



**PEARL CAYS WILDLIFE REFUGE ASSESSMENT REPORT**  
**REGIÓN AUTÓNOMA DE LA COSTA CARIBE SUR, NICARAGUA**  
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## LIST OF ACRONYMS

BICU	Bluefields Caribbean and Indian University
CBL	Coastal Boundary Layer
DIPAL	Proyecto de Desarrollo Integral de la Pesca Artesanal en Laguna de Pearla
DPSE	Drivers-Pressures-Ecosystem Services-State-Response
EBM	Ecosystem-based Management
FADCANIC	Fundacion para la Autonomia y el Desarrollo de la Costa Atlantica de Nicaragua
FARENA	Facultad de Recursos Naturales y del Ambiente
IEA	Integrated Ecosystem Assessment
INPESCA	El Instituto Nicaragüense de Pesca y Acuicultura
MARENA	Ministerio del Ambiente y los Recursos Naturales
MPA	Marine Protected Area
PCWR	Pearl Cays Wildlife Refuge
RACCS	Región Autónoma de la Costa Caribe Sur
SEAR	Regional Autonomous Educational System
SERENA	Secretaría de los Recursos Naturales
URACCAN	Universidad de las Regiones Autónomas de la Costa Caribe Nicaragüense
WCS	Wildlife Conservation Society

## EXECUTIVE SUMMARY

This document represents the activities associated with grant funding from the Paul M. Angel Family Foundation from January 2015-April 2016. The grant proposal was written in a manner that would produce the foundation document for characterizing the Pearl Cays Wildlife Refuge (PCWR) and steps towards the development of a management plan for the region. A significant portion of staff time was spent on developing a literature review, conducting informational conversations to update our current understanding of community perceptions related to the refuge, holding workshops to bring together disparate information for this characterization and promoting awareness of the refuge through social media and community interactions. Activities and achievements from the first phase of the management planning project include:

- Develop the first conceptual diagrams of the Pearl Cays Wildlife Refuge for use in management planning
- Synthesize the biophysical and human dimensions of the refuge for use in guiding workshop discussions for management planning
- Defining indicators to measure ecosystem health and change over time
- Participate and sponsor 8 community workshops in partnership with government agencies to gather information from fishers who depend upon marine resources from the refuge for subsistence and income
- Hold 10 community workshops to gather input from the 12 communities in the Pearl Lagoon Basin to open a dialogue to explore management planning for the refuge
- Conduct informational conversations with community leaders, fishers, and agency staff on a one-on-one basis to gather tacit knowledge about the refuge
- Formalize a partnership with a local university, Bluefields Indian and Caribbean University to facilitate community-based management planning
- Create a WCS Nicaragua web page to promote information sharing about programming and activities <http://programs.wcs.org/nicaragua/>

WCS Nicaragua Marine Program and the communities of Pearl Lagoon thank the Paul M. Angell Family Foundation for funding support to facilitate management planning for the Pearl Cays Wildlife Refuge in Caribbean Nicaragua.

# INTRODUCTION

The Pearl Cays are located offshore of the central Caribbean coast of Nicaragua, Central America and encompass an area of approximately 700 km<sup>2</sup>. The marine and coastal ecosystem is comprised of coral reefs, seagrasses, mangroves, islands, rivers, and creeks that provide habitat for endangered species of sea turtles and manatees. The upland watershed is inhabited by indigenous coastal communities who depend upon the ecosystem services generated by these habitats (e.g., fish, tourism, coastal storm protection). In 2010, the region was declared a wildlife refuge, however, limited support has been directed to develop a management plan to protect and guide the sustainable use of the natural resources. A lack of a comprehensive synthesis of the Pearl Cays ecosystem consisting of baseline information about the habitats and inhabitants is needed to move forward. A synthesis that emphasizes participation from the communities living in this region is recognized as a first step in developing a plan that provides protection and wise use of resources, or ecosystem-based management. The Bluefields Caribbean and Indian University (BICU) and the Wildlife Conservation Society's (WCS) Marine Program have partnered to facilitate the management planning process. The goal of the project is to develop a community-driven management plan to guide conservation and stewardship of shared resources, using local knowledge to build a comprehensive understanding of the Pearl Cays Wildlife Refuge (PCWR) system.

## THE MANAGEMENT PLANNING PROCESS

Ecosystem-based management (EBM) is widely regarded as a method to improve the management of shared coastal marine resources. Effective EBM relies upon synthesizing our current understanding of the ecosystem and transferring this knowledge into management actions. Integrated ecosystem assessments are a framework used to conduct these scientific syntheses using knowledge and information from local communities, researchers, and resource managers. In this way, the highly technical biological, physical, and chemical aspects of the system are integrated with institutional and human dimensions science of the coupled socio-ecological system.

Integrated ecosystem assessments (IEAs) are completed using consensus building workshops. Participants are asked to identify the ecosystem components and processes that are characteristic of a sustainable and resilient coastal ecosystem that is producing ecosystem services at the level society desires (Levin and Wells 2008; Levin et al 2009; Levin et al 2013). Facilitated workshops are used to 1) conceptualize the ecosystem, 2) develop ecosystem indicators that reflect the health of the ecosystem, and 3) conduct risk analysis for identifying management strategies that meet the needs of society and the environment that incorporate climate change adaptations.

Workshops are structured to capture tacit knowledge through actively engaging participants in the management planning process. Participants, in this case community members, researchers, and managers are asked to draw a sketch of the ecosystem on poster board and to think about all of the elements of the natural and human system. These sketches are reviewed as a group until consensus on the diagram is achieved. Then participants are asked to identify flora or fauna that represent a healthy environment, things that can be measured (e.g., fisheries catch rates of lobsters or crabs) that they have seen change over time. Their experiential knowledge of the ecosystem is used to characterize the ecosystem. Then these elements can become the indicators of ecosystem health that have relevance to local communities who can see first-hand changes to these indicators over time. The workshop then leads to a discussion about the future of the ecosystem and associated resources and what the communities envision for the region. The facilitated conversations are used to identify management alternatives that incorporate risk and uncertainty, such as climate change. The information from the three workshop themes--

conceptualizing the ecosystem, developing indicators of ecosystem health, and management strategies-- and data and information from the literature is compiled into a synthesis. It is then shared with the indigenous communities in a workshop format to again allow for discussion for selecting a preferred alternative for managing the refuge and a strategy for implementation.

## PROJECT OBJECTIVES

**Objective 1.** Conceptualize the Ecosystem: Complete an integrated ecosystem assessment of the PCWR using a community-driven process, which relies on knowledge and information-sharing among local communities, researchers, and resource managers. A series of facilitated workshops will result in the identification of components and processes needed for a sustainable and resilient coastal ecosystem that is producing ecosystem services at the level society desires. Success will be measured by the completion of two conceptual ecological models as a starting point for improving the understanding of the PCWR ecosystem.

**Objective 2.** Develop Indicators of Ecosystem Health: A set of indicators that reflect biophysical and human dimensions of the PCWR will be developed through facilitated workshops and community meetings. Success will be measured by the completion of a minimum of five indicators (e.g., components of fisheries, well-being, protected species, habitats). Once developed, indicators will assist decision makers in understanding the condition of the ecosystem and where management actions may be needed to conserve, protect, or restore resources.

**Objective 3.** Identify Management Strategies: Stakeholders will develop an outline of management strategies using the conceptual diagrams and the indicators of ecosystem health. Using a workshop format and survey research, participants can begin to identify ways in which to allow wise use and conservation of shared resources within the PCWR.

## PURPOSE

The purpose of this document is to outline the information obtained to date related to the PCWR. The IEA process was used as a model for developing the plan and this report contains results from the first step in the process called scoping. Scoping consists of gathering information about the study site. Survey research and workshops were held to obtain information from stakeholders and synthesized into a summary report. The knowledge shared by the participants contributes to the summary reports and improving the understanding of the biophysical, institutional, and human dimensions of the refuge. The information below is comprised of the knowledge to date and this summary is considered a living document that will be refined and expand with new information gathered over time.

The deliverables for the first phase of management planning are:

- Literature review and summary information about the biophysical, institutional and human dimensions of the PCWR
- Conceptual diagrams of the PCWR
- List of ecosystem indicators that will be used to monitor ecosystem health
- Outline of management plan alternatives and implementation plan for the refuge
- Workshop summary reports



# METHODS

## LITERATURE REVIEW AND SUMMARY

The first step in the facilitation process began with a literature search of management planning, the biophysical environment, and social science. WCS staff found limited information available about the Pearl Cays region and expanded their research to include case studies examining management planning. A literature list was developed as is available in Appendix A. In addition, Appendix B includes an annotated bibliography of marine reserves (Fletcher and Gregory, *in press*). The literature was used to compile this report and new information will be added to the living document.

## CONCEPTUALIZING THE ECOSYSTEM – BIOPHYSICAL ENVIRONMENT

The Caribbean coast of Nicaragua varies in biological and physical form from the southern border with Costa Rica to the northern limits near Honduras. In the south, the continental shelf is a narrow band that runs along the coastline and to the north is a broad shallow shelf. Caribbean Nicaragua experiences extensive rainfall, an estimated 400-500 cm per year (Roberts and Murry 1983) in the wet “summer” season. The nearshore coastal environment is influenced by the terrestrial runoff during the rainy season carrying both sediment and nutrients from the land and lowering salinity levels. This coastal boundary layer can extend several kilometers offshore where it meets with the turquoise blue water of the Caribbean Sea. The marine influence is clearly noted in the clarity of the water and the ability to see a range of habitats-on the sea floor and the fauna found within the water column.

No formal studies of the benthic habitats (e.g. corals, seagrasses) or islands were found with the exception of mention in a local magazine (WANI 1992, 1993). Documentation for the boundaries of the refuge were found in government documents in 2010. The declaration includes the boundaries of the refuge noting the importance of the marine habitats and sea turtles. Gonzalez and Jentoft (2011) provide a detailed account of the process for developing the refuge.



Figure 1. The Región Autónoma de la Costa Caribe Sur (RACCS) is located in the southeast región of Nicaragua (golden area circled in blue). Source: <http://www.escolesdenicaragua.org/>

The Región Autónoma de la Costa Caribe Sur (RACCS) located in the southern portion of the Caribbean coast is comprised of the city of Bluefields and coastal populations located primarily along the coastal fringe (Figure 1). Gonzales (1995) documented a total population of 473,109 individuals living in the RACCS comprised of 72.54% mestiza, 18.04% miskita, 6.22% creole, 2.45% mayangna, 0.43%

Garifuna, and 0.32% rama. The RACCS communities are connected to the marine environment through the ecosystem services provided as regulating, provisioning, or supporting services (MEA 2005). These may be direct or indirect services such as fishing for food (provisioning) or climate regulation (regulating) or transportation (supporting). In this study, we will take a closer look at one particular area in the RACCS, the Pearl Lagoon Basin including the Pearl Cays Wildlife Refuge (PCWR) and the connection of people to the ecosystem (Figure 2).



Figure 2. Map of the Pearl Cays Wildlife Refuge with enlarged area of the Pearl Cays (Gonzalez and Jentoft 2011).

The PCWR is comprised of terrestrial and marine habitats. Terrestrial areas include tropical humid forest, mangrove and marsh vegetation (Incer 2002). The marine component of the refuge includes corals, seagrass, mudflats, algal reefs, the water column, and the habitats found on the 22 cays. A generalized conceptual diagram of the Pearl Cays Wildlife Refuge (Figure 3) has been developed to obtain tacit knowledge from the communities living in the region and is intended to capture the biological, physical, and human dimensions of the PCWR.

Conceptual diagrams are useful for building a common understanding of the biophysical environment that does not require, for the most part, translation into multiple languages since they use symbols to represent biophysical and human dimensions components of the ecosystem. The development of the conceptual diagrams is part of the Integrated Ecosystem Assessment (IEA) process. IEAs are one method to achieve ecosystem-based management (EBM) that in general, includes biophysical (biological and physical), institutional, and human dimensions in the management process. The integration of all three components is intended to present a holistic view of the ecosystem and factors to be considered when managing a coupled human-ecological environment.



Figures 3 and 4 were first developed as drafts for use during workshops and interactions with stakeholders. They are used to begin a dialogue about the PCWR and to document the present and past conditions in the refuge and to ask stakeholders what they envision for the future of the PCWR.

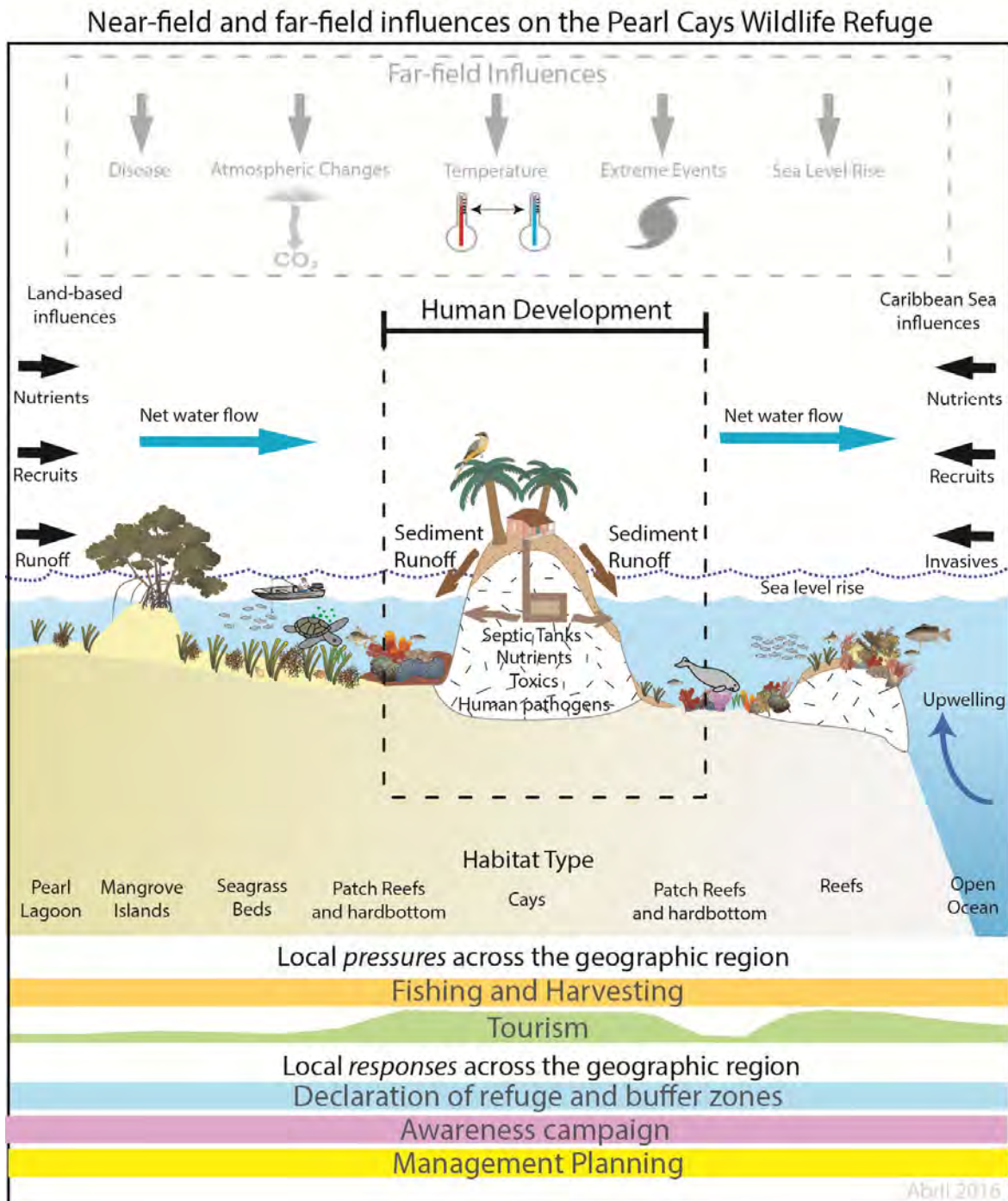


Figure 3. Draft conceptual diagram of the Pearl Cays offshore environment and spatial representation of pressures and responses affecting the PCWR.

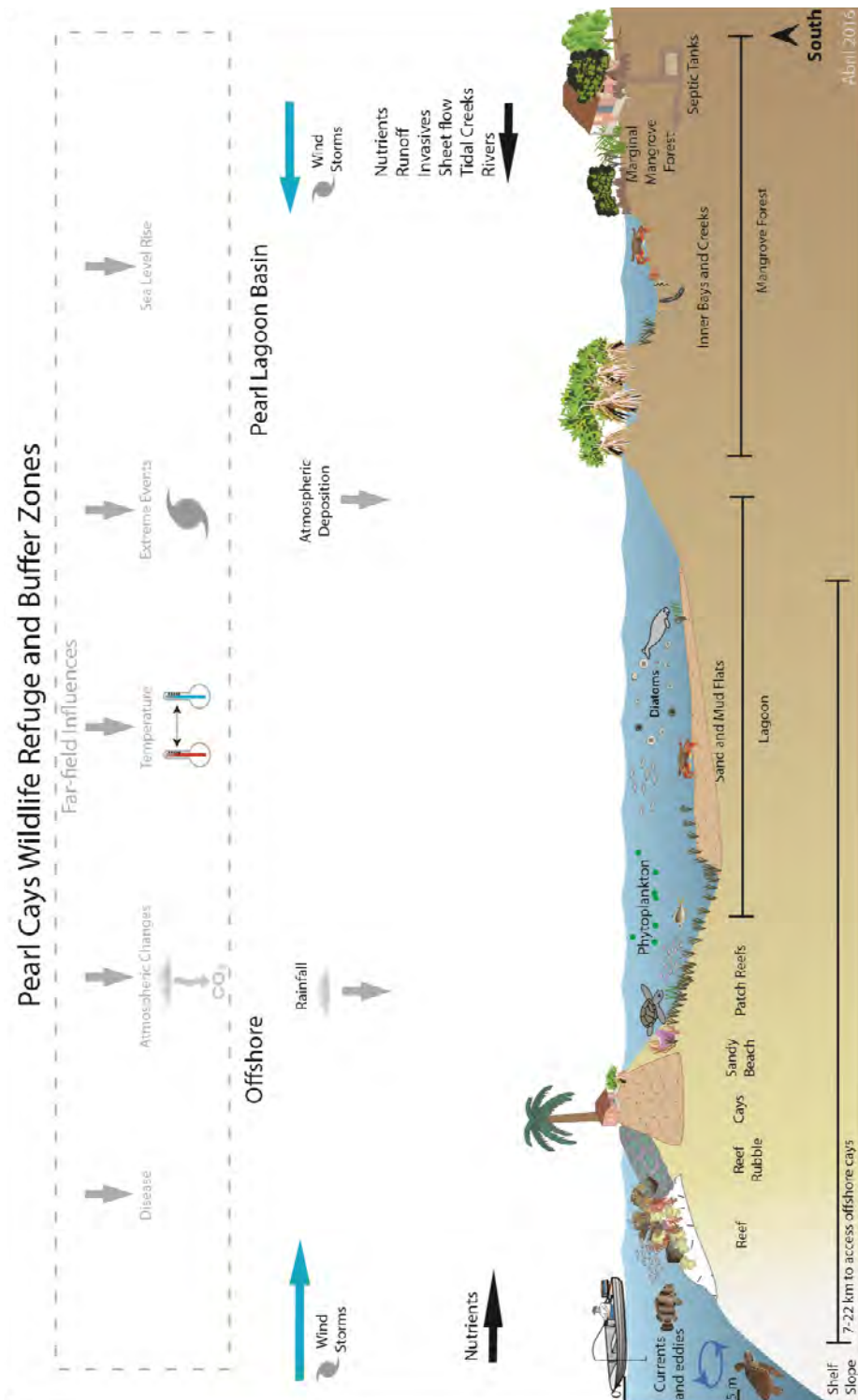


Figure 4. Draft conceptual diagram of the Pearl Lagoon Basin to the Pearl Cays offshore environment for use in obtaining feedback and input from stakeholders.

The IEA process relies on the DPSEIR model – Drivers-Pressures-Ecosystem Services-State-Response. The DPSEIR model is used worldwide as a tool to identify the multiple factors to be considered when developing a management plan. The model allows stakeholders to work in a step-wise process to outline the barriers and benefits for managing shared resources. The conceptual diagrams (Figures 3 and 4) can be used to develop a draft DPSEIR model, but then can be expanded to include additional information and specifics about each of the model components. The DPSEIR model was adapted from earlier studies in Florida USA (Fletcher et al 2014) for application in the refuge. The DPSEIR model definitions can be used as a guide for creating a location-specific model, in this case, for the Pearl Cays. WCS staff developed the DPSEIR model for the Pearl Cays (Figure 6) and shared it with their academic partner for review. The model will be used in community meetings and workshops throughout the management planning process.

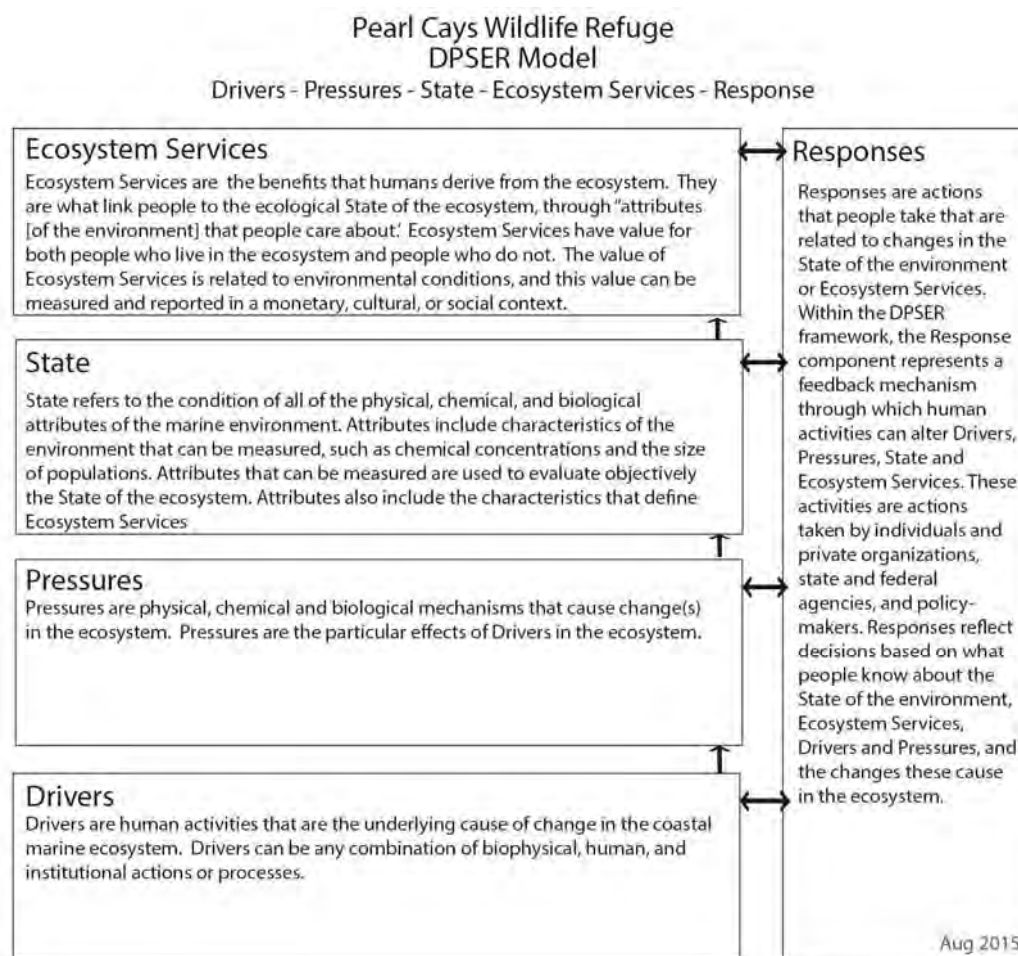


Figure 5. The Drivers-Pressures-Ecosystem Services-State-Response (DPSEIR) model components defined.

## Pearl Cays Wildlife Refuge Socio-Ecological State Model

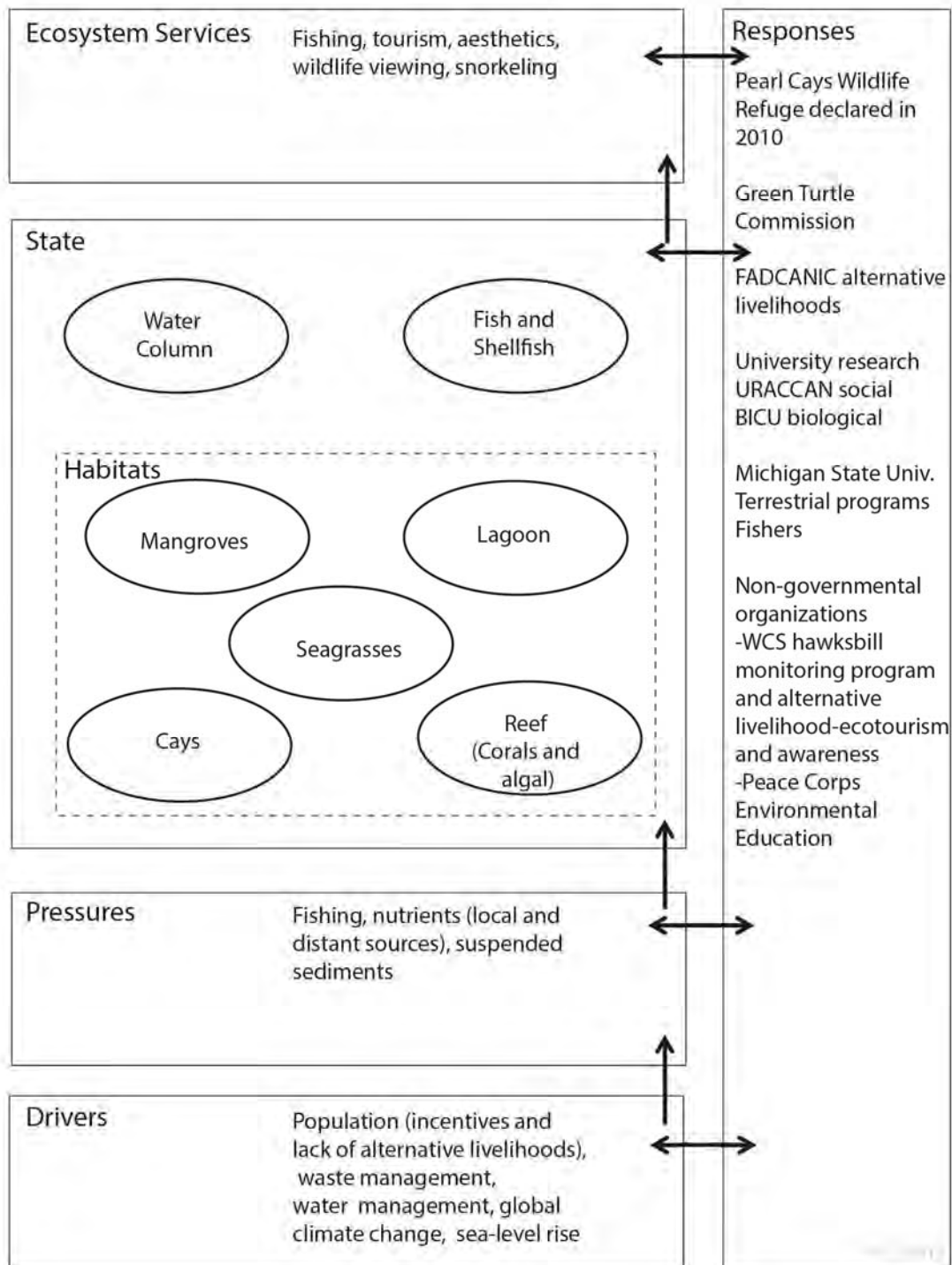


Figure 6. Draft DPSER model for the PCWR used for obtaining feedback and input from stakeholders.

To understand the model, definitions of each component are as follows:

*Drivers* are defined as those changes caused by human activities and these can be biophysical, institutional, and human-related. In the PCWR, the Drivers include population, waste management, global

climate change and sea level rise. When developing Drivers, it may be helpful to think about the global or broader-scale impacts to the environment. The Drivers can lead to more localized pressures on the ecosystem in the form of Pressures.

*Pressures* as described in the DPSEIR model relate to the mechanism(s) influencing the state of the environment and are often a result of the Drivers described above. Pressures in the PCWR are fishing, nutrients, and suspended sediments that are in the water column as a result of deforestation or manipulation to the terrestrial area of the refuge.

*Ecosystem Services* were defined using the Millennium Ecosystem Assessment (2006) Ecosystems and Human Well-being Synthesis and with input from Farber et al (2006), Costanza and Folke (1997), and Farber et al (2006). Emphasis on ecosystem services in the DPSEIR model was placed on recognizing humans as a part of the ecosystem and to later assist in developing indicators to measure the desired change taking place in a study area. Using the framework that ecosystem services include the benefits to humans entices one to think more broadly about the services (regulating, provisioning, and supporting) that exist for human well-being, economic gain, livelihoods, etc. Ecosystem services in the PCWR include fishing, tourism opportunities, wildlife viewing, snorkeling.

*State* refers to the ecological state of the habitat(s) within the study site. In the PCWR the States include water column, fish and shellfish, and then the habitats comprised of mangroves, seagrasses, cays, lagoon, reef (coral and algal). Few long-term monitoring programs exist in the PCWR to evaluate ecological state. Nevertheless, knowledge from community members can be obtained through survey research to make an assessment of the ecological State. The way forward for facilitation of a management plan needs to include some form of evaluation and long-term monitoring of ecological States is needed to assess if a management plan and the management responses are achieving the goals of the effort as initially outlined and implemented. Care must be taken to select indicators of the ecological state and support and resources to conduct monitoring are required to realize management planning evaluation.

*Response* in DPSEIR refers to actions human can take that influence all of the other components of the DPSEIR model. These can consist of management actions, enforcement, and extractive use. Response as shown in Figure 6 intentionally has double-headed arrows pointing to and from each of the other model components to show there are feedback loops to and from Response. This illustrates that far-field and local changes can instigate a response, and in addition, Responses can result in a cascade of impacts through the DPSEIR model.

## THE PEARL CAYS ECOSYSTEM

The PCWR ecosystem can be described conceptually, as most of the Mosquito Coast Lowlands Province, The Pearl Lagoon-Pearl Cays Integrated Coastal Land – Seascape” is develop into a mosaic of five ecosystems and their corresponding habitats, each of which is closely connected through ecological and physical-chemical processes (Ryan 1993b). Lowland rain forest, swamp forest and pine savanna are the principal terrestrial ecosystems found in the Pearl Lagoon-Pearl Cays coastal landscape (Christie 2000; Ryan 1993b). The aquatic ecosystem of the area is composed of the lagoon and connected rivers that drain fresh water into it, littoral and marine ecosystems (Ryan 1993b).

The PWCR include habitats which are presumed to host a rich but largely unknown biodiversity and are the base for the marine resources that sustain the livelihood of the local human inhabitants of the Pearl Lagoon Basin. This region is comprised of: terrestrial ecosystem, freshwater ecosystem including riverine

habitats and wetlands, brackish water ecosystem including mangroves habitats and estuaries, littoral ecosystem which includes sand beach coastline and coastal boundary layer, and marine ecosystem integrated by coral reefs, seagrass beds, and barrier islands habitats (Ryan 1992, 1993a, 1993b). The Pearl Cays ecosystem can be described using the DPSEIR model State components: Water Column, Fish and shellfish, mangroves, lagoon, seagrasses, cays and reef all of which are found within the Caribbean region of Nicaragua that includes a land-sea interface.

#### The land-sea interface

Freshwater ecosystem is defined as the complex of riverine and wetland environments (Ryan 1993b), on the Caribbean coast of Nicaragua this system consists of 13 catchments discharging into 56 rivers and tributaries (Nicaragua III report on the state of the environment 2007). There is a low alluvial floodplain that ranges in height from sea level to 20 m. The system is covered with palm swamps and mixed rain forest, and numerous backwater canals and creeks. These habitats represent a vital link (physical and chemical processes) for the functioning of all aquatic ecosystems on the Caribbean coast of Nicaragua (Ryan 1992, 1993a, 1993b; Ryan et al 1993; Ryan et al 1998).

Most often wetlands are at boundaries between terrestrial and aquatic ecosystems, which constitute transition zones between the terrestrial environment and Pearl Lagoon (Boavida 1999). While the defining the boundaries and ecological classification of a wetland could be problematic, the presence is noted in the coastal mainland of the Caribbean coast. As a result of periodic inundation by water, wetlands fall along a transitional zone between permanently wet aquatic ecosystems and dry terrestrial habitats, in this case, wetland boundaries may expand or contract over time (Bulluck and Acreman 2003).

According to Boavida (1999) wetlands are among the most important ecosystems on Earth. This is due to their ecological contributions to the global environment by improving water quality, recharging aquifers, flood control, and functioning as storm buffers. Wetlands also supply food and habitat for a diversity of local and migratory aquatic and terrestrial animals. Wetzel (1992) and Boavida (1999) found that retention and cycling of nutrients in the sediments constitutes a very important ecological function of wetlands are extremely important in the processing of organic matter and therefore contribute significantly to the productivity of aquatic ecosystems.

The central mountains of Nicaragua help define the watersheds, a portion of which drain to the Caribbean Sea. This hydrologic network covers approximately 85,600 km<sup>2</sup> representing 65% of the national territory and drains approximately 90% of the country's surface water (Ryan 2005; USACOE 2001). This system comprises the 13 river catchments among these are some of the largest rivers in Central America, including San Juan (39,545 km<sup>2</sup> basin area), Rio Coco (24,746 km<sup>2</sup> basin area), Rio Grande de Matagalpa (17,556 km<sup>2</sup> basin area), Escondido (12,308 km<sup>2</sup> basin area), Prinzapolca (10,548 km<sup>2</sup> basin area), among others, (Roberts and Murray 1998).

#### Water Column

The littoral zone is another important transition area between the land and the sea. It includes beaches and the coastal areas including the coastal boundary layer (CBL) (Ryan 1992; Ryan 2005). The CBL as defined by Ryan is described as a turbid belt of brackish water occurring shoreward edge of the coastal boundary current (no more than 10 km wide), where a ramp of terrigenous sediment forms the interface between the continental shelf and the shore line (Roberts and Murray 1983). According to Ryan (2005) this zone even though poorly studied, it is shown to be rich in nutrients and therefore highly productive, evidence of this is the use given by artisanal fisheries and even industrial shrimp trawlers in some areas.



The marine environment is described as the entire continental shelf of the Caribbean coast of Nicaragua. Covering a total area of 53,500 km<sup>2</sup> (Ryan 2005), it is the broadest of Central America, extending into the Caribbean Sea approximately 250 km in the northern portion of the region to 20 km wide to the south near the border with Costa Rica (Roberts and Murray 1983). According to Roberts and Murray (1983) this broad shallow shelf of carbonate substrate support the development of extensive fringing and patches coral reefs, seagrass beds, and large shoals associated with small offshore cays and islands. The area is presumed to sustain a diversity of wildlife, including many commercially and locally valuable resources, such as shrimp, lobster, sharks, scale fish, and sea turtles.

#### Fish and shellfish

Coastal lagoons are critical habitats for fisheries in Nicaragua (Marshall 2007; Jemieson 2011). Many tropical fish and invertebrate species spend part or all of their life cycle in mangrove lined bays and seagrass beds and then migrate offshore to mature and spawn (Jemieson 2011). According to Christie (2000), Pearl lagoon is an outstanding representation of coastal estuaries in Nicaragua and is found to play an important role in maintaining fish populations, both resident species and seasonal migratory species. Christie (2000) also states that ecological studies (e.g., DIPAL in 1996) confirmed by interviews of local fishers (CAMPlab unpublished data) show that there may be overexploitation, for example, a snook species (*Centropomus undecimalis*) that is exploited in the Nicaraguan fisheries, reproduces mainly just outside the lagoon's opening to the ocean. Larvae and post-juvenile snook migrate into the lagoon and upstream to develop as part of their life cycle. Other genera of fish, such as tarpon, snapper, and croaker, are likely to spawn offshore, with their juveniles using the lagoon as a nursery. The lagoon is also important for a number of threatened species, such as crocodile and manatee (Christie 2000).

#### Lagoon

Pearl Lagoon is an estuary. An estuary is defined as a semi-enclosed coastal body of water which connects with an ocean or sea within which sea water is measurable diluted with freshwater derived from land drainage (Pritchard 1996; Beatley et al 2002). According to Beatley et al (2002) this implies that estuaries are coastal aquatic systems formed by the mixing of fresh water from the riverine systems and salt water from the ocean. Additionally Dalrymple (1992) suggests that the estuaries are zones of interactions between rivers and a variety of marine processes, including tides and waves.

The total area of Pearl Lagoon, including Top Lock, Sunnie and little Sunnie, is approximately 571 km<sup>2</sup>, making it one of the largest of Central America (Roullot 1980; Brenes et al 2007). Four rivers provide the main source of fresh water to the Pearl Lagoon, these are: Rio Grande de Matagalpa (through an artificial canal that connect the rivers to Top Lock), Kurinwas, Wawasan, Patch and Ñary. The hydrodynamic and salinity of the lagoon exhibits seasonality resulting from the rainy and dry seasons.

#### Mangroves

Mangroves are extensive on the Caribbean coast of Nicaragua and are estimated to cover an area of 600 km<sup>2</sup>. Mangroves forest are found along the coastal fringe of the mainland and on the cays (nearshore and offshore) of the Caribbean coast of Nicaragua Rivers in the region are often lined with mangroves (Robinson 1991; Jamieson 2011). Maintaining the presence and health of mangroves is extremely important, both environmentally and economically. They are an essential component of estuarine systems, filtering sediment, fertilizers, pesticides and other debris from inland water as it flows to the sea as well as providing nurseries for the reproduction of fish and other marine organisms, many of which are important commercial species. These organisms may also spend part of their life cycle within mangrove habitats. In turn, terrestrial animals such as birds feed upon the marine life supported by mangroves and even some animals feed on the mangroves themselves. The presence of mangroves is crucial in assuring the

maintenance of ecosystem function and the conservation of biological diversity (FAO 1994; Jamieson 2011).

#### Seagrasses

Seagrass beds (predominately *Thalassia testudinum*) on the Nicaragua continental shelf (nearshore and offshore) are some of the most extensive in the Caribbean, if not the world (Ryan 2005). Sea grass beds not only play an important role as nursery habitat and feeding grounds for fishes and invertebrates (Ryan 1994b,1995), but they are also major feeding grounds for what is reported to be the largest green turtle (*Chelonia mydas*) aggregation in the western Atlantic Ocean (Carr et al1978) and (Lagueux and Campbell unpublished). Reefs, seagrasses, and mangroves interact physically in a number of ways including: a reduction of water energy, sediment relationships and flow regulation. Seagrass and mangroves are highly dependent on hydrodynamic barriers such as coral reefs which dissipate wave energy. The seagrass and mangrove communities are enhanced in structure when these barriers are present. Reefs are active producers of carbonate skeletal material (Zieman and Zieman 1989).

#### Cays

The Pearl Cays are located at the south-central Caribbean coast of Nicaragua. The Pearl Cays and surrounding aquatic area is comprised of 18 coralline and mangrove islands located from 3 to 22 km from the mainland and encompasses an area of approximately 700 km<sup>2</sup> (Lagueux and Campbell unpublished data). According to Roberts and Murry (1983) The Pearl Cays complex shallow reefs lie close to shore on the edge of the turbid coastal boundary believed to support a community of coral colonies (*Acropora palmate*) (Roberts and Murry 1983). Mangroves and vegetation are found on some of the cays.

According to Lagueux and Campbell (unpublished data) the cays have fringing and patch reefs and seagrasses and provide important migratory, reproductive, and developmental habitat for numerous species from different taxa, including resident and migratory birds (including shorebirds, forest birds and wading birds), marine turtles (including green, hawksbill, loggerhead, and leatherback turtles), invertebrates (including crabs, spiny lobster, mollusks, and clams), and a wide variety of fish species (including several species of snapper, barracuda, parrotfish, and grouper). The Pearl Cays are also used by artisanal fisheries, tourists, and residents.

#### Reef (coral and algal)

Coral reefs are distributed across virtually the entire Nicaraguan continental shelf, with exception of the narrow zone occupy by the coastal boundary current. They occur in a variety of forms ranging from small patches and pinnacles to large, complicated platform and well defined belt (Roberts and Murray 1983). There are 4 major coral reef areas known: Miskito Bank, north-east of Puerto Cabezas; Man O'War Cays area (Little Sandy Bay and Rio Grande Bar); Pearl Cays area, including King's Cay and Asking Cay (east of Tasbapauni and Set Net); the Lesser Corn Island area; and Great Corn Island area (Ryan 2005). Coral reefs on the continental shelf can also be divided into 3 zones: 1) the nearshore shelf (from MHW, seaward to 25 km), the central shelf (from 25 km offshore to the edge of the shelf) and 3) the Shelf Edge (Ryan 2005). River flow rates, and the frequency of storms play an important role in the distribution of coral reefs on the Nicaragua shelf (Ryan 2005). The total area of the continental shelf covered by coral reefs is still unknown but was estimated to exceeds 1,500 km<sup>2</sup>, most of which are in the range on 20 m depth (Ryan 2005).

## CONCEPTUALIZING THE ECOSYSTEM – HUMAN DIMENSIONS

Historical information is useful to explain social processes and changes, and examine the relationship between society and the environment. This is not a complete research document, rather, the following information presents background to illustrate change over time in Caribbean Nicaragua and the link between this change as well as the current status of the local socio-ecological system. The overview presents one perspective on the political and socioeconomic history and gradual shift in socio-cultural changes that may influence patterns of natural resource use and give rise to current patterns of socio-ecological systems. It is our goal to document the socio-ecological and political history that shapes Caribbean coast of Nicaragua's society and pattern of natural resource use as it relates to management planning for the PCWR.

## **HISTORICAL PERSPECTIVE OF RESOURCE USE IN CARIBBEAN NICARAGUA**

Before European contact, Caribbean Nicaragua appeared to be inhabited by “a number of kinship-based small nomadic and semi-nomadic groups” of indigenous people (Helms 1969a). These groups hunted, fished, and were involved in limited agriculture for subsistence (Helms 1969a), while practicing egalitarian principles (WANI 1987). The literature suggests that the identity and socio-cultural patterns of the current multiethnic society of the region emerged as a result of outside socio-economic influence (Helms 1969a, b). The Miskitu identity and political superiority is believed to have evolved during the ‘colonial period’ as a result of contact with foreigners and attainment of both fire arms and trade privileges (Helms 1969a, b). The afro-descendent presence in Caribbean Nicaragua is believed to have resulted from the slave trade in the 1600-1700s. Slaves were brought to the region to work on plantations and assist in trade between England and Spain. Plantations brought commercial influences during this period and were later followed by American interests in resources.

The colonial period in Caribbean Nicaragua began with the presence of European buccaneers and settlers in the 17th century and ended with the departure of the British authority in 1860 (Jamieson 1996, 2003; Christy 1999). The 200-year presence of Europeans included a relationship between the local inhabitants and outsiders and it was primarily based on the commercial exchange of local natural resources for foreign manufactured goods such as animal hides, turtle shells, canoes and food items being exchanged rum, machetes, and fire arms. The region became part of the “Anglophone Caribbean economy” and thus a “British economic hinterland” (Jamieson, 1996, 2003).

The arrival of the Moravian church in Caribbean Nicaragua in 1849 also played a key role in the incorporation of Christian values in the local culture. The Moravian Christian faith that promoted collective action practices, including collective work in subsistence agriculture (referred to as ‘pana pana’ among Miskitus and ‘hand go hand come’ among Creoles), and solidarity in time of sickness and death foster change in the Caribbean societies. The Moravian church also promoted participation in community life and the sense of unity within the community.

The theory of Purchase Society (Helms, 1969) is a socio-cultural category used to describe local inhabitations of Caribbean Nicaragua. This emerged during the colonial period when indigenous communities adapted to outside influences and a new cultural norm emerged. The Miskitus, the dominant native population during the colonial period, went through a process of adaptation to the demands of foreign commerce. Foreign manufactured goods progressively became “cultural necessities” and were incorporated into local habits. These new cultural necessities modified the patterns of use of the natural environment and resources. As a result, a new economic pattern developed and consisted of the previous subsistence culture combined with a new cash or exchange economy. In this regard, subsistence activities were altered to make room for new types of work or expansion of traditional subsistence activities for commercial purposes.

Helms (1969a, b) concluded that the Miskitus have exploited local land and marine natural resources in order to supply European markets since 1600's. This was accompanied by cultural changes in the society. Locals were progressively induced to adapt the way of life of their colonizers, including trade with profit motives and consuming foreign goods. However, subsistence practices persisted. The gradual dependence on foreign goods and other cultural adaptations by the local community did not happen by chance, rather by a deliberate strategy designed by the colonial system (Helms 1969b). The colonial period can be describe as a stage of cultural adaptation that changed the pattern of local resource use which gave way to an initial stage of commercial exploitation of the local natural resources. The new economic system required a more intense exploitation of the natural environment; however, the intensity of natural resource exploitation was moderate since extraction capacity, limited largely by technology, and market availability was relatively low. This assumption seems plausible since the reported abundance of natural resources persisted for a period of time.

With support from the United States and under the terms of the Treaty of Managua in 1860 and the Harison-Altamirano Treaty in 1905, Nicaragua gained sovereignty over the Caribbean coast (Jamieson 1996, 2003). This political shift gave way to the expansion of US commercial interests in Nicaragua. From the mid-nineteenth century until 1979, the Caribbean coast of Nicaragua experienced the development of an "enclave economy" with boom and bust cycles (Yih et al 1991; Jamieson 1996, 2003). This economic model consists of well-capitalized foreign companies, especially from North America, that exploited natural resources for exportation. With the support of the Nicaraguan government, these foreign companies obtained concessions to establish banana plantations, and extract lumber, gold, rubber, turtles, fish lobster, shrimp, etc. Although some portion of the products were sold to the companies by locals, most were produced in the 60's and 70's by the Nicaraguan companies. Companies brought their most skilled workers from abroad and locals were assigned lower-level jobs. Once the exploited resource was depleted, the companies departed or moved to a new resource-rich area to develop new activities. Exploitation capacities compared to the earlier colonial period had increased. Local resource extraction was now aided by greater access to markets, government support, and improved technologies, including transportation. The boom and bust cycle was linked to a rich resource-base during the development stage of exploitation, followed by periods of exhaustion of the local resources. The exploitation of a new resource initiated a new cycle of boom.

The enclave economy during the neocolonial period further shaped the "purchase society" category given to Miskitus and now multiethnic society of the Caribbean coast of Nicaragua (Helms 1969a). Foreign goods continued to be supplied to locals by commercial companies. Local engagement in the commercial exploitation of local, natural resources continued and likely increased along with adaptation to outside influence. The economic system continued to accommodate subsistence and commercial activities, especially since commercial exploitation goes though cycles of boom and bust. Among the Miskitus, the male-female division of labor also provided a good fit for combining the subsistence economic system with commercial trade or labor (Helm 1969a).

As a result of economic depression in the region in the early 1960s, many foreign companies fled the country, causing a bust to the local economy (Helms 1969a). Locals were forced to return to subsistence living without the same commercial opportunities and benefits. At the end of the 1960s, fishing companies began exporting turtles, lobster, shrimp and fish. With the lack of jobs and developed need for cultural necessities, locals engaged in the commercialization of the local resources by harvesting and selling to the companies. Nitchman (1971) reported an erosion of social capital (i.e. disappearance of trust and reciprocity in the form of turtle meat as a gift and exchange in Tasbapauni, a Miskitus village in the

Pearl Lagoon basin) locals were engaged in the internal (among one another) and external (with the outside) commercialization of subsistence goods such as turtle meat that was used before in gift and exchange among families (Nitchman 1971).

From the analysis of the history of the pre-colonial epoch, one may deduce that the enclave economy drove one of the most intensive and unsustainable exploitation periods for natural resources in the Caribbean coast of Nicaragua. Likewise, with the arrival of fishing companies at the end of this period (60's and 70's), coastal communities began trading common property resources including subsistent goods like turtles that were important items in gift and exchange practices among the Miskitus. The commercialization of subsistence goods among the local inhabitants and with foreigners intensified profit motives triggered moral conflict among the inhabitants which resulted in the erosion of traditional communitarian institutions (gift and exchange).

#### *Pause in resource exploitation*

The outbreak of civil war, especially during the last part of 1970 and subsequent overthrow of the Somoza dictatorship and the installment of the Sandinista social revolutionary regime in July 1979 marked the beginning of a slowdown in capitalist investment and unsustainable exploitation of natural resources in Nicaragua (Bennett, 2010). With the support of the US government, armed conflict escalated during the mid-1980's, and many economic activities had become dangerous in the terrestrial and coastal areas off the Caribbean coast of Nicaragua. Extractive activities of natural resources were drastically reduced. Speculation that the natural resources of the Caribbean coast were in a period of rest and rehabilitation during this time is communicated by community elders. This also meant that there were few company jobs and markets for trade of natural resources, so the local inhabitants returned to subsistence activities while receiving government aid. Informational conversations with community members reflect a period where there was limited access to cultural necessities. This resulted in the Sandinista revolution being unpopular in Caribbean Nicaragua and reason for many Miskitus to rise up in arms against the Sandinistan Government.

#### *Resurgence of foreign capitalist influence: advanced erosion of social capital and unsustainable exploitation of local natural resources*

In 1990, with strong influence from the US, a democratic government was established in Nicaragua. The guidance of the International Monetary Fund and World Bank structural adjustment policies resulted in a shift of the country's Sandinistan economic policies toward neo-liberalism. The new government under President Violeta Chamorro quickly established free markets, or privatization of state-owned enterprises, and private investment was also encouraged, among other economic policies. According to Henriksen and Kimbald (2011), Nicaragua quickly became internationally famous for its propaganda of abundant natural resources, lack of regulations over natural resource exploitation, and easy access to inexpensive labor. The new political environment triggered a rapid increase in fish processing plants along the Caribbean coast (Bennett 2010). The local inhabitants quickly resumed their involvement in the commercialization of local natural resources, as done in the colonial period and late part of the neocolonial period. As a result, the exportation of lobster, shrimp and fish progressively increased (Bennett pers. Obs).

Under the new economic model guided by free markets and poor regulation of natural resource exploitation, communities furthered their unregulated commercial exploitation of local resources. According to Henriksen and Kindblad (2011), the inhabitants of Tasbapauni found themselves competing with one another for the sale of local natural resources during the 90s, especially with regard for lobster and the legal harvest of green sea turtles. This competition resulted in more individualism, as families

became more independent from their neighbors and more reliant on the market. Now in order to obtain “cultural necessities” locals were willing to sell without any regard to sustainability or conservation (Bennett pers. obs). Moreover, conservation could be seen as a threat to their attainment of cultural necessities. As a result, commercial exploitation of local natural resources grew in addition to the increased erosion of local communitarian institutions that were already affected during the neo-colonial period. This includes less support for collective work, solidarity in time of sickness and death, and community care for elders and children. This societal erosion often leads to a fragile society that conducts unsustainable exploitation of natural capital leading to poverty, underdevelopment, and environmental stress. The history of the Caribbean coast is viewed as a primary driver in the current socio-ecological system in Pearl Lagoon and is summarized as:

- The five decades of socio-economic and political history of the Caribbean coast of Nicaragua indicates that the multiethnic society and culture of today is the product, in part, of externally induced processes and changes that are typical to frontier societies with limited cultural and commercial exchange
- A foreign driven tradition of unsustainable commercial exploitation of natural resources can gradually develop overtime in which locals either participate in or tolerate
- Local participation in the commercial exploitation of local natural resources can be driven by a need to fulfill individuals desires for cultural necessities that may induced by foreign influence
- Exploitation likely evolved without any conservation ethics and minimal management considerations
- Social capital developed overtime, especially with the influence of Christianity by the Moravian church but then gradually eroded with capitalist profit motives and fulfilling of cultural necessities



## CONCEPTUALIZING THE ECOSYSTEM – GOVERNANCE

Governance has been described by N.J. Bennett (2015) as “an umbrella term that refers to the structures, institutions (i.e. laws, policies, rules, and norms), and processes that determine who makes decisions, and how decisions are made, and how and what actions are taken and by whom.” Bennett (2015) also cites Jones (2014, p 63) when describing governance as “steering human behavior through combinations of state, market and civil society approaches to achieve strategic objectives” and continues with concepts related to “co-evolutionary hierarchical governance – top down, bottom up and market based approaches with five governance categories: 1) economic, 2) interpretive, 3) knowledge, 4) legal, and 5) participative.” R. Chang (pers. comm. 2015) describes two levels of governance 1) consisting of institutions and governments and 2) the system to be governed comprised of both the people and the environment. Governance for the refuge includes the combination of processes and institutions as well as recognition of social norms of the stakeholders involved in the management planning process.

### *Institutional governance*

The first level of governance can be viewed through the development of the PCWR. One example of this form of governance is the process for creating a protected area in Nicaragua. The process to declare a Marine Protected Area (MPA) in Nicaragua, in simplest terms, consists of five steps. The first includes forming a planning team in collaboration with stakeholders from local universities, government entities, and local and regional authorities. The second step is obtaining community approval to create an MPA through community engagement consisting of surveys, focus group meetings, and consultations. The third step is presenting the community-approved MPA proposal to the regional government, often in consultation with the local natural resources department. The final step is to present the MPA plan as approved by the local community and regional government to the national government’s ministry of the environment. The ministry then presents the MPA proposal to the president for approval and declaration, signing it into law. It’s important to recognize that once an MPA is declared in Nicaragua, there are few to no enforceable, legal protections for that area until legally-binding management and implementation plans are approved.

Once an MPA is established, the management planning process can begin. Community input drives the process through stakeholder consultations similar to those needed for MPA declaration. The management plan can include an implementation schedule for the established MPA. The management planning process is similar to the MPA designation with facilitation and guidance from the planning team with emphasis on a community-based approach. The first step is assembling a planning team to oversee and guide the process comprised of stakeholders. The second step in the management planning process occurs through approval at the community and territorial authorities by majority vote and input from the agencies responsible for natural resources management. The third step is to draw up a resolution for approval by the regional council. The council approves the plan by adopting the resolution. The final step is to present the resolution to the national government for review and approval. The national government can request additional information, accept, or deny the request. Once approved, the resolution stands as the legally binding management plan and the implementation plans outlines in detail the responsibilities of management entities (e.g., universities and government authorities when a co-management plan is developed, enforcement authority, etc.).

### *Socio-ecological governance*

Governance systems as they relate to humans and the environment hold a different perspective than the institutional component of governance. This aspect is closely tied to the socio-ecological system described in the historical overview provided earlier in this text, but with greater recognition that humans

are part of the ecosystem. During the development of this report, additional research was underway to capture the socio-ecological governing system. Informational conversations and survey research will be used to expand the concept. The evaluation will include using guiding questions from cornerstone research in socio-ecological systems Ostrom (1990, 2009) and Ostrom et al (1993) with additional input from more recent research in this field (N.J. Bennett 2015; Agrawal et al (2001)). These questions can help formulate appropriate, acceptable, and supportive environmental governance policies and processes, enabling more effective management and ultimately enhancing the social and ecological outcomes of MPAs as recommended by Ostrom, Bennett and Agrawal.

#### Socio-ecological governance guiding questions (N.J. Bennett 2015)

1. How are individual and collective behaviors shaped by different governance institutions?
2. What is the ideal governance structure for managing people and resources: community based or top down, or co-management?
3. How and why do governance institutions change and to what effect?
4. What decision-making processes are more socially acceptable and lead to better ecological outcomes?
5. What are the roles of different actors and organizations (e.g., governments, NGOs, private sector, local stakeholders, and resource users) in shaping governance processes and determining outcomes?
6. How can governance address interconnected social-ecological systems and interactions across ecological, social, and institutional scales?
7. How can governance be designed to fit different sociopolitical and ecological contexts?
8. What limits are placed on governance by different social, political, and ecological factors?
9. What norms or ideals (e.g., transparency, accountability, trust) should guide governance?
10. What is the appropriate scale for governance to occur?
11. How can collaboration and cooperation be facilitated most effectively?
12. How can governance be designed to be stable and also to adapt to mounting social and ecological changes and unpredictable circumstances?

# INDICATORS OF ECOSYSTEM HEALTH

Indicators of ecosystem health are used to measure and report change within the ecosystem. Indicators are the “end point of a process involving stakeholders and scientists” and help managers gauge the state of the ecosystem (Beliaeff and Pelletier 2011). Long-term monitoring is often needed to apply indicators so managers can assess change and response to management actions. The DPSEER framework used to characterize the ecosystem (above) (OCED 1993; Mangi et al 2007; Kelble et al 2014; Fletcher et al 2014) is helpful for developing and selecting indicators. In the PCWR, limited information about the biophysical environment exists and there are limited resources available to train and oversee long-term monitoring to assess change. The need for capacity and resources is required to monitor changes in indicators, thus, indicator selection will include those attributes of the ecosystem that are both good indicators of ecosystem change, but realistic with regards to monitoring in the near term.

Developing indicators of ecosystem health is not an easy task. A draft list of indicators that includes socio-ecological and biophysical factors was developed for review and refinement by stakeholders. Indicators were selected using a systematic process of asking questions about each attribute (Table 1) developed in earlier IEA studies (Nuttall et al 2011; Fletcher et al 2014). The criteria were split into three components: primary criteria, data/analysis criteria, and communication. Primary criteria questions focus on the indicator itself with regards to measurements and how it relates to the other components in the DPSEER model. Data/Analysis criteria relate to the monitoring aspect and the ability to gather accurate, timely information about the indicator. The third criterion is communication and is important for relaying information to stakeholders. The latter is an important feature of indicator selection since without a clear understanding of what is being measured and the meaning of the results, managers and stakeholders may not be able to make an informed decision about selecting and implementing a *Response* in the DPSEER model.

Table 1. Criteria for developing indicators for the PCWR (Fletcher et al 2014).

<b>Primary Criteria</b>
1. Does the indicator provide an integrative measure of the overall status of the ecosystem or of essential ecosystem structures, functions or processes? (Doren et al. 2009, Dale & Beyeler 2001, Luckey 2002)
2. Does the indicator relate to ecosystem service(s)? (modified from Feld et al. 2009)
3. Is the indicator relevant to management goal(s)? (Bradley et al. 2010)
4. Is the indicator sensitive to system Drivers and Pressures? (Doren et al. 2009, Dale & Beyeler 2001, ICES 2002)
<b>Data/Analysis Criteria</b>
5. Is the indicator based upon data that can be generated with accuracy and precision relatively easily and for which there is sufficient existing data to evaluate change going forward? (Doren et al. 2009, ICES 2002, Dale & Beyeler 2001, Rice & Rochet 2005)
6. Is it possible to predict how the indicator will respond to changes in the ecosystem (including societal changes) over management-relevant time scales? (Feld et al. 2009, Dale & Beyeler 2001)
7. Does the indicator have a response that is easily detectable above the background variability to make it useful in measuring response to management actions or a change in a Pressure that may or may not be a result of management action(s)? (This also means the response signal should be attributable to a change in management or pressure.) (ICES 2002, Bradley et al. 2010)
<b>Communication</b>
8. Is the indicator understood by managers and the public? (Rice & Rochet 2005)
9. Does the indicator respond to stress earlier than the rest of the system (i.e. is it a leading indicator?)? (Dale & Beyeler 2001)

10. How long will it take for the indicator to show a response to possible management actions? (Dale & Beyeler 2001)

11. Has the indicator been employed effectively either in south Florida or elsewhere? (NRC 2000)

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Indicators for the PCWR need to be developed by and vetted with stakeholders and managers. Defining management questions and using a guide such as the questions in Table 1 can be a starting point for developing indicators. In this manner, indicators are selected to directly respond to manager needs. At the time of this study, management agencies were not convened to develop a list of management questions; rather, information gathering from community members was viewed as a necessary first step in the process by which managers could review their knowledge and perceptions and in Phase II of this project (Listening and Learning). From this information, a list of management questions based on community needs and desires for the PCWR can be constructed. Preliminary biophysical indicators for consideration based on past study studies are: fish and shellfish (lobsters), nesting hawksbill sea turtles, reef (coral, algal, and hardbottom), seagrass extent and quality, mangrove forest extent and quality, and water quality.

Throughout the project period, informational conversations with community members were conducted to characterize the audience living in the Pearl Lagoon basin. This is an important step in framing the issue and building an understanding of community perceptions and beliefs surrounding natural resource use and protection in the refuge. Conversations consisted of open ended questions and gathering specific measures of how resources are governed. A summary of those results was prepared for informational purposes and a formal survey process is scheduled for the future based on these initial findings. Although there are a limited number of the informational conversations, the preliminary results of these interactions suggest that social norms of reciprocity and trust were regulating the behavior and interactions of the community members and likely influenced the state of the environment. It is likely that these social norms and resulting networks enabled local communities to work together to produce collective good. The information gleaned from informational conversations and observations about resource use were used to draft potential indicators that will be refined in late 2016 and used to further evaluate their utility as indicators for management planning. The indicators are described in Table 2 below.

Table 2. Information conversations and observations of community members were used to develop an outline for designing indicators for the PCWR management planning process and will be used for further analysis in late 2016.

<b>Pattern of resource use</b>	<b>Consequence(s)</b>	<b>Potential driving forces</b>
Fishing/overfishing	Decreasing abundance trends in gillnet , lobster and legal green sea turtle fishery	Market pressure; new technology; lack of enforcement; poor conservation ethic of resource users; poverty
Fishing/closed season - The harvest of gravid female of the commercial important species (lobster, blue crab, snook)	Loss of reproductive potential	Unregulated fishery; lack of enforcement
Fishing/regulations - Harvest of undersize (lobster, crab, snook, turtle)	Loss of economic gain and reproductive potential	Unregulated fishery; lack of enforcement
Increasing fishing capacity-pressures:  Change in fishing technology Increasing number of boats,	Lots of biodiversity; decrease in abundance and size composition; ability to improve catch per unit effort using new fishing	Lack of enforcement; technological improvements (GPS, engines, nets); Market pressure; Change in lifestyle and increase cost of living promotes desire to catch more for

Increasing number of gear, Increasing vessel capacity and efficiency	technology/gear	profits; Benefit from abandon drug vessels that is linked to increased fishing effort; misguided government and development project interventions (e.g. DIPAL)
Increasing pressures on terrestrial ecosystem:  agriculture and livestock production,  Increase individual fencing and selling of communal lands,  Aggressive current and historical harvest of forest goods for local construction, exportation and charcoal	Degradation of forest; forest thinning; loss of biodiversity; loss of traditional livelihood (hunting and gathering of food); decrease abundance resulting in scarcity causing individuals needing to place greater effort to harvest/catch to obtain profit; loss of communal rights for land ownership	Agriculture frontier; Market pressure; Change in lifestyle and increase in cost of living
Exploitation of resources that leads to commercial exploitation of new resource species (e.g., blue crab, stingray, sand for construction, sea cucumber, jelly fish)	Loss of biodiversity; cascade of impacts to ecosystem; loss of ecosystem services	Market demand; greed
Resistance to conservation and management efforts	Regulations ignored and loss of biodiversity; lack of respect for regulations; inequity of shared resources resulting in communal disputes	Poor conservation ethics; poverty; culture of exploitation (historical legacy); lack of understanding/knowledge/concern for the environment

In addition to the outline of resource use (Table 2), the causal pathways describing the linkages from resource use was developed. Table 3 describes *Drivers* impacting the state of the ecosystem. The Drivers are further defined as secondary drivers where appropriate. Then using the DPSEIR model, the Drivers are linked to pressures placed on the ecosystem. Pressures are then linked to potential consequences in the socio-ecological system. The consequences are to humans and the environment. Again, this outline was derived from informational conversations and will be further vetted with stakeholders as the management planning process continues.

Table 3. Drivers, secondary drivers, pressures and consequences of the drivers and pressures were developed from informational conversations with stakeholders. The matrix will be expanded in Phase II of the project to include additional components of the DPSEIR model (above) and vetted with stakeholders. Note, the authors recognize there are assumptions and biases within this table, and its use is for grant reporting only and a final draft will be provided once further vetting has occurred.

Primary Driver	Secondary driver	Pressure	Consequence for sustainability of socio-ecological system
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Market availability	Increasing demands for local natural resources;  Change in local people lifestyle that is linked to increase cost of living	Increase exploitation of natural resources  Increase fishing intensity (more gears, bigger boats, transport capacity) Exploitation of new resources	Overexploitation leading to:  Loss of local biodiversity Degradation of the resource base (habitat destruction, declining stocks); poverty; poor conservation ethic; Erosion of social capital,
New technologies	More efficient extractive methods	Increase fishing intensity; Efficient fishing gear; Sequential exploitation of natural resources;  Expansion to new habitats and stocks from larger vessels and engines	Select few with ability to obtain new technologies excludes smaller, artisanal fishers
Increase in local human population	Increase demands for local natural resources	Increased exploitation	Degradation of the resource base; poverty; Reduced stocks
Poor conservation ethics	Lack of knowledge and understanding for the environment; Lack of awareness and consequences to the sustainability of their socio-ecological system	Resistance to management and conservation measures; Unsustainable resource exploitation practices	Failure of management and conservation efforts; Poor governability of the socio-ecological system
Weak governing system	Poor performance of governing roles; poor resource users trust in governing actors;  Lack reliable scientific information and communication; lack of enforcement	Unsustainable resource exploitation practices; Exploitation; Resistance to management and conservation measures; Desire to take as much as you can while you can	Overexploitation; Poor governability of socio-ecological system
Poverty	Short term interests	Resistance to management and conservation measures	Poor governability



## IDENTIFYING MANAGEMENT STRATEGIES

Strategies to manage natural and human resources within the PCWR were drafted during facilitated workshops, survey research, and stakeholder interactions. Stakeholder information was reviewed and summarized to include management strategies data needs/gaps to inform management strategies, and indicators to measure management success and/or ecosystem health. Table 4 contains a synthesis of the workshop input and planning team review. This is considered a draft for consideration from the larger stakeholder community and is further described in the bulleted lists below and workshop meeting notes in Appendix C. The project team will continue to work with stakeholders to refine and define specific indicators that can be used to assess short-, medium-, and long-term outcomes of the management plan for the PCWR.

Table 4. Synthesis of management strategies, data and information needs/gaps, and indicators of management success gathered from stakeholders from July 2015- April 2016.

Management Strategy	Data and information needs/gaps	Indicators
Design, develop, implement an <b>awareness campaign</b> to garner ownership and empowerment for wise stewardship of PCWR resources Includes: Outreach Education (formal and informal) Political will	Survey research to assess target audience needs and develop awareness campaign based on the assessment -Curriculum development (informal and formal) -Human dimensions science studies to inform management of stakeholder needs, desires for the PCWR over time	Measured by knowledge, skills, abilities and awareness of the refuge and its resources.  Measured by positive community perception of NGOs through survey research increases over time and the conservation ethic of residents increases
Facilitate <b>policy development</b> including implementation, enforcement, and monitoring Explore: Co-management opportunities to leverage resources Regional management to address connectivity Emphasize fisheries management	Fisheries monitoring and policy implementation: -Support for monitoring to assess current rules -Support for implementation and enforcement of existing rules -Status of community support for management planning and empowerment/political will -GIS/mapping of the region and its habitats and socio-ecological aspects -Outline of legal aspects of the PCWR and its cays and resources	Measured by policy development measured from the number of management plans (policies) refined or created to address and implementation success of the refuge
Design, development, implement a <b>monitoring</b> plan for biophysical and human dimensions science (social science) and considerations for habitat restoration	Carrying capacity of natural and built environment: -Habitat restoration -Habitat assessments -Stakeholder perception surveys -Resource allocation	Ecosystem health measured through survey research (biophysical and human dimensions) Baseline information is needed at this time but examples would be

	-Impact assessment	improvements in coral health and/or water quality near cays; Land-use change that incorporates the natural environment into the developed/built environment (restoration activities and acres restored where development is allowed)
Promote <b>livelihood diversity</b> planning through capacity building Consider: Building a biological field station SCUBA diving for research and tourism Tourism Education Research Outreach Monitoring	Opportunities for livelihood diversification within the PCWR Literature review and audience characterization that relates to historical perspectives, has success stories/lessons learned, and options for the future Fisher-focused research to understand use patterns and options for management planning Impact assessments (e.g. Kabu Tours)	Measured by the number of opportunities for diversification of livelihoods recognizing development (economic and physical) in the region. Again, baseline information is needed to use this indicator.
Develop a <b>funding</b> plan to carry out management activities that is a collaborative effort	Institutional capacity to seek, secure, and oversee funding support for all aspects of the management planning process and its outputs	Measured by grant dollars secured for programmatic activities.
Build a platform for <b>communication and outreach</b> within the management entity(ies) and with stakeholders to foster two-way communication throughout the management planning process and future activities		Measured by opportunities for stakeholder input and outcomes generated by their input into the management plan and components.

Workshops with community leaders and stakeholders were held from July 2015 – April 2016. The objective of the management planning process was to identify a minimum of two management scenarios with input from stakeholders. During the workshops, a recorder captured the thoughts and ideas of the participants to represent community-based perspectives for managing the Pearl Cays’ resources. The perspectives (Appendix C) and recommendations (below) will be used to design and present a draft management plan for consideration by the local, regional, and national governments for consideration in the development of an implementation strategy. Inclusion of representatives from these governments in the 2015-2016 discussions was part of the project design to ensure input from the policy/enforcement entities at the start of the project. The results include recommendations to address three fundamental questions to proceed with developing the PCWR management plan followed by prioritization of those activities needing urgent attention. They are:

#### I. What do we need to develop a management plan within a communal system?

- Mapping key informant from both institutional and communal level.
- Work on the reality of the communities condition and characteristic
- To Develop workshop addressing the different level of governance we need funding, which are the main constrain to guarantee the rest of activity proposed
- Develop workshops based on “they roles and resources allocation and management. Directed to different level of governance (Territorial, municipal and communal).
- Ecological mapping
- Mapping of the cays and zones which we will like to be integrated in the management plan.
- Guarantee strategies and method of participation
- Make agreements with fisher for mapping zones
- Develop strategies of how to obtain communities support, counting that they are now in a situation of opposition. Pearl lagoon basin is divided by two territorial governments.
- Review of legal situation of the cays.
- Find out if they are political will at the central level. Which will be a cay for develop a management plan.
- Resource allocation to develop all different activity proposed.
- Research on actual condition, biological and ecological.
- General Historical aspect of the cays.
- Case studies of Positive impact. Good thinks that have been done.
- Create awareness campaigns

## **II. What are the constraints and challenges?**

- What and how should we address community’s members to accept the idea of the management plan, as a multiethnic and multicultural community?
  - o Participation in all senses
  - o Acceptance of the proposal
  - o Positioning the idea – get things clear
  - o Empowering
  - o Appropriations
  - o Infatuation [with taking as many resources now]
- How can we counteract the negative incentives? Resume conservation ethic.
- Implement and strength positives actions that is practicing in some communities.
- What type of incentives we can implement (social and economic)
- Alternative livelihood
- Tourism
- Institutional strengthen to increase monitoring.
- Management of solid and liquid waste.
- Government (central, regional, territorial, communal, and municipals) strengthen at a different level.

## **III. What positive aspects can we count on?**

- Alternative livelihood (Kabu Tour)
- Community organization
- Community participation at certain level
- Institutional credibility in communities (BICU, INPESCA, WCS, etc).
- Positive impact of some projects (DIPAL, etc.)
- Institutional agreements
- We have the SEAR (Regional Autonomous Educational System)
- The existence of CUMAJ in the municipality (youth organization)

The results of the community workshop resulted in priorities to move forward with management planning. The results include:

**What are the priorities in the communities on the management Plan of the Pearl Cays Wildlife Refuge and its fishery resources?**

- a. Identify and review proposals, management plans, projects, resolutions (regional, municipal, territorial and others) prior to establish a base line (literature review)
- b. Conformation of a technical / working team that includes the participation and presence of the territorial government.
- c. Establish a formal communication line with the communities as part of the consolidation process.
- d. Strengthening the communal and territorial government structures (Strengthening the development territorial plan).
- e. Establish strategy and tools for the use of the Cays in conjunction with the territorial government, the Navy and communities
- f. Establish a baseline or monitoring station / local surveillance.
- g. Involve the territorial government throughout the construction process of the management plan as a whole.
- h. Action plan:
  - a. Recovery of cays and coral reefs (habitat recovery)
  - b. Research

**What can be done, how it can be done, what do we need, and when it should be started?**

- a. Payment of fees for access and use the cays
- b. Control the number of people accessing the keys and dwell time.
- c. Who can and should help, and how they can or should do?
- d. Create a campaign or effort unification process
- e. Implement close season system for other species such as fish, sea cucumber, jelly fish and others.
- f. Incorporate pearl Lagoon in the management plan as a buffer zone?
- g. Mangrove reforestation.
- h. Strengthen surveillance and monitoring within the Community of Pearl Lagoon and its cays.
- i. The communal authority is helping the police to cover certain operating expenses to make more effective their presence and permanence in the community.
- j. The formulation of policy must strongly integrate the participation and perspective of communities.
- k. Create awareness actions and addressing problems together.
- l. Capital allocation. Who will cover all the expenses?

## CONCLUSION

There were many achievements in the first year of facilitating a management plan for the PCWR. WCS and BICU forged a partnership to work together to initiate and complete the first phase of the management planning process. Opening a dialogue with stakeholders is viewed as an important first step in the management planning process. Workshops, informational conversations, and survey research were used to obtain insights to characterize the ecosystem and the concerns for the PCWR, challenges and benefits for pursuing the development of a community-based management plan.

This summary report represents the beginning of the process and to lay the foundation for future management planning efforts. Workshops and interactions with the community within the WCS-BICU partnership are important for laying the foundation for building trust in both the process and with the organizations and representatives of those organizations involved. It is recognized that planning is not only a science-based activity, but largely reliant on the personal interactions that enable management strategy development to truly represent community perceptions and their desires for the future of shared resources within the PCWR.

While the second phase of the management planning process has begun, this first phase was monumental in documenting the biophysical and historical aspects of the Pearl Lagoon Basin. Characterizations of the ecosystem using the DPSIR model allow for comparison with other areas around the globe and to measure change in the ecosystem over time. The diagrams were helpful for opening a discussion about the ecosystem due to their utility for working in areas with multiple languages and in some instances the inability to read. Indicators need refinement, but provide examples for further analysis and additions. The management strategy alternatives are still in their infancy. Caution was used in presenting management options due to the implications of documenting strict parameters at this early stage of the project. Rather, stakeholders were asked to respond to a series of questions that could aid in framing management strategy alternatives for refinement in phase II of this project. A workshop was being scheduled to review the questions at the time this report was written. Care was taken to ensure stakeholders feel that this process is not being rushed and that input is sincerely being considered and included.

WCS continues to collaborate with BICU and partners to facilitate the management planning process. Phase I met expectations with regards to establishing relationships with stakeholders and documenting socio-ecological components of the PCWR. Phase II of the effort focuses on listening and learning to obtain additional stakeholder input and delving into the social constructs of the management plan. Concurrently, funding support to reduce the data gaps in biophysical information about the PCWR are being pursued. Combining this information will assist in seeking both a science-based and community driven management plan for the refuge.

## APPENDICES

In 2015-2016, a series of workshops were held to gather input from the communities, community leaders, academics, governmental and non-governmental organizations. The results of the workshops, in addition to informational conversations that were also funded by the Paul M. Angell Family foundation, are included in the management strategies section of this document and the appendices. Workshops were focused on information sharing among the communities and agencies WCS has partnered with to gather baseline information about the knowledge and perceptions of natural resources and their management in the PCWR. The Appendices in this report include documentation for each of the workshops (e.g., participant lists, agendas, meeting notes). The appendices are:

**Appendix A** literature list of marine protection and marine reserves. This is being developed by one of the authors and their colleague and is *in press*. A full report will be available in early 2017.

**Appendix B** is a copy of the letter of intent between WCS and BICU that includes partnering to further the development of the PCWR management plan.

**Appendix C** outlines all of the workshops carried out wholly or in part with funds from the Paul M. Angell Family Foundation. The appendix contains a listing of the eight Green Turtle Commission workshops and participants and the two workshops with managers, academics and members of the 12 communities in the Pearl Lagoon Basin. The result of the green turtle workshops was a resolution 863-10-09-2015 to manage the legal harvest of green sea turtles within the RACCS. The results from the manager and community workshops illustrate feedback and information gathered from the participants.



## APPENDIX A

Annotated bibliography of marine reserves and MPA literature assembled by Fletcher and Gregory (*in press*).

Agardy, T. M. 1995. Critical Area Identification and Zoning in Coastal Biosphere Reserves: One Way to Make Conservation Work in Canada Pages 214-219 in N.L. Shackell, and J.H. Martin Willison (editors). *Marine Protected Areas and Sustainable Fisheries*. Published by Science and Management.

Canada's marine areas suffer from mismanagement, overuse, and chronic environmental degradation. Attempts to reverse the alarming trend in marine resource decline in the past have largely failed. New tools are needed to complement traditional management methods; biosphere reserves and other forms of protected area planning constitute one potentially effective method. The UNESCO Biosphere Reserve Programme provides a useful model to incorporate human needs into long term planning for conservation. Central to the model is multiple use zoning to protect sensitive habitats and critical ecological processes in core areas, while allowing managed use in buffer zones. This model has particular potential in coastal areas, where conventional "garrison reserve" measures to preserve nature or protect the environment are not compatible with the open, multi-jurisdictional and common property nature of marine systems. The successful application of the biosphere reserve model in Canadian waters will require a functional perspective that recognizes all the important linkages between and within marine and terrestrial areas. A functional approach allows delineation of the outer boundaries of the protected area (making the managed area a functionally viable entity), as well as helping to highlight where critical processes that drive the system are concentrated. If such "vital organs" of a system can be protected, humans will be able to continue to reap its resources and derive benefits from its use, leading to greater economic and sociological sustainability. The following paper describes why biosphere reserve models may be useful in coastal and marine management in Canada, and how science can be harnessed effectively to create zoning that serves conservation and development needs simultaneously.

Allard, J., Chadwick, M., and LaPierre L. 1995. The Model Ocean: An Experiment in Marine Resource Management Pages 249-256 in N.L. Shackell and J.H. Martin Willison (editors). *Marine Protected Areas and Sustainable Fisheries*. Published by Science and Management

The ocean with its marine resources and coastal areas is an important part of Canada's heritage, providing wealth, quality of life throughout our history, and the economic foundation of many coastal communities. Managed in a sustainable manner, the ocean will continue to ensure long-term, social and economic benefits by providing livelihood, transport, recreation, and tourism, and by supporting fish and marine wildlife. We propose a national network of Model Oceans. Each Model Ocean will be a working model of sustainable resource development that reflects the biological diversity and the full range of stakeholders within its region. The objectives of the Model Oceans will be: (a) to promote a balanced and sustainable development of all resources provided by the oceans; (b) to integrate management into a partnership of stakeholders, permitting all marine resources to be shared for maximum sustainable socio-economic benefit to develop successful strategies for coastal communities to acquire a suitable quality of life and standard of living. Fisheries will be an important focal point of the Model Oceans program. Other ocean-related economic activities, however, will be brought to the fore, thereby ensuring long-term, sustainable growth to coastal communities. With regard to Atlantic fisheries, a strong emphasis will be placed on strategies that allow communities to maintain their economic prosperity despite biological variability and market uncertainty.

Attwood, C.G., and B.A. Bennett. 1994. Variation in dispersal of Galjoen (*Coracinus capensis*) (Teleostei: Coracinidae) from a marine reserve. *Canadian Journal of fisheries and Aquatic Sciences* 51:1247-1257. The dispersal of the surf-zone teleost galjoen (*Coracinus capensis*) from the De Hoop Marine Reserve, South Africa, was investigated. Over a period of 5.5 yr, 11,022 galjoen were tagged in the center of the reserve. Most of the 1,008 recoveries were at the site of release, while the remainder covered a distance of up to 1040 km. There was no difference with the respect to age, sex or season between those that dispersed and those that did not. Six models were developed to test the hypothesis that (1) galjoen are polymorphic with respect to dispersal behavior, (2) non-reporting of tags masks a random dispersal process, and (3) the recovery distribution is the result of unequal movement rates in different areas. It is inferred from the likelihoods of the various models that the tagged population was polymorphic, with fish displaying either resident or nomadic behavior. This conclusion is unaffected by a large uncertainty in the extent of non-reporting of recoveries, or by spatial variability of movement rates. The estimate of emigration from the reserve implies that the unharvested reserve population is restocking adjacent exploited areas with adult fish.

Auster, P.J., and R.J. Malatesta. 1995. Assessing the role of non-extractive reserves for enhancing harvested populations in temperate and boreal marine systems. Pages 82-89 in N.L. Shackell and J.H. Martin Willison (editors). *Marine Protected Areas and Sustainable Fisheries*. Published by Science and Management of Protected Areas Association.

Habitat complexity in temperate and boreal low topography habitats is a combination of sedimentary features (e.g., gravel rock, sand ripple) and biogenic structure (e.g., emergent epifauna, amphipod tubes, biogenic depressions, shell, burrows). A framework for understanding the potential benefits of non-extractive reserves is based on the premise that habitat complexity will increase in areas which are not impacted by mobile fishing gear (e.g., increases in biogenic structure). Increased complexity would then result in increased survivorship of postlarval and early juvenile size classes, thus increasing recruitment to harvested populations. This approach requires development of survey protocols for habitat identification and mapping as well as understanding linkages between habitat level processes and population dynamics.

Ballantine, W.J. 1989. Marine reserves: Lessons from New Zealand. *Underwater Science* 13:1-14.

For the past decade a five km stretch of coast in NE New Zealand has been protected by law from all exploitative and damaging activity. The creation of this marine reserve encouraged the production of under-water habitat maps, allowed baseline surveys of more natural densities and distributions and permitted investigations of natural behavior and interactions. The results of this work are not just interesting in their own right, they also strongly suggest that effective understanding of marine ecology may not be possible without such protected areas. The idea of controls is central to scientific investigation. The effects of pervasive exploitation cannot be determined without observations and experiments in areas where exploitation does not occur. A system of representative, unexploited and permanent marine reserves is needed to allow proper understanding and hence efficient management of living resources. The New Zealand experience is that the social and political problems of creating such reserves are much larger in prospective imagination than in actual practice. However the scientific, social and economic benefits of fully protected marine reserves proved in the event to be considerable, in both degree and range.

Ballantine, W.J. 1992. General versus specific solutions in the conservation of marine resources. Coral Reef Coalition Conference in Key West, Florida. 7 pages.

Temporary closures, gear restrictions, size limits and quotas have a long history in marine

fisheries management, but are applied to particular species and/or on a local basis as problems arise. More recently non-extractive marine reserves have been established in several countries, but again only on a local basis or in response to specific problems. So far, there seem to have been no attempts, in the sea, to apply standard terrestrial conservation principles. On land, systems of unexploited reserves are regarded as having important intrinsic values, as well as providing general solutions to a wide range of potential problems. The questions discussed in this paper are: (i) Would a system of marine reserves have intrinsic values, and if so, would they include scientific benefits? (ii) Do the differences in ecology between land and sea make marine reserve systems impossible or merely alter the necessary arrangement? (iv) If the answers to these questions cannot be established clearly on present evidence, what trials should be conducted now. It is suggested that present knowledge of marine ecological principles is sufficient to design a network of non-extractive marine reserves large enough to test the important questions, while being small enough (at least in New Zealand) to be politically practical. It is further suggested that the likely benefits are sufficiently large and varied to make this highly desirable, and that the pressures on marine resources are increasing so rapidly as to make action urgent. It is concluded that a full-scale trial should be conducted forthwith comprising a network of "no take" marine reserves covering a minimum of 10% by area of all marine habitats in all bio-geographic regions.

Ballantine, W.J. 1995. Networks of "No-take" marine reserves are practical and necessary. Pages 13-20 in N.L. Shackell and J.H. Martin Willison (editors). *Marine Protected Areas and Sustainable Fisheries*. Published by Science and Management of Protected Areas Association.

The first marine reserve in New Zealand was established in 1977 for scientific reasons. The rules were simple but strict--no fishing, no removals and no disturbance. Everyone was welcome to come and study or just appreciate the more natural conditions. The value of having "no-take" areas in the sea has, since then, become widely appreciated by recreational groups, schools, tourists, scientists, and fisheries interests. The list of potential benefits has steadily expanded, and evidence for their existence has accumulated. Specific benefits are commonly perceived, but the possibility of wider benefits, resulting from a network of ecologically-representative marine reserves, is beginning to receive serious consideration. As a result, marine reserves are being proposed at an increasing rate. By early 1994, eleven reserves had been established, five more await final decision and 20 further proposals are in various stages of public discussion. All political parties in New Zealand now endorse "no take" marine reserves in principle, and some are proposing "10% of all marine habitats by the year 2000. The lessons are simple but surprising. Management of marine resource exploitation and its problems is necessary but not sufficient. An independent and additional system that ignores the "problems (of controlling fisheries, waste disposal, habitat destruction, etc.) and concentrates on providing unexploited areas in the sea is scientifically essential (for observational and experimental controls); economically sensible (for insurance and sustainability); and socially acceptable in democracy (for a wide variety of positive reasons, including conservation principles, education and recreation).

Barr, B. W. 1995. The U.S. National Marine Sanctuary Program and Its Role in Preserving Sustainable Fisheries Pages 165-173 in N.L. Shackell, and J.H. Martin Willison (editors). *Marine Protected Areas and Sustainable Fisheries*. Published by Science and Management.

The U.S. National Marine Sanctuary Program provides for the protection of discrete areas within the waters of the U.S. deemed to be of special national significance through comprehensive and coordinated conservation and management of those sites. The Program currently includes 14 sites from New England to American Samoa that protect and preserve a broad array of critical marine resources and habitats. It is because of this variety of habitats and resources, and the many different site-specific management frameworks developed to insure the protection of those resources, that provide the opportunity for sanctuaries to play an important role in the preservation of sustainable fisheries.

Beckmann, Leslie 1995. Marine Conservation in the Canadian Arctic Pages 227-234 in N.L. Shackell and J.H. Martin Willison (editors). Marine Protected Areas and Sustainable Fisheries. Published by Science and Management

This paper discusses marine protection in the Arctic by: I) describing the Arctic marine region; ii) describing the areas to be protected; iii) detailing past efforts to protect marine ecosystems; iv) describing the Nunavut Agreement as a good model for marine management; and v) describing a project recently begun by the Canadian Arctic Resources Committee and the Canadian Nature Federation to ensure that areas in all three of Canada's marine regions receive adequate protection.

Ruckelshaus, M, Klinger T, Knowlton, N and D DeMaster. 2008. Marine ecosystem-based management in practice: scientific and governance challenges. BioScience. Vol 58 No1: 53-63.

Outlines 6 principles for using EBM framework to manage marine resources

1. Define the spatial boundaries of the marine ecosystem to be managed
2. Develop a clear statement of the objectives of EBM
3. Include humans in characterizations of marine ecosystem attributes and indicators of their response to change
4. Use a variety of strategies to hedge against uncertainty in the ecosystem response to EBM approaches
5. Use spatial organizing frameworks such as zoning for coordinating multiple management sectors and approaches in EBM
6. Link the governance structure with the scale of the ecosystem elements to be managed under an EBM approach.

Sheffer M, Brock W and F Westley. 2000. Socioeconomic mechanisms preventing optimum use of ecosystem services: an interdisciplinary theoretical analysis. Ecosystems. 3: 451-471.

Presents 3 key ingredients to correct the problems of bias and compromise when using ecosystem services.

1. Clear insight into ecosystem dynamic and responses to human use
2. Broad inventory of credible measurements of ecosystem utilities
3. Avoidance of bias due to differences in the organizational power of groups of stakeholders

On page 53 there are some figures of possible responses of ecosystems to stress imposed by human use and the "catastrophe fold."

Sheffer et al (2000) describe the concepts of common culture, incentives, social networks, free-riders (cites Ostrums 1994 models), hill-climbing strategies, willingness to pay, flip, optimum, decentralized regulation schemes, with strategies that include: 1) reliable model of the ecosystem's response to different forms of use; 2) An overview and valuation of the range of ecosystem services to society; and 3) Correction of political bias due to differences in the organizational power of groups of stakeholders.

#### Websites

INFORME: Nicaragua es un país con vocación forestal - el 25% del territorio nacional corresponde a bosques. December 12, 2013. Available from:

<http://www.tortillaconsal.com/tortilla/es/node/13951> (Accessed 7 April 2016)

Website contains a listing of all of the protected areas in Nicaragua. The PCWR is not included.

Map of Forest Protected Areas Nicaragua. Available from:

[http://www.vmapas.com/Americas/Nicaragua/Map\\_Forest\\_Protected\\_Areas\\_Nicaragua.jpg/maps-en.html?map\\_viewMap=1](http://www.vmapas.com/Americas/Nicaragua/Map_Forest_Protected_Areas_Nicaragua.jpg/maps-en.html?map_viewMap=1) (Accessed 7 April 2016)

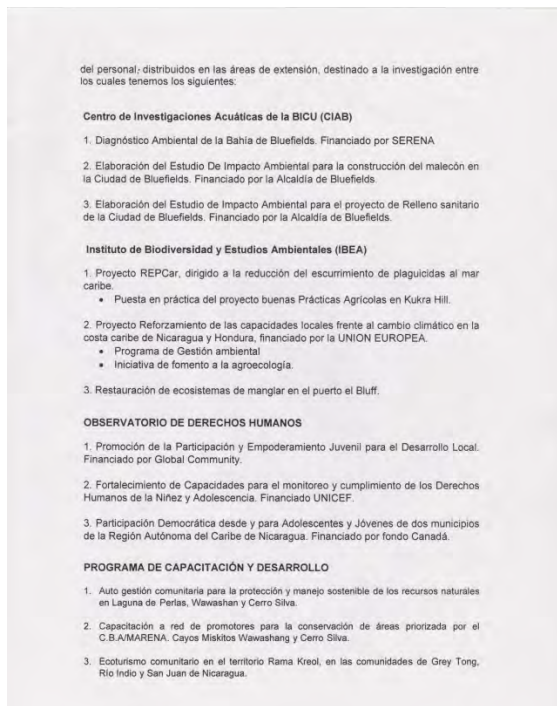
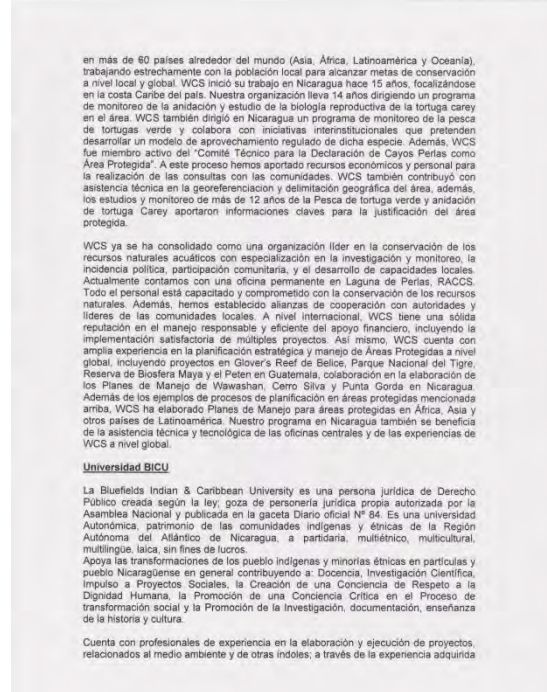
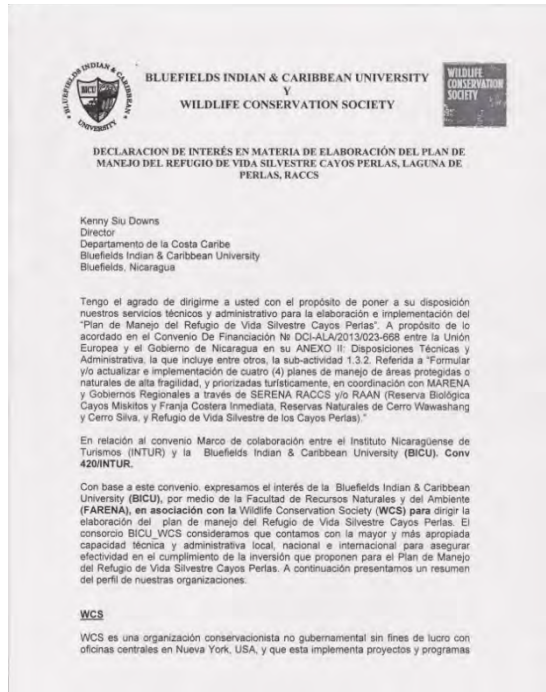
Website contains all terrestrial protected areas. There are 2 areas in the RACCS that are of interest. One located adjacent to the Pearl Lagoon Basin and one to the south (Indio Maiz).

Website for census information in Nicaragua - . Instituto Nacional de Información de Desarrollo (INDIE)

Available from: <http://www.inide.gob.ni/> (Accessed 7 April 2016).

## APPENDIX B

### Letter of intent between the Wildlife Conservation Society's Nicaragua Marine Program and the Bluefields Indian and Caribbean University





## APPENDIX C

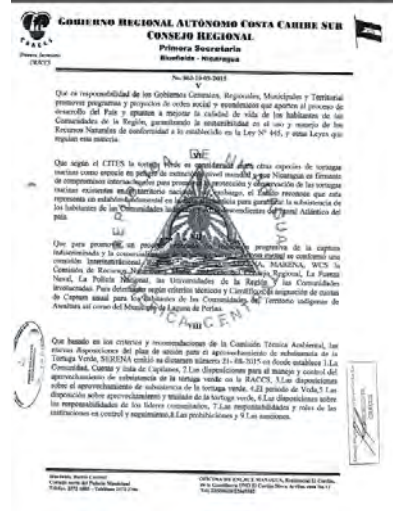
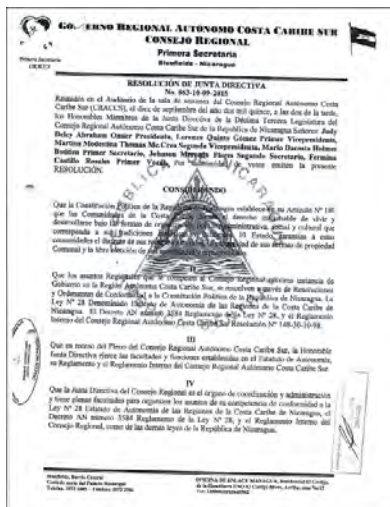
### Green Turtle Commission July 2015

Paul M. Angell Family Foundation Funds were used to support refreshments at the Green Turtle Commission meetings held in July 2015. WCS is a member of the Green Turtle Commission which is overseen by the Secretary of Natural Resources (SERENA) based in Bluefields.

There were eight community workshops held in July 2015. The purpose of the workshops was to gather input from the communities on the regulations for the legal harvest of green sea turtles in the RACCS. WCS provided science-based information during several of the workshops highlighting the plight of sea turtles worldwide and the need for enforcement on the legal harvest of all sea turtles, especially greens.

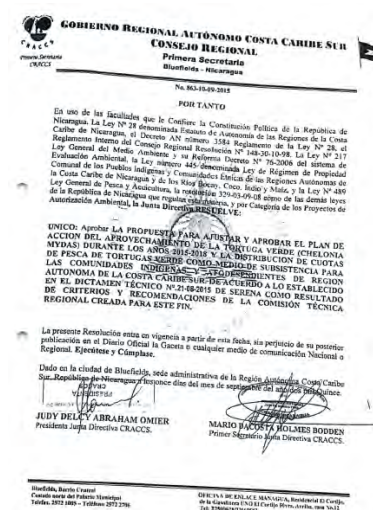
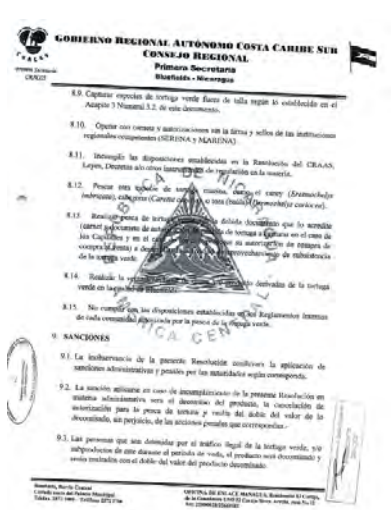
The result of the workshop was a resolution by the regional government stating harvestable quotas from each of the communities. Resolución 863-10-09-2015 Tortuga verde was authorized in October 2015. The Resolution states the names of the individuals permitted to harvest with their cedula (identification) numbers. The catch quotas for each community are also included. WCS does not endorse the resolution, but continues to promote the conservation of green sea turtles through outreach, alternative livelihoods and management planning.

### Resolution 863-10-09-2015









Community workshops related to the Green Turtle Commission information gathering to assess the status of the green sea turtle harvest in the Pearl Lagoon region.

## Workshop 1 held on 26 July 2015 Sandy Bay-Walpa; 34 participants

**GOBIERNO REGIONAL AUTÓNOMO COSTA CARIBE SUR**  
Secretaría de Recursos Naturales y de Medio Ambiente  
**SERENA**  
Región Autónoma Costa Caribe Sur

26/07/15

Lista de Asistencia

N.	Nombre y Apellido	N. de Cédula	Comunidad	Cargo
1	Aracely Zapata	678-20000-0000	Sandy Bay	Asesor
2	Aracely Zapata	678-20000-0000	Sandy Bay	Asesor
3	Aracely Zapata	678-20000-0000	Sandy Bay	Asesor
4	Aracely Zapata	678-20000-0000	Sandy Bay	Asesor
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35	Aracely Zapata	678-20000-0000	Sandy Bay	Asesor

Dirección: Residencial El Cortijo, gasolinera UNO 50 varas arriba, casa No 12,  
Bluefields: Costado Oeste Parque Reyes. Teléfonos Managua Teléfonos 22669582 - 2250629;  
Bluefields Tel: 25720110/25721541

## Workshop 2 held on 27 July 2015 Sandy Bay; 5 people

**GOBIERNO REGIONAL AUTÓNOMO COSTA CARIBE SUR**  
Secretaría de Recursos Naturales y de Medio Ambiente  
**SERENA**  
Región Autónoma Costa Caribe Sur

27/07/15

Lista de Asistencia

N.	Nombre y Apellido	N. de Cédula	Comunidad	Cargo
1	Aracely Zapata	678-20000-0000	Sandy Bay	Asesor
2	Aracely Zapata	678-20000-0000	Sandy Bay	Asesor
3	Aracely Zapata	678-20000-0000	Sandy Bay	Asesor
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35	Aracely Zapata	678-20000-0000	Sandy Bay	Asesor

Dirección: Residencial El Cortijo, gasolinera UNO 50 varas arriba, casa No 12,  
Bluefields: Costado Oeste Parque Reyes. Teléfonos Managua Teléfonos 22669582 - 2250629;  
Bluefields Tel: 25720110/25721541

Workshop held on 26 July 2015 Sandy Bam de Rio Grande; 12 people

**GOBIERNO REGIONAL AUTÓNOMO COSTA CARIBE SUR**  
Secretaría de Recursos Naturales y de Medio Ambiente  
**SERENA**  
Región Autónoma Costa Caribe Sur

Lista de Asistencia  
27/07/15  
Sandy Bam

N.	Nombre y Apellido	N. de Cédula	Comunidad	Cargo
1	Remy Delmas	622-0000-0000	La Barra	
2	Rebeca Molina	622-77782-0000	La Barra	
3	Rebeca Hernandez	"	"	
4	Rebeca Hernandez	622-0000-0000	La Barra	
5	Rebeca Hernandez	622-0000-0000	La Barra	
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Bluefields Tel: 25720110/25721541

Workshop 4 held on 28 July 2015 Tasbapauni; 10 people

**GOBIERNO REGIONAL AUTÓNOMO COSTA CARIBE SUR**  
Secretaría de Recursos Naturales y de Medio Ambiente  
**SERENA**  
Región Autónoma Costa Caribe Sur

Lista de Asistencia  
28/07/15  
Tasbapauni

N.	Nombre y Apellido	N. de Cédula	Comunidad	Cargo
1	Rebeca Hernandez	622-0000-0000	La Barra	
2	Rebeca Hernandez	622-0000-0000	La Barra	
3	Rebeca Hernandez	622-0000-0000	La Barra	
4	Rebeca Hernandez	622-0000-0000	La Barra	
5	Rebeca Hernandez	622-0000-0000	La Barra	
6	Rebeca Hernandez	622-0000-0000	La Barra	
7	Rebeca Hernandez	622-0000-0000	La Barra	
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# Workshop 5 held on 28 July 2015 Kahkabila; 19 people

GOBIERNO REGIONAL AUTÓNOMO COSTA CARIBE SUR			
Secretaría de Recursos Naturales y de Medio Ambiente			
SERENA			
Región Autónoma Costa Caribe Sur			
Lista de Asistencia			
28/07/15 Kahkabila			
N.	Nombre y Apellido	N. de Cédula	Comunidad
1	Hernando Sandoz		Kahkabila
2	McGowan		Kahkabila
3	Alfonso Sandoz	626 162 169 0001 C	Kahkabila
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# Workshop 6 held on 28 July 2015 Set Net Point; 18 people

GOBIERNO REGIONAL AUTÓNOMO COSTA CARIBE SUR			
Secretaría de Recursos Naturales y de Medio Ambiente			
SERENA			
Región Autónoma Costa Caribe Sur			
Lista de Asistencia			
28/07/15 Set Net Point			
N.	Nombre y Apellido	N. de Cédula	Comunidad
1	Alfonso Sandoz	607 212 81 51	Set Net Point
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Workshop 7 held on 29 July 2015 Laguna de Pearl; 11 people

**GOBIERNO REGIONAL AUTÓNOMO COSTA CARIBE SUR**  
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Región Autónoma Costa Caribe Sur

Lista de Asistencia: Laguna de Pearl

N.	Nombre y Apellido	N. de Cédula	Comunidad	Cargo
1	Juan Tallo	616-21187-0001	Laguna de Pearl	Residente
2	Demian Peralta	616-161187-0001	Laguna de Pearl	Residente
3	Guillermo Morales Sarmiento	616-050856-0001	Residente	Residente
4	John Watson	626-284-762-0001	Residente	Residente
5	Ubaldo Ayasso	626-300-770001	Residente	Residente
6	Ubaldo Nelson Pineda	626-300-770001	Residente	Residente
7	Rodolfo Chaves	626-250174-0001	Residente	Residente
8	Kayvan Ortiz	626-130373-0001	Residente	Residente
9	Guillermo Ortiz	626-130373-0001	Residente	Residente
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Workshop 8 held on 28 July 2015 Awás-Ritipurra; 8 people

**GOBIERNO REGIONAL AUTÓNOMO COSTA CARIBE SUR**  
Secretaría de Recursos Naturales y de Medio Ambiente  
**SERENA**  
Región Autónoma Costa Caribe Sur

Lista de Asistencia: Awás

N.	Nombre y Apellido	N. de Cédula	Comunidad	Cargo
1	Kayvan Ortiz	626-130373-0001	Laguna de Pearl	Residente
2	Carla Ramírez	626-130373-0001	Laguna de Pearl	Residente
3	Marlene Ramírez	626-130373-0001	Laguna de Pearl	Residente
4	Marlene Ramírez	626-130373-0001	Laguna de Pearl	Residente
5	Marlene Ramírez	626-130373-0001	Laguna de Pearl	Residente
6	Kayvan Ortiz	626-130373-0001	Laguna de Pearl	Residente
7	Shandy Hall Wilson	626-130373-0001	Laguna de Pearl	Residente
8	Ubaldo Nelson Pineda	626-300-770001	Laguna de Pearl	Residente
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Pearl Cays Wildlife Refuge Management Planning Workshop | Science Workshop  
Bluefields Indian and Caribbean University, Video Conference Center  
Bluefields, Nicaragua, April 25, 2016

## Agenda

Pearl Cays Wildlife Refuge  
Science Workshop

April 25, 2016 | 9:00 am – 5:00 pm

Bluefields Indian and Caribbean University  
Bluefields, RACCS, Nicaragua

### Meeting Objectives

- Bring together researchers and representative from science-based organization to share information about their knowledge of the Pearl Cays Wildlife Refuge
- Review a preliminary overview of the Pearl Cays Wildlife Refuge
- Provide project background about the Integrated Ecosystem Assessment Process as a tool to develop management plans
- Review the draft materials for the Pearl Cays Wildlife Refuge's Integrated Ecosystem Assessment
- Gather additional information about the science and research gaps needed to improve the understanding of the Pearl Cays Wildlife Refuge

### Workshop Purpose

The purpose of the workshop is to share knowledge about the Pearl Cays Wildlife Refuge for use in developing a characterization of the ecosystem and for identifying research needs.

### Workshop Sponsor

The meeting is being sponsored by a grant award to the Wildlife Conservation Society to facilitate the development of a management for the Pearl Cays working in partnership with the Bluefields Indian and Caribbean University.

Time, Leads	ACTIVITIES and OBJECTIVES	Set up and materials
8:30–9:00  All WCS and BICU staff	<b>Set up, Participants Arrive, Snacks</b>  Activities/Interactions: <ul style="list-style-type: none"> <li>• Room set-up. Load presenters' powerpoints on one computer, set up conference call or other call-in feature (gotomeeting, cell phone) for Pamela</li> <li>• Participants arrive, get meeting materials, get settled, each breakfast snacks. Sign-in.</li> </ul>	Breakfast snacks  Agendas Sign-in Map of refuge Handouts -IEA materials

	Total: 30 minutes	-laptop and projector prepared for presentations
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9:00-9:45  Eddy and Chang -facilities -Format for the day -Questions	<b>1. Welcome, Objectives, &amp; Introductions</b>  <u>Objectives:</u> Workshop welcome and introductions and review of workshop purpose/objectives and project background.  <u>Activities:</u> <ul style="list-style-type: none"> <li>Eddy and Chang welcome attendees, review objectives, and explain meeting objectives. (5 min)</li> <li>Review agenda. (5 min)</li> <li>Round table of introductions, asking each participant to <i>briefly</i> share whether they are involved in the Pearl Cays Wildlife Refuge (35 min)</li> </ul> Total: 45 min	Definition-read ahead material
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9:45 -10:30  Chang	<b>2. Pearl Cays Wildlife Refuge Overview</b>  <u>Objectives:</u> Deliver summary overview of the information obtained about the Pearl Cays Wildlife Refuge  <u>Activities:</u> <ul style="list-style-type: none"> <li>Q and A</li> </ul> Total: 45 minutes	Laptop, projector pre-loaded ppt  Publications  preliminary summary
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10:30-10:45	<b>Break</b>	Snacks, beverages
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10:45 - 11:00  Chang (Pamela if internet connection is available)	<b>3. Integrated Ecosystem Assessment Process</b>  <u>Objective:</u> Deliver overview of the Integrated Ecosystem Assessment Process and how it was used to develop the Pearl Cays Wildlife Refuge summary  <u>Activities:</u> <ul style="list-style-type: none"> <li>Q and A</li> </ul> Total: 15 minutes	Laptop, projector  Conference call (gotomeeting.com) what is in auditorium)
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11:00 - 12:00  Eddy and Chang	<b>4a. Gather expert opinion to expand the PCWR summary</b>  <u>Objective:</u> Gather additional information about the science and information	Flip charts  Maps
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facilitate discussion  Karen record information	available to improve the understanding of the Pearl Cays Wildlife Refuge  <u>Activity:</u> <ul style="list-style-type: none"> <li>Participants will provide expert opinion sharing information about the knowledge of the Pearl Cays Wildlife Refuge</li> <li>Use the IEA framework to gather information about the socio-ecological system</li> <li>Work in small groups with Eddy, Chang, and Karen leading each to work as one larger group</li> </ul> Total: 1 hour	Background information
<b>12:00 – 1:30</b>	<b>Lunch (catered)</b>	provided
1:30 - 2:30	<b>4b. Gather expert opinion to expand the PCWR summary <i>continued</i></b>  Total: Total: 1 hour	
<b>2:30 – 2:45</b>	<b>Break</b>	Snacks, beverages
2:45 – 3:30	<b>4c. Gather expert opinion to expand the PCWR summary <i>continued</i></b>  Total: 45 min	
3:30 – 4:45  Eddy and Chang facilitate discussion  Karen record information	<b>5. Identify information needs/gaps for the PCWR</b>  <u>Objective:</u> Gather additional information about the science and research gaps needed to improve the understanding of the Pearl Cays Wildlife Refuge  <u>Activities/Interactions:</u> <ul style="list-style-type: none"> <li>Review briefly the information about the PCWR (30 mins)</li> <li>Identify critical research needs and gaps for the PCWR (45 mins)</li> </ul> Total: 1 hour 15 mins	
4:45 - 5:00  Eddy	<b>5. Wrap up and next steps</b>  <u>Objective:</u> Science workshop wrap up and overview of what's next	Confirm all



	<u>Activities/Interactions:</u> <ul style="list-style-type: none"> <li>Meeting recap, Q &amp; A, and next steps</li> </ul> Total: 15 min	participants signed in to the workshop
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<b>5:00</b>	<b>Adjourn</b>	
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#### List of Participants

##### **Name and surname**

##### **Institution /Organization**

- |                         |                                |
|-------------------------|--------------------------------|
| 1. Edgar Chamorro       | INPESCA                        |
| 2. Maylin Martinez      | SERENA                         |
| 3. Edward Siu           | FARENA / BICU                  |
| 4. Anthony Rojas        | SERENA                         |
| 5. Xiomara Treminio     | UNIVERSIDAD URACCAN            |
| 6. Rodolfo Chang        | WCS                            |
| 7. Karl Tinkam          | CONSEJO REGIONAL               |
| 8. Lindolfo Hodgson     | IBEA / BICU                    |
| 9. Katherine Rojas      | estudiante biología BICU       |
| 10. ADA Segar           | estudiante BICU                |
| 11. Rodney Sambola      | Docente BICU                   |
| 12. Rene Romaero        | IBEA /BICU                     |
| 13. Sandra Downs        | Turismo / BICU                 |
| 14. Billy Ebanks        | FARENA / BICU                  |
| 15. Julio Hernandez     | Central American Fishery (CAF) |
| 16. Withney Aristhomene | Estudiante de Biología BICU    |
| 17. Keren Matus         | Estudiante de Biología BICU    |
| 18. Neyda Dixon         | Periodista / BICU              |
| 19. Martina Luger       | Horizon 2000/ Blue Energy      |
| 20. Karen Joseph        | INPESCA                        |
| 21. Pablo Guillen       | ODHA/ BICU                     |
| 22. Maryoree Sequeira   | BICU                           |
| 23. Leonardo Wallace    | BICU                           |
| 24. Leonardo Joseph     | PCD7BICU                       |
| 25. Melvin Archbold     | IBEN/BICU – facilitador        |
| 26. Enoc Rivas          | FARENA /BICU – facilitador     |
| 27. Alvaro Mairena      | FAERENA / BICU                 |
| 28. Daniela Arellano    | BICU                           |
| 29. Lauren Mendoza      | BICU                           |
| 30. Silver Vanega       | BICU                           |
| 31. JOSE Ramirez        | BICU                           |
| 32. Deborah Humphys     | BICU                           |
| 33. Jose Castellon      | BICU                           |
| 34. Erwin Castro        | BICU                           |

Meeting notes provided by BICU staff (M. Archbold, E. Rivas, and K. Joseph)

The workshop opened with BICU Presentations by Melvin Archbold and Enoc Rivas (Powerpoints available upon request) describing the marine and coastal ecosystem of the PCWR. A discussion about the PCWR ensued with the following notes:

#### Principal problems Part 1 – Melvin archbold

- No previous studies
- Clear evidence of impacts to and a reduction in reef ecosystem
- There is a high level of uncertainty of the status of the PCWR because the actual situation and ecological condition of the Pearl Cays is largely unknown because of limited research in the cays
- Information from other countries with similar physical, chemical and geophysical conditions are being used to make our assessment

#### Principle problems Part 2 - Enoc Rivas

- Problem related to lionfish and other invasive species
- How can we make incidence with the damage caused by agriculture processes and upland/terrestrial changes that impact the reefs?
- We have observed the presence of domestic animals on cays, which is not good for sea turtle nesting as it relates to the effect that it has on the nesting process
- Erosions and pollution are major concerns in the cays
- Case Study from Sea Flower Marine Reserve in San Andres Columbia
- Climate change will impact marine resources
- 1° increase in temperature is sufficient to make changes on ecosystem, some of these changes can be mention such as coral bleaching, immigration and emigration of species and expansion of calcareous algae's.
- The have evidence of the increase of diadems
- we cannot ovoid the theme of Climate Change

#### Immediate actions and needs

- We need to develop an action Plan towards lionfish in the PCWR, but at this time no data available
- Develop action Plan for coral bleaching around the coral reef of Pearl cays
- Need to protect species such as parrot fish

#### Questions and Answers

Lindolfo Hodgson is there any information available, related to Biodiversity?

Response - we do have information related to Sea Cucumber, Sea urchin and macro-algae on Eater cay, no other Cay. We have a lot of uncertainties related to distribution and abundance.

Pedro Guillen We cannot talk about Management plan when we don't use science-based information. We need to have solid and reliable information for us to talk about level of impact.

We need to define what type of research we need, what should we focus on what is need to be done immediately.

Melvin Archbold there is evidence that they were no turtles nesting on Wild Cane years ago, now they are.

Karen Joseph I do agree that we don't have reliable information, but the reason of this workshop is precisely for that, what and how can we do, to obtain the information that is needed to make the next step. The following workshop will be with community leaders.

\_\_\_\_\_ Another suggestion is to; obtain ecological maps, infrastructure impact, how to get other people involve in the process, political will, regional political conservation.

Anthony Rojas; what about the agro-chemical produced by the African palm in Kukra Hill and related sedimentation

Rodney Sambola yes we don't have sufficient studies in relation of the Pearl cays, but we do have enough evidence that the management plan is needed

Martina Luger I suggest that what is needed is a co-management plan, to guarantee the participation of the government and the resource users. Doing so, we can guarantee a constant monitoring by authorities. We need to involve the people, make them be conscious about the negative affect that certain activity produce on the coral reef.

Melvin Archbold we need to develop an integral program, community are also worry about the Pearl Cays, including the lagoon.

Comments - Some ideas that can be done

- 1- Contact tours operators
- 2- Establish a diving school
- 3- Make an integral co-management plan that will includes Pearl cays, Kings Cays and Man of War Cays also the Pearl Lagoon.
- 4- Do reef check
- 5- Management
- 6- Establish a Biological station
- 7- Develop a permanent Monitoring plan.

Karl Tinkam I been in so many presentations, but most just focus on the bad things that people are doing. They never talk about good things that community people have done. Those Cays in the past were desolated, no coconut trees, no mangroves, they were lone rock, community people such as my grandfather began to plant them, and that's how we now have lovely Cays. So we cannot think to develop a Management plan base on ecological impact, but also we need to think on social and economic issues, because there is an unknown number of fisher that works on those Cays and an unknown number of families who depend of the fishing activity for living. We need to establish a baseline. We need to be responsible when we talk about people's health, well-being, sustainability and sensibility.

Rodney Sambola This process began in 2008, and the idea came out from the communities, we are in 2016 and still we don't have a management plan for the Pearl Cays. Based on the information and worries express by Tinkam, we need to develop a plan to increase awareness to define the fishing zones and no take zone.

Julio Hernandez we need to address the theme of sea cucumber, the effect that it has on the coral. There are in-discriminated extractions of sea cucumber

Lindolfo Hodgson what alternative will you all provide to community, to reduce the extraction of Sea cucumbers, and the use of lobster traps on coral reef.

Melvin Archbold this management plan is a proposal to visualize where we are and how we are, so the alternatives will come from the community, the resource users, not from us.

Enoc added that the management plan will also contemplate norms and policies and that at some point people will need to adjust themselves to it.

Sambola community people have already started to say what they want.

Pablo we need to guarantee people's participation, we need to retrieve good practices, and at what point we will involve community participation.

#### Governances and Natural Resource in Communal land presentation – Rodolfo Chang

- Relation between social and natural environment is not an easy topic
- Each resource has its own life strategy and characteristics
- The problem is how to define the system that regulates and govern the interaction between the government, social system and environment.
- In the case of the communities, the system functions with a number authorities from different entities that's deal with the same resources such as INPESCA, MARENA, Territorial and communal Government also municipal government, and each one work separately and have their own function base on their own internal regulation system.
- Governance comes from the interaction between the system that govern and the system to be governed. The governing regulates the interaction between society and resources. The market is part of the system that governs. All different forms of governments. What do we govern? There are different roles of actors (each governance structure). It is important to sit with people who govern to determine their role in the governances of resources. First you must sit with the community so that they can be clear and can define how these governments should work.
- Communities must respect the laws, rules and regulation, but the central government needs to address themselves to community for them to understand what they are referring about, and also respect communities.
- Need to address a few fundamental questions
  - What are the weaknesses in the system?
  - What are strengths in governance system?
  - What is the implementation of the system? The implementation of the mandates of the central government for example (closures), are they given in an effective way?. How they are established in the municipality? There distractors to address governance or the different functions of the governments of the community.
  - Which activities can be performed in the cays: fishing and tourism. Who grants these rights of access to these activities? Who regulates the construction of infrastructure?
  - There are access rights and who gets the benefits? Who and how do they regulate these rights?

- How to make the central government to coordinate with the rest of government system such as Regional, Territorial, Municipal and communal.
- Which resources must be regulated and which should have free access.
- There needs to be a study of the abundance of these resources that are given exploitation concession? How do you prepare the community when there is a new non-traditional resource to be exploited? How to control the exploitation of non-traditional resources in the region? Who controls or should control the incentives that are generated from the exploitation of resources, as perceived by the people and the rulers. Who regulates the market in the community? Is the government regulates the market?. What is the correct way to address the issue of regulating the exploitation of resources between institutions and community?
- As we engage resource users, to be part of the process of establishing the management of the PCWR

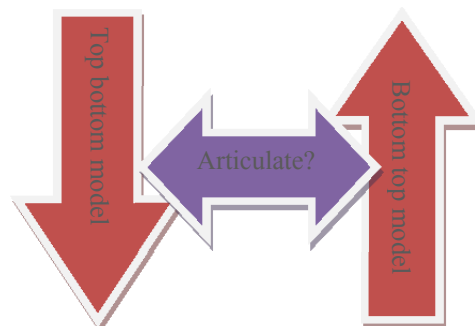
### Weakness and areas for improvement

1. Mandates unclear
2. Government structure not well defined
3. Political will
4. Access rights
5. Low law enforcement
6. Articulation system. How can we articulate the Central with communal, territorial, regional and municipal government?

We are working with a complex grouping – the PCWR, around the cays, the variety of stakeholders- is consider as open access and other in limited access [is considered, but there are regulations], but also we are dealing with tourism and fishing activities. Fishers capture fish, sea turtle, sea cucumber, jellyfish, fishes, lobster, conch and blue crabs. This can be artisanal and industrial fishery. Because of a lack of enforcement of rules and regulations, we have negative incentives which appears to propel the behavior of resource user. “If he can do it, I can do too.”

How can we change the top/bottom model to a bottom/top model, where;

Central Government  
Regional government  
Territorial government  
Municipal Government  
Communal government



Communal government  
municipal government  
Territorial government  
Regional government  
Central government

### We need

1. Institutional strengthen
2. Law enforcement
3. Institution decentralization, based on autonomy regime.

4. Increase monitoring, guidance and control
5. Collective actions
6. We need to recover our social and conservation values
7. Communities need to assume their responsibility and act right
8. The theme of "The advance of the agriculture frontier need to be put on the table.

### **Question and Answers**

Rene Romero A simple closed season does not function, we need to be stricter with the resource user. If not we will end in the paradigm of Harding "the tragedy of the commons."

Edgar Chamorro As INPESCA, we implemented the use of tracking device for industrial boats, also the bringing of their garbage to main land after fishing. I do believe that the lobster closed season works and has had good results.

Karl Thinkam We are in a governability crisis, fishing effort had increased, capture (volume) and size has decreased and many species have despaired. There is evidence that we need to do something but we cannot cover the sun with a finger. We have uncertainties, the theme of the Pearl Cay Wildlife Refuge management plan needs to be addressed with a lot of patience and in elegancy.

### **Facilitated discussion - Edward Siu, BICU**

#### **Three main questions we need to address**

#### **IV. What do we need, to develop a management plan within a communal system?**

- Pablo; Mapping key informant from both institutional and communal level.
- Work on the reality of the communities condition and characteristic
- Edward Siu; To Develop workshop addressing the different level of governance we need funding, which are the main constrain to guarantee the rest of activity proposed
- Melvin; Develop workshop base on "they roles and resources allocation and management. Directed to different level of governance (Territorial, municipal and communal).
- Karen; Ecological mapping
- Karen; Mapping of the cays and zones which we will like to be integrated in the management plan.
- Pablo; Guarantee strategies and method of participation
- Enoc; make agreement with fisher for mapping zones.
- Melvin Develop strategies of how to obtain communities support, counting that they are now in a situation of opposition. Pearl lagoon basin is divided by two territorial governments.
- Edward; Review of legal situation of the cays.
- Pablo; Find out if they are political will at the central level. Which will be a cay for develop a management plan.
- Edward; Resource allocation to develop all different activity proposed.
- Karen; Research on actual condition, biological and ecological.
- General Historical aspect of the cays.
- Karl, Case studies of Positive impact. Good thinks that have been done.

- Sambola; Awareness campaigns.

**V. What are the constraints and challenges?**

- What and how should we address community's members to accept the idea of the management plan, as a multiethnic and multicultural community?
  - o Participation in all senses
  - o Acceptance of the proposal
  - o Positioning the idea – get things clear
  - o Empowering
  - o Appropriations
  - o Infatuation
- How can we counteract the negative incentives? Resume conservation ethic.
- Implement and strength positives actions that is practicing in some communities.
- What type of incentives we can implement (social and economic)
- Alternative livelihood
- Tourism
- Institutional strengthen to increase monitoring.
- Management of solid and liquid waste.
- Government (central, regional, territorial, communal, and municipals) strengthen at a different level.

**VI. What positive aspects can we count on?**

- Alternative livelihood (Kabu Tour)
- Community organization
- Community participation at certain level
- Institutional credibility in communities (BICU, INPESCA, WCS, etc).
- Positive impact of some projects (DIPAL, etc.)
- Institutional agreements
- We have the SEAR (Regional Autonomous Educational System)
- The existence of CUMAJ in the municipality (youth organization)

Pearl Cays Wildlife Refuge Management Planning Workshop | Community Workshop  
Territorial House, Pearl Lagoon, RACCS, Nicaragua, April 27, 2016  
Agenda

Pearl Cays Wildlife Refuge Management Planning Workshop  
April 27, 2016 | 9:00 am – 5:00 pm

Territorial House  
Pearl Lagoon, RACCS, Nicaragua

Meeting Objectives

- Bring together decision makers from the Pearl Lagoon Basin to review the science-based information about the Pearl Cays Wildlife Refuge
- Review a preliminary overview of the Pearl Cays Wildlife Refuge
- Provide project background about the Integrated Ecosystem Assessment Process as a tool to develop management plans
- Review the draft materials for the Pearl Cays Wildlife Refuge's Integrated Ecosystem Assessment
- Gather information about the decision-making process in the Pearl Cays Wildlife Refuge
- Describe information needs and gaps for managing the Pearl Cays Wildlife Refuge
- Outline a process for implementing a management plan for the Pearl Cays Wildlife Refuge

Workshop Purpose

The purpose of the workshop is to share knowledge about the Pearl Cays Wildlife Refuge and develop a strategy for facilitating a management plan for the refuge.

Workshop Sponsor

The meeting is being sponsored by a grant award to the Wildlife Conservation Society to facilitate the development of a management for the Pearl Cays working in partnership with the Bluefields Indian and Caribbean University.

Time, Lea	ACTIVITIES and OBJECTIVES	Set up and materials
8:30–9:00  All WCS and BICU staff	<b>Set up, Participants Arrive, Snacks</b>  Activities/Interactions: <ul style="list-style-type: none"> <li>• Room set-up. Load presenters' powerpoints on one computer, set up conference call or other call-in feature (gotomeeting, cell phone) for Pamela</li> <li>• Participants arrive, get meeting materials, get settled, each breakfast snacks. Sign-in.</li> </ul> Total: 30 minutes	Breakfast snacks  Agendas Sign-in Map of refuge Handouts -IEA materials -laptop and projector prepared for presentations
9:00-9:45  Eddy and Chang	<b>4. Welcome, Objectives, &amp; Introductions</b>  <u>Objectives:</u> Workshop welcome and introductions and review of workshop purpose/objectives and project background.	Definition-read ahead materials



-facilities -Format for the day -Questions	<u>Activities:</u> Eddy and Chang welcome attendees, review objectives, and explain the meeting objectives. (5 min) Review agenda. (5 min) Round table of introductions, asking each participant to <i>briefly</i> share whether they are involved in the Pearl Cays Wildlife Refuge (35 min)  Total: 45 min	
9:45 -10:30  Chang	<b>5. Pearl Cays Wildlife Refuge Overview</b>  <u>Objectives:</u> Deliver summary overview of the information obtained about the Pearl Cays Wildlife Refuge  <u>Activities:</u> Q and A  Total: 45 minutes	Laptop, projector, pre-loaded ppt,  Publications  preliminary summary
<b>10:30-10:45</b>	<b>Break</b>	Snacks, beverages
10:45 - 11:00  Chang (Pamela if internet connection is available)	<b>6. Integrated Ecosystem Assessment Process</b>  <u>Objective:</u> Deliver overview of the Integrated Ecosystem Assessment Process and how it was used to develop the Pearl Cays Wildlife Refuge summary  <u>Activities:</u> Q and A  Total: 15 minutes	Laptop, projector  Conference call (gotomeeting or what is in auditorium)
11:00 - 12:00  Eddy and Chang facilitate discussion  Karen record information	<b>4a. Gather expert opinion to expand the PCWR summary</b>  <u>Objective:</u> Gather additional information about the <i>science and information available</i> to improve the understanding of the Pearl Cays Wildlife Refuge  <u>Activity:</u> <ul style="list-style-type: none"> <li>Participants will provide opinions about their knowledge of the Pearl Cays Wildlife Refuge</li> <li>Use the IEA framework to gather information about the socio-ecological system</li> <li>Work in small groups with Eddy, Chang, and Karen leading each topic</li> </ul>	Flip charts  Maps  Background information

	or work as one larger group  Total: 1 hour	
<b>12:00 – 1:30</b>	<b>Lunch (catered)</b>	provided
1:30 - 2:30  Eddy and Chang facilitate discussion  Karen record information	<b>5. Build an understanding of the decision-making process for the Pearl Cays Wildlife Refuge</b>  <u>Objective:</u> Gather information about the decision-making process in the Pearl Cays Wildlife Refuge  <u>Activities/Interactions:</u> <ul style="list-style-type: none"> <li>Ask participants to share information about the decision-making process related to the PCWR (30 mins)</li> <li>Identify barriers and benefits to facilitating/developing a management plan for the PCWR (30 mins)</li> </ul> Total: 1 hour	
<b>2:30 – 2:45</b>	<b>Break</b>	Snacks, beverages
2:45 – 3:45  Eddy and Chang facilitate discussion  Karen record information	<b>6. Identify needs and gaps for managing the Pearl Cays Wildlife Refuge</b>  <u>Objective:</u> Describe information needs and gaps for managing the Pearl Cays Wildlife Refuge  <u>Activities/Interactions:</u> <ul style="list-style-type: none"> <li>Ask participants to identify management needs and gaps (30 mins)</li> <li>List out needs and gaps and identify potential solutions to overcome items (30 mins)</li> </ul> Total: 1 hour	
3:45 – 4:15  Eddy and Chang facilitate discussion  Karen record information	<b>7. Outline the management planning process for the PCWR</b>  <u>Objective:</u> Outline a process for implementing a management plan for the Pearl Cays Wildlife Refuge  <u>Activities/Interactions:</u> <ul style="list-style-type: none"> <li>Outline the legislative process to create a management plan for the PCWR (30 mins)</li> </ul> Total: 30 mins	

4:15 - 5:00	<b>8. Wrap up and next steps</b>	
Eddy	<p><u>Objective:</u> Review information obtained from the workshop, respond to questions, and discussion next steps</p> <p><u>Activities/Interactions:</u></p> <ul style="list-style-type: none"> <li>Meeting recap, Q &amp; A, and next steps</li> </ul> <p>Total: 45 min</p>	Confirm all participants signed in to the workshop
<b>5:00</b>	<b>Adjourn</b>	

#### List of Participants;

Name and surname	Institution /Organization	community
1. Xenia Gordon	Municipal Government/ fishery inspector	P. Lagoon
2. Orvin Watson	communal Judge	Set net point
3. Marlene Carlos	communal secretary	Tasbapaunie
4. Wesley Williams	community Leader	P. Lagoon
5. John Watson	Sindigo	P. lagoon
6. William McCoy	WCS	P. lagoon
7. Mercelina Sambola	Sindigo	Orinoco
8. Telia Suartz	Fiscal	Kahkabila
9. Stennett Theodore	coordinator	Kakkabila
10. Bertha Thyne	coordinator	Set Net Point
11. Marie Tinkam	FADANIC	Haulover
12. Lola Sambola	coordinator	SanVicente
13. Wilfred Sambola	secretary	San Vicente
14. Norman Lopez	Vocal	La fe
15. Owen Douglas	Sindigo	Broun bank
16. Arwel Davis	coordinator	Broun bank
17. Kenneth Fox	community adviser	Rocky Point
18. Leonardo Benneth	territorial leader	Marshal Point
19. Felix Sinclair	Wihta Tara	Orinoco
20. Kevin Davis	community coordinator	Marshal Point
21. Eduardo Siu	Facilitater	La Fe
22. Delving Prudo	community leader	Tasbapaunie
23. Miriam Allen	community coordinator	Raitypura
24. Karen Joseph	logistic	Bluefields
25. Suling Dixon	Territorial president	Tasbapaunie

26. Marjuleth Cassanova	Territorial President- P. Lagoon	Haulover
27. Jeysie Fox	secretary	Pearl Lagoon
28. Nuria Dixon	communal Board	Pearllagoon
29. Enoc Rivas	facilitator	Bluefields
30. Melvin archbold	facilitator	Bluefields
31. Luis Alvares	community leader	Kahkabila
32. Wilberth Suartz	member	Kahkabila
33. Norton Stamp	secretary	La Fe
34. Rodolfo Chang	WCS	P. Lagoon

Pearl lagoon April 27, 2016

Presentation by Melvin and Enoc (powerpoints can be furnished upon request)

### **Question and Answer**

Questions posted to community members:

- How much can we take (sea cucumber)?
- Who control?
- What can we do?

Chang Outsiders come, take out and leaves nothing. We can do tourism. We can zone up areas, which can help us manage.

Keneth fox we cannot talk about protected area as something strange or new. The issue is not how much to take, the issues is "How much control do we got over the resources, and how do we do things. To talk about management, it got to be something integral. Why--because communities change, people change and cultural activities change, everything changes with markets. The truth is that we need to start somewhere.

### **Question addressed to participants:**

What is happening in the Perl Cays and or communities?

- Accumulation of solid and liquid waste
- The use of gill nets on cays and coral reefs
- Using of patch reefs over and over
- Increase and development of tourism activities is uncontrolled.
- All tourists need a legal authorization to be in the cays
- Illegals Purchase / Sale of the Pearl Cays
- Illegal fishing gear with illegal mesh size
- Catching of resource in close season
- Habitat degradation
- Resource reduction in catch and size

Wesley Williams fishers are taking out stones and pieces of coral for sinking lobster pots (the rocks and corals are removed from the Cays but not returned). What can we do?

Bill McCoy turtle fishers used the corals to tie they nets and sink them as anchors. They take out corals to construct breakwaters on cays. Others after using the corals they throw it back on other live corals. Loading capacity of Cays is unknown. Infrastructures on cays. Destruction of natural habitats.

Bertha Thyne Boats come from Bluefields to catch sharks and ray, they trout the garbage and waste in the water near the corals and cays. Uncontrolled number of fishers.

Felix Sinclair We need to take back on reflect what the Bible says, live in harmony with the environment, if we do so we will be blessed.

### **Natural Capital and social norms presentation - Rodolfo Chang**

- Overview of society and environment
- How we are govern the socio-ecological system
- We see environment as a resource unit. Resource units are compose by the natural resources in this case fish, lobster, crab etc.
- Government system regulates the relationship between society and environment by rules and regulations. They put the rules and mechanism in place to manage.
- Government system is ruled by the market and is composed of by the state of Nicaragua, but it also recognizes other ways of control and administration through other parts of the government: Central government, regional government, territorial government, Municipal government and communal government.
- The government system is also weak; it cannot have control where there is open access. Government regulates the relationship between society and environment.

Victoriano sambola The problem comes when we talk about articulation, how we can articulate these governing system that was mentioned before. We consider that central government does not respect the other governments in our region or communities.

Chang Because of changes in time, these changes also have effect on:

- Populations
- Lifestyle
- Environments
- Social and capital worthy

Once we trust the system, social capital can enhance people working together. This can promote:

- Collective actions.
- Conservation ethics
- Poverty
- Malpractice towards resource exploitation
- Centralize rules, give negative influence
- Law enforcement (negative incentives)
- Open access
- Political influence

Leroy Beneth How can we protect our lagoon, when government is giving away gears, engine and boats? It is increasing pressure on the resources. What should we do, if we have necessity to survive? We need to establish certain regulation in the cays and in the lagoon. For example, close seasons for fish, crab, sea cucumber, similar to lobster. We need to get together and sing the same song.

Marcelino sambola We need training and workshops to create consciousness and get everyone unite. But in the management plan we need to put in also the lagoon not only the pearl cays. Because fish abundance and sizes have been reduced in the lagoon and it's have direct effect on the cays.

Felix sinclair We are experiencing an increase in habitat destruction, the cutting down of the mangroves.

Delvin prudo There are problems with some authority, making illegal charges.

Leroy B As communal leaders, we cannot do it alone, we need accompaniment and support from the central government and NGO's. yes we have communal laws that support our governing system, but we have not shown to have the capacity to do our role as leader.

Suling Dixo We might be leaders but we do not have the support of the rest of the community. We are having internal problems, which leads to mistrust. Consciousness got to be accepted by everyone, not by a few, like that we can make changes, if not we stay the same. "One bad fowl egg mess all."

Johnn Waters Community is based on rules. When one is under control, the other is permitting illegality. Example. When close season is is close season, we as leader we need to give support to the government to guarantee that it is comply.

Kenneth Fox These governing system (TG, MG, and CG) was created to give power to communities and owner of the resources to be managed and administrated by themselves. So we need to be careful when we says that we do not have the capacity to administrate, what we need is to train the right ones that can do the job.

Leroy The laws are clear, who are not clear is the people who are doing what they think they should be doing and not what they really need to do. They are acting selfish. We need to give support to the central government to guarantee that the laws are been complying base on what is establish. Example, we receive the benefit of 25% of revenues that comes from the use of our Natural resource, but where it goes, do we have develop a formal plan to demonstrate that we are using it correctly?

Marjuleth Cassanova We need to talk one word, one language, to start solving our problem. We need to stop fighting between one another.

Eduardo Siu Fishing system is complex, because fish is not static, the fish that's in Tasbapaunie is the same fish that is in Pearl Lagoon and the rest of the communities, is a common use resource. So all decision need to be made as one.

Arwell davis Cheating are increasing, fishermen are doing all things out the way, illegality, they are working with no fishing permeation, no navigation permeation, using illegal gears with illegal mesh size and so on.

Rodolfo Chang The tragedy of the commons -- people are destroying their own resource. What we need is the cooperation and collaboration of all. The starting point is to get the governing systems to keep going as one.

Nuria Dixon Our cays are been offered on the net to the highest bidder. Our government, what is it doing? The paving of the road is good, its bring development, but also it will have negative impact in our communities, more people will invade us. Especially in the fishery, our resource is coveted, based on market demand people fishing more and more. We need authorities to support us and defend our right, we cannot do enforcement if we don't have who to protect us from our own people.

Marie tinkam Our people need to start be transparent with everything to get the support from the rest of communities, if we ackt selfish and not honest we will never get the people support. We need to start working with our people for us to get on the same track as mentioned before. If governor's in the government system at different levels remember who they are, where they

come from, and what are they responsibility, then we will have progress, but we have a lack of vision, and the lack of vision is perish. We need to co-manage, which is necessary.

Lola Sambola I agree with Marie, but also we have others taking over our land, they are cutting our trees and taking out all our resource, we cannot act alone, we need to get strengthen.

Rodolfo Chang Social capital and collective action. If we don't have social capital, we will have no action. And community conflict got to be solve by communal people.

**What other problems:**

- The catch of fish, turtles and lobster with eggs
- Uncontrolled capture of species such as sea cucumber, jelly fish, sharks and rays
- Developing foreign fishing activities without regard to the damage caused in the ecosystem.
- It is increasing the use of gillnets in the lagoon,
- No close seasons are propose for fish in the lagoon or Cays
- Loss of mangroves
- Corruption in governing system at different level
- Low or non-monitoring activities on cays
- The lagoon access and use of its resources is too flexible and allows anyone to enter and /or develop a harvesting process.
- Communities are being developed haphazardly and with little or no planning or projections about the impacts that it may cause on the resource and its user.
- Political intervention in the Community actions is causing division in communities

**II. What are the priorities in the communities on the management Plan of the Pearl Cays**

**Wildlife Refuge and is fishery resource?**

- i. Identify and review proposals, management plans, projects, resolutions (regional, municipal, territorial and others) prior to establish a base line (literature review)
- j. Conformation of a technical / working team that includes the participation and presence of the territorial government.
- k. Establish a formal communication line with the communities as part of the consolidation process.
- l. Strengthening the communal and territorial government structures (Strengthening the development territorial plan).
- m. Establish strategy and tools for the use of the Cays in conjunction with the territorial government, the Navy and communities
- n. Establish a baseline or monitoring station / local surveillance.
- o. Involve the territorial government throughout the construction process of the management plan as a whole.
- p. Action plan:
  - a. Recovery of cays and coral reefs (Habitats recovery)
  - b. Research

**VII. What can be done, how it can be done, what do we need, and when it should be started?**



- a. Payment of fees for access and use the cays
- b. Control the number of people accessing the keys and dwell time.
- c. Who can and should help, and how they can or should do?
- d. Create a campaign or effort unification process
- e. Implement close season system for other species such as fish, sea cucumber, jelly fish and others.
- f. Incorporate pearl Lagoon in the management plan as a buffer zone?
- g. Mangrove reforestation.
- h. Strengthen surveillance and monitoring within the Community of Pearl Lagoon and its cays.
- i. The communal authority is helping the police to cover certain operating expenses to make more effective their presence and permanence in the community.
- j. The formulation of policy must strongly integrate the participation and perspective of communities.
- k. Create awareness actions and addressing problems together.
- l. Capital allocation. Who will cover all the expense

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