.9), but in only 195 km of coast line. The Golfo Dulce has more than double the number of species of macro crustaceans, mollusks, marine worms, plankton and fish than Golfo Nicoya per km^2 (1.37 – 1.28 species, vs. 0.5 species) in less surface (802-750 km^2 vs. 1990 km^2) (Morales-Ramírez, 2011).

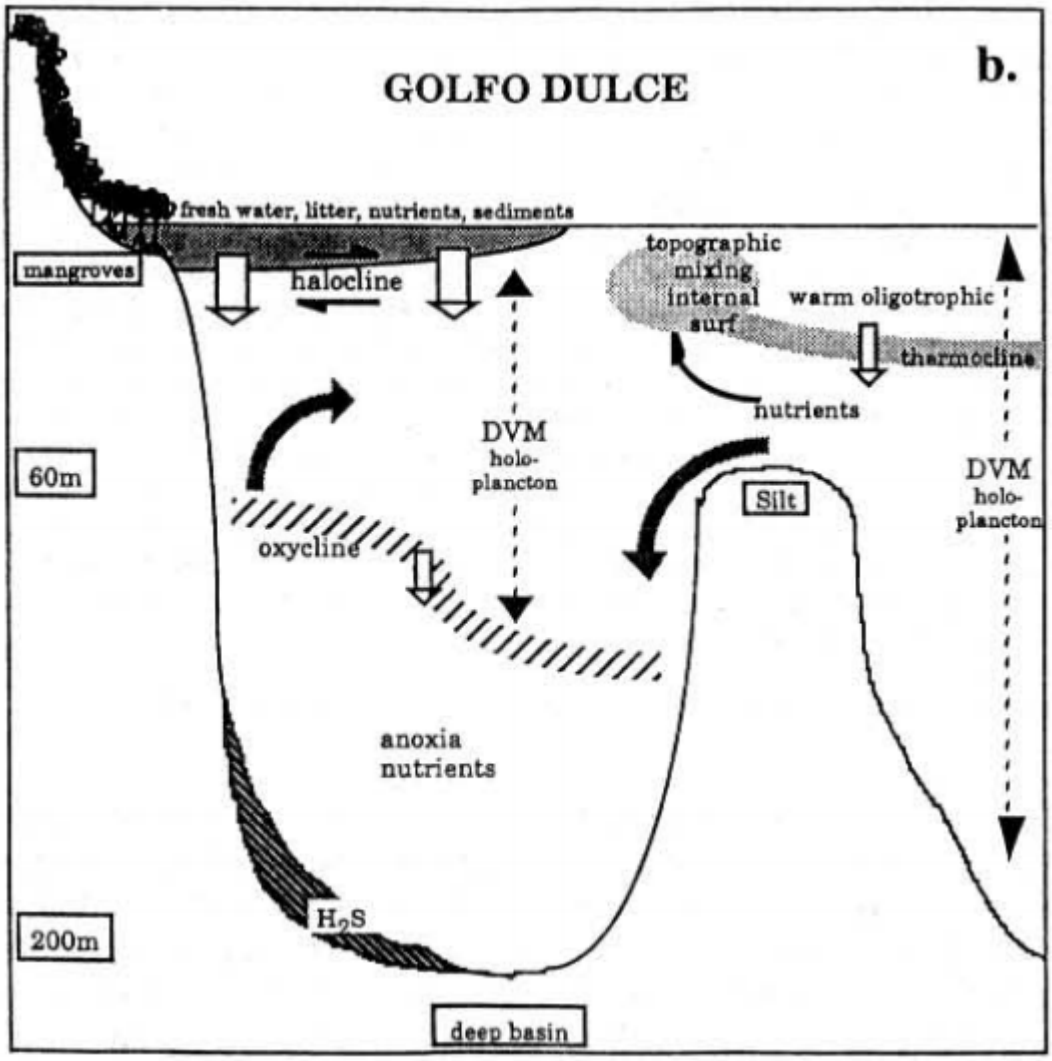


Figure 4. Golfo Dulce trophic flux representation.

Source: (Matthias Wolfr, Hartmannl, & Koch, 1996)

II. Mangroves of the Golfo Dulce

The gulf is bordered primarily by a steeply sloping coastline, so there is relatively little topographic area available for mangroves to develop (Wolff *et al.* 1996 in (Stern-pirlot & Wolff, 2006). The mangroves present in Golfo Dulce are in three distinct and noncontinuous regions: 1) Rincon/La Palma, 2) Golfito/Purruja, and 3) Boca Rio Esquinas, and cover about 1,000 ha in total. Rincon/La Palma is a ~100 ha narrow strip of mangrove area at the mouth of the Rio Rincon in the northwest corner of Golfo Dulce that stretches between the villages of Rincon and La Palma and is backed by the steep slopes of the Osa peninsula covered with primary rainforest. Golfito/Purruja is a very small mangrove area (~70 ha) at the mouth of the Purruja River, which feeds into Golfito's southeast corner. It is loosely linked to the largest mangrove estuary in Golfo Dulce, where the Coto-Colorado and Manzanillo Rivers converge south of

Golfito. The prevailing tree species here are of the genera *Rhizophora* and *Avicennia* (Stern-pirlot & Wolff, 2006).

III. Coral reefs and coral communities of the Golfo Dulce and the Caño Island Biological Reserve

Several types of coral reefs and coral communities have been found in the gulf, and they can be divided into two groups: 1) the ones of the inner section of the gulf and 2) the ones in the outer section (Cortés 1990a in Quesada-Alpízar & Cortés, 2006). The inner Gulf reefs are characterized by live and dead *Porites lobata* on the reef front and dead *Pocillopora damicornis* and *Psammocora stellata* on the reef flat. Coral diversity is low and topographic relief high, with steep reef-fronts and sides. Live coral cover ranged from less than 1% to 8% in 1987. The outer Gulf reefs are characterized by a relatively high live coral coverage (range from 29 to 46%), high coral diversity, and low topographic relief (Cortes, Jimenez, Fonseca, & Alvarado, 2010).

The broadest coral communities in the Eastern Tropical Pacific are present in Caño Island Biological Reserve. This Reserve is located 15 km offshore of the Peninsula de Osa, and the coral reefs were studied by Guzman in 1986 (in Nielsen-Muñoz & Quesada-Alpízar, 2006)). The island had five coral reef flats, ranging in size from 0.8 to 4.2 hectares. These fringing reef flats were mainly built by dead pocilloporid corals, covered by crustose coralline algae, isolated live colonies of pocilloporids and poritids, and microatolls of *Porites lobata*. The reef slope and base was dominated by the massive coral *Porites lobata*, which was the predominant species of the island. The shallow sections of the reef were structured mainly by physical factors: wave action, temperature and salinity fluctuations, and low tide exposure, while the deeper sections were controlled by biological interactions: bioerosion, damselfish algal lawns, and corallivores (Guzman 1988, Guzman & Cortés 1989 in Nielsen-Muñoz & Quesada-Alpízar, 2006). Caño Island reefs were impacted by the 1982-83 El Niño, losing up to 50% of the live coral coverage followed by phytoplankton blooms that killed shallow pocilloporid reefs. Again, during the 1992 and the 1997-1998 El Niño, there was extensive bleaching but lower mortality, less than 5%. Pulses of recruitment have been observed after the 1982-83, 1992 and 1997-98 El Niño events (Guzmán & Cortés, 2001) .

Most reefs are within protected areas, but management and conservation are limited due to inadequate funding. Also, some of the main problems facing coral reefs of the area are natural (warming events) or originate outside the protected areas (sediments from adjacent watersheds) (Guzmán & Cortés, 2001). Outside the protected areas there are regulations to decrease the impacts of adjacent land use, for example, a requirement to maintain a belt of forest along rivers. This is not always applied, however, resulting in degraded reefs due to chronic siltation, as in Marino Ballena National Park, Golfo Dulce, and other areas.

IV. Térraba-Sierpe National Wetland: the largest mangrove estuary in the country and its biodiversity

In 1998, it was estimated that the Térraba-Sierpe National Wetland (HNTS) comprised just over 40% of all mangrove cover in Costa Rica (Cordero 2000 in (Herrera *et al*., 2009). In addition, it possesses other relevant floristic associations and formations, both cerillo forests (*Symphonia globulifera*) and the palm forests locally called "Yolillales" or "Taguales". Because of its ecological, biological, and socio-economic characteristics related to mangroves, the HNTS has been recognized as one of the most important wetlands in the country (Sierra *et. al.* 2007, (Earth Economics, 2010; Herrera *et al.*, 2009).

The territory occupied by the HNTS contains several wetland types: marsh, lake, riverine, estuarine and marine. They can be grouped into two well-defined subunits. One subunit corresponds to micro river basins, formed by freshwater swamp forests, herbaceous swamps and drainage systems (rivers and streams) that provide water to Sierpe. The other subunit is a system of estuaries, which consists of mangrove ecosystems. The estuary system can be divided into estuaries under the direct influence Térraba River and Sierpe River, and estuaries that are marine-dominated in the central section. In addition to riverine and estuarine communities present in the HNTS, there is a marine wetland fringe which is closely linked to the coastal marine and estuarine system in conjunction with lower basin of the Grande de Térraba river (Bravo & Windevoxhel, 1997).

HNTS wildlife inventories have concentrated on the main groups associated with estuarine mangroves such as birds, fish, mollusks, and crustaceans, while research on land and amphibious wildlife have been less intensive, especially on those groups associated with wetlands, lake and marsh areas. The estimated total species richness reported for HNTS is 625 species. The Ecoticos project highlights that 43% of the recorded species are from coastal and marine environments, 22% are estuarine species, and 13% are generalists in terms of salinity of their habitats. On the other hand, more than half of the species are from the demersal zone and 21% are important for commercial fishing (Earth Economics, 2010).

On the Diagnostic Management Plan for Térraba-Sierpe National Wetland (Sierra & Arguedas, 2007), there is a biophysical description, in which it is mentioned that there are reports of up to 90 species of mollusks, but it is expected that number may well exceed 100 species. Crustaceans are quite diverse in the HNTS, with 62 known species, and perhaps 80 species total. As for the fish species, the inventory made by the project Ecoticos (Earth Economics, 2010) confirms the presence of at least 167 species, although it is likely that there are more than 200 species of estuarine fish, including 5 species of rays and sharks.

V. Wildlife aggregations

Whale and dolphin aggregations

Important aggregation areas for humpback whales (*Megaptera novaeanglia*), Bryde's whale (*Balaenoptera brydei / edeni*), false killer whale (*Pseudorca crassidens*), rough-toothed dolphin (*Steno bredanensis*), bottlenose dolphin (*Tursiops truncatus*) and spotted dolphin (*Stenella attenuata*) have been identified by the Keto Foundation, in front of Marine Protected Areas (MPAs) such as the Térraba-Sierpe National Wetland, Caño Island Biological Reserve, Marino Ballena National Park and Corcovado National Park (BIOMARCC-SINAC-GIZ, 2012). Due to the good condition of these MPAs and their coral reef systems, they serve as shelter to the prey species of these cetaceans (Montero-Cordero, Martinez-Fernandez, Salas, & Sanchez, 2008). In addition, the HNTS has been recognized as a high diversity site and a nursery area for many species (Chicas, 2001).

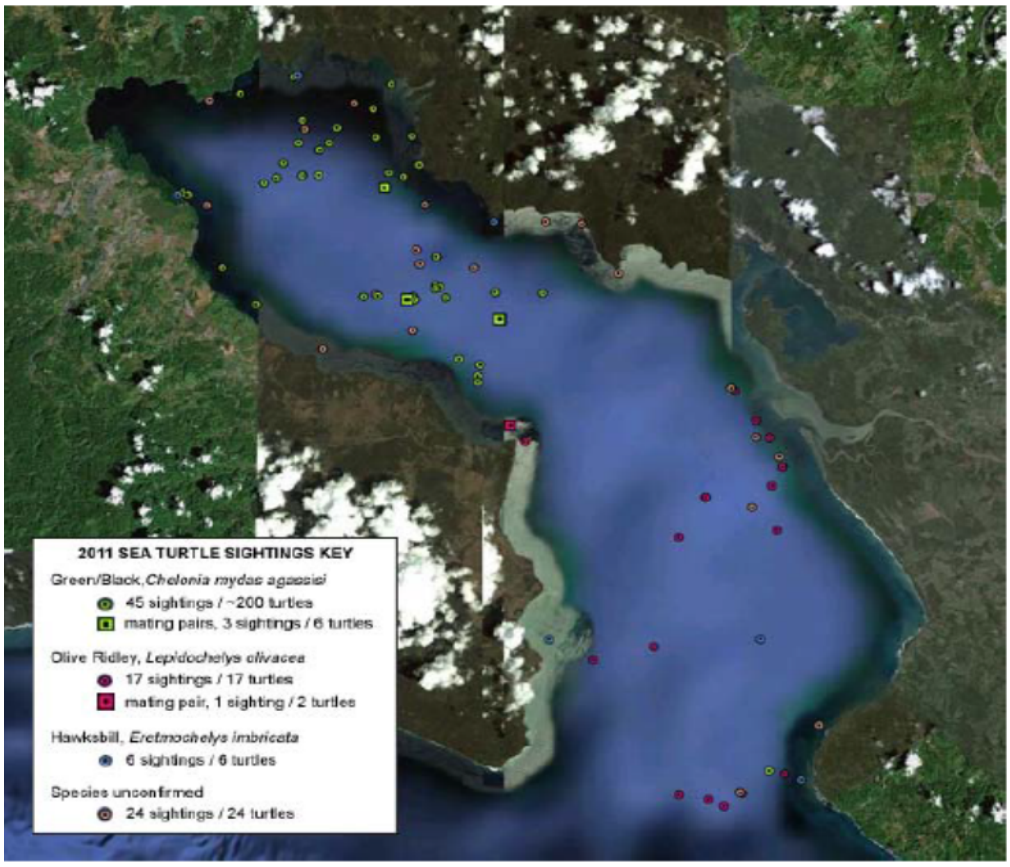


Figure 5. GPS points for rainy season sea turtle sightings. Squares symbolize sightings of breeding pairs. Fuente: Bessesen 2011.

The Bryde's whale aggregation is an especially interesting case, as this is a species that was rarely seen up until 2009, when reports became more common, particularly around the shores of these MPAs. This species has been poorly studied worldwide and in Costa Rica there have been no studies or population estimates. It is believed that the aggregations observed in Costa Rican waters belong to populations coming from the South, migrating from cold waters. Warmer waters contain a higher number of reproducing krill species, providing the whales with more food. This appearance is an important milestone for science and conservation, as well as whale-watching tourism, which could benefit coastal communities during the rainy months. Monitoring these organisms is especially important in order to gather the knowledge needed for appropriate management and responsible ecotourism (Fundación Keto, 2009).

Cetacean aggregations occur for various reasons. In addition to foraging, dolphins get together to rest in the areas around Caño Island, although not in the presence of tourism boats (Montero-Cordero & Lobo, 2010). Regulations in this area should focus on reducing the negative impacts of tourism and other activities on resting aggregations.

Humpback whales (*M. novaengliae)* migrate annually from colder feeding grounds to warmer equatorial breeding/birthing grounds. The waters around the Osa Peninsula represent the only place in the world where a spatial overlap has been documented for Humpbacks from both the northern and southern hemispheres (Acevedo & Smultea, 1995; Rasmussen *et al.*, 2007 in (BIOMARCC-SINAC-GIZ, 2012). From December to March, peaking in January to February, these whales can be spotted coming from the north, and from July to October, humpback whales visit the area from the southern hemisphere, on one of the planet's longest migrations made by any mammal (Bessesen, 2010). DNA studies suggest a migratory cross-over in the eastern Pacific that allows genetic exchange between subpopulations (Baker *et al*. 1993 in BIOMARCC-SINAC-GIZ, 2012). Bathymetric conditions around the Osa Peninsula appear conducive for breeding, and the Golfo Dulce may serve as a calving ground and nursery habitat (Oviedo & Solís, 2008).

Regarding toothed whales inside the Golfo Dulce, False Killer whale (*Pseudorca crassiddens*) and Pilot whales (*Globicephala macrorhynchus)* have been recorded. Fishermen have reported seeing Orcas while on day trips outside the gulf (Bessesen, 2010).

Sea Turtles

The region of study is an important site for sea turtle conservation inland and in neritic waters. Aggregation of sea turtles in these waters, at depths less of than 50 m, was reported for the first time by Keto Foundation research (BIOMARCC-SINAC-GIZ, 2012). There are congregations of three species the Olive Ridley sea turtle (*Lepidochelys olivacea*), the "Pacific Black" Green sea turtle (*Chelonia mydas agassizii*) and the Hawksbill sea turtle (*Eretmochelys imbricata*) in front of HNTS. According to observations of sport fishermen, the turtles stay at a distance of approximately 40 miles from the coast, where they interact with fisheries, vessel traffic and pollution.

Nesting sites

In the study region there are the following sea turtle nesting beaches: Ballena, Corcovado, Colorada (Drake), Carate, Pejeperro, Pejeperrito, Piro, Sombrero, Platanares and Punta Banco. There, 4 sea turtles species have been reported: the "Pacific Black" Green sea turtle (*Chelonia mydas agassizii*) the Olive Ridley sea turtle (*Lepidochelys olivacea*) the Hawksbill sea turtle (*Eretmochelys imbricata*) and the nearly extinct Leatherback sea turtle (*Dermochelys coriacea*) (Bessesen, 2010). It is suggested that the intensive use of Costa Rican beaches by sea turtles is due in part to the geographical location of the country's landmass relative to ocean currents (Richard & Hughes, 1972 in Bessesen, 2011).

According to Bessesen (2011) mating behavior and use of the sea grass feeding sites occur in the Golfo Dulce, demonstrating that it is a year-round breeding and feeding ground for endangered Green/Black sea turtles (*C. mydas agassizii*). For Olive Ridley sea turtles (*L. olivacea*), it has been suggested that the lower half of the gulf is the principal sector for this species within the Golfo Dulce. It is thought that solitary nesting beaches are the key factor in maintaining the Olive Ridley populations. A project conducted by the organization TUVA in 1994 confirmed that Carate beach is of great importance for nesting sea turtles (http://cotorco.org).

The Hawksbill sea turtle (*E. imbricata*) has been found close to the shoreline in various locations around Golfo Dulce. Nesting sites in the embayment include the beaches of Platanares, Sombrero, Punta Banco (Bessesen 2011) and Los Mogos (WIDECAST, 2011). In fact, mangroves have been described as a nursery habitat for this species (Gaos *et al*., 2011 in b Bessesen, 2011)

Leatherback sea turtles (*D. coriacea*) have been seen especially near the embayment's southeastern shores of Pavones. It is known that this species does have several principal nesting beaches in Costa Rica; but it is yet unknown whether that species enters Golfo Dulce for reasons of reproduction, although many species of jellyfish, a food source for Leatherbacks, have been reported in the Golfo Dulce waters (Bessesen 2010).

Several organizations, including Osa Conservation, run sea turtle conservation programs on or near the Osa Peninsula. Such programs are designed to integrate preservation, research and educational outreach on behalf of Costa Rica's sizeable population of sea turtles. Most of the fieldwork is done in the rainy season along the Pacific side of the Peninsula, and the chief documented species is the Olive Ridley sea turtle, with lesser numbers of Green/Black sea turtles (Bessesen 2010).

In spite of being a very rocky area exposed to the marine swell, the external area of the Peninsula of Osa has the largest number of marine turtle nesting beaches. Quesada *et al*. (2006) conducted a review of available literature on coastal marine resources and according to this study the nesting sites on the area are Piro, Pejeperro, Río Oro and Carate. The beach at Río Oro is the main site in terms of solitary nesting of sea turtles in the Osa Peninsula. In this review, most of the nests belonged to the Olive Ridley turtle (97 %) followed by the Black/Green (2.4 %), Leatherback (1 %) and Hawksbill (0.03 %).

Whale Shark aggregations, and other sharks and rays

Whale sharks, *Rhinocodon typus*, are found seasonally inside the Golfo Dulce. According to fishermen, they are normally seen alone or in small numbers of around twenty individuals at a time (Bessesen 2010). In general, they have been described as swimming close to the coast and remaining in the embayment for several days at a time. A reduction in whale shark sightings in Golfo Dulce was suggested in 2007. Just a decade ago, the scientific community became aware of these outstanding aggregations. But in 2005, an IUCN's assessment stated, "…there are now concerns that Whale Shark populations are decreasing in many locations as a result of stock depletion by unregulated fisheries (The Red List, 2011)." In more recent years, fewer individuals have been seen traveling alone inside Golfo Dulce, and while overall numbers are perhaps declining, it is clear that whale sharks still make use of the embayment (Bessesen 2011).

Regarding other species of cartilaginous fishes (Chondrichthyans), the Térraba-Sierpe mouth is an important area for at least 5 species of rays and sharks. The main locations for shark breeding have been identified as the area from the river mouth to depths of 50m. There is a frequent presence of pregnant female sharks, especially of the Brown Smooth-hound, *Mustelus henlei* (Clarke, *et al*. 2011). According to these authors, the highest diversity of sharks is found at depths of 100m or less.

Another remarkable shark species, White tip Reef Shark (*Triaenodon obesus*) is normally seen in Caño Island along with the Hammerhead Shark (*Sphyrna lewini*), one of the shark species most impacted by overfishing worldwide. This species was included in the IUCN Red List, and was included in Appendix II of the Convention on International Trade of Endangered Species (CITES) since March 2013. CITES permits are now needed in order to commercially exploit this species and evidence must be provided ensuring that they are being captured in a sustainable and legal manner (www.cites.org, 2013).

VI. Human communities in the Osa and Golfito Region

A general overview of the region's demography

According to the Southern Region census, Osa and Golfito are the least populated cantons in the region. Covering 3,684.2 Km^2, they represent 7.2 % of the national territory but scarcely 1.6 % of the population of the country. These populations were estimated at 29.433 and 39.136 inhabitants, respectively. The population growth rate is higher than the national average in both cantons (Table 2).[3]

Forty percent of the Osa and Golfito sub region territory is protected (3 national parks, 1 biological reserve, 2 wetlands, 1 forest reserve and wildlife reserves). In addition, the terrestrial maritime zone imposes restrictions on the use of land. This is a notable issue, as the regulatory

[3] A deeper analysis on demographic issues can be found in: Roman and Angulo. 2012.

plans (land use plan) of both cantons are still being discussed and have not yet been approved (Román & Angulo, 2013).

Table 2. Demography of the cantons of Osa and Golfito

Canton	Area Km^2	2002		2011		
		Population	Population Density per km^2	Population	Population Density per km^2	Population growth rate
Golfito	1753.90	33823	19,28	39136	22.31	15.71
Osa	1930.20	25861	13,40	29433	15.25	13.81

Source: INEC 2002, 2011

For many decades, the economic indicators for these cantons have shown a high percentage of economically inactive population, and their unemployment rate exceeds the national average. This is related to a lack of technical qualification, insufficient productive activity and few employment opportunities (ProDUS, 2009).

Tourism has become the main source of income for coastal communities in the study area. Fishing takes place at all levels, including artisanal, semi-industrial and industrial activities. Subsistence[4] fishing has always been a traditional activity along the shoreline. The main resources of fisheries interest are white marlin, tuna, wahoo, swordfish, snapper, comber and conger.

As the following graphic shows, more than half of the population benefits from tourism activities (Marín, 2012). Fisheries only support a quarter of the population although they exist in most of the shoreline communities. The following map shows the geographical distribution of the main socio-economic activities in the South Pacific, with larger circles representing the main activity (benefitting more than 50% of the population) and smaller circles representing the secondary activity (less than 50% of the population obtaining benefits).

[4] Subsistence fishing: catch retained for the fishers' personal/familiar consumption.

A) B)

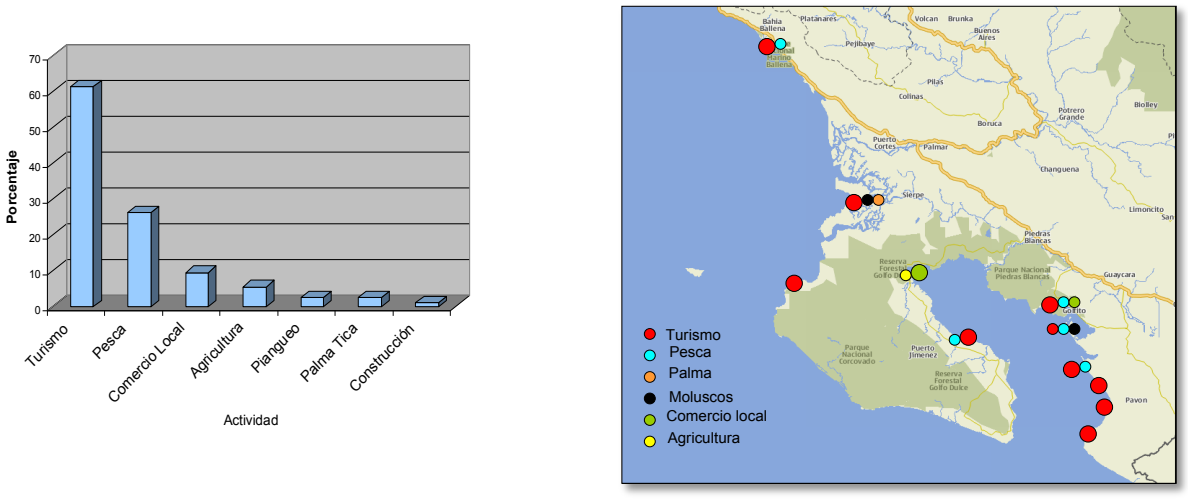


Figure 6. A) Percentage of population benefited by economic activity. B) Geographical distribution of the main socio-economic activities in the South Pacific. Source: Marín. 2012.

Chapter 2. THE HUMAN DIMENSION

2.1 Marine ecosystem services and human wellbeing

Sustainable marine ecosystems must support both the biophysical and human components of coupled social–ecological systems. The concept of ecosystem services is often used to describe links between nature and the economy. From an economic point of view, the flow of ecosystem services can be seen as the 'dividend' that society receives from natural capital (TEEB, 2010).

The Millennium Ecosystem Assessment defines "ecosystem services" as those benefits that people obtain from ecosystems. These benefits are divided into four categories, each dependent on intact biodiversity (Millenium Ecosystem Assessment, 2012).

These benefits can be direct:

- **Provisioning services**: As in the production of provisions, such as food, water and plant-derived medicines;
- **Regulating services:** Regulation of features such as floods, land degradation, desiccation, soil salinization, filtration of pollutants by wetlands, climate regulation through carbon storage and water cycling and protection from disasters;

Or can be indirect benefits such as:

- **Supporting services:** Processes of photosynthesis and the formation and storage of organic material; soil formation; nutrient cycling; and the assimilation, neutralization and detoxification of wastes**;**
- **Cultural services:** Ecosystems also provide people with non-material benefits such as aesthetic pleasure, recreational and education opportunities, and spiritual and cultural sustenance.

Ecosystem services are commonly known as environmental services in Costa Rica. There are four forms of environmental service payments, separate into the following categories:

a. Watershed services, concerned primarily with the provision of adequate amounts of good quality water, and secondarily with hydrological regulation of such phenomena as flooding, erosion and soil salinization;
b. Control carbon sequestration, involving the long-term storage of carbon in woody biomass and soil organic matter;
c. Biodiversity conservation, related to those processes that determine and maintain biodiversity at all levels (landscapes, species and genes);
d. Aesthetic features or landscape beauty, the maintenance of which serve as sources of inspiration, culture and spirituality, as well as commerce in the form of eco-tourism.

The marine systems provide the natural capital that supports a variety of local livelihoods. Main direct uses of marine resources in the study area include fisheries and mollusk extraction (cockles), tourism, marine transportation, and recreation tourism. Furthermore, the marine spaces have a huge importance in the regional context and activities such as commercial transport and maritime commercial fishing for highly migratory species.

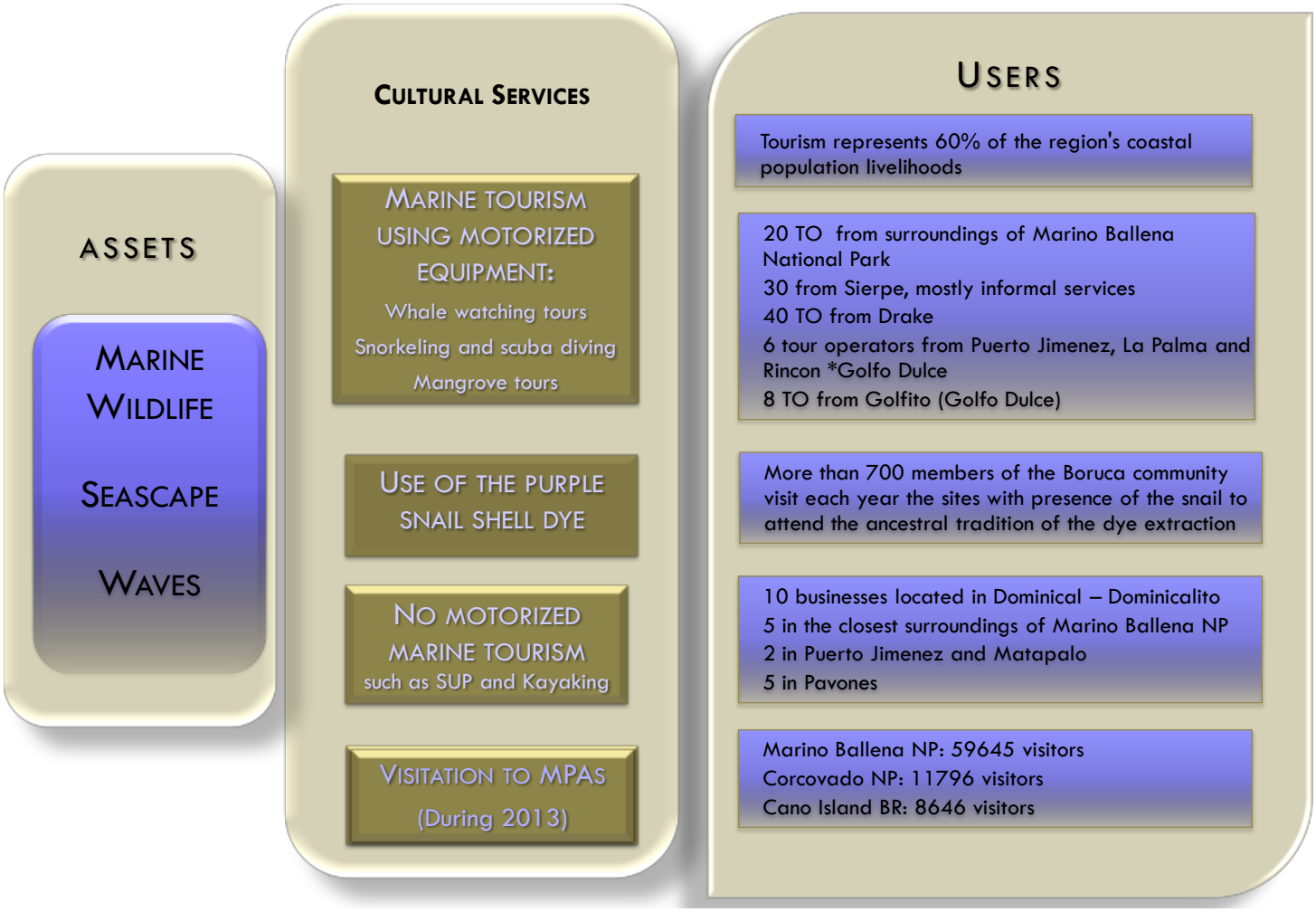
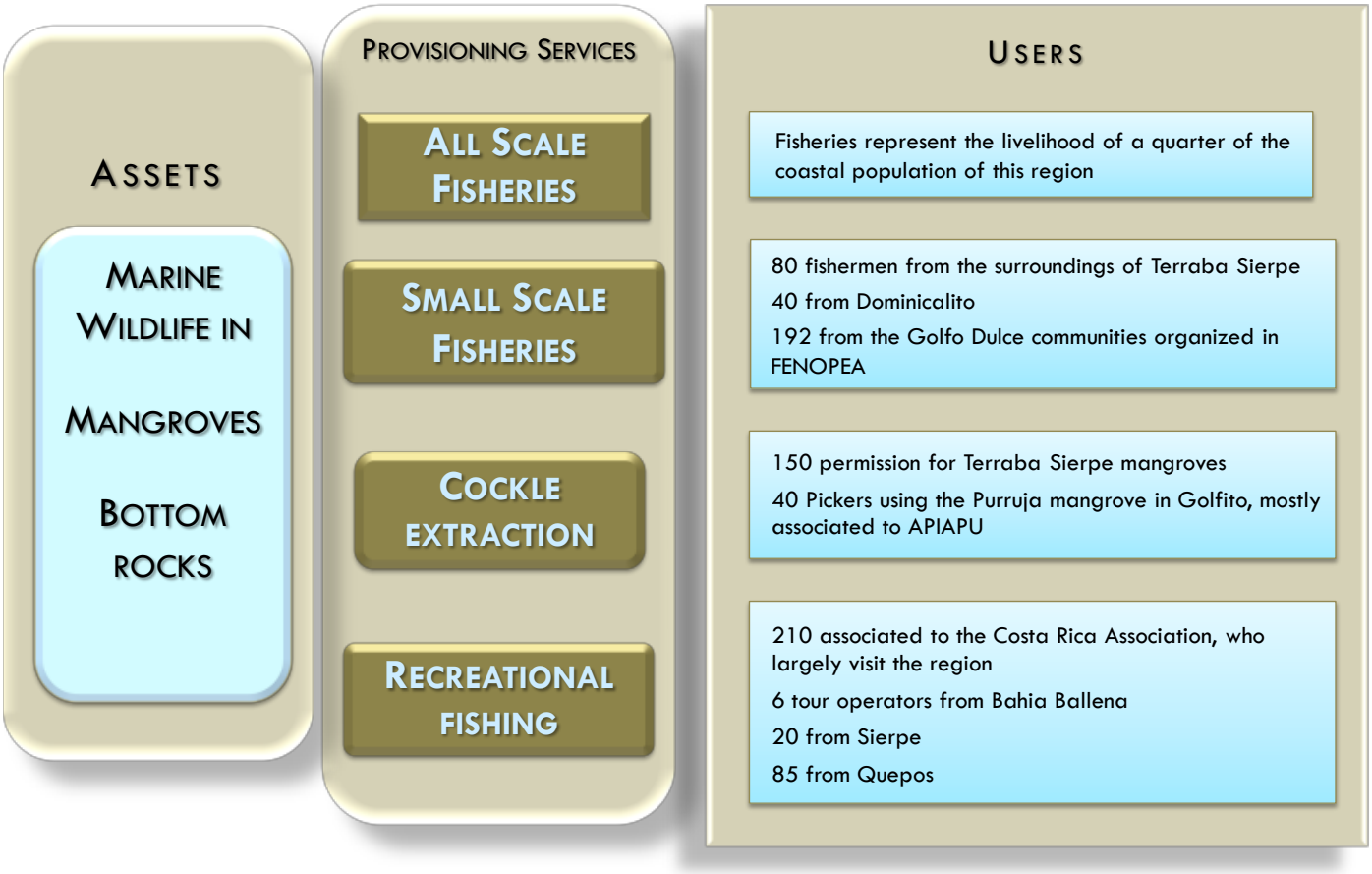


Figure 7. Beneficiaries of the Osa and Golfito marine ecosystem services.

Source: Prepared by Catalina Molina, based on: Marín 2012; Román y Angulo 2013; Mory 2014; Asociación de Operadores en el Parque Nacxional Marino Ballena pers.com., BIOMARCC-SINAC-GIZ. 2012, CoopeSoliDar R. L. 2013, pers. Com. From a Boruca community leader.



Cont. Figura 7

I. Communities Livelihoods based on marine assets in the Osa and Golfito Region

Tourism and recreation

Costa Rica has gained momentum shifting away from traditional commercial exploitation, spearheading conservation in the region. The country has become a hotspot for diving, recreational fishing and other forms of ecotourism that currently generate around 50 million USD in yearly expenditures (Trujillo, Cisneros-montemayor, Harper, & Zeller, 2012).

To estimate the value of Marine Recreational Activities, Cisneros-Montemayor & Sumaila (2011) identified three indicators of socio-economic value in ecosystem-based marine recreational activities: 1) the level of participation; 2) the total employment in the sector; and 3) the sum of direct expenditure by users. Studies have identified the number of users, such as tourism entrepreneurs or tour operator that are offering recreation services, to assess the level of participation. Available statistics collected by the ICT provide a gross estimation of the number of visitors that are temporary users of marine activities. In addition, MPA visitation data can be used to approximate the number of visitors to these areas.

Tourism in the Southern Pacific region dates back three decades, when it first emerged in Drake Bay and Playa Zancudo. The establishment of the road access more recently, to Puerto Jimenez and La Palma, enhanced tourism activities in the last decade**.** The emergence of tourism has been driven by the existence of wild protected areas, such as Corcovado National Park, Caño Island Biological Reserve and, more recently, Ballena Marine National Park.

Under the cluster approach, it was demonstrated that the economic contribution of Corcovado and Caño Island to economic development reaches $91,590,697 USD. Of this total, $41,132,095 USD (close to 45%) is distributed through various activities in Puerto Jimenez and Drake, and extends to other actors in the local economy, particularly hotels and restaurants. About $8,889,304 (close to 10%), is distributed through the Osa Conservation Area (Otoya, Moreno, Cordero, & Mora, 2010).

According to the records of the ACOSA Ecotourism Program (PROESA 2012), the Ballena Marine National Park received most of the visitors accounted for over the past three years. The economic benefits that this park is generating have not yet been quantified, but it is expected that they exceed the value found by Otoya *et al*. (2010) for the Osa area study. According to data from the PROESA (Mory, 2012), 75,785 people, both residents and non-residents, visited Ballena in the first half of 2012. In the same period, Corcovado received 22,992 visitors, and Caño Island 18,504 visitors, maintaining the 2011 and 2010 trends. Marine tourism activities are especially linked with whale watching in and around the Ballena Marine National Park (PNMB) and Isla del Caño Biological Reserve (RBIC). Also, coral reefs on the Pacific side of Costa Rica have become important for diving tourism.

Unfortunately, the increase in marine tourism in the Osa and Golfito Region has not been regulated. Caño Island, which has the broadest coral population of the Costa Rican Pacific coast,

spanning around 2,700 marine hectares, has only four diving locations that receive 1,500 visitors per month (Acuña, 2007). Drake Bay, an important breeding and feeding area for 12 cetacean species (May-Collado, Gerrodette, Calambokidis, Rasmussen, & Sereg, 2005), has seen increases in tourism income around 500% in the last 7 years (Montero-Cordero & Martínez-Fernández, 2007). In Sierpe, a Ramsar Site, channels are used as routes for hundreds of tours boating to Caño Island and others destinations (J. González, personal communication, July 3, 2012). Planning and regulations have not been promoted as fast as tourism demand, failing to prevent tourism activity that may stress coastal marine ecosystem.

Tourism activities may have direct and indirect effects on important marine resources key to attracting tourism, such as coral reefs. Direct effects include coral extraction and damage to colonies by divers and boat anchors. Indirect effects include over-exploitation of resources (fish, lobster, mollusks), increased sewage and increased sediment loads from coastal alteration such as urbanization, road construction (Cortes *et al.*, 2010).

Irresponsible vessel anchoring and diving activities cause coral reef damage and, as a result, habitat destruction for other species that rely on this ecosystem (Cortés & Jiménez, 2003). In addition, several studies have detected that tourism vessels (presence and maneuvering) can cause animals to avoid certain areas, reducing or degrading their habitat (Montero-Cordero & Lobo, 2010).

Responsible practices include correct wastewater and solid waste management, appropriate fuel disposal and responsible navigation. The development of an evaluation indicator system may ensure that the execution of these guidelines truly mitigates the impacts of tourism activities on the marine systems.

Recreational fishing

Recreational fishing has steadily increased, surpassing commercial fishing in economic terms. Sport fishing, specifically, is a rapidly growing sector in Costa Rica, mainly targeting billfish on the Pacific coast. The main species caught are sailfish (*Istiophorus platypterus*), followed by marlins (*Makaira spp*.) and swordfish (*Xiphias gladius*) (Cisneros-Montemayor and Sumaila, 2010). A study of the University of Costa Rica (Jiménez *et al*., 2010) quantifies the contribution of this sector within the US$599 million generated by tourism (2.13 % of the GDP). They found that US$78 million is generated by taxes, from the 4,000 work places serving 280,000 tourists that take part in sport fishing in the high period. About 3,700 crafts belonging to foreign tourists generate US$138 million in services and maintenance. The contribution of the tourism sector is superior to that of commercial fishing, estimated in US$527 million (1.88 % of the GDP). This study does not allow an analysis of specific areas (Román & Angulo, 2013).

Even though it is a recreational activity with an interesting growth potential, these fisheries may have a significant impact on catches. Assuming significant operations began in 1980, it has been estimated that over 10,000 tons of billfish (~90% sailfish) were killed by recreational fishers in Costa Rica from 1980-2008, with an average of 600 tons per year during the last ten years.

Almost 94% of this estimate was a result of post-release mortality, highlighting the need to take this into account, even while encouraging catch-and-release practices (Trujillo *et al.*, 2012).

Fishing activity is carried out by different actors at different scales of operation and investment. In the case of the Golfo Dulce area, there are places specialized in offering service packages such as the Zancudo Lodge, Crocodile Bay, Banana Bay and Parrot Bay, among others. These centers work in two ways, either as hotels that sell an entire tourist package to customers, or as private clubs engaged in fishing and offer their services only to partners (case of Parrot Bay). The other actors linked to sport fishing are independent operators (fishermen in the area with equipment, boats and adequate knowledge) that offer tours in the Gulf to different hotels and operators (Araujo & Marín, 2011).

The evolution of this activity has increased development of marine infrastructure in the South Pacific; with the construction of a variety of wharves in Golfito to dock sport-fishing vessels, and works of smaller scale in Zancudo. The Marina Crocodile project arose in relation to the boom in this activity. There are still conflicts between the local population and tourism development. Sport fishing has generated a number of businesses in which most nationals are excluded from access to facilities and services. Though the local populations recognize the positive contribution of sport fishing to the economy, they also recognize that the benefits generated by this activity are indirect, with most of the profits being retained by the owners and investors in the businesses and the shops that provide secondary services (gas stations, supermarkets, restaurants, etc.).

Another conflict related to sport fishing is the direct and incidental catch of species targeted by commercial fisheries, and vice versa. Additionally, there are currently restrictions stated by INCOPESCA on commercial fisheries regarding the catch of sailfish, one of the major sports fishing targeted species. The scarcity of commercially important species (Tuna, Mahi-Mahi) during the past few years has caused a redirection of commercial efforts to sailfish, generating more tension over this resource[5]. A more dramatic deterioration of the conditions for sport fishing in Golfo Dulce has been noticed since 2006 (Araujo & Marín, 2011).

The Association of Costa Rican Tourist Fishing (APTCS, by its acronym in Spanish) was organized to promote the responsible and equitable use of fisheries resources. It was later strengthened by the creation of FECOP, who have been working on proposals and incidence.

Small scale fisheries

There are many definitions of **small-scale,** but such fisheries are usually characterized by being relatively labor-intensive, less capital-intensive, more tied to coastal communities and less mobile (UNEP, 2011). Other terms sometimes used for these fisheries, are artisanal (versus industrial), coastal or inshore.

[5] A more in-depth analysis about the sport fishing targeted species decrease and its relation with the commercial fishing and the market can be found at: Araujo y Marin. 2011. “Informe Final: Factores socioeconómicos y usos humanos del recurso marino y costero en Drake y Golfo Dulce”.

In a 2007 study on the fisheries of the Golfo Dulce, Zancudo, Pavones and Playa Blanca are mentioned as the most important towns for artisanal fisheries. The study also mentions Golfito, which is the largest town in the area and the only port that reports its catches to the National Institute for Fisheries and Aquaculture (known as INCOPESCA by its Spanish acronym). In these sites, 67% of all landings correspond to 4 species, *Lutjanus peru* (Pacific Red Snapper, 31.7%), *Lutjanus guttatus* (Spotted Rose Snapper, 15.9%), *Scomberomorus siena* (Pacific Sierra, 12.8%) and *Pomadasys panamensis* (Panama Grunt, 6.6%). The other 33% is divided amongst 64 other observed species. Campos (1989) reported that 40% of all catch corresponded to snapper and mackerels, whilst in 2007 that percentage went to 60.7%. This increase was likely due to an increase on the fishing of *L. peru* specifically, which doubled from 13.5% (1989) to 31.7% (2007). This increase has had a direct impact in the vulnerability of this species as the 2007 landings report showed many individuals below the length of sexual maturity, although the majority was over that size. The case of *L. guttatus* is worse, since the mean length was barely over the length of sexual maturity, with very few individuals of an adult size. Out of the 4 most captured species, mackerels and grunts are the least vulnerable (Guzmán & Molina, 2007).

Box 1. Ballyhoo: management issues for a key species for recreational fishing

The Ballyhoo (*Hemiramphus saltator*) economic importance has increased in the last decade due of its use as bait for sport fishing. This fish has been captured since 2006, and though this activity has been sustainable so far, it is necessary to reconsider the state of its populations.

In the Golfo Dulce, during dry season (January to March), fishermen can catch up to 2000 individuals per night. Based on total and natural mortality combined with catch data, it is known that the population is currently overexploited (the ballyhoo exploitation rate is 0.68).

Recent assessment has shown that there are management issues that need to be addressed, including the number of fishing licenses granted, which is currently too high. Another problem is that some of these licenses are obtained without following proper procedures. There is also a high volume of illegal fishing, due in part to the loose control by local authorities. In many cases, the individuals' captures are under the sexual maturity size and the use of formaldehyde to fish has been observed in several areas.

Therefore, urgent handling guidelines must be enacting to mitigate the irrational use.

Source: Marin, B. 2011. INCOPESCA Research Department.

While all fisheries face a range of challenges, many of those facing small-scale fisheries are related to factors within the broader social-ecological system, external to the fisheries

(McConney and Charles 2009 in (UNEP, 2011)). These factors include (1) negative impacts of industrial and foreign fleets: depletion coastal fish stocks, and in some cases destruction of coastal fishing gear; (2) degradation of coastal environments and fish habitat through: land-based sources of marine pollution, development of urban areas, shrimp farming, tourism, mangrove extraction, etc., leading in each case to reduced fish stocks; (3) infrastructure challenges such as limitations on processing and transportation of fish products; and (4) global forces, such as climate change and globalization of fish markets. In addition, over-fishing by the small fisheries themselves contributes to the problem in many cases.

In the Osa and Golfito Region, artisanal fisheries started 30 years ago, promoted by some companies that brought improvements in the fishing gear and the financing mechanism to support fishing equipment, fuel and bait. Although artisanal fishing has been carried out by small vessels with limited storage capacity and reduced navigation capacity (up to 3 miles), artisanal fishermen mainly exploit the resources of the Golfo Dulce, where the Responsible Fishing Area has been created. Records of INCOPESCA state that there are about 120 permits in the areas of Golfito, Pavones-Zancudo and Puerto Jimenez-Rincon, and an additional 100 permits in Sierpe-Cortes. The extractive activity in the Gulf is low volume, at about 45 tons per year. However, these 240 permits support the broader communities directly and indirectly, through post-catch activities and workers' dependents. The total number of people depending on the fishery has not been quantified (Araujo & Marín, 2011).

These fishing communities often lack adequate storage and processing facilities to control the fishing resource. They depend on an unequal value chain, in which their income barely reaches 20% of the market price of the product. Local small-scale fisheries (SSF) are of key importance to coastal communities, providing crucial food supplies, sustaining regional economies, and supporting the social and cultural values of the area. However, they are threatened as pressures on coastal areas increase (UNEP, 2011).

Many factors influence increases in illegal fishing during closures, including low average income, limited subsidy for fishermen, lack of training in alternative livelihoods and lack of clear economic alternatives. The use of illegal fishing gear occurs when fishers see a decrease in the amount and size of their catch, motivating the use of ever-smaller mesh nets. In Puntarenitas of Golfito, only 7 fishermen of the 29 total are considered to be environmentally responsible fishermen (Araujo & Marín, 2011). There is resistance from fishermen to adopt more selective fishing methods, as they will land the same amount of product with a higher cost of fishing. Incentives to fish responsibly need to be developed within the market.

According to locals, the risk of over-exploitation is aggravated by the tourism sector, restaurants and hotel owners, who claim that there is a weak commitment on the part of the fisherman to deliver a sufficient amount of quality product on a regular basis. They argue that if there were an agreement, the fisherman could not justify failure to deliver product because "the fishing was not good". Fishermen are led to use illegal fishing gear in order to satisfy the demand from their buyers. In addition, marine resources are left vulnerable with little capacity within the authorities to apply control and monitoring (Araujo & Marín, 2011).

Cockle[6] harvesting

In Costa Rica, *Anadara tuberculosa* – a cockle commonly known as the piangua – is harvested in the mangrove channels of the Gulf of Nicoya, Térraba-Sierpe and Golfo Dulce and in other smaller mangrove complexes along the Pacific coast. Cockles are harvested by dedicated 'piangüeros', who often do not identify themselves as being fishermen, even if they occasionally fish (Trujillo *et al.*, 2012). This has contributed to underrepresentation of this fishery in statistics and research, despite the clear social and economic significance of the resource to small coastal communities in Costa Rica and most of tropical Latin America (MacKenzie, 2001).

In the INOGO study area, most cockle pickers are located in Golfito, Puntarenitas de Golfito and Sierpe. This activity is usually carried out on an individual level with little higher-level social organization. There is only one small association of pickers (Asociación de Piangüeros de Purruja), which works in the Purruja mangroves and involves approximately 21 families[7]. One decade ago, the majority of their income (86.4%) came from the extraction of the bivalve, while one smaller percentage came from other activities, such as domestic employment, construction, agriculture and fisheries (Silva & Carrillo, 2004). *"Piangüeros*" from Purruja restrict their collecting activities to the smaller Purruja river area due to limitations in transportation.

In the case of Térraba-Sierpe National Wetland, there are around 100 cockle pickers that belong to different fishermen associations, and likely an additional 100 non-associated pickers (E. Vargas, personal communication, February 19, 2013). Usually, women are in charge of collecting cockles while men work as fishermen.

In general, data on the scale of collecting operations is very limited. MacKenzie (2001) estimates that around 500 piangüeros live in Costa Rica, with an average per-day catch of 145-500 cockles. According to this estimation, a portion of the daily catch (~12%) is kept by piangüeros for their own consumption, which is handled separately from commercial cockles, and regarded as subsistence catch. Cockles are usually sold to middlemen by the dozen or 100 individuals, for an average of US$0.05 per whole cockle. The cockles are then made into a "ceviche" (a cold salad with onions, peppers, and lime juice); a ceviche with the meat of ten cockles typically sells in tourist establishments for around US$ 3.00.

Previous studies, as well as anecdotal reports from cockle harvesters, indicate that most areas of Costa Rica have seen a decline in the abundance and sizes of *A. tuberculosa* over the past 10-20 years, suggesting that the extraction pressure on this species is too high. In addition, based on preliminary information, it is assumed that the local *A. tuberculosa* stocks are subjected to differential exploitation rates, with the highest exploitation to be found at Purruja, and the lowest at Rincon (Stern-pirlot & Wolff, 2006).

[6] The 'piangua' (*Anadara tuberculosa*) is an ark clam (cockle) that inhabits muddy substrates in and around mangrove forests. Individuals are found at about 15 cm deep among the prop roots of Rhizophora spp.

[7] http://www.osagolfito.com/apiapu.php

Different environmental conditions such as exposure time, and water temperature and turbidity, salinity, and contamination have been shown to affect growth in *Anadara* spp (Stern-pirlot & Wolff, 2006). As it was mentioned, populations of these species are important to small-scale fishing communities and may be affected by changes in environmental conditions driven by developments such as the Diquís Hydroelectrical Project.

The largest body of scientific work on *A. tuberculosa* in Costa Rica has focused on reproductive biology as well as descriptive studies on the size structure of the population in Térraba-Sierpe and elsewhere in Latin America. However, despite its commercial importance for coastal dwellers, the fishery potential, present harvest rate and population dynamics of this species in its natural habitat have not been assessed. Because of its slowed growth, high exploitation, and the susceptibility to overharvesting shown by other *Anadara* spp, it is clear that conservation measures should be implemented to prevent *A. tuberculosa* from becoming locally endangered in Costa Rica (Stern-pirlot & Wolff, 2006).

II. Coastal communities characterization

As mentioned above, formal and informal employment in the local communities is categorized by two central activities: tourism and fishing. The below table outlines the more nuanced reality in each community examined.

Table 3. Coastal Communities Characterization.

Communities	Main economic activities with influence on sea-land interactions	Community Based Organizations	Main Challenges for a Sustainable Community Based Development
Sierpe and small settlements within the HNTS	• The HNTS landscape is a mixed of uses that includes native forest, agriculture (primarily palm oil plantations, rice production, banana plantations, shrimp farming, and livestock grazing). • The Sierpe River is an important 'passage routes' to access Drake Bay and Caño Island Biological Reserve.	The HNTS Local Council (ACOSA)	• In the case of Sierpe, the lack of organized groups and their low incidence has resulted in inequities in the distribution of tourism and fishing benefits. • The Rio Sierpe watershed has gradually undergone human development resulting in significant portions of the original forest being eliminated and replaced by human activities. Moreover, significant changes are expected in the near future due to increased interest in African oil palm, urbanization associated with the possible construction of an international airport and the Diquís Dam.
Bahia Ballena[8]	• It is key site for whale watching, that has spawned a rapid growth in the tourism activity mostly owned and operated by locals or nationals. • The Ballena Marine National Park has experienced a dramatic increase of visitation. • It generates a significant visitors flux to the Caño Island Biological Reserve and Corcovado National Park. • Important growth of Real Estate activities has promoted urban and services development.	Tour Operators Association of Marino Ballena National Park Tour guides Association Costa Ballena Businesses and Tourism Chamber	• Interaction ability between the Park and the community to improve the customer service, public infrastructure and safety. • The area has been highly impacted by real estate development. • Lack of environmental management in the Fila Costeña area, without clear planning for the short, medium and long terms.
Drake Bay	• It is an access point to very unique tourist attractions: Corcovado National Park and Caño Island Biological Reserve. Although this advantage has been exploited by the settlers, has also generated a high dependence on a single source of economic resources. • Whale watching and scuba diving are also important recreational activities that are operated from this community.	AGUINADRA (a Tourism Guides Association) Integral Development Association (ADI) Corcovado Foundation Peninsular Council, with representatives from	• As it depends on a single source of income – tourism - Drake is more vulnerable to any change that involves the reduced influx of tourists. Tourism has been affected by the global economic situation and by restrictions that have been imposed to regulate the demand on MPAs. A diversification of the

[8] Bahía Ballena, which is not included in the continental area of the INOGO project, has a strong influence on the marine side and, besides, it interacts with other communities included in the study.

		Caño Island & Corcovado.	economic alternative has been suggested.
Puerto Jimenez	• It is one of the most important population centers, with 5,025 people. Since 1960, its economy was related to gold mining. • Since Corcovado National Park became a famous tourism destination, there has been development of a large amount of tourists and commercial services, such as tour operators, hotels, shops, and aquatic and land transportation. There is also an important sector of both artisanal and sports fishing. This community is a strategic point for the provision of tourist services. • Rice and palm oil crops are also important activities in the surrounding areas.	Puerto Jimenez Tourism Chamber, Corcovado Cooperative, Asociación de Pescadores Turísticos Costarricenses (APTC), or Tourist fishermen's Association	• Puerto Jimenez, like Golfito, presents largest sources of employment, mainly due to tourism. Both, tourism and small-scale fisheries marketing should be improved. • Sedimentation due to roads and urban development affects the aquatic ecosystems. • Agrochemical pollution is another major issue impacting watersheds.
La Palma and Rincon	• Traditionally these locations were fishing villages. • Gold extraction became the main livelihood until this activity was prohibited with the establishment of the Corcovado National Park. Nowadays, La Palma economy is based on local commerce. • Tourism is a small-scale activity; the community has not been able to take advantage of being so close to Corcovado. This is contrasting with the evolution that Puerto Jimenez has had with tourism	Integral Development Associations (ADIs)	• The community has not been able to get involved in the new emerging activities, despite the excellent road connection with Puerto Jiménez.
Golfito and Surroundings (8738 inhabitants)	• Golfito, the county head, is where the local offices for Governmental institutions can be found (Municipality, University of Costa Rica, and INCOPESCA). They represent important sources of employment. • The "Depósito Libre de Golfito", or duty free shopping zone, is a source of stable employment. Due to a requirement to spend the night in the region in order to gain access to tax free shopping, Golfito has nearly 70% of the accommodations in the Osa and Golfito cantons. "Shopping tourism" generates a lot of indirect employment (transportation, restaurants, parking lots), supporting most part of Golfito's economy. • Golfito has the major offer of services related to vessels' maintenance and sport fishing within the Osa and Golfito Region. Private wharfs for sport fishing are used mostly by foreigners.	Asociación de Pescadores de Puntarenitas. It gathers 29 members from the Puntarenitas Island. It is part of FECOP Asociación de Pescadores Conservacionistas Artesanales de Golfito Asociación de Pescadores y piangueros Golfo Dulce	• Despite the fact that Golfito has a high tourism potential, it is not generating the expected profitability mainly because necessary infrastructure improvements have not been completed and there is also a lack of trained human resources. • Given all the urban development that Golfito has experienced, there is a need for better waste water management. • The largest number of fishermen using illegal gear has been identified in Puntarenitas de Golfito. Although gillnets are not allowed, most of the fishermen are still using this gear type. According to Marin (2012) they are waiting for sustainable arts projects that haven't been completed.

	• Fishering operations of many different sizes work in this area. Semi-industrial fleets make up a significant component, and originating in Quepos, Puntarenas, Perez Zeledón and farther places, such as Colombia, Panama and Nicaragua. They fish in broader areas. • Intermediate enterprises distribute seafood at the local, national, and international levels. Exportation enterprises buy the semi-industrial and industrial fisheries products. Main exportation products are: white marlin, tuna, Wahoo, swordfish, snappers (spotted rose and pacific red snapper, categories 1-4), grouper and conger. • In Puntarenitas of Golfito and Golfito, most of the population benefits directly or indirectly from fisheries. Main fishing products consist of pacific sierra, spotted rose snapper, sardine and snook. Some of the fisherman dive in order to catch lobster and oysters. • Primarily local businesses buy the small, medium, and artisanal fishermen products. Their catches are mostly distributed in locations around the Golfo Dulce.	Asociación de piangueros de Purruja, it is the only association of cockle pickers in the region of study	• According to Marin (2012), it is estimated that the price that dealers pay is only 20% of the price that they charge to the final consumer. This 20% is reduced due to the costs of fuel, fishing equipment and bait. The percentage of profit gained from fishing, which has no impact on fishermen, is very high (about 80%). In addition the fishermen experience declining profitability so their capacity of investment has been reduced (Araujo and Marin 2011). • Despite this situation and according to its inhabitants, tourism is not an attractive alternative due to the concentration of tourism services that are provided in the main town of Golfito.
Zancudo (20 km south from Golfito)	• Zancudo has a unique geographical feature as it consists on a 6km long strip of land, located between the sea and the Coto-Colorado river mouth, so that one side is beach and the other side is a mangrove. These factors have a strong influence on the quality of life in the community and the potential for improvement. • Accessing Zancudo is possible by sea or by land; the most popular means of transportation for the inhabitants is by boat, but there is only one provider, who operates with a minimum of 5 persons. Private shuttle cost ten times more and is mostly used by tourists. • Main source of employment is as a day laborer. Since this is a seasonal job, most people, especially men, work in other activities depending on the season: tourism, fisheries, transportation and construction. • Half of the Playa Zancudo population benefits from fisheries. This is a high percentage considering that although there is a storage center, but is in need of renovation and lacks direct marketing of the fish. Fisheries here are related with the muddy bottom formed by the sediments coming from the Coto Colorado River. Mackerel, shrimp and sea bass abound in these areas but, according to fishermen, they can't be caught easily using rope or line. • There is a dependence on tourism, promoted by foreign entrepreneurs and is mostly related to sport fishing. Benefits in the community are mainly indirect, through domestic services or maintenance in hotels.	Four local based groups: 1) Small-scale Fishing and Tourism Association 2) Health Board 3) Education Board 4) Sports Committee 5) Pro-citizen Association (a group promoted by the Minister of Education and the Municipality, which captures funds for cleaning of the beach and other undeveloped areas).	• Landholding is probably the most important problems due to building restrictions of the ZMT and river protection zone. Despite this situation most of foreigner's houses and hotels are located in these areas. • A total of 300 hundred houses and commercial establishments are located in Zancudo, 50 of them are vacation homes. Only a third part of the houses belong to nationals. • There is a high rate of emigration due to the lack of employment alternatives.

	• Recently the aquatic tourism activities have diversified, offerings include dolphin watching, snorkeling, kayaking and mangrove tours. • Tourism facilities are located on the beach side and the small wharf and small businesses frequented by locals are on the mangrove side.		
Pavones	• It possesses one of the best beaches for surfing worldwide. This condition has been favorable for the growth of tourism. • It is a fishermen community that has traditionally made use of sustainable fishing gear. • In Rio Claro de Pavones, the fishing storage center becomes an alternative source of resources during tourism low season but not in the proportion that would be expected. Dependence on intermediaries reduces the income obtained by fishermen.. • In Punta Banco, subsistence agriculture takes place mostly among Indigenous communities, which obtain additional resources by bartering with the neighboring native communities along the border and other minor activities.	Three Artisanal Fishermen's Associations share the fish storage and processing center: 1) Río Claro de Pavones Fishermen's Association 2) Puerto Pilón Fishermen's Association 3) Cocal Amarillo Fishermen's Association	• Fishing is a very unstable activity. The average profit of the fisherman does not reach operating costs. This situation could lead to the informalization of fishing activities and the use of unsustainable fishing methods. As in most fishing communities, it is important to improve the marketing networks.

2.2 Marine assets governance and stakeholder participation

Stakeholder characterization has been done for the study area (Marín, 2012 ; Camacho & Ovares, 2013). Based on existing studies, the following is a description of governmental institutions, local groups, NGOs, networks and linkages, and other formal/informal instances for participation related to the state, use and management of coastal marine resources.

I. Governance of the marine territory

There are several governmental institutions to which Costa Rican laws delegate crucial responsibilities for the management of the natural assets and the coastal-maritime territories. In order to achieve a clearer view of the institutions' scope of work and related policies, a brief diagram of the national legal framework is presented, based on the "Kelsen' Pyramid" (Figure 8). This hierarchy means that a norm of minor status cannot contradict one of major status. At the top of the hierarchy is the Constitution, which contains the judicial basis of the country's whole legal system. International conventions ratified by the Congress, such as Ramsar or the Convention on Biological Diversity, are placed in the following level. In the third level are the laws, followed by the fourth level decrees proclaimed by the Executive Branch (for example, those regulations that are promulgated by a Minister that specify the application of each law) (Cajiao-Jiménez, María Virginia Roxana Salazar-Cambronero, Naranjo-Vargas, & Arauz, 2003).[9]

[9] Detail of marine resources legal framework can be found in : Cajiao *et al*. 2003. Régimen legal de los recursos marinos y costeros en Costa Rica. 1ª Edición, San José, Costa Rica, Fundación AMBIO. Junio del 2003.

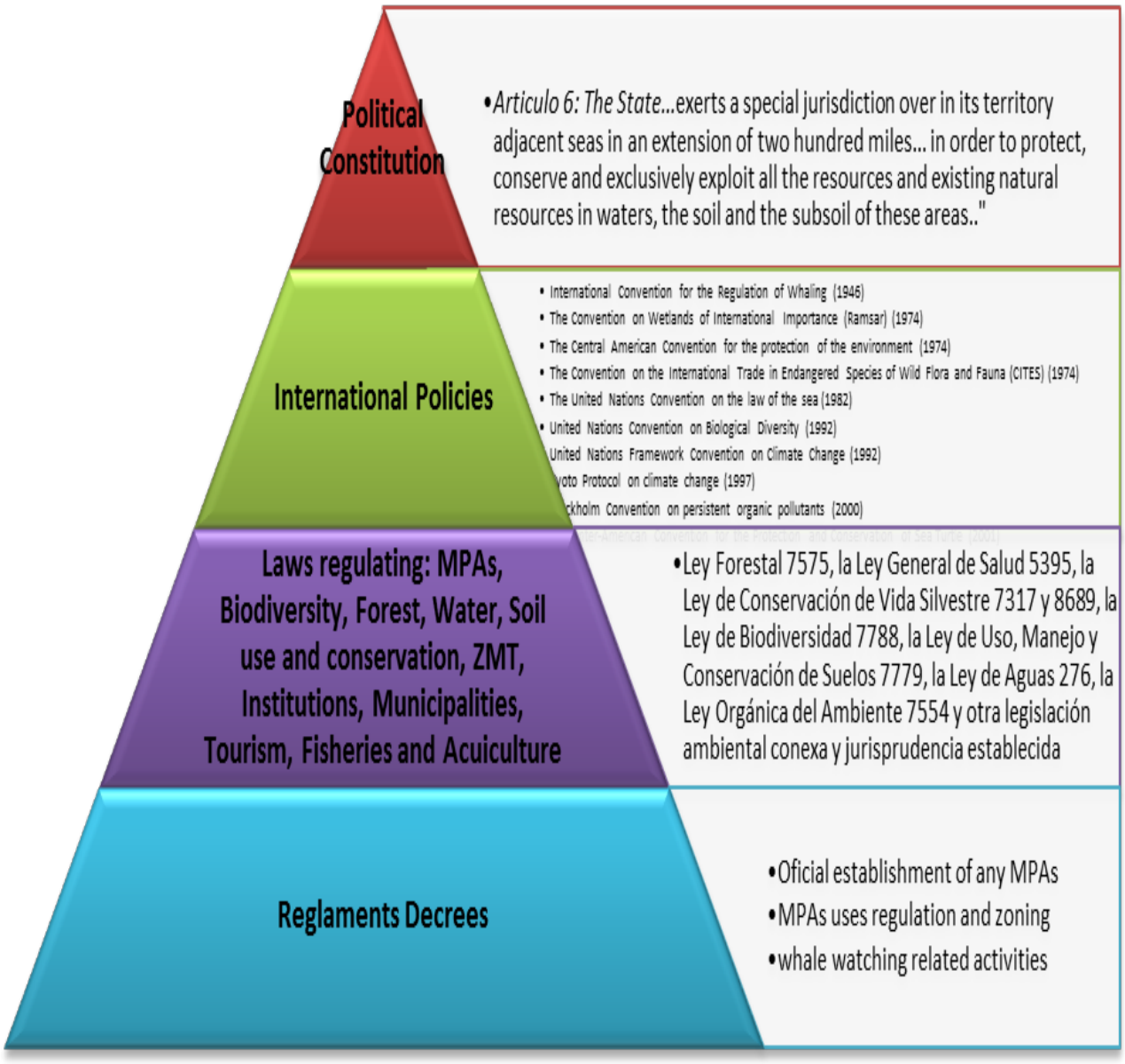


Figure 8. Hierarchy of regulations of Costa Rican environmental law.

The following diagram highlights the policies of the institutions that have the large roles in determining management and use of marine resources, according to the perception of civil society groups, analyzed by the characterization of stakeholder in the South Pacific Marine Multiple Use Area (AMUM, in Spanish) (Marín, 2012).

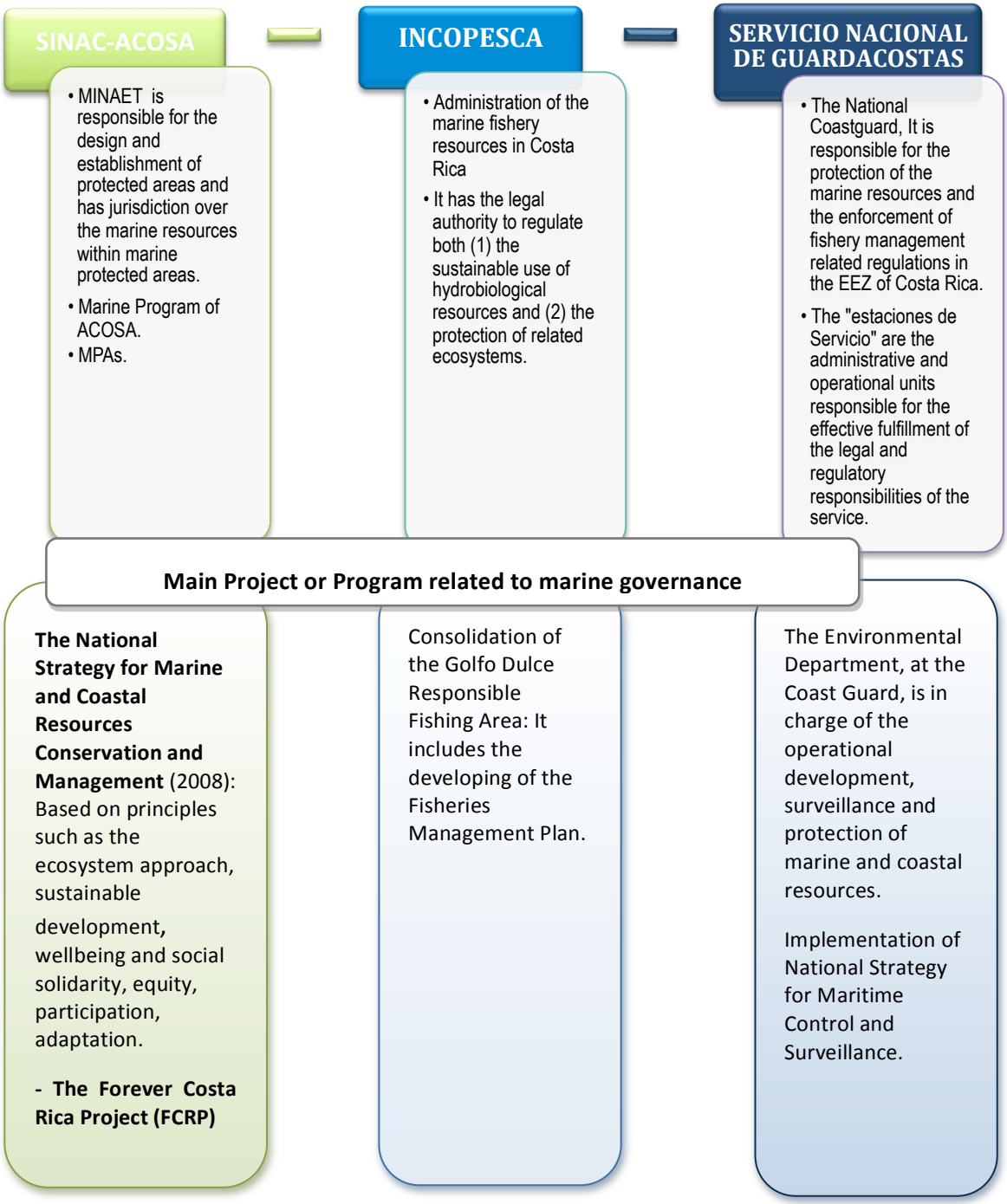


Figure 9. Institutions with greatest involvement in management and use of marine resources. Source: Marin, 2002.

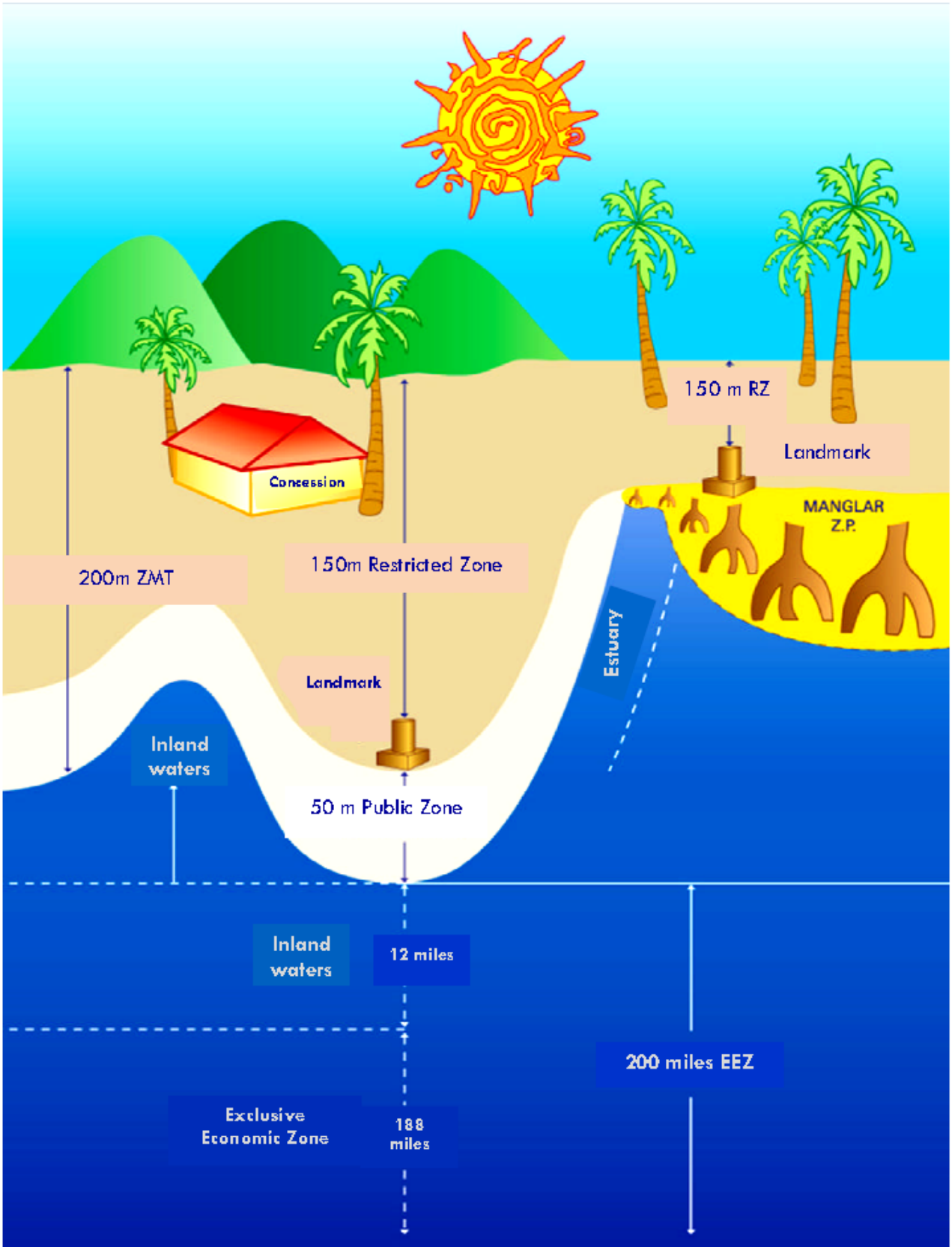


Figure 10. Location of Costa Rica's EEZ. Source: adapted from Cajiao *et al.*, 2005.

Box 2. The National Marine Commission – CONAMAR: building a country agenda, enhancing the inter-sectoral coordination

Vision: "For 2022, Costa Rica will have all of its marine areas and resources spatially and temporarily managed, thus ensuring its economic and biological sustainability, the health of coastal communities and the safety of the marine areas under the jurisdiction of the State, as well as the human life on the seas".

In 2011, the ad hoc Presidential Commission for Marine Governance was established with the goal of analyzing marine governance and institutionalism to propose concrete policies and actions that allow suitable marine-coastal management and protection.

Based on this analysis, the Decree Nº 37212-MINAET-MAG-SP-MOPT established the creation of a superior coordination commission to promote the strengthening of the institutionalism of the State and attend the implementation of a country agenda. This initiative was led by the President's office, with the participation of these ministers: Environment, Public Security, Public Transportation and the Agriculture and Livestock. This commission will be the highest authority for the integrated management and articulation amongst the different public sector offices involved.

The structure of this commission contemplates the creation of a Technical Office to execute the decisions made by CONAMAR. The goals set for the first stage of work are:

- Consolidate a permanent high standard space to define a national marine policy.
- Integrate the existing planning instruments such as the National Strategy for the Integrated Management of the Marine-Coastal Resources, The National Plan for the Development of Fisheries and Aquaculture, amongst others.
- Analyze the needs for the institutional strengthening of MINAET Marine Program, the Marine Port Division, SNG and INCOPESCA.
- Promote a Marine-spatial planning process in the short term.
- Examine the creation law of INCOPESCA, especially in regards to the integration of the board.
- Promote the approval of various laws, agreements and policies related with coastal marine themes.

Source: Comisión Presidencial para la Gobernanza Marino Costera, 2012).

Marine Responsible Fishery Area

On April 2008, Costa Rica's Institute for Fisheries and Aquaculture (INCOPESCA) created a category called the "Marine Area for Responsible Fisheries"[10] (AMPR, acronym in Spanish) that is intended to become a zoning instrument regulating fishing activities within a determined area. Their creation will depend upon the biological, fisheries or socio-cultural features that require enforcement of specific regulations for guaranteeing the sustainable use of fish in the

[10] For detail on the legal basis of Marine Areas for Responsable Fisheries check: Executive Decree no. 35502-MAG: Reglamento para el establecimiento de las Areas Marinas de Pesca Responsable y Declaratoria de Interés Público Nacional de las Areas Marinas de Pesca Responsable (2009).

long term, as well as their use, conservation and management, all with the help of local communities and institutions.

AMPRs differ from MPAs in goals and objectives. MPAs deal with numerous aspects related to fisheries, however, they regulate several other activities that include conservation, tourism, environmental education, research, and navigation. Even though the creation of Marine Areas for Responsible Fisheries is very recent, many local communities are interested in promoting the creation of such areas where fishing activities take place.

In 2010 an AMPR was created in Golfo Dulce. As an important precedent, shrimp fishing using trawls was prohibited, therefore, to date, the only fishing gear authorized for Golfo Dulce are handlines, rods and reels, bottom longlines and traps. These are the most selective and environmentally friendly fishing methods. There are also restrictions for some kinds of fishing fleets (Table 4. Allowed fishing fleets in the Golfo Dulce AMPR).

The first Fisheries Management Plan (Plan de Ordenamiento Pesquero, POP) for the Golfo Dulce was established in 2010 with a validity of two years (INCOPESCA, 2010). In 2012 the Commission made the decision to update the POP. Through an inter-sectoral process, stakeholders have been working in the design of the new POP. The process has been led by a Follow-up Committee (Comisión de Seguimiento) that consists of INCOPESCA, The National Coastguards, MINAE-SINAC, FENOPEA, The National University, APTC, FECOP, MarViva Foundation, ProNature, and Conservation International.

The following regulations are among the proposals that could be included in the new plan:

- A closed season for bottom line use in the Puerto Jimenez-Cabo Matapalo sector.
- The restriction of certain types of hooks.
- An auto control system of minimum sizes, carried out by the fishermen.
- The prohibition of sharks and rays targeted fishing.

The small-scale artisanal sector has had representatives chosen by FENOPEA, as well as from within the associations of fishers from all communities, including the fishing sector and the sector of craft trawling. It is expected that by 2014 the plan will be approved, and implementation will begin (J. Cole, personal communication, February 19, 2013).

Table 4. Allowed fishing fleets in the Golfo Dulce AMPR.

Allowed fishing fleets	Not allowed fishing fleets
• Artisanal small scale • Subsistence • Sport fishing • Tourist fishing	• Medium and advanced scale, regardless of the fishing gear • Artisanal drag • Semi-industrial trawling • Industrial • Underwater fishing with arbaleta

Source: C. Molina 2014.

Terrestrial Maritime Zone (Zona Maritimo Terrestre, ZMT)

The Maritime-Terrestrial Zone (ZMT, by its acronym in Spanish) constitutes a 200 m wide strip of land, measured horizontally inland from the high tide line on the shore. It includes islands, islets and sea boulders, as well as all land or natural formation that stand out over the ocean surface inside the limits of the territorial seas belonging to the Republic of Costa Rica. Law #6043 (March 3rd, 1977) regulates the ZMT in Costa Rica, and defines it as an area of public domain, part of the national patrimony, belonging to the State, inalienable and imprescriptible. Its protection, along with that of the natural resources existing in the area, is the responsibility of the State and all the inhabitants of the country. This law requires the participation of a number of public institutions at all different stages of surveillance and control, including the Costa Rican Tourism Board (ICT), town councils and the Institute for Housing and Urban Planning (INVU).

There are particular regimes in the ZMT to which this law is not applicable, such as National Parks, Biological Reserves, National Wild Life Refuges, Forestry Reserves and private properties registered on the National Register before the promulgation of the law #6043.

All of the regulations on the ZMT are crucial for the protection of sea turtle nesting sites, especially in subjects such as building activities and the installation of artificial lighting on the first 50 m of the ZMT (also called the public zone). It is also important to protect and maintain the vegetation present in the area, so that they can be a natural barrier to light pollution and to limit the access of people.

Marine Protected Areas

In Costa Rica, the official definition of an MPA is as follows (Art. 1 Decree Nº 35369, 2009): “any area of intertidal or sub tidal terrain, together with its overlying water and associated flora and fauna, and historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment”. Protected areas in general are defined by article 58 in Costa Rica’s Biodiversity Law as “geographically delimited areas, composed by land, wetlands and portions of the ocean. They are declared as such since they represent particularly valuable ecosystems, and threatened species, areas for recovery and reproduction, and other values, and because of their cultural and historical significance. These areas will be dedicated to the conservation and protection of biodiversity, water and soils, cultural values, and ecosystems services in general”.

Before 2008, there were seven management categories that put high priority on terrestrial conservation, ignoring marine conservation, with the exception of those protected areas that included marine zones under management categories like National Parks, Biological Reserves and National Wildlife Refuges. Each of these three categories has particular limitations, like absolute prohibitions of commercial and sport fishing, geographic restrictions (6 m at low tide for wetlands), and scope of conservation and management objectives for land-based wildlife rather than marine or insular species and ecosystems.

In 1995, the Government created a category called “Marine Multiple Use Area”. This category is not a management category; since its purpose is to create a single area combining a marine

protected zone and a buffer or influence zone. Regarding the different management types and different activities to be regulated, several authorities are responsible for regulating such activities including the Ministries of Environment, Security, and Agriculture as well as the Coast Guard.

In 2009, two additional management categories, entirely marine, were established: Marine Reserves and Marine Management Areas (Executive Decrees 34433, 35369). Marine Reserves are defined as coastal-marine and/or oceanic areas that ensure the maintenance, integrity and viability of natural ecosystems as a priority, benefiting the communities through a sustainable use of the resources, characterized by its low impact according to technical criteria. Marine Management Areas are defined as marine, coastal and/or oceanic areas where several activities take place in order to guarantee the protection and maintenance of the marine biodiversity on the long term (MINAET, 2009). These two categories shall pursue to benefit the communities (dependent on the use of resources), and for education, scientific research and monitoring. A comparison between MPA management categories regarding permitted and prohibited uses is presented in Table 5.

MPA Management Plans

Human interventions within MPA's and Wetlands are regulated by their Management Plan, which defines both zoning and regulation of uses**.** In cases where an MPA lacks a Management Plan, related legislation is applied.

Costa Rican environmental legislation has established three bodies participating in natural resources management: The Local Councils, established in 1993 via decree, Environmental Regional Councils, created in 1995 by the Organic Law of the Environment (Ley Orgánica del Ambiente) and the Regional Councils of the Conservation Areas, created in 1998 by the Biodiversity Law. These councils have similar responsibilities, integrating representatives from the community-based organizations, the NGO sector, the municipality, and representatives from the productive and the education sectors. The local council also counts on the participation of an MPA representative, as well as expecting the participation of the Conservation Area director on the Regional council.

One of the major roles of these councils is to participate in the design and validation of a management plan, and in the approval procedure. After it has been accepted by the COLAC (Local council) and the CORAC (Conservation Area Regional Council), an MPA management plan is ratified by the Conservation Areas National Council (Consejo Nacional de Areas de Conservacion, known as CONAC) and the executive director of the SINAC board.

Table 5. Comparison of Costa Rica's Marine Management Categories.

Management Category	Marine Reserve	Marine Management Area	Biological Reserves	National Park	Wetland	Wildlife Refuge
MPAs and extension	There are no MRs in the region	There are no MMAs in the region	Caño Island Biological Reserve Total: 55,33 km^2 Marine: 52,07 km^2	Marino Ballena National Park 52,29 km^2 of marine area 10 km coastline Corcovado National Park 13,56 km^2 of marine area Piedras Blancas National Park Coastline with the Golfo Dulce	Terraba-Sierpe National Wetland Lacustrine Wetland Pejeperrito	Río Oro National Wildlife Refuge
Conservation Objects	--	--	**Caño Island:** - Coral reefs - White tip shark - Humpback whale	**Marino Ballena:** Punta Uvita Coral Reef, Ballena Island, Tres Hermanas Rock, Humpback whales, and commercial importance species **Corcovado:** Mangroves and coral communities. **Piedras Blancas:** Piedras Blancas River Estuary, natural forest, Pacific agujon needlefish.	**Térraba-Sierpe:** Mangroves, Fisheries species nursery, Ramsar Site, Archeological assets.	**Río Oro:** Sea Turtles; it integrates the Osa Coastal Wetlands Corridor (along with Pejeperro, Pejeperrito and Laguna Azul).
IUCN equivalent category [11]	VI-Protected area with sustainable use of natural resources	VI-Protected area with sustainable use of natural resources	I- Strict Nature Reserve/ Wilderness Area	II- National Park	IV-Habitat/Species Management Area	IV- Habitat/Species Management Area
NON EXTRACTIVE USES						
Research and Training	√	√	√	√	√	√
Tourism and recreation	√	√	√	√	√	√

[11] Source: http://www.unep-wcmc.org/iucn-protected-area-management-categories_591.html

Tourism infrastructure	√	√	√	√	√	√
Environmental education and interpretation	√	√	√	√	√	√
Concessions of non essential services	√	√	√	√	**√**	**√**
Use permits	√	√	√	√	√	√
Marinas						
Motorized equipment	√	√	√	√	√	√

EXTRACTIVE USES						
Access to genetic resources	**√**	**√**	**√**	**√**	**√**	**√**
Oil exploration	⊘	⊘	⊘	⊘	⊘	⊘
Mining	⊘	⊘	⊘	⊘	⊘	⊘
Wildlife hunting	⊘	⊘	⊘	⊘	⊘	⊘
Subsistence[12]	**√**	**√**	**√**	**√**[13]	**√**	**√**
Artisanal: Up to 5 miles, business purpose.	**√**	**√**	⊘	⊘	**√**	**√**
Commercial: **- Small scale 3 miles (license required)**	**√**	**√**	⊘	⊘	**√**	**√**
-Medium Scale: 40 miles	⊘	**√**	⊘	⊘	⊘	⊘
-Advanced: 40 miles, long line or mechanical means	⊘	**√**	⊘	⊘	⊘	⊘
Semi-industrial: trawling and fences (Shrimp, sardines, tuna)	⊘	⊘	⊘	⊘	⊘	⊘
Industrial, factories is prohibited	⊘	⊘	⊘	⊘	⊘	⊘
Sport fishing and recreational (non-profit)	**√**	**√**	⊘	⊘	**√**	**√**
Tourist fishing profit	**√**	**√**	⊘	⊘	**√**	**√**

[12] If it is permitted by the **Management Plan**

[13] Management plan indicates zones where it is permitted

II. Citizen Stakeholders of the Osa and Golfito marine region

The sustainability of livelihoods is very much grounded in the action of local organizations ranging from individual resource users to businesses and local government bodies. Groups such as fishermen's associations, watershed committees, and village councils provide the institutional structure for local ecosystem-based initiatives and the resource rights and management authority devolved from the state. In the coastal region of Osa and Golfito, the following types of groups are working:

Table 6. Groups working in the coastal region of Osa and Golfito.

Social Stakeholders	AMUM South Pacific
Artisanal fisheries and *piangua* [14] cockle pickers groups	8
Tourism organizations	7
Cooperatives	1
Federations	2
Nongovernmental organizations (NGOs)	11
TOTAL	29

Fuente: Marín 2012.

The two federations that were identified in the South Pacific area work closely with fishermen and NGOs, but do not have important connections with the tourism groups, despite the fact that FECOPT specializes in these topics. It is possible that this federation is developing ties outside the current network.

Local organizations have many qualities that make them effective in local settings, but face significant challenges as well. More specifically, some of the challenges are related to the fact that women often have a limited role in the economy, mostly working in tourism and local commerce. In general, their involvement is scarce in the fishing activities, though they sometimes contribute to the preparation of bait and other fishing equipment and with fish storage, especially in Golfito. Participation is much more common in the extraction of piangua in Golfito and Sierpe.

[14] Piangua is the local name for Anadara sp. The locally called 'piangüeros' often do not identify themselves as being fishers, even if they occasionally fish (Andrés M. Cisneros-Montemayor, pers. obs.).

Another challenge has to do with the very low participation of the fishermen, cockle pickers and tour operators in the community development associations. Limited cases of involvement occur when the development associations (ADIs) work closely with the marine resources users association.

BOX 3. Promotion of Responsible Artisanal Fisheries: the PASE project

PASE is a Project that aims to promote responsible artisanal fisheries in Osa, based on the protection and conservation of the coastal-marine ecosystems of the region to achieve the goal of sustainable fisheries.

Currently, the project works with around 100 artisanal fishermen of Osa, from four different associations and it is part of the Program for the comprehensive attention of the artisanal fisheries and cockle collectors of Osa, led by the Osa Municipality, IMAS (Institute for Social Assistance) and Playa Tortuga Reserve. The program consists of three complementary activities:

1. Continuous Training in relevant topics such as fair commerce, biocommerce, SMEs, responsible fisheries and conservation. The focus of this activity is to prepare the participants to take part on the other two components of the program, by giving them the necessary knowledge.

2. Research on marine resources, fishing stocks of commercial value and related ecosystems. This is done with a combination of fieldwork and the use of information already available in other institutions. A secondary goal of this section is to use the information gathered for a better management of the Terraba-Sierpe National Wetland.

3. Commercialization based on the idea of practicing fair trade and responsible commerce on a local level, to provide better economic benefits for the fishermen and a more sanitary product for the consumer.

So far, the program has taught two training modules on responsible fisheries, bio-commerce and marine protected areas. The project also prepared a diagnostic analysis of the fishing communities in Osa and used this information to establish the first links with hotels, restaurants and other local businesses that are interest in collaboration with the program. They were also able to establish connections with institutions such as UCR, PHD-ICE, INA, SINAC, INCOPESCA, SENASA and ICT to support the Project.

The challenge for the program now is to strengthen the fishermen associations and to work towards a better local commercialization of the fisheries products. It is also necessary to establish business plans for local initiatives and pertinent market studies, and continue training the fishermen on key topics such as accounting and marketing.

Source: ACOSA. 2013; Vargas, 2013.

Furthermore, when it comes to marine and coastal resources, the communities are most concerned about the impact of illegal fishing gear, over exploitation, pollution-- especially downstream effects of agriculture on the steep parts of the watersheds, and the "low efficiency" of the governmental authorities that are responsible for managing the use and conservation of resources (Román & Angulo, 2013).

The promotion of closer relations between institutions and civil society is a key necessity if efforts are to be more effective. This is often stressed by the National Coastguard Service, and is a stance shared by different local associations. Community participation can be promoted throughout institutional plans or programs (Marín, 2012).

Progress towards a green economy must promote community-driven development. This approach requires paying attention to the needs of local organizations for capacity building and continuing support as these groups slowly mature and develop their institutional capabilities, technical skills and connections (UNDP-UNEP Poverty Environment Initiative, 2011).

Local ecosystem-based initiatives can be quite diverse. Many are small business enterprises focused on generating income from the sale of nature-based goods and services such as fisheries or tourist experiences. Other initiatives focus not on a single business, but on facilitating better management or more equitable access to a particular natural resource used by the community.

The level of outside support influences the structure and activities of initiatives. Outside actors such as NGOs, universities, donors or government agencies often play a constructive role as catalysts, partners and providers of support services such as training, technical advice or networking with other community groups involved in similar efforts. Some initiatives benefit from substantial direction and support from government or international agencies.[15] Others, such as producer cooperatives or local business consortia, help ecosystem enterprises produce a high-quality product or gain access to markets. Still others, like self-help groups or savings groups, help marginalized groups organize and empower themselves to join an ecosystem based initiative or start their own initiative (UNEP, 2011). According to Marin (2012) there is a strong tendency in Costa Rica's South Pacific for many stakeholders to stay completely isolated from networks, far from the centers where information concentrates.

Table 7 provides a synthesized view of most entities working in the region which boost local strengths and provide support to community stakeholders focused on leveraging marine and coastal resources.

[15] UNDP. ENABLING LOCAL SUCCESS: A Primer on Mainstreaming Local Ecosystem-Based Solutions to Poverty-Environment Challenges

Table 7. Entities that provide support services for local stakeholder development.

Service	Service description (examples)	Services that are been provided		
		State/ Government	Non Government	References to specific projects or programs
Capacity building: Technical training	Fishery extension services, technical training in ecotourism skills and business management, including tour guiding, first aid, computer skills, conversational English	INCOPESCA INA (National Learning Institute), Public Universities (TEC, UCR, UNA, UNED) through social and extension services	Sustainable Artisanal Fishing Project (PASE, acronym in Spanish); located in Playa Tortuga Reserve Pretoma GEOPORTER Neotropica Foundation Keto Foundation	Sustainable Artisanal Fishing Project (PASE, in Spanish) See box 3 http://accionsocial.ucr.ac.cr/buscar?search_api_views_fulltext=pase
Social capacity building	Group Facilitation, leading visioning and team/building		NGOs* such as COOPESOLIDAR	
Business skills training	Coursework in accounting or other financial skills, internships and mentoring programs		FUNDECOOPERACION	
Resource analysis and forecasting	Timber assessment, fishery stock assessments, resource mapping	INCOPESCA ACOSA-SINAC	WideCast, Pretoma, FAO BIOMARCC, INOGO, Costa Rica Por Siempre Assocciation, Osa Conservation Keto Foundation, CIMAR	http://www.cms.int/news/PRESS/nwPR2013/10_oct/nw_221013_project_of_the_month.html
Marketing	Market research, outreach to new distribution network advertising	Economy Ministry Tourism Board (ICT)	Mar Viva Foundation Keto Foundation CRUSA Foundation	
Legal Services	Writing contracts and reviewing permits regarding natural asset use	SINAC, SETENA ZMT department at Municipalities, Some universities' projects provide assistance to local users of natural assets		http://www.setena.go.cr/viabilidades.html
Advocacy	Political organizing and advocacy addressing government agencies and	Consultorios juridicos at UCR	Federations such as FENOPEA, FECOPT Coalitions such as Frente por los Oceanos, Coalición Costarricense por las	http://www.fecop.org/category/nuestros-temas/

Service	Service description (examples)	Services that are been provided		
		State/ Government	Non Government	References to specific projects or programs
	legislators; Technical analysis, application of environmental legal framework to economic projects		Ballenas Frente Comunal por el Golfo Dulce Mar Viva Foundation	https://www.facebook.com/pages/Frente-Comunal-por-el-Golfo-Dulce/174658242683776?fref=ts
Enforcement	Patrolling fishing grounds, rangeland to prevent inappropriate or illegal activity	COASTGUARDS, TAA SINAC Park Rangers INCOP (Port Authority)	Tour operators, tourism guides, local based groups	: http://www.costaricaporsiempre.org/assets/global/pdf/Control-and-Surveillance.pdf http://www.incop.go.cr/objetivos_y_funciones.php?p=15
		The National Strategy of Maritime Control and Surveillance promoted by Costa Rica por Siempre Association and Conservation International		
Communication and outreach	Newsletter profiling initiative activities or products; webpage describing initiative goals, activities and results	Municipality of the Osa operates a news channel. ACOSA-SINAC organize an annual meeting (called Taller de Acciones Marino Costeras) where different stakeholders projects, initiatives and results regarding marine issues are disclosed	Tourism Chambers NGOs webpages	http://www.gobiernolocalosa.go.cr/rss.html
Financial services	Banking services including loans, savings and checking accounts	For specific information on financial services: see Camacho, 2013	Fundación Integral Campesina, FINCA - Lending Community Enterprises (Empresas de credito comunal) PPD, TNC, BID, PNUD Non refundable funds for sustainable entrepreneur groups	http://www.fincacostarica.org/impacto.htm
Financial sources based on conservation of ecosystem services		SINAC International Cooperation projects: Barreritas, Barreras, BID-Turismo, BID-Golfos, Costa Rica For Ever, Canje de Deuda por Naturaleza EEUU-CR.		http://www.sinac.go.cr/documentacion/Proyectos/Proyectos%20de%20Cooperaci%C3%B3n%20Internacional%20en%20Ejecuci%C3%B3n.pdf
Risk management	Property insurance; crop insurance; disaster preparedness	CNE, National Commission for Emergency and CIMAR throughout MIOCIMAR (a center of oceanographic information);	Private insurance companies that insure tour operators activities, vessels, equipment, etc.	http://www.miocimar.ucr.ac.cr/

Service	Service description (examples)	Services that are been provided		
		State/ Government	Non Government	References to specific projects or programs
		Local Emergencies Committees; INS National Insurance Institution		
Certification	Sustainable certification, best practices program	ICT Sustainable Tourism Certification, CST	Rainforest Alliance Best Practices for coastal lodging FAO Fisheries Code; Keto Foundation's Sea Star System for Marine Tourism Activities; MSSS for fishing; PASE, sustainable fishing practices for artisanal sector (see box 3)	http://www.fundacionketo.org/seastarsystem.php http://www.marviva.net/index.php/es/marviva-promueve-el-consumo-responsable-de-pesca
Tax preparation	Preparing tax returns and rendering tax advice	Ministry of Hacienda (Treasure Minister)	Private sector contractors	

Source: compiled by the authors, based on the categories suggested by UNDP-UNEP Poverty Environment Initiative, 2011 .

III. Stakeholders Network and Linkages

Networks and associations can magnify and extend the collective action often critical to the success of ecosystem initiatives**.** They allow initiatives to receive the latest information on local resource conditions, markets and technologies. In networks, stakeholder groups more easily stay aware of available support from governments, NGOs and development agencies. They are particularly useful in fostering innovation and experimentation. They provide a platform for initiatives to share lessons learned with others facing similar challenges, and can be a mechanism for undertaking joint research or field trials. In this way, they lower the risks to those in the network of adopting new technologies or ecosystem management strategies. Promoting learning networks is thus one way of increasing the adaptive capacity of initiatives-providing a route to more successful sustainable development (UNDP-UNEP Poverty Environment Initiative, 2011).

In light of these opportunities, we have included the following section, based on the analysis of the characterization of institutional and civil society stakeholders in the South Pacific AMUM, part of the BID Golfos-SINAC project[16].

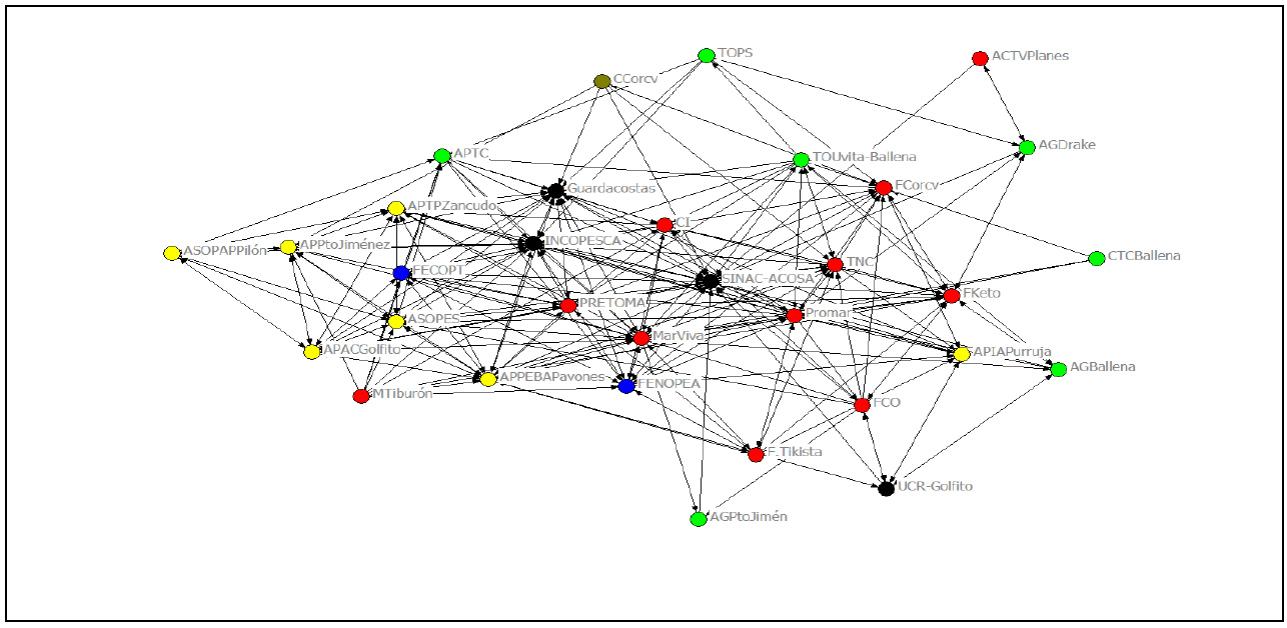


Figure 11. Institutional and social stakeholders linkages in the South Pacific AMUM.

Black: Government institutions; Yellow: Groups of fishermen; Blue: unions; Red: NGO; Green: Tourism groups.

[16] The project "Integrated management of coastal and marine resources of the Multiple Use Marine Areas (MUMA) of the Gulf of Nicoya and the Southern Pacific in Puntarenas province, also known as "BID Golfos" is implemented by Mar Viva Foundation hand in hand with the National Conservation Area System (SINAC) with funding from the Inter-American Development Bank (IDB)/Global Environment Facility (GEF). The project aims to strengthen policy frameworks and local capacity for using resources sustainably, and to improve and systematize information for making decisions using environmental and economic criteria. Source: http://www.marviva.net/index.php/en/proyects/idb-costa-rica/integrated-management

Source: (Marín, 2012). Identificación y Caracterización de Actores Institucionales y de la Sociedad Civil Claves en la Gestión de las AMUM Golfo de Nicoya y Pacífico Sur.

The network is dominated not by individual actors, but by very cohesive blocks of stakeholders. The cooperation and alliances network in the South Pacific AMUM presents an important core around which all other players revolve. The most impactful projects and actions are being centralized by a well-defined group of actors. The entire South Pacific network depends first on the NGOs standing together, and second on governmental institutions. The absence of any of these entities can generate significant divisions in the network.

All of the members of this network can influence others, which means that they can all be recipients of information or coordinators of proposals. Despite the low cohesion, the fact that all of the entities involved know each other makes it easier to obtain an efficient joint response to any possible emergencies, although these responses may not be permanent. A good example is the campaign organized against the tuna farms in Golfo Dulce. The social dynamics in the South Pacific greatly depend on geographic distance and people's ability to afford transportation to meetings and other activities.

There are three geographical sub-networks in the South Pacific AMUM, plus another one defined by the joint work of two of these sub-networks:

A. Punta Banco a Golfito.
B. Puerto Jiménez a La Palma.
C. Bahía Ballena, Sierpe y Drake.
D. Networks A y C.

The fishermen's association of Rio Claro, Pavones, is the central axis that keeps network A together, and the fisherman's association (ASOPES) in Puerto Jimenez is key on network B's cohesion. The tight connections that keep networks A and B united are led by a number of organizations. This diversity gives the networks stability and increases the chance that they will join together on projects. The Costa Rican Tourist Fishing Association (Asociacion Turistica de Pesca Costarricense, ATPC) in Puerto Jiménez is the key link for network C, and its relationships with the other networks, because of its connections with the La Perla Tour Operator, from Sierpe.

Each stakeholder is important in maintaining network dynamics, along with the relationships that define the sub-networks. Regarding these relationships, it is possible to identify 21 "modular structures" in the South Pacific AMUM, which is evidence of the intense involvement of all stakeholders and their efforts to participate in multiple ways, as well as the extension of their connections.

Any action working to secure this social network needs to be designed to allow the participation of all members, always considering strategic actions to obtain the best results over the least amount of time. It is necessary to take action to consolidate these networks in a way that actors can respond in an efficient way to the region's social and environmental issues and take advantage of development opportunities.

Amongst these sub-networks there are what are called “Bridge-players” which have control over the information and the way it gets distributed to other participants. They concentrate the power up to the point that they maintain the cohesion of the network (or otherwise cause its fragmentation) avoiding scattered efforts, resources and opportunities. The actors with the strongest connections are Mar Viva, ProMar, Keto Foundation, the Fishermen’s Association of Pavones, TNC, Ballena Tour Operators and FENOPEA. The following table synthesizes each stakeholder’s role in the South Pacific network:

Table 8. Stakeholders’ main roles in the social networks of the South Pacific.

Role	Justification	Stakeholder name
Socially dynamic	Can easily convene groups or start larger processes	MarViva Promar
Reference, popular	Other stakeholders can take part on the process because of their sole presence	Coastguards
Intermediary	They are important because they help in the efficient diffusion of information	Fundación Keto
Intersectoral connectors Key connections	Keep the network cohesion Important to achieve relevant agreements with key stakeholders	Fundación Keto, APTC Promar, Fundación Keto, Asociación de Pescadores de Pavones
High impact on management	Experience and wide knowledge on responsible fisheries	FENOPEA
Representation of sectors non-generally considered as decision-makers	Guaranteed participation of these usually non-represented sectors	APIAPU in Golfito
Diverse members coming from different communities	Wider diffusion of information and more reality-representative decision making	APTC in Puerto Jimenez

Source: (Marín, 2012).

The actors are important for the network and for the sub-groups of relationships that they maintain. In this sense, in the AMUM Pacifico Sur, there are identified many "backbones" of the network (21 exactly). The fact that clearly separate backbones do not exist provides evidence of the intense work on the part of all the actors in integrating through various mechanisms of participation.

Chapter 3. Marine ecosystems health and the wellbeing of coastal communities: Challenge and threats

Nearly all the human activities have at least some effect on the ecosystem in which they occur, including those upstream of marine ecosystems. Watersheds connect human actions on land to adjacent marine environments. These effects can be positive, as with protection or restoration activities, or more typically negative, as with most extractive activities and other forms of land use change.

Rivers are critical conduits that connect terrestrial and freshwater aquatic habitats with the coastal ocean. Integrated watershed management is of the utmost importance, to assure that the development of activities at any location in a watershed have the smallest possible impact on other areas. This vision depends on the conservation of strategic resources (quality and quantity in the case of water), the control of erosion where it may negatively impact lower elevations and marine ecosystems, and efforts to prevent damage caused by natural threats such as floods. For this particular case, it is key to maintain forest coverage at high and middle elevations to increase rainwater retention, which has a delaying and laminating effect on water moving down the slope. The Costa Rican Water Law (N°276) and Forestry Law state that all waters are of public domain. These laws define a protection area for riverbeds of 15 meters on each side in rural areas, 10 meters in urban areas if the terrain is flat, and 50 meters in urban areas if the terrain is steep. Furthermore, the National Plan for Soil Management and Conservation sets regulations for the protection of soils and determines the intervention criteria for the remediation of soil resource issues. However, the Executive Decree n° 31051-MAG-MINAE-S-HACIENDA-MOPT established priority areas for the execution of the National Plan for the 2002-2012 period, which did not include any areas in the Osa and Golfito Region.

3.1 Land use changes and downstream effects: a long standing threat in the Osa and Golfito Region

Key links between various landscape plans and marine systems (like the Terraba-Sierpe mangrove estuary and the unique tropical fjord, Golfo Dulce), involve changes in nutrient loading rates (particularly nitrogen), pollutants, organic material and sedimentation. Landscape alterations for new agricultural development, road building, or urban development inevitably lead to removal of ground cover, which increases these loading rates, especially when alterations occur on steep slopes.

Nutrient loading can benefit fisheries when nutrient input is relatively low, due to increased productivity, but can also lead to fisheries collapses if nutrient loading leads to excess production and hypoxia (Halpern, McLeod, Rosenberg, & Crowder, 2008). In this section, we briefly examine to key sites, the Terraba-Sierpe National Wetland and the Golfo Dulce, that are highly exposed to upstream pressures threatening marine biodiversity and coastal livelihoods.

I. The Térraba-Sierpe National Wetland

The Térraba-Sierpe National Wetland presents a striking example of the impacts of land use change on ecosystems. In this case, the main driver is agricultural expansion to the north, where there are large plantations of oil palm, bananas, rice, teak and some cattle grazing. The constant use of fertilizers on these crops and the manure produced by the cattle farms are two of the probable reasons why this area presented concentrations of ammonium slightly higher than other sites sampled in the region (Arscott, Eldridge, & Sweeney, 2010).

A 2012 study on pesticide pollution on the HNTS detected at least one type of pesticide in the tissues of each of nine species of fish and shellfish tested (Eldridge, Arscott, & Sweeney, 2012). They found that the concentration of these chemical substances varied depending in part on the ambient concentrations, with higher concentrations found in the tissue of those individuals collected from the most polluted areas. The analysis determined the presence of 21 different pesticides, of which 3 are of restricted use and 11 are banned substances, including DDT. This confirms reports of obsolete agrochemicals still in storage in the area, presenting a threat of pollution with substances that are proven to be more harmful than the ones currently in use (Fournier & Ruepert, 2007). The fish with the highest concentrations of these banned pesticides came from downstream sampling sites, far from the farming areas that are using pesticides nowadays, which might mean that the banned pesticides detected came from persistent legacy residues rather than recent applications.

In the most recent inspection to the HNTS by the TAA, they determined that there are currently no environmental management or preventive measures taken to protect this fragile and vulnerable area or to reduce the environmental damage. This is in contrast with what happens in the Osa Peninsula, where constant controls decrease the negative environmental impacts to levels far less than those found in Sierpe and the Fila Costeña (Tribunal Ambiental Administrativo, 2012).

Although the TAA recognizes SINAC as the entity working for the protection of natural resources in the area, it has also confirmed a lack of both material and human resources in the HNTS region, which makes it difficult for SINAC to do an efficient job. The peninsular sub-regional office works in an orderly and well-planned manner, in coordination with the TAA and other governmental bureaus. It is still necessary to establish a work plan involving ACOSA and the Rural Development Institute (INDER), so that they can assume their corresponding roles on the environmental issues regarding land use change in forested areas under INDER's jurisdiction (Tribunal Ambiental Administrativo, 2012).

II. The Golfo Dulce

The Golfo Dulce is a unique system already facing many challenges. Tropical fjords are rare and the sill separating the northern basin from the southern basin inevitably traps nutrients and resulting production, along with organic material entering the gulf. This material sinks and decomposes leading to a permanently anoxic basin at 200m depth, with a surface mixed layer above the sill at 60m depth. The shoreline of the upper basin supports a number of critical habitats including coral reefs, as well as small-scale fisheries. The first oceanographic survey of Golfo Dulce was done in 1971[17] and has only been repeated in a limited number of locations (H. Molina, personal communication, May 25, 2012). A physical-oceanographic investigation based on field experiments and applications of a numerical model was carried out by CIMAR. The field program was carried out in the Golfo Dulce from a small boat on three short cruises, of 3 days each, in 1999 and 2001. The purpose of the program was to sample data to describe the main characteristics of circulation and hydrography of the Golfo Dulce. The results obtained determined that the circulation on the waters in the gulf is slow, due to both the topography and the ocean current patterns. The superficial layer of the water has low salinity and higher temperature. This is stable through much of the year, given the fresh water inflow coming from four rivers.

Threats such as gold exploitation, the use of agrochemicals, the opening of new roads and untreated sewage are characteristic of the watershed around the Golfo Dulce, the Corcovado National Park sector and the Golfo Dulce Forestry Reserve (RFGD). A 2004 paper on oil pollution at a number of marine sites in Costa Rica reports concentrations of petroleum hydrocarbons that are well under the maximum permitted values found, and in some cases, the concentrations were so small that they went undetected by analysis methods used (Acuña-González, Vargas-Zamora, Gómez-Ramírez, & García-Céspedes, 2004). Polychlorinated biphenyls (PCBs) are another important pollutant found industrial materials such as electric parts, ship oil, hydraulic fluids, and in some pesticides. It would be expected to find residues in the water, sediments or concentrated in marine organisms. However, a 2006 study, which tested marine worms that feed on sediments, found only very low to non-detectible concentrations of PCBs (Spongberg, 2006).

Metals such as iron and manganese are necessary for biological functions in small concentrations, but act as pollutants at higher concentrations, causing stress and even death to many marine organisms. Other common metal pollutants are mercury, cadmium, zinc, copper and lead. For the Golfo Dulce, it has been determined that the Golfito Bay has the highest values of iron found in sediments than any other of four sites sampled around the country in 2004. The same was true for copper concentrations, while they found zinc at the second highest concentration and lead at the third highest (Acuña-González *et al*., 2004).

With regard to gold exploitation, it is believed that two artisanal gold diggers working in a river can cause damage 2-10 kms downstream. In the 1990s, it was estimated that these gold diggers

[17] Richards, F.A., J.J. Anderson & J.D. Cline. 1971. Chemical and physical 0bservations in Golfo Dulce, an anoxic basin on the Pacific coast of Costa Rica. Limnol. and Oceanogr. 16:43-50.

were removing 2000 cubic meters of soil daily within the RFGD. This activity affected both the rivers and marine ecosystems, producing up to 2 tons of sediments per day (Beita-Sandí & Barahona-Palomo, 2010). In June 2013, a joint investigation by ACOSA and the National Police estimated that 9656.6 square meters inside the protection area had been affected by this persistent threat. Over 15638.6 cubic meters of material had been removed from the river beds of six rivers in the PNC (equivalent to 1954 dump trucks) (SINAC, 2013).

BOX 4. Gold exploitation

In the Osa Peninsula there is an important amount of alluvial gold. In the 1930s during the so-called "gold fever" the illegal gold exploitation became an important economic activity in the region due to lack of land availability, unemployment and the marginal socioeconomic conditions.

This type of gold extraction requires the removal of sediments that subsequently need to be washed in a water current to separate the gold from the soil, sand and gravel, releasing a large amount of sediment into rivers and streams. There are three types of gold extracting techniques, artisanal, industrial and mixed, each causing different environmental impacts.

In 1982, there were at least 10 mining companies using heavy machinery and extracting up to 150g of gold per day. Between 1981 and 1989, about 4500 kg of gold were extracted from the Osa Peninsula.

In 1985 approximately 1400 gold miners destroyed about a third of all aquatic ecosystems in the southern part of the Corcovado National Park, even though this activity was illegal.

Gold mining is still a threat in the region for its high market value (27.000 colones per gram, about $54 at the current exchange rate). It is believed that there are still hundreds of gold miners in the region, despite the fact that there have been stronger controls in place for many years now, including environmental education programs for offenders. In June 2013, ACOSA authorities and the National Guard identified 63 extraction spots causing alterations in the six rivers located in the Corcovado National Park.

Stronger controls, awareness-raising and livelihoods alternatives are probably needed to reduce the number of illegal gold miners.

Sources: (Dirzo et al, 2013; SINAC 2013; Lobo, J. y E.Chacón, 2009).

Hebbeln and Cortés studied the sedimentation process of the Golfo Dulce in 2001. They found a large proportion of non-biogenic material, reflecting the dominance of terrigenous[18] sediment input to Golfo Dulce, and that biogenic components such as organic carbon and carbonate are also supplied from terrigenous sources. The two components, however, originate from different parts of the coast surrounding the gulf (Svendsen *et al*., 2006).

Terrigenous sediments have affected several reefs in the Golfo Dulce. Sedimentation has increased because of deforestation in surrounding watersheds, road and tourist complex

[18] Terrigenous refers to Geological deposits formed in the sea from material derived from the land by erosion.

construction, and inappropriate agricultural practices (Alvarado, Cortés, Esquivel, & Salas, 2012a). A significant reduction in reef accretion has been observed in reef cores from Golfo Dulce, which scientists attribute to recent terrigenous sedimentation (last 50 years) produced as the area was deforested for banana plantations (Cortes *et al*., 2010).

In ACOSA, as in the rest of the country, the inappropriate disposal of household wastewaters is an important threat to watershed health, as the area does not have any treatment system. 78% of total houses use septic tanks, 18% use latrines, 3% don't have a sewage disposal facility and 1% uses other disposal systems. A 2006 study sampled the waters of the Golfito Bay, finding contamination levels of bacterial coliforms high enough that the water was no longer suitable for swimming (García, Acuña-González, Vargas-Zamora, & García-Céspedes, 2006).

Wastewaters flowing into the Golfo Dulce and the HNTS also increase nitrogen concentration in the form of nitrates. These contaminants, along with the nitrogen from fertilizers, pollute underground waters (Sierra, Vartanián, & Polimeni, 2003). The problem is likely underestimated, as some studies have determined that there are rivers with water quality parameters that show little to no impact from human activities. For example, Rincon River exhibited low to non-detectable nitrate and phosphate concentrations, compounds that are usually used as indicators of the presence of pollution by fertilizers (Beita-Sandí & Barahona-Palomo, 2010). However, the sediments of this river contain pesticide residues (JICA & ICT, 2001).

A paper from 1998 reports the presence of organochlorinated pesticides in sediments collected from 9 sites around the Gulf, including core samples taken at depths between 20-200 m. The samples coming from shallower areas of the Gulf contained residues of almost all 15 pesticide types they tested the sampled for. Even more interestingly, the sediments from the deeper areas contained 8 of these pesticides, meaning that the sediments that get transported from the rivers get carried to those depths, contaminating the Gulf at all possible levels. However, the anoxic conditions of the Gulf's deep basin make it the ideal setting for the breakdown of these substances, since they biodegrade anaerobically (Sponberg and Davis 1998 in Nielsen-Muñoz & Quesada-Alpízar, 2006).

The cumulative effects of various activities in land or in water may substantially affect major ecosystem services, either those directly tied to market-based valuations, and in many cases, those services not accounted for in the usual sector-by-sector analysis. For example, activities associated with provisioning services such as seafood (either wild caught or farmed) or offshore energy necessarily affect supporting services such as coastal wetlands that provide habitat for wildlife and buffers from natural disasters (Halpern *et al.*, 2008).

Even minimal amounts of coastal engineering that remove nursery habitat for a fished species or decrease recruitment into an estuary (as with a protective channel jetty that inhibits an inlet passage for larvae, combined with low catch rates that fall below the maximum sustainable yield), may seem to be sustainable when considered in isolation, or even if considered together, because they are assumed to have additive effects. With due regard of those interactions, one of the greatest challenges in understanding how various human activities affect ecosystems is that consequences of these activities often interact in a manner that is not simply additive (Halpern *et al*., 2008).

Some measurements of nutrient and pesticide concentrations have been made, but there seems to be little (or no) information on stream flows. To estimate nutrient or pollutant loading, one needs measures of nutrient or sediment concentrations and estimates of flow rates. We did not have access to a hydrologist for this study, and given the huge variance in stream flows from the rainy to dry season, getting good data on flows would be challenging. If nutrients, agricultural chemicals, organic inputs, and sedimentation are as important in this system as elsewhere in the world, managers in Osa are likely to need these data to estimate total pollutant loading to vulnerable ecosystems.

3.2 Non sustainable fisheries

I. Shrimp fisheries

The vast majority of commercial fishing activities and landings are concentrated on the Pacific coast of Costa Rica, which covers approximately 1254 km (Wehrtmann *et al.*, 2009). Bycatch and discarding in industrial-scale shrimp trawl fisheries have resulted in large-scale depletion of Costa Rican fish populations, and a waste of potential economic benefits. The information gathered up to 2008 shows that the amount of bycatch has decreased by 90% relative to 1986, the peak of shrimp landings. It is acknowledged that there is a major problem of unreported data. Nevertheless, this is a classic sign of overexploitation and subsequent depletion of non-target species, particularly as no bycatch-reducing devices are currently used by the trawling fleet (Alvarez & Ross, 2010).

A greater retention of commercially valuable bycatch also has the effect of reducing discards and may make up for some of the economic impacts of lower shrimp catches. However, this does little to offset the much larger economic losses that have come with overfishing of shrimp resources, and thus simply serve as a minor subsidy to maintain excessive trawling effort (Trujillo *et al*., 2012). Shrimp trawling has been one of the most significant sources of fishing mortality in Costa Rica's marine ecosystem. Moreover, the trend of progressively moving from shallow coastal waters to deeper offshore waters on the Pacific Ocean, with no visible recoveries in shrimp stocks, implies that there is nowhere new to go. Shrimp trawling in Costa Rica is extremely unpopular with artisanal fishers, does not employ a substantial amount of people, and has significant environmental impacts on marine populations and habitats (Alvarez and Ross, 2010). Furthermore, it has depleted shrimp populations to the point that their commercial importance is compromised (Tabash, 2007 in Trujillo *et al*., 2012). It therefore seems clear that this is a fishery in urgent need of reform and a substantial reduction in intensity.

Sea turtles are an ecologically important bycatch species, with leatherback (*Dermochelys coriacea*), olive ridley (*Lepidochelys olivacea*) and hawksbill (*Eretmochelys imbricata*) turtles caught in Costa Rica. Though we do not address this issue in this study, it is important to mention that, following large-scale exploitation for meat and eggs, significant positive advances in turtle conservation have been made in Costa Rica, including the creation of MPAs and the monitoring of nesting beaches by NGOs and park rangers, communities and volunteer groups.

BOX 5. 106 Sea turtles death in the Golfo Dulce

On January 2013, 106 Olive Ridley (*Lepidochelys olivacea*) and Green (*Chelonia mydas*) Turtles were found dead floating on the Golfo Dulce waters, between Pavones and Punta Burica, which is part of the Marine Responsible Fishing Area of Golfo Dulce (Área Marina de Pesca Responsable de Golfo Dulce, AMPRGD).

According to the information gathered by different environmentalist organizations, the turtles died of forced submersion caused by fishing gear, although the official histopatology report issued weeks later by SENASA (National Service for Animal Health) deemed the cause of death as unknown, after performing necropsies on the turtles.

Members of local fishermen associations reported the presence of 15-20 longliners fishing for living bait inside the AMPRGD and using that bait to catch Marlins, which seriously affects the migration of this species and causes the incidental catch of other organisms such as turtles that are later discarded for not having commercial value. These sea turtles, which are included on the UICN red list of endangered species, are an important part of the ecosystems and can be used as bioindicators of the quality of their habitat. They have been reported to be a source of food for jaguars on the Corcovado National Park and also have economic importance for tourism, since people come to see them nest and in some towns there are programs for the responsible use of turtle eggs, so the inhabitants of these areas get an economic benefit without harming the animals.

Increased government collaboration and protection is needed to ensure that sea turtle conservation work can proceed, as the death of conservationist Jairo Mora Sandoval clearly demonstrates.

II. Large Scale fisheries: the case of tuna fishing

Tuna is an important commercial fish. In 2011, 4,230,000 tons were caught worldwide, with 70% coming from the Pacific Ocean. 488,178 tons come from the Eastern Pacific Ocean (EPO) (IATTC 2011), with about 23,000 tons specifically from Costa Rican waters. In 2013, there were high selling prices of $5.50 to $6.50 USD per kilo, with a record of $1.76 million for a 222 kg bluefin tuna fish on the Japanese market in January (FAO Globefish, 2013).

All of the tuna fishing activity on the Pacific side of Costa Rica takes place within the Exclusive Economic Zone (543,842 km^2). It is done by both Costa Rican artisanal fishermen and by foreign

vessel fleets using licenses issued by the Costa Rican Government, partly in order to keep the tuna canneries functioning. In the last 10 years, the foreign fleets captured over 90% of all the tuna caught in this country's waters, taking all of this production to international markets with only 15% of the total catch landed in Costa Rica. This presents a complex array of social, economic and environmental issues, since about 100,000 people living on the Costa Rican Pacific coast depend on fishing as their main source of income, and the international high-tech fleets compete on a level that cannot be matched by the Costa Rican fishers (FECOP, 2013). In addition, the huge amount of fish captured by these fleets has caused a 24.75% decrease in the total biomass captured from 2002 to 2011 (Cubero-Pardo & Martínez-Cascante, 2013).

There are 5 species of tuna exploited in these waters: Yellowfin Tuna (*Thunnus albacares*), Skipjack Tuna (*Katsuwonus pelamis*), Bigeye Tuna (*Thunnus obesus*), Black Skipjack Tuna (*Euthynnus lineaus*) and Frigate Mackerel/Bullet Tuna (*Auxis thazard/A. rochei*). Most of the large industrial vessels use purse seine nets, which are long nets that enclose schools of fish along with other accompanying fauna, resulting in a high percentage of bycatch. During 2002-2011, this fleet embarked on 1512 fishing trips in which 84% of the sets were done on tuna schools found alongside dolphin pods, causing dolphin bycatch. Some sets are made on tuna schools found on their own, but it is preferred to fish on those associated with dolphins, because surfacing dolphins make it easier to locate the tuna. Of Costa Rica's total tuna catch, 85% are Yellow Fin Tuna, with all Yellow Fin schools caught using the dolphin association (Cubero-Pardo & Martínez-Cascante, 2013). These fishing techniques are illegal in Costa Rica because of the negative environmental impact they have on marine fauna, with some reports estimating the amount of bycatch at around 15,000 tons per year. The bycatch includes 52 species other than dolphins, including sharks, sea turtles, marlins, billfish, and other kinds of juvenile fish (Ramírez, 2013 ; Trujillo *et al*., 2012).

The case of tuna farm project

In 2004, a private company by the name of Granjas Atuneras del Pacifico S.A., presented a project to SETENA (National Technical Environmental Secretariat), to seek validation of the environmental viability of a tuna farm 1.5 km off the shores of Punta Banco. The project consisted of 10 cages, each 50 m in diameter, placed in open waters at a depth of 40 m. They proposed to farm Yellow Fin tuna weighing 30-80 kg, captured by tuna ships in areas adjacent to the cages. These fish would be fed with imported frozen sardines to increase the weight of each individual, with the goal of obtaining an average of 120 tons of fish per cage on a 3 month feeding cycle, with 3 cycles per year (MINAET-SETENA, 2011). The fish would then be processed and exported, mainly to the Japanese market. This project was given environmental viability in 2005, which is valid for 2 years, but did not start development. In 2011, the project was denied an extension to the viability, due to a breach of administrative procedures. Prior to that, in 2006, several organizations had prepared a report in which they presented all the negative impacts that tuna farms could have on the environment, including the increase in concentrations of organic matter coming from the tuna's excretions, the non-consumed food and the by-products of evisceration during processing. This increase could have caused anoxic conditions in the bottom habitats if the natural benthic community was not able to properly

decompose the additional organic matter, as well as causing elevated nutrient concentrations and bottom sediment accumulation. This eutrophication process can also cause an increase in dinoflagellate populations, with the associated risk of red tides (The Nature Conservancy, CEDARENA, Fundación Promar, Conservación Internacional, & FundaciMarviva, 2006). Along with these issues, the environmental community claimed that the Tuna Farm could affect the migration of different species of whales which use the Golfo Dulce area and its vicinities to breed, or cause entangling of these whales, dolphins or sharks (Oviedo-Correa, Pacheco, & Herra-Miranda, 2009). This argument is uncertain since the net pens were not constructed, so this behavior was not observed.

The local governments and the people of the region are faced with the challenge of finding better ways to exploit their tuna resource. The government may need to reconsider the current regulations on international fleets, to improve conditions for the local fishermen and allow them to take better advantage of the fishing stock. It would be possible to create new incentives, such as lower prices for fishing gear or access to better technology for the locals. The State could benefit as well with the increased landings in Costa Rica, the potential for additional jobs, and the opportunity of increased tax revenue**.**

III. Shark Finning

Fisheries of large pelagic species, such as sharks and tunas, are very difficult to monitor in Costa Rica. A significant source of uncertainty comes from the large foreign fishing fleets that operate in the region *(Trujillo et al.,* 2012), with foreign markets driving demand (Clarke *et al.*, 2006). One particularly problematic practice is that sharks are often dressed at sea, so that only shark trunks are recorded in catch statistics. A large part of the difference between the data supplied to FAO and reconstructed shark catches is based on our assumption that recorded landings after the onset of laws prohibiting landings of shark trunks without fins or heads reflects a change in landing practices, but not fishing practices at sea. For example, a recent issue of debate has been the landing of shark fins at private docks, which are not subject to government inspection (Andrés M. Cisneros-Montemayor, pers. obs. en Trujillo *et al*., 2012).

In October 2012, the Costa Rican government signed the decree N°37354 that makes the importation of shark fins illegal (MINAET-MAG-SP-MOPT-H., 2012), declaring a “zero tolerance” policy towards the practice of capturing sharks, de-finning them and throwing the body back into the ocean while the shark is still alive, after years of research and pressure by environmentalist organizations. Even though this decree represents an important first step towards the protection of the sharks, further policy and enforcement is necessary to achieve the “zero tolerance” goal. A “zero tolerance” policy would include other measures such as a total prohibition of both importation and exportation of shark fins, adequate regulation of shark fishing and the commercialization of shark products in the national market. Instead, the only measure this decree puts in place is the requirement of a certification issued by the country of origin, stating that the fins imported were embarked while still attached to the body of the shark. This certification can be easily forged due to loose customs control, making it difficult to enforce this policy. As there is not a substantial market in Costa Rica for shark fin, as

there is for the shark meat, regulation of the whole process of shark fishing may be appropriate, such as minimum capture sizes, selective fishing gears, ban on the capture of stingrays, establishment maximum percentages of shark by-catch and the protection of the reproduction sites of these animals (Gutiérrez, 2013).

Another potential problem with this decree is the lack of regulation on exporters of the fins. More comprehensive policy could regulate the distribution and commercialization of the fins once unloaded in the country, since there is no sanction on the commercialization of illegal fins. Given these facts, the challenge now is to promote the modifications needed on this legislation so that the goal of a "zero tolerance" will become a reality in the future (Gutiérrez, 2013).

The FAO has reported a decrease in shark landings, which can be considered to represent a decrease in catch, but the estimated amount should be inflated by 40% when converted to whole shark weight. This presents a good example of the importance of adequate monitoring of regulated fishing practices. The existing policy efforts in Costa Rica are a solid foundation for future work related to the decrease of unsustainable shark fishing practices. Despite the need for expanded policy and enforcement to meet the "zero tolerance" goals, the current regulatory framework can serve as a basis for other countries trying to achieve sustainable catches to take their first steps towards this goal (Trujillo *et al.,* 2012).

3.3 Climate change and its consequences for the region of study

Human activities have had an impact on global climate since the mid 1800s, with an average temperature increase of about 0.8°C. This augmented temperature has had visible consequences, such as the retreat of northern hemisphere snow and Arctic sea ice in the last 40 years, the retreat of most mountain glaciers since the 1850s, and an increase in heat storage in the oceans during the last 50 years. There was an increase in sea level of 1-2 mm per year in the 20th century. The greater concentration of carbon dioxide in the atmosphere and ocean has already caused a drop of 0.1 pH units since the pre-industrial era, which represents a 26% increase in the ocean's acidity. Ocean pH is projected to drop an additional 0.2-0.3 units over this century (Church, Gregory, White, Platten, & Mitrovica, 2011; Doney *et al.*, 2012).

I. The Warming Events: El Nino Southern Oscillation

El Niño Southern Oscillation (ENSO) is a phenomenon characterized by a change in Pacific sea surface temperature that occur every two to seven years. These swings in temperature are accompanied by changes in the subsurface of the ocean, variability on the equatorial easterly trade winds, shifts in atmospheric convection and an overall change in meteorological patterns that lead to variations in rainfall and general weather in various parts of the world (Collins *et al*., 2010). The current process of global warming may affect the occurrence of ENSO, with some climate models suggesting that global temperature increase will result in a more El Niño-type average state (Benestad & Pierrehumbert, 2006). Some data suggests that the ENSO can

have an impact on sea level, and there are reports of predicted increases in sea level of up to 20 cm (Kennedy *et al*., 2007 , Latif & Keenlyside, 2009).

ENSO events have caused significant reduction of live coral communities in Costa Rica, with an extensive coral bleaching during the 1982-83 event (Cortés *et al*. 1984 in Quesada-Alpízar & Cortés, 2006) which caused a mortality of about 50% of the corals at Isla del Caño (Guzman *et al.* 1987 in (Quesada-Alpízar & Cortés, 2006). In 1992 and 1997-1998 there were two more El Niños, that again caused bleaching, but in both occasions mortality was lower and recovery was faster than in 1982-83 (Guzmán & Cortés, 2001 ; Cortés & Jiménez, 2003). Coral reefs at Isla del Caño were affected during severe phytoplankton blooms in 1985, which may have been associated with La Niña. During the bloom, mass mortality of corals occurred down to 3 m depth, completely eliminated some coral species from the shallow reef zones (Guzman *et al*. 1990 in Quesada-Alpízar & Cortés, 2006).

In addition, mid-day low tidal exposure of Eastern Pacific reefs during La Niña years causes extensive mortality of reef-flat organisms (Eakin & Glynn 1996 in Cortés & Jiménez, 2003). Mortality due to low tides had been observed at Isla del Caño and Corcovado. In general terms the coral reefs of Costa Rica are recovering, but degree of human activity will directly affect this recovery (Quesada-Alpízar & Cortés, 2006).

There are other physical and chemical changes in the oceans that are consequences of global warming, such as stronger stratification, alteration of ocean circulation patterns, changes in precipitation and freshwater input, changes in salinity, and reduced subsurface oxygen concentrations. All of these changes have happened rapidly in the last few decades, and their combined effects may determine the way in which different organisms adapt or will adapt in the future to the new conditions in their ecosystems (Church *et al* 2001). Amongst the traits that could be modified in response to changes in temperature and chemistry in the ocean are the physiological functioning, behavior and population dynamics of species, which can cause differences on size structure, spatial range, and seasonal abundance of populations. All of these shifts will bring adjustments on the biological networks as they will produce variations in species interactions and trophic chains, from the lower levels such as decomposing bacteria, to primary producers, primary consumers, fish, sea birds and sea mammals (Doney *et al* 2012).

One of the projected effects of global warming and the resulting increases in ocean temperatures will be that the habitat of many species will move pole-ward from their current locations. This will increase the risk of extinction for many species that are already vulnerable, such as those with limited climatic ranges, restricted habitat requirements or small and isolated populations (Gitay *et al*., 2002). Warmer waters will also cause coral bleaching, and the associated negative impacts on the whole ecosystem. There will also be developmental impacts, such as changes in the age of sexual maturity, time of spawning, growth and survival of most fish and cephalopods. The increase in water temperatures will also result on a decrease in upwelling events, so fewer important nutrients will be transported from the deeper waters to the surface. This will affect many ecosystems that depend completely on upwelling nutrients, for example the ecosystems around the Galapagos Islands and the areas along the coast of California in the United States (Conservation International, 2011).

In Costa Rica specifically, the effects of climate change on the ocean have become evident. Increasing sea level has pushed the shore lines inland as much as 50 meters in some areas, causing erosion and the displacement of human settlements. In some coastal towns in the Central Pacific whole abandoned houses and buildings have been lost from sight. In the Southern Pacific, the towns of Zancudo and Pavones have been most affected, according to Oceanographer Omar Lizano (Lizano & Gutiérrez, 2011). This scenario, along with an observed increase in precipitation towards the south of the Osa Peninsula, and an increase in 2-4°C for maximum temperatures and 1-3°C for the minimum, will likely have consequences on the distribution of species (MINAET- IMN, 2009). It has been estimated that by 2050 there will be important changes in the Eastern Pacific Ocean that will affect Costa Rican waters. About 1066 species of fish of commercial importance will migrate as much as 40 km towards the poles, affecting behavior of and outlook for local fishermen (cambioclimatico.org 2013).

There are organizations within Costa Rica, both private and governmental, currently doing research and proposing strategies to identify and mitigate the effects of climate change. The government is part of the SICA (Central American Integration System) and the Central American Commission for the Environment and Development (CCAD). In 2009 CCAD presented a Regional Strategy for climate change, in which they include management proposals in various fields. For example, since it has been observed that the temperature increase in the coastal areas has led to an increase in the populations of the Dengue transmitting mosquito, which has caused a greater expense for the Health System in Costa Rica, there was a specific proposal on public health. They have identified the loss of marine resources, flooding of coastal areas and salinization of coastal watersheds as some of the climate change related issues that need to be prioritized and addressed (Comisión Centroamericana de Ambiente y Desarrollo - CCAD / Sistema de la Integración Centroamericana - SICA, 2010).

One of the private projects producing data on climate change in Costa Rica is BIOMARCC, a project working on the marine biodiversity of Costa Rica and the potential for adaptation to the consequences of climate change. This project strengthens the work of the National System of Conservation Areas (SINAC) and the MINAE. It has been implemented by the German Agency for Development Cooperation (GIZ) on behalf of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), and its International Climate Initiative (IKI). They are currently working on many core topics, that include the State of Biodiversity, Management Effectiveness, Climate Change Vulnerability and Adaptation, as well as proposing management plans for Marine Protected Areas (Proyecto BIOMARCC, 2011)

3.4 Emerging Threats

I. The Diquís Hydroelectric Project

The Diquís Hydroelectric Project, currently in the planning stages, depends on the water of the Grande de Térraba River, which currently discharges into the Térraba-Sierpe National

Wetland. This is a Ramsar Site, which would be affected by a change in the Grande de Térraba River flows due to the dam operations.

The Osa and Golfito Initiative (INOGO) released a Case Study of the potential impact of the Diquís Dam on the Térraba-Sierpe National Wetland (HNTS) ecosystems (Umaña, 2013). The study reviews available technical information and explores the arguments of scientists and academics from several institutions, as well as those of experts from the ICE (the Costa Rican Electricity Institute)[19].

Diquís Hydroelectric Project has a number of ongoing sampling and scientific studies on the dynamics of this wetland's estuarine sector. The Administration of HNTS keeps a list of all the research generated by this project. Though this information is not public, it is expected that these results will be available to decision makers, as a base line to informed management decisions (J. González, personal communication, July 3, 2012).

The development of the Diquís Dam will alter the hydrology of the Grande de Térraba River, changing the seasonal patterns of flows into the top of the estuary. Some effects could be beneficial, such as sediment retention in the reservoir, but this will depend on erosion rates at the mouth of the estuary. Other effects such as changing the salinity profile and seasonal dynamics could drive structural and functional changes for mangrove ecosystems and their inhabitants.

The Diquís development, if it proceeds, would create a unique opportunity to quantitatively assess the effects of hydrological alterations on the mangrove ecosystem and the attendant ecosystem services. The Térraba-Sierpe estuary has 2 major inflows; the Diquís will be on the Grande de Térraba, and the Sierpe – which while far from pristine or unimpacted – could be used as a control. A Before-After-Controlled-Impact (BACI) design would allow the Diquís effects to be separated from other environmental effects with data on both systems before and after the dam is in place. This geography, with 2 inflowing rivers, provides a unique scientific opportunity. It could allow for careful assessment of the dam's effects. It could also potentially allow assessment of alternative hydrological manipulations currently being considered to mitigate the dam's effects.

II. Crocodile Bay Marina Project

During the development of this report, Crocodile Bay Marina was a central topic of discussion in the Osa and Golfito Region. INOGO has chosen to maintain neutrality in relation to this development. Why did INOGO choose to maintain neutrality? First of all, INOGO believes that the development pathway of the Osa and Golfito Region should be chosen by the people of the region, and that academic institutions in foreign countries are not in a position to voice an opinion. So what is the role of INOGO here? With this summary we aim to share the

[19] The Costa Rican Electricity Institute (ICE is the Spanish acronym), is the country's government-run electricity and telecommunications services provider and is also the institution in charge of the Diquis proposal, design, technical studies and future operation.

information that we were able to gather both from the groups who want to see the marina development and those who do not want to see the development.

The Crocodile Bay Marina, as described by Crocodile Bay representatives

The Crocodile Bay project in Puerto Jiménez began 14 years ago with the operation of the Crocodile Bay Hotel. The hotel employs an average of 120 staff and has contributed to the local economy in many other ways by contracting third parties for local tours and other hospitality-related services. Crocodile Bay describes themselves as one of the companies that generates the most employment in the Golfito canton (Williams, 2013).

The Crocodile Bay Marina project's stated plan is to build 107 slips (although they have approval for 259 slips), a two story hotel with 74 rooms, a multipurpose pier for community use which would also have a public commercial area, a parking lot, a public fuel station for boats, a wastewater treatment plant for the boats, an official office of immigration and customs and commercial premises for lease; and on the private property, 84 condominiums of one to three bedrooms would be built (Williams, 2013).

According to Williams (2013) the marina would use exactly the same area where the Crocodile Bay Hotel and its pier have operated since 1998. The project is located within the boundaries of the urban area of Puerto Jiménez and very close to the public dock. Nowadays, the presence of yachts and other fishing boats, in the absence of a well-equipped marina, leads to environmental damage due to the careless transfer of fuel, wastes, sewage, detergents, paints and others potential pollutants. More responsible marina operations would mitigate these impacts.

A study carried out five years ago by the Research Institute of Economic Sciences at the University of Costa Rica (Jiménez *et al*., 2010), indicates that approximately 3,700 sport fishermen with their own vessels have invested $278 million in fuel, maintenance, repairs, furniture, accessories, staff, crew, marina rights, taxes and insurances. Therefore, it can be argued that the establishment of facilities related to the vessel operation may present an opportunity for economic growth in Puerto Jimenez and surrounding area.

On the other hand, a marina takes about 20 years to get to its "mature stage". Los Sueños is the only marina that has reached complete occupancy, and it was opened in 2000. Marina Pez Vela has 100 slips and maybe 70 boats, though the projection was made for 200 to 300 vessels. In Papagayo, they have 180 slips with 35% occupancy (R. Soto, personal communication, February 19, 2013).

The opposition to the Crocodile Bay Marina

The Crocodile Bay Marina project has been approved by SETENA and declared environmentally viable. The project is currently waiting for the Golfito Municipality to provide construction permits in order to begin. Heated discussions are underway regarding the expectations of the

benefits that the project will bring, as well as concerns related to the environmental and social impacts of the marina and hotel development. According to González and Lobo (2013) the project also has already processed independent permits at SETENA to build two additional hotels (El Ceibo and Las Rosas) and to expand Crocodile Bay's existing hotel. The authors consider that this project is a marina-hotel complex which includes a set of four hotels, the marina, and its shopping infrastructure and facilities. For the construction of this complex, seven additional water wells would be constructed. The Ceibo project would be built on an area of 86,000 m^2, 30 buildings, 270 rooms, 6 pools and 2 tennis courts. Las Rosas would have 10,000 m^2 of construction, 26 buildings and 104 rooms. This infrastructure would be added to the existing Crocodile Bay Hotel (40 rooms) and the 74 new rooms of the Marina. These hotels would be located on both sides of the access road to the piers, covering an area of approximately 15 hectares in addition to the 25 hectares of impacted area in the sea (Figure 12).

Since the process has been divided into different records, SETENA has not assessed the cumulative impact of the project (water demand, pollution, noise, solid waste) or the cumulative and synergistic effects that the individual projects might have with respect to one another – during construction and operation – as well as with others in construction or operation in the area of indirect influence, as required by the SETENA Guidelines for Environmental Impact Evaluation. The practice of evaluating components of a larger project separately has been criticized by the Comptroller General's Office, which has drawn attention to how this procedure has served to reduce the perception of the impact of large real estate and touristic projects (González & Lobo, 2013).

Figure 12. Coverage of the Crocodrile Bay Marina Project.

Source: González & Lobo, 2013.

The Crocodile Bay Marina would enlarge an existing marina from 40 to 257 slips, which will require a 16-hectare landfill in front of the Preciosa-Platanares Wildlife Refuge. According to conservation specialists, the project would be built on an environmentally fragile mangrove area. The Maritime Terrestrial Zone Law establishes restrictions on the use and exploitation of the first 150 meters inland from the shoreline, which is public domain. In spite of that, the area that has been proposed for protection represents only a 29,58% of the total existing mangrove area of Rio Platanar River, while about 61,89% will be used for tourist development (Córdoba, 2013).

Seemingly ignoring the impact on the mangroves of the Rio Platanar River, the plan received authorization by the Institute of Housing and Urban Planning (INVU), The Costa Rican Tourism Board, and the Municipality of Golfito. A coalition of environmentalist organizations, professionals, students and people from different communities in the South Pacific then filed an action of unconstitutionality against Puerto Jiménez Master Plan that allows for a concession for a pier and the construction of a marina. Some of the plaintiff's arguments indicate that this plan and its zoning regulations were never submitted for consideration by the National Technical Environmental Secretariat (SETENA), which violates article 50 of the Constitution, the Convention for the Protection of Flora, Fauna and Scenic Beauty of the Americas, Convention on the Protection of the World Cultural and Natural Heritage and the Ramsar Convention (Francia, 2013).

The plaintiffs of the action asked the Court to declare the master plan unconstitutional and to cancel all concessions that have been approved based on this plan in accordance with precautionary principle, the right of access to information, the right to sustainable development and Article 50 of the Constitution, which expresses the right of each and every citizen to a healthy and ecologically balanced environment. The plaintiffs also requested that any regulatory plan approved without being submitted to SETENA be declared unconstitutional (Córdoba, 2013).

Comparative analysis of opportunities and threats

Another role that INOGO can play related to the marina project is to discuss the scientific information that is available and pertinent to this situation. For example, the fact that there are no reliable studies on the availability of water in the region is a concern, as it is difficult to plan for development without being able to understand whether or not there is sufficient water supply for existing and future development needs. Another helpful piece of information would be to better understand the navigation routes of key marine animals that use the Golfo Dulce such as dolphins, whales, and sea turtles, to evaluate the impact that the marina could have on these species, and to consider which navigation routes would be best for yachts and other boats should the marina be constructed.

In order to guide an objective and constructive analysis of the Crocodile Bay Marina Project, the following table lists 10 opportunities and 10 threats, based on available reports and conversation with experts:

Table 9. Opportunities and Threats of the Crocodile Bay Marina Project.

OPPORTUNITIES	THREATS
1. Increase in available jobs of about 30%. Puerto Jimenez would be the main source of work force, as it is nowadays, where 75% of Crocodile Bay Hotel staff is local. There could be a wider offer of direct positions (operative, administrative) as well as indirect positions such as captains, sailors, maintenance technicians, general services personnel, tourism, construction, gastronomy, health, others.	1. Absence of an approved Master Plan in Puerto Jimenez and areas of influence (ex. Golfito): It is expected that the project will generate jobs and will require hiring personnel from communities in the vicinity, so there will be an accelerated urban development which could stress local resources such as water, access to health care services, access to education, etc.
2. Some seamen think that public facilities related to the marina would provide them with better conditions, guaranteeing safe docking, adequate waste management, and the resolution of illegal situations related to nautical activities.	2. The country doesn't have a Navigation Law or any spatial planning for the marine territory in question, which means any navigation in the Golfo Dulce would be unregulated and could pose a thread to the wildlife that live there.
3. The marina would make it easier for government authorities to monitor boats, since more of the region's boats would be docked at one central marina. CIMAT – the National Marina Authority – would continue to monitor hydrocarbons and fecal pollution in collaboration with marina owners. Since 2012 CIMAT has been sampling to generate a baseline (including heavy metals and sedimentation). They have carried out a comparison between pristine places and areas where there are boats out of a marina., Methodologies of the US EPA are being applied to polycyclic aromatic hydrocarbons.	3. The institutions in charge of issuing permits and concessions for marinas and touristic piers are limited in terms of infrastructure, organization, resources and proper legal frameworks in order to guide and regulate these types of projects. Thus, any negative effects or further environmental alterations produced by the marine construction or operation won't be anticipated or detected in a timely manner that would allow for a rapid response.
4. Local tourism micro entrepreneurs and leaders of indigenous communities believe that the development of the tourism business, the marina and all associated activities will benefit the Boruca community, opening new markets to them. It will also mean new job opportunities for native people, who currently lack economic growth alternatives.	4. Increased development in the area could result in higher land prices, and an increase in land being purchased by foreigners. It is even possible that land in the indigenous reserves could be illegally bought and sold. Prices of services could also been increased, making them inaccessible for much of the local population.
5. The increase in the demand of supplies and services could stimulate the local economy.	5. The installation of marinas demands large amounts of services and critical resources such as water. Puerto Jimenez and the surrounding area does not have regional studies on the capacity of groundwater reservoirs or on the demand and supply of water (including illegal usage), it is thus impossible to determine the potential water available at this time.
6. The area will gain a higher status as a tourism destination for a wealthier segment of the market, mirroring what has happened in Garabito County in the Central Pacific, attracting more tourism, both domestic and foreign.	6. The current paradigm of green tourism and small local tourist businesses can easily transform into a Guanacaste-like model, which will eventually change the image of this destination. Even if the interest is to keep the existing model, the carrying capacity of the area is unknown.

OPPORTUNITIES	THREATS
7. The potential tourism sector growth could bring new training opportunities for the locals, which would greatly improve their possibilities of finding better jobs. Under this assumption, there will also be an impact on the female population, since they usually represent the majority of the services sector labor force. The tourism businesses could help to lower the high unemployment rate of this region's employable population.	7. Some "leisure" activities are associated with negative aspects of marinas and fishing events such as prostitution, drugs, tax evasion pose a high risk to young people in the local communities. The key issue is how these risks could be controlled?
8. Good practices tools like the ones already in place in other regions, such as the Blue Flag in Europe or the Clean Marine in the USA could be enforced.	8. The risk of environmental degradation due to hydrocarbons, sewage and other substance spillages could increase if the marina attracts a significant increase in vessels. There is also a biological risk of pathogenic organisms and the introduction of invasive species transported from remote marine sites.
9. The environmental quality is in part already undermined by other human interventions (sewage spills and fuels and other substances used regularly in the boat). The facilities that the Crocodile Bay Marine would provide for public use would allow for a safer disposal of sewage, oils, and other water products. The project could implement an environmental management plan to mitigate the different impacts that are affecting this area.	9. The marina would protect only 29,58% of the Rio Platanar mangroves, the area that is required be protected area under the Maritime Zone Law. About while 61,89% of what is currently mangrove would be used for newly constructed lodging. This ecosystem is an important nursery site for many marine species, including species of commercial interest.
10. There are stakeholders' networks (such as Frente Comunal por el Golfo Dulce) that watch over the protection of the environment, with the potential of generating constructive proposals.	10. The cumulative impacts of other megaprojects in the region – such as the proposed International Airport for the South – could result in a shift in the type of development in the region. While many community leaders have voiced their preference for small/medium family run hotels, these large-scale projects could push this region in another direction.

Compiled by authors based on: (Aguilar, 2013; Borowy, 2006; Córdoba, 2013; Frente Comunal por el Golfo Dulce, 2013; González & Lobo, 2013; Kioscos Ambientales-Universidad de Costa Rica, 2009; Pacheco, 2013; Williams, 2013).

CONCLUSIONS

The lack of documentation on subsistence and small-scale fisheries is the responsibility of government agencies charged with fisheries monitoring and management. The general lack of attention to such sectors continues to be driven by a misguided and erroneous belief that these sectors' small size and limited socio-economic importance means they have a small impact (Pauly, 2006 en Trujillo). New research suggests that small-scale fisheries may be removing biomass comparable to industrial fisheries globally, and that they provide livelihoods for more than 90% of fishermen around the world. A new research network on small-scale fisheries has an appropriate name, Too Big To Ignore (TBTI, www.toobigtoignore.net). While these sectors may be overshadowed by large industrial fisheries, it is precisely the socio-economic benefits and ecological sustainability of such localized fisheries that are not only vital to the welfare of coastal communities but will increasingly be fundamental to national food security, and therefore warrant better monitoring and reports.

Managers and stakeholders should consider establishing, as a joint effort, a monitoring program that targets deepwater resources and associated bycatch. Moreover, the use of more selective fishing methods should be encouraged in order to reduce the amount of discarded biomass, as well as to study possibilities for an adequate (commercial) use of the discards. At the same time, the establishment of temporal and spatial fishery regulations (in the context of cross-sectoral marine spatial planning efforts) should be considered to protect the threatened deepwater resources of Costa Rica.

As demand for tourism and fishing in coral reef areas increases, managers should consider whether new regulations are needed, and to designate scientific criteria related to the carrying capacity of dive sites. Reef sites should be permanently marked with mooring buoys. A diving etiquette, with coral conservation and protection as its main objective, must be elaborated and implemented.

During discussions with INOGO, regional experts made suggestions that pointed to a need for technical support for better management. Research, technical support and tools could include the following:

- To develop a data base on marine currents and satellite images. Aquatic systems productivity during the dry season can be viewed throughout satellite images. Productivity is related to the presence of false killer whales, a type of dolphin observed in South Pacific. Dolphin aggregations in river mouths could be an indicator of nursery fisheries site health.
- To monitor flows and movement of "food" nutrients, sediments, etc. from the estuaries through hydrological assessments and the use of technologies such as radar.
- To carry out bioacoustics studies to clarify potential how sonic effects coming from aircraft traffic due to the proposed airport project could affect wildlife (birds, marine

mammals) as well as vessel traffic, potentially increased by the marina. In general, carrying capacity studies.

- To strengthen the scarce research on agrochemicals with downstream impact on the Térraba-Sierpe National Wetland and other important watersheds, in order to determine the levels of toxicity reaching fish and shrimp captured by fishermen.
- To assess the economic, legal and environmental sustainability of using hand nets for shrimp fishing within the HNTS and other areas.
- Examine new approaches to increase institutional capacity to manage marine resources to sustain ecosystem services as development unfolds.

This may require some government reform, but also could involve building capacity at the community level to advance joint management for both landscape development and marine resources. There seems to be a great opportunity on the Osa and Golfito Region to build on existing relationships among government agencies, NGOs, resources users, developers, and other stakeholders to maintain and enhance the flow of benefits to people that this rich and productive region can provide.

The Osa and Golfito Region has been the subject of extensive study but remains threatened by fragmented approaches to development and a lack of good data to link landscape development to impacts downstream in important productive marine ecosystems. These ecosystems vary in terms of the level of degradation and stress they have already endured, so fully understanding impacts of human activities prior to expanding development is necessary. Large-scale landscape changes that alter hydrology and pollutant loads could have significant impacts on marine ecosystems and the ecological services they provide. Given the level of dependence on these services by local communities, development should proceed with solid plans to assess potential impacts and to make adjustments to sustain services. The local governmental and non-governmental organizations provide a solid foundation on which to build this adaptive management framework.

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