

Management Plan

Corozal Bay Wildlife Sanctuary

2020 - 2024





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Corozal Bay Wildlife Sanctuary

Management Plan

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Management objectives for Corozal Bay Wildlife Sanctuary in the North East Coastal Complex seascape

- To ensure the effective conservation and sustainable use of natural resources of Corozal Bay Wildlife Sanctuary
- To contribute towards the health and effective management of the larger Northern Belize Coastal Complex seascape
- To ensure adequate knowledge for biodiversity and human resource use management
- To increase community engagement, awareness and participation in the conservation of the natural resources of Corozal Bay Wildlife Sanctuary
- To ensure public use is conducted in an environmentally aware and environmentally sensitive manner

These are supported by the fifth objective:

- To provide SACD with an effective administration structure with mechanisms to promote financial sustainability

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Plan Facilitated By:



Introduction

Background and Context

Situated in the north east of Belize, Corozal Bay Wildlife Sanctuary was established in 1998 as part of Belize’s National Protected Areas System, principally to provide protection for the large population of West Indian manatee (*Trichechus manatus*) utilizing the waters. The national protected area encompasses approximately 178,000 acres (72,000 hectares) of the Belize portion of the Mesoamerican Reef’s largest estuarine system, and much of the northern shelf lagoon behind Ambergris Caye.

The boundaries of Corozal Bay Wildlife Sanctuary are defined by Statutory Instrument 48 of 1998, with its northern border following the Belize Mexico border, and land-based borders defined by the high water mark rather than the 66’ used in a number of other protected areas in Belize. The cayes within the Wildlife Sanctuary are not included within the Wildlife Sanctuary, which has implication on the ability to protect coastal and caye mangroves, important as bird nesting sites, storm barriers and as protective nurseries for many fish species.

Corozal Bay Wildlife Sanctuary is a component of the Northern Belize Coastal Complex (NBCC), a river-to-reef seascape of four connected protected areas in northern Belize. It is also a part of the important transboundary drainage system shared by Mexico and Belize, and

Corozal Bay Wildlife Sanctuary

Size: 178,000 acres (72,000 ha)

Statutory Instrument: SI 30 of 1982

IUCN Category: VI

Management Authority: Forest Department

Co-management Partner: Sarteneja Alliance for Conservation and Development (SACD)



Location: Corozal Bay Wildlife Sanctuary is the northern-most protected area in Belize, with a boundary with Mexico to the north. It encompasses the estuary system to the west of Ambergris Caye. It is accessed primarily through Corozal, Sarteneja and San Pedro.

Uses: Non-extractive – tourism, education and research. Some traditional fishing also occurs, in acceptance of the need for continued cultural use of the bay by local communities.

Visitation (2016): No data

On-site Staff (2016): 1 Executive Director, 1 Natural Resource Manager, 1 Education and Outreach Manager, 3 rangers, 1 boat captain, supported by a Finance Officer, Administration Assistant, and 4 community interns and 6 community researchers. SACD is based from an office in Sarteneja.

Biodiversity Information: Extensive research work by Ecosur (Chetumal) in the adjacent Sanctuario del Manati. CBWS Research and Monitoring Plan and associated reports. Coastal mapping, fish catch assessment, water quality monitoring reports.

one of the two areas in Belize with transboundary issues (GEF, 2001), though these have been significantly reduced over the past five years. SADC is working to strengthen the transboundary collaboration with Sanctuario de Manati and other transboundary partners, in the recognition that the two protected areas are a single system.

The Wildlife Sanctuary status is equivalent to IUCN Category IV, designated for management mainly for conservation through management intervention. This may, however, need to be amended with the introduction of the legal framework to integrate sustainable fishing activities for traditional fishers within the Wildlife Sanctuary – with the revision to Wildlife Sanctuary (2).

Commercial fishing pressure within the Wildlife Sanctuary is considered a significant impact, and sport fishing is increasing, the protected area being a destination for tarpon, bonefish, and other targeted sportfish fishers. Tourism use is low, but gradually increasing.

Although Corozal Bay Wildlife Sanctuary was declared as a protected area in 1998, it was a classic example of a ‘paper park’ until 2008, when the first steps were taken towards increasing the management effectiveness of the protected area. This was through the establishment of the Sarteneja Alliance for Conservation and Development (SADC) - a community-based, organization, with its office in Sarteneja. Since 2008, SADC has built its capacity for management of the marine protected area, and has active programmes for Natural Resource Management (including Research and Monitoring) and Education and Outreach supported by the Administration Programme. The organization has identified and prioritized a series of conservation targets and threats to guide its management decisions, working closely with its primary stakeholders, and engaging them in management decisions and activities. It has also prioritized conservation activities in the seascape, engaging the NBCC partners in strengthening communication and collaboration across the seascape. In 2017, management effectiveness for Corozal Bay Wildlife Sanctuary rated as **GOOD**, overall, with a percentage effectiveness of **71.3%**. This continues a steady trend of increasing management effectiveness since the first assessment in 2006

This Management Plan provides the background information for informed management decisions, and a structured framework of activities to assist the co-management organization, the Sarteneja Alliance for Conservation and Development, in working with the Forest Department,

Summary of Key Characteristics

- Specific protection for critical West Indian manatee area
- Supports local traditional fishing industry
- Belize’s only verified bull shark nursery area
- Important goliath grouper habitat
- Potential remnant sawfish population in coastal lagoons

Key Resilience Features

- Seagrass is resilient to high temperatures and high turbidity
-

the legislated management authority, and other partners to implement effective conservation management.

Purpose and Scope of Management Plan

The management of Corozal Bay is guided by its categorization as a Wildlife Sanctuary - the Corozal Bay Wildlife Sanctuary, designated under the National Park Systems Act of 1981 (Chapter 215, Laws of Belize, Revised Edition 2000), being set aside:

“for the protection of nationally significant species, biotic communities or physical features.”

This Management Plan, the second for Corozal Bay Wildlife Sanctuary, has been developed by the Sarteneja Alliance for Conservation and Development (SACD), the co-management partner, in compliance with the co-management agreement with the Belize Forest Department, the management authority, signed in 2012. It is designed to guide SACD through the next five years, providing a framework for both broad management activities as well as more specific research and monitoring activities. The revision of the management plan also takes a widened scope, assessing issues not only in the Wildlife Sanctuary, but also in the Northern Belize Coastal Complex, in recognition of connectivity across protected area boundaries, in the larger seascape. It also takes into account the transboundary context.

Providing the Context: The Plan includes information on the physical and biological attributes of the Wildlife Sanctuary, based on past and current research conducted in the area and documents the legislative framework. It summarises current uses and management challenges, outputs of the conservation planning processes, both for the Wildlife Sanctuary itself and for the larger NBCC, and integrates both the system level NBCC and climate change assessment outputs. It identifies the management challenges, as well as defining the goals and objectives of management. It also outlines specific management programs, sets in place the means for measuring management effectiveness, and recommends an implementation schedule.

The Management Plan seeks to protect the resources of the area while establishing a mechanism for continued, more sustainable harvesting of local fish stocks by traditional fishermen, based on the national Managed Access framework. It also seeks to increase economic benefit for the communities through increased, environmentally sustainable tourism. The management programmes are based on the best available data and scientific knowledge, with the integration of conservation planning strategies.

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Conservation Planning: The Management Plan summarises the outputs of the conservation planning processes for the Wildlife Sanctuary, as part of the larger river to reef NBCC seascape and integrates climate change assessment outputs. It identifies the management challenges, as well as defining the goals and objectives of management.

Management Strategies: The Plan provides a framework for both broad management strategies as well as more specific activities to achieve the goals of maintaining coastal ecosystem functions and natural resource values, providing tourism benefits and supporting local fishers in the CBWS area. It also outlines specific management programs, sets in place the means for measuring management effectiveness, and recommends an implementation schedule. The management programmes are based on the best available data and scientific knowledge, with the integration of conservation planning strategies, as well as relevant strategies of national and regional plans. It is recommended that detailed annual operational plans be developed based on the framework provided by this management plan, with an annual review of implementation success, allowing for adaptive management over the five-year period – 2019 to 2023.

Section One

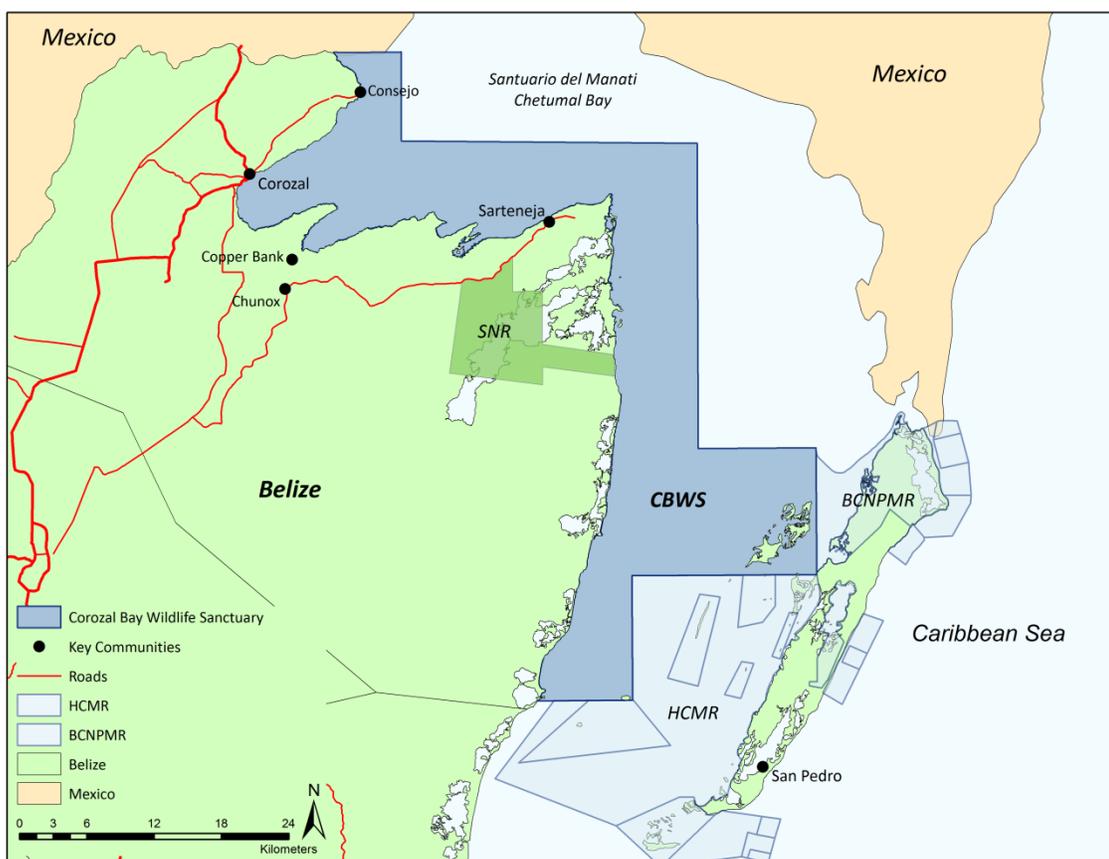
Current Status



1. Current Status

1.1 Location

Situated in the north east of Belize, Corozal Bay Wildlife Sanctuary was established in 1998 under the National Park Systems Act of 1981, as part of Belize’s National Protected Areas System, and as part of a transboundary protected area, twinned with the Santuario del Manati of Mexico, through Belize /Mexico bilateral agreements. This national protected area encompasses approximately 178,000 acres (72,000 hectares) of the Belize portion of the estuary system and much of the northern shelf lagoon behind Ambergris Caye.



MAP 1: THE LOCATION OF COROZAL BAY WILDLIFE SANCTUARY

BCMRNP: Bacalar Chico Marine Reserve and National Park

HCMR: Hol Chan Marine Reserve

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The boundaries of Corozal Bay Wildlife Sanctuary are defined by Statutory Instrument 48 of 1998 (Map 1). The aquatic boundaries of Corozal Bay Wildlife Sanctuary are contiguous with those of Bacalar Chico Marine Reserve to the east, Sanctuario del Manati of Mexico to the north and the Hol Chan extension to the south. The land-based boundaries of the protected area are defined by the high water mark (rather than the 66' used in a number of other protected areas in Belize), with cayes not included within the Wildlife Sanctuary. This has implication on the ability of the area to protect the ecosystem services provided by coastal and caye mangroves, important as bird nesting sites, storm barriers and as protective nurseries for many fish species.

Several communities are situated around the Wildlife Sanctuary on the Belize coast - Corozal (pop: 9,100), Copper Bank (approx. pop: 525), Chunox (approx. pop: 1,400), and Sarteneja (approx. pop: 2,000). To the north, in Mexico, lies Chetumal, in the state of Quintana Roo, in Mexico, with a population of more than 150,000.

Access: The protected area can be accessed by road, sea and air – the main entry points are Corozal, Sarteneja, Consejo and San Pedro, with boat access from all coastal communities. It can also be accessed by boat from the adjacent Mexican waters of the Bahia de Chetumal / Sanctuario de Manati.

Communities and stakeholders adjacent to Corozal Bay Wildlife Sanctuary: The main stakeholders of the Wildlife Sanctuary are the fishermen of Sarteneja and, to a lesser extent, Corozal, Chunox, Copper Bank and Consejo, though the protected area is also important to all residents of the coastal communities that lie on the northern shores. Whilst the tourism industry is small, the aesthetic beauty of the estuary has led to the establishment of a number of hotels in Corozal and Sarteneja, and the development of international retirement communities. Sport fishing guides of San Pedro, Sarteneja and Corozal use the Wildlife Sanctuary. The city of Chetumal, in Mexico, can also be considered a stakeholder, as it lies on the same estuarine system, and has significant impacts in terms of sewage and other contaminants.

The Sarteneja Alliance for Conservation and Development (SACD), the co-management partner with responsibility for day to day management, has an office in Sarteneja.

1.2 Regional and International Context

Corozal Bay Wildlife Sanctuary lies within Mesoamerica, a region highlighted as a world ‘hotspot for species diversity’ (Conservation International, 2003), and considered critical for the preservation of the biodiversity of the Western Hemisphere. It is the largest estuary in the Mesoamerican Reef (MAR) with an assemblage of ecosystems of great socio-economic and scientific value, and important for many species of conservation concern - among them the threatened Antillean manatee (*Trichechus manatus manatus*). Belize has an estimated 1,668 km² of the Mesoamerican Reef (MAR) within its waters (GCRMN, 2013). The MAR stretches from the southern Yucatan in Mexico to the Bay Islands in Honduras, stabilizing and protecting coastal landscapes, maintaining coastal water quality, sustaining species of commercial importance, and providing opportunities for employment in the fishing and tourism industries for nearly two million people living in coastal areas (Global Environment Facility, 2001; Healthy Reefs, 2015). This reef system is included on a global list of 18 richest centers of endemism and has been highlighted as one of the areas most threatened by human impacts (Roberts et al., 2002). It is also important for many species of global conservation concern, among them the critically endangered hawksbill turtle (*Eretmochelys imbricata*) and goliath grouper (*Epinephelus itajara*), as well as the endangered green and loggerhead turtles (*Chelonia mydas* and *Caretta caretta*), and endangered Antillean manatee (*Trichechus manatus manatus*) a regional sub-species. Corozal Bay Wildlife Sanctuary has been identified as a priority site under the MARFund regional project, receiving targeted investment for capacity building, infrastructure and equipment requirements, ending in 2019.

Belize, with its small population and relatively low coastal development rate, has always been highlighted as having the lowest human impacts in the region. However, impacts are increasing - quantitative data on fish populations comparing 2002 and 2008 observations on the main Belize reef, for example, indicate a staggering decline in populations and sizes of larger reef fish such as grouper, snapper, and triggerfish (Mumby, 2009). More recent studies show that this trend has continued. In the past fifty years, there has been a greater than 50% decline in living corals throughout the Wider Caribbean (GCRMN, 2013), including Belize.

The Northern Belize Coastal Complex is, itself, part of a larger, transboundary seascape - it is contiguous with the Sanctuario del Manati and Parque Nacional Arrecifes de Xcalak, in Mexico. Whilst the scope of the Northern Belize Coastal Complex Plan is confined to the northern protected areas of Belize, a forum has been establishing for transboundary coordination and collaboration.

Belize has signed a series of conventions and agreements designed to ensure continued viability of natural resources and biodiversity. As a signatory of the **Convention on Biological Diversity (CBD) (1992)**, Belize has a commitment to ensuring it has measures in place to protect

biodiversity, with promotion of sustainable use, contributing to the 2011 – 2020 CBD strategic goals of the Convention. In 1983, Belize signed the **Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region** (the ‘Cartagena Convention’), with the primary objective of protecting the ecosystems of the marine environment, based on the regional importance of the Mesoamerican Reef System.

Under the **Convention Concerning the Protection of the World Cultural and Natural Heritage**, Belize has a serial nomination of seven sites, designated in 1996 as components of the Belize Barrier Reef Reserve System - World Heritage Site (Table 3). One of these is Bacalar Chico Marine Reserve, which lies adjacent to CBWS within the NBCC. These seven sites are seen as representative of the Belize Barrier Reef under criteria (iii), based on the classic examples of fringing, barrier and atoll reef types, and in recognition of their global value.

In 2009, however, Belize’s World Heritage Site was placed on the List of World Heritage

in Danger based on the sale and lease of public lands for development within the serial sites leading to the destruction of mangroves and marine ecosystems. Also of concern was the issuing of past oil and gas leases within the protected areas of the WHS. Both are in contravention of the Convention commitment that “No areas within the property and in its immediate vicinity are developed in ways that affect the property’s natural outstanding beauty and status as a globally significant natural phenomenon of Outstanding Universal Value”. This status was upheld at the recent sitting of the WHS Committee (2016), as Belize is still to comply with the required actions for reducing threats to the reef.

The Belize Barrier Reef Reserve System contains an intact ecosystem gradient ranging from the terrestrial to the deep ocean: including, littoral, wetland, and mangrove ecosystems, to seagrass beds interspersed with lagoonal reefs, to the outer barrier reef platform and oceanic atolls. This ecological gradient provides for a full complement of life-cycle needs, supporting critical spawning, nesting, foraging, and nursery ecosystem functions. Maintaining these ecological and biological processes ensures robust and resilient reefs, which are themselves one of the world’s most ancient and diverse ecosystems.

From: Belize Statement of Outstanding Value, BBRRS World Heritage Site (Draft), 2011

International Conventions and Agreements of Relevance to Corozal Bay Wildlife Sanctuary and the NBCC	
Convention on Biological Diversity (Rio de Janeiro, 1992) Ratified in 1993	To conserve biological diversity to promote the sustainable use of its components, and encourage equitable sharing of benefits arising from the utilization of natural resources <i>CBWS provides an important and integral part in the national protected areas system, protecting biodiversity and threatened species, as per Belize’s commitment under the CBD. It provides benefits to local communities through fishing and tourism, with management by a community based organizations.</i>
Alliance for the Sustainable Development of Central America (ALIDES) (1994)	Regional alliance supporting sustainable development initiatives. <i>CBWS provides an important and integral part in the national protected areas system, protecting biodiversity and threatened species, as per Belize’s commitment under the CBD.</i>
Central American Commission for Environment and Development (CCAD) (1989)	Regional organization of Heads of State formed under ALIDES, responsible for the environment of Central America. Initiated Mesoamerican Biological Corridors and Mesoamerican Barrier Reef Systems Programs. <i>Belize is working with other ALIDES members towards the implementation of MAR2R, focusing on integrated watershed management for protection of the reef. CBWS has an important role in management of watershed impacts on the reef in the NBCC.</i>
International Convention for the Protection and Conservation of Sea Turtles for the Western Hemisphere (December 21 st , 1997)	To protected and conserve sea turtle species of the Western Hemisphere <i>As part of the NBCC, CBWS provides a foraging area for a small number of marine turtles, monitored during aerial surveys.</i>
Convention Concerning the Protection of the World Cultural and Natural Heritage (Paris, 1972)	The World Heritage Convention requires parties to take steps to identify, protect and conserve the cultural and natural heritage within their territories. <i>As part of the NBCC, CBWS is important in maintaining the water quality of the larger seascape for healthy biodiversity of Bacalar Chico Marine Reserve, one of the protected areas that make up Belize’s World Heritage Site.</i>

TABLE 1: INTERNATIONAL CONVENTIONS AND AGREEMENTS OF RELEVANCE TO COROZAL BAY WILDLIFE SANCTUARY AND THE NBCC

International Conventions and Agreements of Relevance to Corozal Bay Wildlife Sanctuary and the NBCC

<p>Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (Cartagena Convention Cartagena de Indias, Colombia, 1983)</p> <ul style="list-style-type: none"> ▪ Protocol Concerning Co-operation in Combating Oil Spills in the Wider Caribbean Region (adopted in 1983 and entered into force on 11 October 1986. Ratified by Belize in 1999). ▪ Protocol Concerning Specially Protected Areas and Wildlife (SPAW) in the Wider Caribbean Region (adopted on 18 January 1990 and entered into force on 18 June 2000. Ratified by Belize in 2008). ▪ Protocol Concerning Pollution from Land-Based Sources and Activities (LBS) (adopted on 6 October 1999 and entered into force on 13 August 2010. Ratified by Belize in 2008). 	<p>Regional convention with the objective of protecting the marine environment of the Wider Caribbean through promoting sustainable development and preventing pollution. <i>Belize takes measures to prevent, reduce and control pollution in the marine environment. It also seeks to protect and preserve rare or fragile ecosystems, habitats of depleted, threatened or endangered species; and to develop technical and other guidelines for the planning and environmental impact assessments of important development projects in order to prevent or reduce harmful impacts within coastal waters. This is achieved through the Integrated Coastal Zone Management Plan (particularly the Northern Belize section), the National Sustainable Tourism Master Plan, enforcement of relevant legislation and the EIA / ECP process.</i></p> <p><i>Belize takes measures to prevent, reduce and control pollution in the marine environment. It also seeks to protect and preserve fragile ecosystems, depleted, threatened or endangered species; and targets development projects as part of its surveillance and enforcement activities in order to prevent or reduce harmful impacts within coastal waters.</i></p> <p><i>CBWS provides an important and integral part in the national protected areas system, protecting biodiversity and threatened species, as per Belize’s commitment under this Convention. It provides filtration of land based pollution and sediment before water reaches the reef in the NBCC</i></p>
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TABLE 1: INTERNATIONAL CONVENTIONS AND AGREEMENTS OF RELEVANCE TO COROZAL BAY WILDLIFE SANCTUARY AND THE NBCC 2

With the increasing threats to the overall health of the reef system, the Governments of Mexico, Belize, Guatemala and Honduras (the four countries bordering the MBRS) committed to the development of a 15-year Action Plan – the **Mesoamerican Barrier Reef System Project** - for the conservation and sustainable use of this ecosystem, through the **Tulum Declaration (1997)**. This initiative, adopted by the Heads of State in June 1999, was supported by the **Central American Commission on Environment and Development (CCAD)**, which seeks to harmonize environmental policies within the region. A second phase project is now underway – the Integrated Transboundary Ridges-to-Reef Management of the Mesoamerican Reef (MAR2R) - focused on enhancing regional collaboration for the ecological integrity of the Mesoamerican Reef, scaling up the ridge to reef approach to its management.

1.3 National Context

As well as the regional and global importance of ensuring the presence of effective conservation management of the area within the NBCC, Corozal Bay Wildlife Sanctuary is also important at the national level. Corozal Bay was first highlighted as a priority site under the Ecoregional Assessment of the Mesoamerican Reef (Arrivillaga et. al., 2008), based on the importance of the estuarine system, manatee habitat, and extensive mangrove systems (particularly on the East Coast). The shallow bay provides a protected nursery habitat for a variety of fish and invertebrates species and supports numerous wading birds, providing outstanding nesting sites for herons and egrets, magnificent frigatebirds and brown pelicans, and foraging habitat for wading and migratory birds in the littoral forest and the mangrove cayes found within the protected area (Kramer et al. 2002). The protected area is considered an important site for mating and calving of the endangered Antillean manatee (Auil, 2004; Morales-Vela et al. 2000), as a regionally important pupping area for bull sharks, and the coastal lagoons are important nursery areas for sport fish...including permit, snook and tarpon.

The fish resources of the protected area support a small number of traditional, artisanal fishermen who focus on estuarine species such as striped and yellow-fin mojarra – a cultural preference in the northern coastal communities. Corozal Bay also offers diverse ecosystems and the potential for a growing tourist industry that could allow the surrounding communities, traditionally dependent on fishing, to transition to a more sustainable livelihood.

Corozal bay Wildlife Sanctuary is an important component of the Northern Belize Coastal Complex (NBCC), a river-to-reef seascape of connected protected areas in northern Belize. Water flows from the Rio Hondo, New River and coastal lagoons of the Belize and Mexico mainland into the Corozal Bay Wildlife Sanctuary / Santuario del Manati, and on to the reefs of Bacalar Chico, Hol Chan and Caye Caulker Marine Reserves. The shallow estuary acts as an important filter for water from the rivers. With the lack of flushing or strong currents, the bay acts as a catchment for accumulating contaminants, settling out sediments and contaminants before the water reaches the reef at Bacalar Chico (a component of Belize’s World Heritage Site), Hol Chan and Caye Caulker, reducing potential stress from land-based pollutants on these biologically and economically important reef areas.

1.3.1 National Planning Strategies

The national goals and objectives for conservation revolve around the sustainable use, conservation and protection of Belize’s natural resources within the context of sustainable human development. These objectives are implemented through the **National Biodiversity Strategy and Action Plan** (GoB, 2016), which recognizes the need to mainstream biodiversity across all sectors in Belize, improve integration of biodiversity into national planning strategies, and build both

human and institutional capacity to effectively manage the biodiversity resources. It provides a framework for strategies under five national goals:

GOAL A. MAINSTREAMING: *Improved environmental stewardship is demonstrated across all society in Belize, as is an understanding and appreciation of marine, freshwater and terrestrial biodiversity, its benefits and values.*

GOAL B. REDUCING PRESSURES: *Direct and indirect pressures on Belize’s marine, freshwater and terrestrial ecosystems are reduced to sustain and enhance national biodiversity and ecosystem services*

GOAL C. PROTECTION: *Functional ecosystems and viable populations of Belize’s biodiversity are maintained and strengthened*

GOAL D. BENEFITS: *Strengthened provision of ecosystem services, ecosystem-based management and the equitable sharing of benefits from biodiversity*

GOAL E. IMPLEMENTATION: *Effective implementation of the NBSAP through capacity building, strategic decision making and integrated public participation*

The **National Protected Areas Policy and System Plan (NPAPSP)** (GoB, 2005; revised in 2015) guides system-level and individual protected area management efforts. There is a strong focus on co-management partnerships between the Forest Department and NGO co-management partners, including the Sarteneja Alliance for Conservation and Development. The NPAPSP centres on the following policy statement, taken into consideration in the development of this plan:

The Government of Belize shall promote the sustainable use of Belize’s protected areas by educating and encouraging resource users and the general public to properly conserve the biological diversity contained in these areas in order to maintain and enhance the quality of life for all. This shall be achieved by facilitating the participation of local communities and other stakeholders in decision-making and the equitable distribution of benefits derived from them, through adequate institutional and human capacity building and collaborative research and development.

Both the National Biodiversity Strategy and Action Plan and the National Protected Areas Policy and System Plan support Belize’s **Growth and Sustainable Development Plan (GSDS)**, part of the 15-year national development framework under Horizon 2030. The GSDS recognizes effective implementation of both the NBSAP and NPAPSP as critical in achieving national development goals.

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A key goal of the National Protected Areas Policy and System Plan is to ensure that the “*National Protected Areas System includes high quality examples of the full range of environment types within Belize, with balanced representation of the ecosystem types they represent*” (NPAPSP, 2005). Belize falls short of the CBD targets for ecosystem representation. One of the gaps is for mangroves - Corozal Bay Wildlife Sanctuary includes important inundated mangroves, and much of the coastline is fringing mangroves, important for providing protection against erosion. However much of the mangroves in the landscape / seascape lie outside the protected area, and SACD is wishing to address through targeted land purchase.

The overall goals of both the National Biodiversity Strategy and the NPAPSP reflect the national objectives - ecological and economic sustainability over the long term, with the development of human and institutional capacity to effectively manage the biodiversity resources within Belize. There are also moves towards decentralisation of the management of these resources, with a strong focus on co-management partnerships, community-based participation and equitable benefit from conservation efforts.

The **Coastal Zone Management Authority and Institute** was established under the Coastal Zone Management Act for ensuring conservation of the Barrier Reef and other coastal resources, and the planning, management and sustainable development of resources within the coastal zone. The Act does not provide any enforcement capacity (this being through more specific agencies – the Fisheries Dept. (Fisheries Act), the Forest Department (Mangrove Regulations), Department of the Environment (Development regulations) and Geology and Petroleum Department (dredging and oil exploration), but for monitoring, planning and coordination to ensure that activities within the coastal zone are sustainable.

A number of objectives have been identified under **the Integrated Coastal Zone Management Plan** for the Northern Belize Region. Whilst this plan focuses on a larger scope than just Corozal Bay Wildlife Sanctuary, it provides the context in which CBWS operates:

- 1. Encourage and promote the sustainable development of coastal and offshore areas within the Northern Region that will promote economic growth while simultaneously ensuring ecosystem stability and the efficient delivery of ecosystem services.*
- 2. Protect and preserve the traditional way of life of the stakeholders within the Northern Region*
- 3. Ensure sustainability of coastal resources by identifying areas in need of conservation and reducing user conflicts*

The key objectives of the Northern Belize Coastal region guidelines (CZMAI, 2015) are summarized as follows:

- Protecting the fishing resources and traditional fishing rights, especially for the fisherfolk from the communities of Sarteneja, Chunox, Copper Bank, Corozal, and San Pedro
- Promoting orderly and sustainable development, based on suitable land use planning, and with effective development guidelines that will meet the needs of current and future generations
- Maintaining and protecting on going and future conservation, recreational and tourism areas and uses
- Preventing inappropriate high-impact, unsustainable developments that are incompatible with community needs
- Protecting and preserving significant national and international natural features and ecological biodiversity of special interest or uniqueness that define the character and scientific importance of the Northern coastal zone
- Preserving the social and cultural values of the people and communities of the region that are connected to the environment
- Representing trans-border cooperation to address territorial disputes and impacts to the region's natural resources originating beyond national borders
- Fostering and supporting a continued partnership among stakeholders for managing the coastal resources
- Establishing a framework for regulating the development and use of resource of the region through the continuation of CZMAI's coastal planning program activities and coastal advisory committee process

A series of principles have also been identified under the Coastal Management Plan:

Principle 1: Recognition that the Northern Region needs special protection and management because of its physical, economic, scientific, cultural and aesthetic attributes

Principle 2: Recognition of the need to avoid placing undue strain on the terrestrial and aquatic environment of the region by ensuring that proposed development activities do not exceed the carrying capacity of the region

Principle 3: Recognition of the rights and interests of traditional users and stakeholders while acknowledging the national development policy which promotes tourism and job creation

***Principle 4:** Recognition that environmental concerns are best handled with the participation of all concerned stakeholders at all levels and from all sectors*

***Principle 5:** Recognition that planning guidelines represent a preventative and precautionary approach to environmental degradation and a tool for pursuing sustainable development of the region*

The national objective of the **Sustainable Tourism Master Plan** is to “*more than double overnight tourist arrivals while enhancing average length of stay and daily expenditure*”. The quality of the environment and the need to conserve these qualities is recognised in the MasterPlan, with the sustainable development program providing the framework that will “*ensure the NSTMP maintains a balance of three pillars of sustainable development: social accountability, environmental conservation and economic prosperity.*” The NSTDP is primarily focused on destination development, financing and marketing, but does recognize the importance of conservation and environmental management in supporting Belize’s tourism industry. Corozal Bay is a focus of the Sustainable Development Project Phase 2 investments, with the potential to increase visitor use of the area, and economic benefits to the communities, though with associated potential impacts on the natural resources of the Wildlife Sanctuary.

1.3.2 Legal Framework

Six key laws have been enacted to protect ecosystems, ecosystem services and biodiversity, contributing to the conservation framework of Belize. The Forest Department is the administrative agency for the **National Protected Areas System Act (2015)**, **Forest Act (1927)**, and the **Wildlife Protection Act (1981)**. These three focus on the protection of the environment and natural resources. Corozal Bay Wildlife Sanctuary is designated under the National Parks System Act. The **Wildlife Protection Act (1982)** also falls under the Forest Department, and provides protection for the endangered Antillean manatee sub-species for which the area was originally designated, marine turtles, dolphins and nesting bird colonies with the prohibition of hunting and commercial extraction. This Act is scheduled for revision and significant strengthening in 2017.

The **Fisheries Act (1948)**, administered under the Fisheries Department, is the principal governing legislation regulating the fishing industry, and is directly concerned with maintaining sustainable fish stocks and protecting the marine and freshwater environments. The Fisheries Act requires all fishers and fishing vessels to be licensed for Managed Area 1. This is supported by Managed Access – a rights based fisheries management regime. The Belize Fisheries Department, whilst not the authority responsible for CBWS, does provide support to the co-managers, especially in the enforcement of fisheries regulations in the protected area. The Sarteneja Alliance for Conservation and Development is partnering with Fisheries Department towards training and joint surveillance and enforcement presence in the protected area, taking an active role in

ensuring a smooth roll out for the Managed Access program. The Fisheries Act is currently in the final stages of being revised as the Fisheries Resource Bill (August, 2019).

The **Environmental Protection Act (1992)** was enacted under the Department of the Environment (DoE) with the aim of ensuring that development initiatives within Belize are planned and implemented with minimum environmental impact. In the context of Corozal Bay Wildlife Sanctuary, this is particularly important when ensuring that the impacts from coastal and caye development within the protected area are minimized, through the Environmental Impact Assessment (EIA) process. The EPA is also responsible for surveillance and response to environmental pollution – for CBWS, DoE response to pollution in the two rivers flowing into the estuary is critical in ensuring improved water quality.

The **Pesticides Control Act (1990)** provides a mechanism for the registration and regulation of pesticide importation and use, important for minimizing pesticide contamination of the rivers feeding into the Corozal Bay Wildlife Sanctuary.

The **Port Authority** is mandated to ensure the safety of navigational channels through navigational aids and has jurisdiction over the navigational lighthouses of Corozal Bay Wildlife Sanctuary, marking the deep channel used by larger vessels such as the sugar barge.

Whilst the above are the legislative acts most relevant to Corozal Bay Wildlife Sanctuary, there are others - such as the **Mines and Minerals Act (1989)** and the **Petroleum Act (1991)**, which regulate the exploration and extraction of all non-renewable resources. These Acts regulate activities that include dredging of the seabed, as well as the exploration and extraction of all non-renewable resources, including oil.

KEY NATIONAL LEGISLATION PROTECTING FAUNA, FLORA, AND NATIONAL HERITAGE

The National Protected Areas Systems Act (2015)

Provides a framework for establishment and maintenance of the national protected areas system.

The Fisheries Act (1948, revised 2000)

Principal governing legislation regulating the fishing industry, and is directly concerned with maintaining sustainable fish stocks and protecting the marine and freshwater environments.

The Wildlife Protection Act (1981)

Provides for the conservation, restoration and development of wildlife and regulation of its use.

The Forest Act (1927)

Promotes the forestry industry, with the implementation of conservation techniques, Responsible for forestry activities in all types of forest, including littoral forests and mangroves.

Environmental Protection Act (1992)

Promotes the preservation and improvement of the environment, the rational use of natural resources, the control of pollution, and associated actions. This is achieved through the EIA / ECP process.

The National Integrated Water Resources Act (2011)

Provides for management of water resources. Its role includes estimating water availability and value, and implementing measures to ensure wise use and long term sustainability of Belize's water resources.

Financial sustainability for protected area and natural resource management is partially addressed at Government level through the development of a funding mechanism to assist in management and development activities within protected areas – the Protected Areas Conservation Trust (**PACT Act, 1996; revised 2015**), generated from a ‘conservation tax’ of Bz\$7.50 levied on non-residents as they leave the country.

The functions of PACT are:

“...to contribute to the sustainable management and development of Belize’s natural and cultural assets for the benefit of Belizeans and the global community, both now and for future generations.”

***Protected Areas Conservation Trust (Amendment)
Act, 2015***

Regulations, such as the **Forests (Protection of Mangroves) Regulations (1989)** provide specific protection for mangroves. Marine turtles have been given some protection since the original Fisheries Ordinance in 1940, which provides protection for both the turtles and nest sites. This was strengthened in 1993, when Belize revised its fisheries regulations to prohibit fishing, possession, or trade in products of all six species of marine turtle that might potentially be found in Belize’s waters (**Fisheries (Amendment) Regulations, 1993 (S.I. No. 55 of 1993)**). The **Sport Fishing Regulations (SI 114 and 115 of 2009)** have been developed to improve management and conservation of the economically important sport fishing species in Belize - particularly bonefish, tarpon and permit, which can only be caught using ‘catch and release’ best practices. These regulations, however, do not extend to protecting nursery areas or adult habitat – only to the sport fish species themselves.

Site level legislation

Corozal Bay Wildlife Sanctuary was created under the National Parks System Act (1981; recently revised as the National Protected Areas System Act, 2016), and is one of eight Wildlife Sanctuaries in Belize, managed under co-management agreements between NGOs / CBOs and the Belize Forest Department. Wildlife Sanctuaries are designated to “protect nationally significant species, biotic communities or physical features” – in the case of CBWS, the Antillean manatee. Although created and managed under the Forest Department regulations (as it has been designated as a species conservation area), Corozal Bay Wildlife Sanctuary is also considered part of the marine protected areas system, with traditional fishing in the MPA being regulated by fisheries regulations. Management policies for the Wildlife Sanctuary are guided by the NPAS Act, which stipulates the type of use permitted in the protected area – in this case, CBWS has been non-extractive, contributing towards the national no-take zones of Belize, and theoretically permitting only non-extractive activities – research, education and tourism Table 2). In reality, however, traditional fishing activities continue within the Wildlife Sanctuary. The designation is not intended to cause a shift in tradition but seeks to maintain the culture of the buffer communities, within the framework of maintaining the biodiversity and ecosystem values for which the area

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was first established. It is proposed under the NPAS Rationalization assessment that **CBWS become a Wildlife Sanctuary (2)**, which allows for traditional extraction of natural resources (in this case local fish species), with approval of a sustainable fisheries plan. The revised National Protected Areas Act (2015) has a framework for this transition.

Protected Areas Categories in Belize		
Category	Purpose	Activities Permitted
Nature Reserve	To protect biological communities or species, and maintain natural processes in an undisturbed state	Research, education
National Park	To protect and preserve natural and scenic values of national significance for the benefit and enjoyment of the general public	Research, education, tourism
Natural Monument	To protect and preserve natural features of national significance.	Research, education, tourism
Wildlife Sanctuary (1)	To protect nationally significant species, biotic communities or physical features.	Research, education, tourism
Wildlife Sanctuary (2)	To protect nationally significant species, biotic communities or physical features, and allow for traditional, sustainable extraction of natural resources	Research, education, tourism, traditional sustainable natural resource extraction
Forest Reserve	To protect forests for management of timber extraction and/or the conservation of soils, watersheds and wildlife resources	Sustainable extraction (timber / NTFP), research, education, tourism
Marine Reserve	To ensure, increase and sustain the productive service and integrity of the marine resources for the benefit of all Belizeans of present and future generations.	Commercial fishing, research, education, tourism
Private Protected Area	To complement the national lands through provision of connectivity, priority species protection, and improved ecosystem representation.	Research, education, tourism, sustainable extraction
Archaeological Reserve	To protect cultural heritage	Research, education, tourism,
Spawning Aggregation Site	To protect spawning aggregation sites	Research, education, tourism,
Special Management Area	To protect biological corridors, critical nesting, roosting or congregation areas requiring active management	Research, education, tourism

TABLE 2: PROTECTED AREA CATEGORIES IN BELIZE (NPAPSP, 2015)

Corozal Bay Wildlife Sanctuary is one of fourteen marine protected areas within the National Protected Areas System (Table 3). Nine of these are designated under the Fisheries Department

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(Fisheries Act, 1948) as Marine Reserves, the remaining five, including the Wildlife Sanctuary, are administered under Forest Department.

Marine Protected Areas in Belize				
Protected Area	Mgmt. authority / Co-mgmt agency	IUCN Category (2012)	SI	Area (Acres)
Bacalar Chico Marine Reserve	Fisheries Dept.	VI	88 of 1996	15,765.8
Blue Hole Natural Monument	Forest Dept. / BAS	III	96 of 1996	1,023
Caye Caulker Marine Reserve	Fisheries Dept.	VI	35 of 1998	9,670.2
Corozal Bay Wildlife Sanctuary	Forest Dept. / SACD	VI	48 of 1998	180,508.5
Gladden Spit Marine Reserve	Fisheries Dept. / SEA	VI	95 of 2003	25,978.3
Glover’s Reef Marine Reserve	Fisheries Dept.	VI	70 of 1996	86,653
Half Moon Caye Natural Monument	Forest Dept. / BAS	II	30 of 1982	9,771
Hol Chan Marine Reserve and extension	Fisheries Dept. / Hol Chan Statutory management body	VI	57 of 1987 18 of 2015	102,400
Laughing Bird Caye National Park	Forest Dept. / SEA	II	94 of 1996	10,119
Port Honduras Marine Reserve	Fisheries Dept. / TIDE	VI	9 of 2000	100,000
Sapodilla Caye Marine Reserve	Fisheries Dept	VI	117 of 1996	38,594
South Water Caye Marine Reserve	Fisheries Dept.	VI	118 of 1996	117,875
Swallow Caye Wildlife Sanctuary	Forest Dept. / FOSC	IV	102 of 2002	8,972
Turneffe Atoll Marine Reserve	Fisheries Dept / TASA	VI	111 of 2012	325,000

TABLE 3: MARINE PROTECTED AREAS OF BELIZE

1.3.3 Land Tenure

Corozal Bay Wildlife Sanctuary is a national protected area, legally established under the National Parks System Act (now revised as the National Protected Areas System Act). Whilst there is no terrestrial component to the Wildlife Sanctuary, it does include a number of inundated mangrove areas, important as nursery areas for juvenile fish of commercial species.

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Whilst not currently within the protected areas, the land tenure of the cayes also have an impact on management, as extensive clearance of the natural vegetation – particularly mangrove – will remove critical habitat for marine species and resident and migratory birds, many of the cayes supporting important bird nesting colonies.

The Integrated Coastal Zone Management Plan assessed land tenureship of cayes within the Wildlife Sanctuary (Table 4), with recognition that development would require specific building standards, with their close proximity to sensitive habitats such as sea grass beds and mangroves. The recommendations for the future of these cayes are as follows:

“Those lands which are nationally owned should remain as such as this state of affairs provides the opportunity for decision-makers to have greater input in land management concerns. Where land is private property, the right to alienate and develop must be recognized, but regulated to ensure that the subdivision of land subscribes to guidelines which ensure that the resulting parcels can sustain the type of permitted development activity. The seabed is national land and thus any proposals to develop the seabed or to construct piers, marinas and seawalls within this region need to receive clearance from the Lands Department and Department of Environment. This action is particularly relevant in the case of the seabed within the Corozal Bay Wildlife Sanctuary (CBWS), which is managed under a non-extractive regime, under the Forest Department.”

Integrated Coastal Zone Management Authority, 2015

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Name of Caye	National		Property		Total Acreage
	Size (Acres)	%	Size (Acres)	%	
<p>Shipstern Caye: <i>Conservation 1 Status.</i> Not suitable for development</p> <ul style="list-style-type: none"> ▪ surrounded by patches of fossilized corals and seagrass beds, ▪ reported by fishermen to be poor in marine life due to overfishing. ▪ low lying and characterized by soil of poor bearing capacity. ▪ very small and lies within the Corozal Bay Wildlife Sanctuary. 	2.38	100	-	-	2.38
<p>Deer Caye: <i>Conservation 2 Status</i> Largest caye in the region.</p> <ul style="list-style-type: none"> ▪ surrounded by fossilized corals and seagrass beds, with its near shore waters off the southwestern portion inhabited by rocky shoals. ▪ constant murkiness of the water, which may be because of its sheltered location in the lee of Ambergris Caye. ▪ soil profile, surrounding sensitive environment and limited accessibility makes its suitability limited for any major development activity. ▪ any development of this cayes should be carried out via an integrated planning approach. 	1,648	99	15	1	1,663
<p>Mosquito Caye: <i>Conservation 1 Status.</i> Not suitable for development</p> <ul style="list-style-type: none"> ▪ small cayes surrounded by lush seagrass meadows and muddy sea floors. ▪ soils are of poor bearing capacity, and the waters surrounding the islands are constantly murky. 	60	100	-	-	60.0
<p>Cayo Falso Cayes: <i>Conservation 1 Status.</i> Not suitable for development</p> <ul style="list-style-type: none"> ▪ includes two small mangrove cayes that lies west of Sarteneja Village. ▪ critical bird nesting cayes for Magnificent Frigatebirds, Brown Pelicans, White Ibis, Roseate Spoonbills, Boat-bulled Herons, Reddish Egrets, Great Egrets and cormorant species. ▪ have low, semi-emergent land dominated by mangrove. Given the low lands of these mangrove cayes, and their importance for nesting bird colonies, these cayes are not suitable for development. 	-	-	-	-	-
TOTAL	1,710.38		15		1,725.38

TABLE 4: PROPORTIONAL LAND TENURE STATUS FOR CBWS CAYES (CZMAI, 2015)

1.3.4 Evaluation of Importance

Corozal Bay Wildlife Sanctuary is recognized as one of fourteen regional priority areas of the Mesoamerican Barrier Reef System, based on the importance of the estuarine system (part of one of the largest estuarine systems flowing into the Caribbean Sea in the Mesoamerican ecoregion), manatee habitat, and extensive mangrove systems (Kramer and Kramer, 2002; Lopez-Galvez, 2007; Arrivillaga et al., 2008).

The sheltered waters of Corozal Bay have been highlighted as regionally important for mating and calving Antillean manatees (Auil, 2004; Morales-Vela et al. 2000),

The shallow bay also provides a protected nursery habitat for a variety of fish and invertebrates species including the critically endangered goliath grouper – supporting a local, traditional fishing industry. It is a pupping area for bull sharks - the only confirmed bull shark nursery in Belize (Graham, 2010). Although the critically endangered sawfish once also present, it is presumed to have been fished to local extinction (Gall, 2006, pers. com.), though up to 2017, several reports from local fishermen suggested that a remnant population may still have existed in the shallow coastal lagoons that flow into the Wildlife Sanctuary.

Key Features of Corozal Bay Wildlife Sanctuary

- Part of the largest, transboundary estuary flowing onto the MesoAmerican Reef
 - Important mating and calving area for the Antillean manatee
 - Regionally important nursery area for bull sharks
 - Critical for filtering water before it reaches the Belize reef
 - Mangrove cayes support important nesting colonies for waterbirds, including the reddish egret, roseate spoonbill
 - One of the few places in the world to have a stromatolite reef – an increasingly rare cyanobacterial formation
 - Potential remnant population of smalltooth sawfish
-

Threatened Species of Corozal Bay Wildlife Sanctuary

Critically Endangered

Hawksbill Turtle	<i>Eretmochelys imbricata</i>
Goliath Grouper	<i>Epinephelus itajara</i>
Smalltooth Sawfish*	<i>Prisitis pectinata</i>

Endangered:

Green Turtle	<i>Chelonia mydas</i>
Antillean Manatee	<i>Trichechus manatus</i>

Vulnerable:

Mutton snapper	<i>Lutjanus analis</i>
Cubera snapper	<i>Lutjanus cyanopterus</i>
Hogfish	<i>Lachnolaimus maximus</i>
Scalloped Hammerhead	<i>Sphyrna lewini</i>

IUCN Red List (2019)

Corozal Bay Wildlife Sanctuary - a High Priority Transboundary Biodiversity Area

Location: Chetumal Bay, Corozal Bay, and surrounding wetlands

Approximate size: 3,209 km²

Ownership: Mexico/Belize

Biological Importance: High

Biological Features: Large area including Chetumal Bay, Corozal, Bacalar Chico, and north Ambergris. Large manatee populations (~ 250 manatees) and one of most important calving areas in Caribbean. About 90% of Chetumal Bay population uses Guerro Lagoon and Río Hondo. Habitat for crocodiles, dolphins, and sea turtles. Two small bird nesting islands with wood storks (one of only two wood stork nesting sites in Yucatán). Over 250 bird species are found in Bacalar Chico.

Description of area: Chetumal Bay is a large (2,450 km²) brackish estuary straddling the Belize-Mexico border with a very shallow water depth of 1 to 7 m (average of 3 m). The bottom is covered with fine mud and algae and localized seagrass beds of *Thalassia testudinum* and *Halodule wrightii*. Several fresh water rivers, including Río Hondo and New River, empty into the bay (Morales et al., 2000). Many coastal lagoons with inlets, salt marshes, and mangrove forests are connected to the bay.

Outstanding biological features

Chetumal Bay is the largest estuary in the ecoregion and supports one of the largest populations of manatees in the Caribbean (Auil, 1998 Thesis). Outstanding nesting and foraging habitat is available for numerous wading birds. The area around Little Guana Caye has the largest nesting colony of reddish egrets in the Caribbean and is also known to have nesting white ibis, tri-colored herons, and roseate spoonbills. Protected islands in Shipstern Lagoon support support two nesting colonies of woodstorks. The shallow estuary also provides excellent nursery habitat for a variety of fishes and invertebrates. Current conservation status Corozal Bay Wildlife Sanctuary encompasses the Belize portion of the bay and much of the Northern shelf lagoon behind Ambergris Caye. The area is declared protected but currently is not being managed. The Shipstern Nature Reserve includes 22,000 acres of wetlands, mangroves, lagoon, cayes, and unique dry hardwood forest. Manatee Sanctuary includes most of Chetumal Bay and San Jose Bay

Moderate Persistence

These priority areas have a moderate capacity to adjust and recover from future disturbances and some intervention would be needed to maintain ecosystem integrity and functioning. For example, Chetumal and Corozal Bays Priority Area has moderately degraded habitat quality due to low fish populations, lack of vegetation, and poor water quality, although the area remains a stronghold for manatee populations. This priority area would require a reduction in pollution from these sources to prevent further habitat degradation.

Adapted from Kramer and Kramer (WWF, 2002)

Corozal Bay Wildlife Sanctuary is an important component of the larger Northern Belize Coastal Complex seascape, with mangrove cayes, coral reefs and seagrass providing key interconnected ecosystems critical to the long term viability of marine resources of the area.

Environmental Services of the Protected Areas

The protected area provides a number of environmental services, supporting livelihoods and protecting lives.

-
- | | |
|------------------------------------|--|
| Regulation | <ul style="list-style-type: none">▪ Shallow water and coastal mangroves protect the coastline from storm surges▪ The prop roots of red mangroves protect the coastline and cayes from erosion▪ Seagrass plays an important role in stabilizing the substrate and settling turbidity in the water |
| Recruitment | <ul style="list-style-type: none">▪ Mangrove and seagrass provide important nursery areas for both commercial and non-commercial species▪ Associated coastal lagoons are important nursery sites for commercial species (including sport fishing species) |
| Cultural and Socio-Economic | <ul style="list-style-type: none">▪ Corozal Bay Wildlife Sanctuary supports a small-scale traditional commercial fishery based primarily on the use of beach traps▪ The protected area has the potential to be an important resource for tourism▪ Aesthetic appreciation of the scenic beauty |
| Support | <ul style="list-style-type: none">▪ Seagrass and mangroves play an important role in the cycling of nutrients▪ Seagrass beds and mangroves provide ecosystems necessary for different life stages of commercial and non-commercial species▪ Seagrass is effective as a CO₂ sink▪ Mangroves provide nesting structure for several bird nesting colonies, as well as the osprey, an important top predator, and the white-winged dove▪ Littoral forest and mangroves provide important stop-over habitat for migratory bird species |

Ecosystem Services of Corozal Bay Wildlife Sanctuary (Adapted from UNEP-WCMC, 2006)

Based on the coastal protection provided by the barrier reef, atolls and mangroves, the support of the fisheries industry and the contribution towards tourism income, the overall value of the reef and mangroves in Belize was estimated at Bz\$790 – \$1,118 million a year (US\$395 - \$559 million a year) (Cooper et. al, 2008). Mangroves also protect coastal properties from erosion and wave-induced damage, providing an estimated US\$231 to US\$347 million in avoided damages per year. In total, reef- and mangrove-associated fisheries are estimated to have a direct economic impact of US\$14 to \$16 million per year (Cooper et. al., 2008).

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Community understanding of the role and importance of CBWS in protecting and maintaining the Belize reef is high - 84% of community stakeholders surveyed in Sarteneja (n=121) in 2014 either agreed (42%) or strongly agreed (42%) that Corozal Bay Wildlife Sanctuary was important. This increased to 86% in Copper Bank (n=49; 73% strongly agreed; 13% agreed) and 88% in Chunox (n=48; 57% strongly agreed; 31% agreed) (Figure 1; SACD data, 2014).

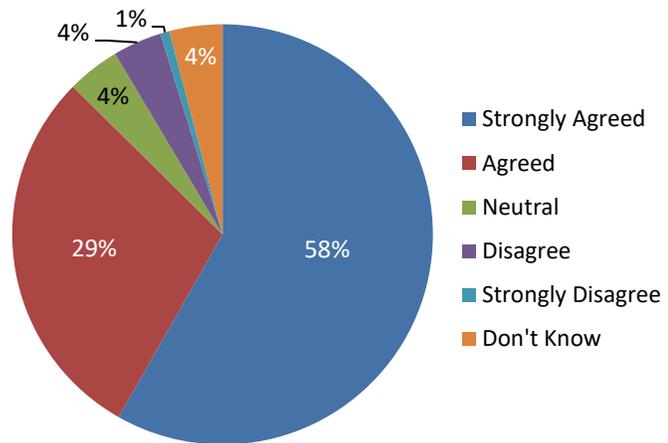


FIGURE 1: AVERAGE STAKEHOLDER PERCEPTION OF THE IMPORTANCE OF CBWS IN MAINTAINING THE REEF (SACD data, 2014)

Recognition of the importance and value of the ecosystem services of mangroves is also high - 87% of community stakeholders surveyed in Sarteneja (n=121) in 2014 either agreed (46%) or strongly agreed (41%) that protecting the mangroves of Corozal Bay Wildlife Sanctuary was important. This increased to 86% in Copper Bank (n=49; 73% strongly agreed; 13% agreed) and 96% in Chunox (n=48; 90% strongly agreed; 6% agreed) (Figure 2; SACD data, 2014).

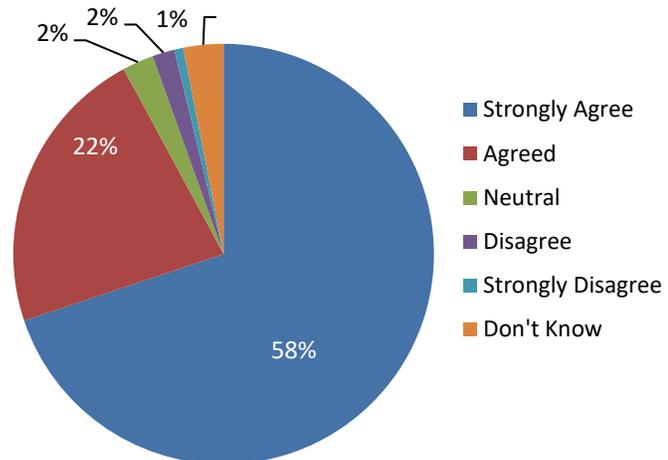


FIGURE 2: AVERAGE STAKEHOLDER PERCEPTION OF THE IMPORTANCE OF PROTECTING MANGROVES OF CBWS (SACD data , 2014)

1.3.5 Socio-Economic Context

National Context

Belize has a population currently estimated at approximately 398,000 (Table 5; SIB, 2016), with the lowest population density in Central America, at just over 14.6 persons per sq. km., concentrated primarily on the northern plain, southern coastal plain, Cayo District, Belize City and the district towns. Much of the remaining country is less suited to habitation, with swampy lowlands and steep terrain in the Maya Mountains.

Belize Demographic Statistics (Average)	
Population (2018 est.)	398,050
Population density (2015)	14.6/sq. km.
Urban Population (2015)	43.1%
Annual growth rate (2015 est.)	2.1%
Life expectancy (2011 est.)	73.7
Below Poverty Level	33.5% (2002)
	43% (2010)
Literacy rate (2015)	82.3%
Unemployment rate (2018)	9.4%
GDP (per capita, 2017)	Bz\$7,243.12
Annual GDP Growth (2015)	1.9%

TABLE 5: BELIZE DEMOGRAPHIC STATISTICS, (SIB, 2018)

It is a country of many cultures, with Mestizo, Creole, Maya and Garifuna forming the major population groups. The indigenous Maya of Belize are descendants of the original Central American civilization, at its height approximately 2,000 years ago. Stakeholder communities of Corozal Bay Wildlife Sanctuary are the northern coastal communities and northern cayes, settled in the 1850's by Mestizo refugees from the Mexican Caste War. These communities can be categorised based on their primary income – Copper Bank, Chunox and Sarteneja are predominantly fisheries-based, whilst San Pedro and Caye Caulker are tourism focused.

In the last 25 years, there has been a shift in the cultural demographic of the country as a whole, with a significant influx of Central American refugees – primarily from Guatemala and Honduras – in 2010, an estimated 20% of heads of households were born outside of Belize (SIB, 2010). There is also an ongoing emigration of Belizeans to the United States – generally those from urban areas who have completed secondary school or have professional training.

Whilst Corozal Bay Wildlife Sanctuary is not considered a key tourism destination in Belize, good management is critical for the maintenance of healthy reefs at Hol Chan Marine Reserve, Belize's primary marine-based tourism site. The **tourism industry** is the number one foreign exchange earner – an estimated 1,299,100 visitors travelled to Belize in 2015, and whilst approximately 73% of visitors arrived through cruise ship visitation, over 326,000 were overnight visitors (BTB, 2016). Tourism is primarily natural- and cultural-resource based, with visitors focusing on the cayes, coastal communities and coral reef (particularly snorkelling, diving and sport fishing activities), and inland protected areas. Direct tourism expenditure in Belize exceeded Bz\$510 million in 2015 – 14.7% of the total GDP. When indirect contributions are taken into account from related support industries, this rises to 38.6% of the GDP (WTTC, 2016). In 2015, the tourism industry supports

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over 18,000 direct jobs – 13.1% of total employment, expanding to 34.8% of total employment when related support industries are taken into account (WTTC, 2016).

Corozal Bay Wildlife Sanctuary plays an important role in supporting the local traditional **finfish fishery**, but is not a key national fishery area. However, fishing is critical to the coastal communities of CBWS, with Sarteneja being the largest fishing village in Belize. Only a small percentage of fishermen use CBWS, the remainder focus on reef fishing throughout Belize’s coastal waters, free-diving for lobster and

<i>Product</i>	<i>2016 (lbs)</i>	<i>2017 (lbs)</i>
Lobster Tail	432,013	546,788
Lobster Meat	40,367	47,841
Whole lobster	447,874	405,270
Conch	849,475	564,760
King Crab	1,713	3,919
Whole Fish	170,496	33,720
Fish Fillet	300	5,135
Sea cucumber	87,407	-
Shark	24,383	41,000
Total	2,054,028	1,648,433

TABLE 6: CAPTURE FISHERY PRODUCTION, 2016 – 2017 (SIB, 2017)

conch. The national fishing industry provides employment for over 2,750 fishers (Ministry of Agriculture and Fisheries, 2010). Nationally, the fishery supports an estimated 12,500 Belizeans from 20 communities, with a further 1,000 people involved indirectly in processing and export (Belize Fisheries Department, 2013). In 2016, the capture fishery produced over 1,648,400 lbs of product – primarily lobster and conch for the export market (SIB, 2017). Lobster exports (tail and meat) were valued at approximately Bz\$18,259,380, with conch and other mollusk exports at Bz\$10,522,230 (Table 6; SIB, 2017).

Economic dependence on the traditional, non-mechanised coastal-shelf fishing industry is high, particularly in the northern coastal communities, with limited options for diversification away from the fishing industry. Alternative job opportunities in many of these coastal communities, particularly those of the north, are limited, with many fishermen leaving primary school to go directly into fishing (SACD, 2009).

Six communities have been identified as stakeholders of the protected area, with three of these, Sarteneja, Chunox and Copper Bank, each having a small percentage of households directly dependent on the CBWS fishery. (Table 7; Map 4). Corozal is the district and business center, with a small satellite community, Consejo. San Pedro is Belize’s primary tourism destination for reef based activities, but with little focus on Corozal Bay Wildlife Sanctuary, with the exception of use for sport fishing.

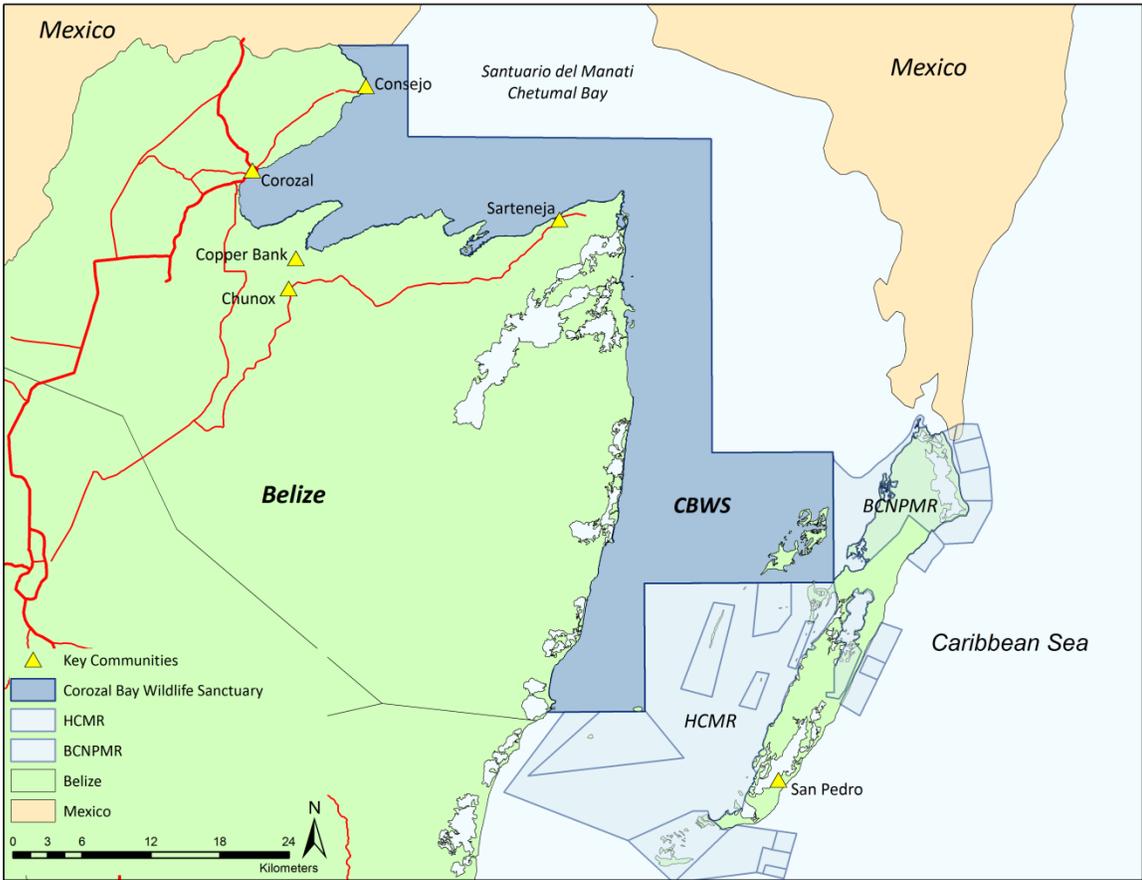
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A basic stakeholder analysis identifies respective interests and impacts (Tables 7, 8 and 9).

Stakeholder Communities of Corozal Bay Wildlife Sanctuary				
Community	Location (UTM) Distance (km)	Distance from CBWS	Population (approx.)	Comments
Sarteneja	E16 0378750 N18 2029500	0km	2,300	Largest fishing community, concentrating on lobster and conch throughout Belize waters. A limited number of local fishermen (12 – 15) dependent on fishing in Corozal Bay
Chunox	E16 0356500 N18 2023500	3km	525	Located on Laguna Seca, part of the Progreso Lagoon system. Increasing number of reef fishermen, focused primarily on Lighthouse Reef Atoll. A limited number of local fishermen (4 – 5 in both communities) using Corozal Bay
Copper Bank	E16 0356700 N18 2026020	1.4km	1,400	District town with major services (banks, post office, Government offices etc.). A limited number (2 to 3) of fishermen dependent on Corozal Bay. Recreational fishing by youths in the mornings
Corozal	E16 0356500 N18 2023500	0km	525	Border community, with some (7) fishermen dependent on Corozal Bay. Large expat component
Consejo	E16 0356700 N18 2026020	0km	1,400	Tourism based economy, embarkation point for majority of visitors to the reef
San Pedro	E16 0398200 N18 1981250	14km	11,510	Mexican coastal town with significant impacts on the estuarine system
Chetumal	E16 363347 N20 46291	1.5km	238,520	

TABLE 7: STAKEHOLDER COMMUNITIES OF COROZAL BAY WILDLIFE SANCTUARY

**Corozal Bay Wildlife Sanctuary – Management Plan
2020-2024**



MAP 2: PRINCIPAL STAKEHOLDER COMMUNITIES OF COROZAL BAY WILDLIFE SANCTUARY

**Corozal Bay Wildlife Sanctuary – Management Plan
2020-2024**

Stakeholder	Role
Sarteneja Alliance for Conservation and Development	Site manager for Corozal Bay Wildlife Sanctuary, under a Memorandum of Understanding with the Forest Department. Responsible for day to day management activities, including surveillance and enforcement, monitoring and outreach
Forest Department	Authority responsible for Corozal Bay Wildlife Sanctuary. Enforcement of mangrove legislation and protection of manatees, American crocodiles, and dolphins
Fisheries Department	Regulates both fishery and spawning aggregation sites towards maximum sustainable yield. Responsible for enforcement of Fisheries legislation, roll out of Managed Access, and protection of sea turtles
Department of the Environment	Responsible for regulation of coastal and caye development activities, and of large scale agricultural and industrial activities in the watersheds
Geology and Petroleum Department	Responsible for regulation of dredging and oil exploration / extraction activities
Belize Tourism Board	Potential for development of tourism that uses the protected area – the focus of the Sustainable Tourism Project Phase 2
Traditional Fishermen	Have livelihoods based on the marine resources of the area – finfish.
Fishing Cooperatives	Promote and encourage increased extraction of marine product. Link fishermen with the export market
Coastal and Caye Developers	Clear terrestrial ecosystems and mangroves to build on coast and cayes of CBWS, with the potential to impact the environment...including dredging, seawalls, over-water constructions
Tourism Services – hotels, resorts, restaurants (Corozal, Consejo, Sarteneja and on coastline)	Provide employment and training in the tourism industry; provide a venue for environmentally sound interpretation activities for visitors. Rely on the aesthetic beauty of Corozal Bay Wildlife Sanctuary for attracting guests to the area.
Tour Guides	Provide interpretation for tourists, and guide visitor behaviour
Belize Coast Guard	Responsible for providing security to life and property

TABLE 8: KEY STAKEHOLDERS OF COROZAL BAY WILDLIFE SANCTUARY

TABLE 9: STAKEHOLDER ANALYSIS FOR COROZAL BAY WILDLIFE SANCTUARY

Stakeholder	Influence or Impact of Corozal Bay Wildlife Sanctuary on Stakeholder	Influence or Impact of Stakeholder on Corozal Bay Wildlife Sanctuary
Community Stakeholder Sarteneja	<ul style="list-style-type: none"> ▪ Management of fish resources ensuring continued viability of fishery ▪ Protection of important mangrove nursery sites, ensuring continued viability of fishery ▪ Recreational opportunities ▪ Protection of an important tourism resource ▪ Employment in management of the protected area ▪ Opportunities for building local capacity through the SACD Community Researcher programme 	<ul style="list-style-type: none"> ▪ Participation in surveillance and enforcement activities ▪ Low level of cooperation towards protected area from reef fishermen ▪ Non-sustainable fishing activities ▪ Poor tourism practices ▪ Pollution from shore based activities (boat painting etc.)
Community Stakeholder Chunox and Copper Bank	<ul style="list-style-type: none"> ▪ Management of fish resources ensuring continued viability of fishery ▪ Protection of important mangrove nursery sites, ensuring continued viability of fishery ▪ Recreational opportunities ▪ Protection of an important tourism resource 	<ul style="list-style-type: none"> ▪ Low level of interest in protected area from community stakeholders ▪ Non-sustainable fishing activities
Community Stakeholder Corozal and Consejo	<ul style="list-style-type: none"> ▪ Recreational opportunities ▪ Protection of an important tourism resource ▪ Management of fish resources ensuring continued viability of fishery and culturally important commercial fish species ▪ Protection of important mangrove nursery sites, ensuring continued viability of fishery 	<ul style="list-style-type: none"> ▪ Medium level of interest in protected area from community stakeholders ▪ Pollution from poor septic systems ▪ Clearance of coastal mangroves
Community Stakeholder San Pedro	<ul style="list-style-type: none"> ▪ Recreational opportunities ▪ Protection of an important tourism resource – particularly for sport fishing ▪ Management of fish resources ensuring continued viability of fishery ▪ Protection of important mangrove nursery sites, ensuring continued viability of fishery 	<ul style="list-style-type: none"> ▪ High level of interest from sport fishing guides ▪ General community interest and understanding of concept of conservation ▪ Pollution from poor septic waste and solid waste disposal on San Pedro ▪ Poor sport fishing practices ▪ Poor development practices

TABLE 9: STAKEHOLDER ANALYSIS FOR COROZAL BAY WILDLIFE SANCTUARY (CONT.)

Stakeholder	Influence or Impact of Corozal Bay Wildlife Sanctuary on Stakeholder	Influence or Impact of Stakeholder on Corozal Bay Wildlife Sanctuary
Transboundary Stakeholder Chetumal / Mexico	<ul style="list-style-type: none"> ▪ Provides additional importance to Santuario de Manati as a transboundary protected area 	+
	<ul style="list-style-type: none"> ▪ Provides a mechanism for transboundary cooperation on conservation activities 	+
Tour Guides (including tour boat captains)	<ul style="list-style-type: none"> ▪ Benefit from having Corozal Bay Wildlife Sanctuary as a venue for snorkeling, dive- and kayak-associated tourism 	+
	<ul style="list-style-type: none"> ▪ Employment in tourism initiatives 	+
	<ul style="list-style-type: none"> ▪ Income from using Corozal Bay Wildlife Sanctuary for tourism 	+
Local / National Tour Operators	<ul style="list-style-type: none"> ▪ Benefit from having Corozal Bay Wildlife Sanctuary as a tourism venue based on its biodiversity and scenic values 	+
	<ul style="list-style-type: none"> ▪ Income from using Corozal Bay Wildlife Sanctuary as a tourism destination 	+
International Tour Operators	<ul style="list-style-type: none"> ▪ Benefit from having Corozal Bay Wildlife Sanctuary as a tourism venue based on its biodiversity and scenic values 	+
	<ul style="list-style-type: none"> ▪ Income from using the Wildlife Sanctuary for tours 	+
Belize Tourism Industry Association	<ul style="list-style-type: none"> ▪ Benefit from having Corozal Bay Wildlife Sanctuary as a tourism venue 	+
		+
General Belize Public (excluding primary stakeholder communities)	<ul style="list-style-type: none"> ▪ Maintenance of local native fish stocks 	+
	<ul style="list-style-type: none"> ▪ Environmental services 	+
	<ul style="list-style-type: none"> ▪ Cultural and aesthetic appreciation 	+
	<ul style="list-style-type: none"> ▪ Increased awareness through outreach activities 	+

TABLE 9: STAKEHOLDER ANALYSIS FOR COROZAL BAY WILDLIFE SANCTUARY (CONT.)

Stakeholder	Influence or Impact of Corozal Bay Wildlife Sanctuary on Stakeholder	Influence or Impact of Stakeholder on Corozal Bay Wildlife Sanctuary		
Visitors: Tourists	<ul style="list-style-type: none"> ▪ Enjoy Corozal Bay Wildlife Sanctuary as a tourism destination 	+	<ul style="list-style-type: none"> ▪ Potential for entrance fee would contribute towards financial sustainability 	+
	<ul style="list-style-type: none"> ▪ Benefit from education and awareness opportunities 	+	<ul style="list-style-type: none"> ▪ Provide marketing nationally and internationally by word of mouth 	+
			<ul style="list-style-type: none"> ▪ Presence deters fishing (and other illegal activities) within protected area 	+
			<ul style="list-style-type: none"> ▪ Negatively impact marine and terrestrial environments 	-
Government of Belize	<ul style="list-style-type: none"> ▪ Provides management framework 	+	<ul style="list-style-type: none"> ▪ Political support (currently being strengthened through the NPAPSP) 	+
	<ul style="list-style-type: none"> ▪ Provides communities with environmental services 	+		
	<ul style="list-style-type: none"> ▪ CBWS is a component of NPAS - Assists in fulfilling Belize Government’s commitment to regional and global commitments 	+	<ul style="list-style-type: none"> ▪ Uncertainty of long term future commitment 	-
	<ul style="list-style-type: none"> ▪ Income generation of foreign revenue 	+		
	<ul style="list-style-type: none"> ▪ Provides employment opportunities in stakeholder communities 	+		

TABLE 9: STAKEHOLDER ANALYSIS FOR COROZAL BAY WILDLIFE SANCTUARY

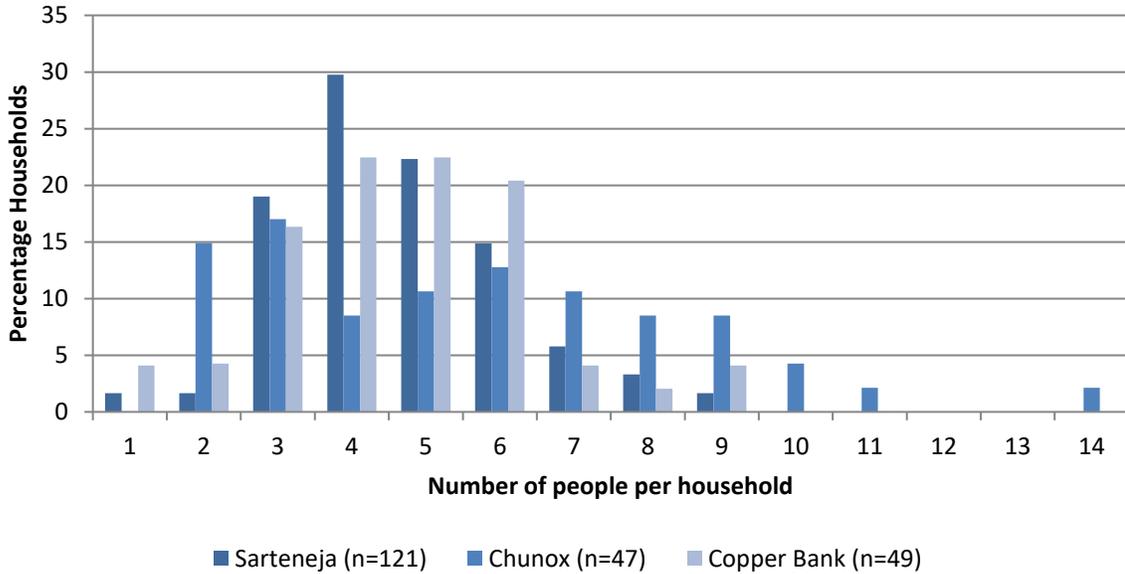
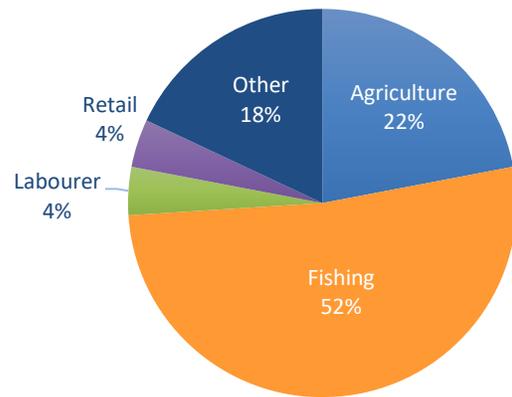


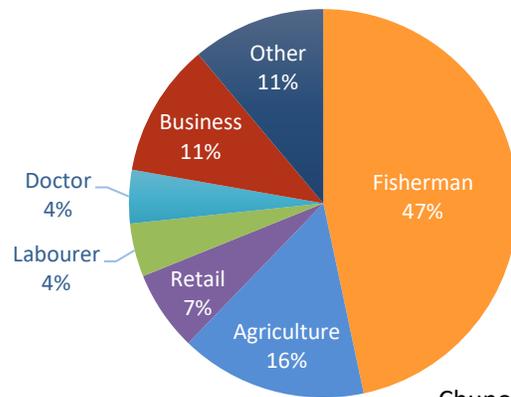
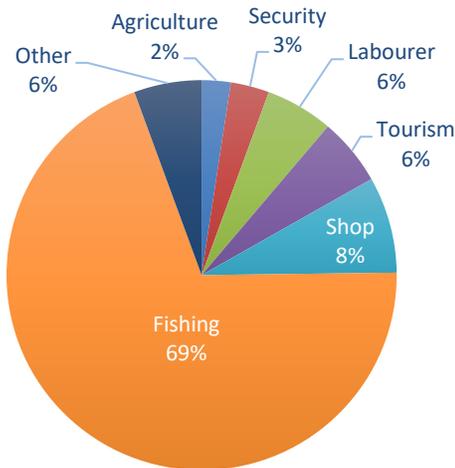
FIGURE 3: FREQUENCY OF NUMBER OF PEOPLE PER HOUSEHOLD PER KEY STAKEHOLDER COMMUNITY (SACD, 2014)

KEY POINTS:

- Fishing is important in all three communities, but its contribution to community economy is highest in Sarteneja
- Agriculture is important in Chunox and Copper Bank, but is minimal in Sarteneja
- Easy access to the District Centre of Corozal provides external, diversified income opportunities for Copper Bank
- Past investment in tourism training is now providing a primary income for some



Copper Bank (n=49)



Chunox (n=47)

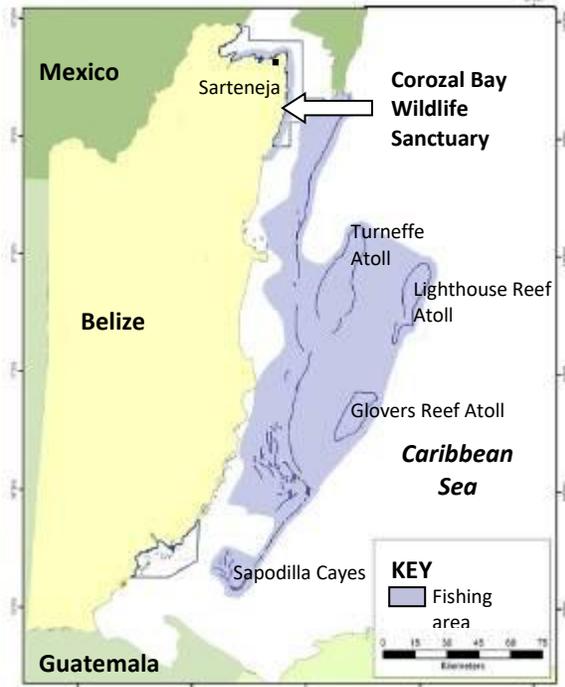
FIGURE 4: PRIMARY INCOME SOURCE FOR KEY STAKEHOLDER COMMUNITY (SACD data, 2014)

SARTENEJA

Sarteneja is the primary user of both Corozal Bay Wildlife Sanctuary and the Belize Reef, and as such is the primary target for management actions. The community is reliant on the traditional harvesting of marine products, notably lobster, conch and finfish, along the entire Belize Barrier reef (CHEC; Map 3). This reliance on the marine resources creates a strong relationship between the state of the resource and the needs of the community.

Against a background of limited education (86% of interviewees in Sarteneja had not progressed beyond primary level education in 2009. This had decreased to 56% by 2014), limited communication skills (95% of respondents are Spanish speaking as their first language, and many have limited English skills), limited financial capital to start new initiatives and lack of training in alternative skills, it is going to be a challenge for this stakeholder community to move from fishing into other livelihoods, especially with the poor quality of agricultural soils, few employment opportunities and lack of alternative industries in the area.

The reliance on tourism income has doubled in the community, from 3% in 2009 to 6% in 2014 (SACD data, 2014), though the majority of tour guides travel to work outside the community, primarily in Belize City with the cruise tourism industry.



MAP 3: SARTENEJA FISHING FOOTPRINT,
(CHEC, 2008)

SARTENEJA COMMUNITY CAPACITY

Established Community Organizations

Sarteneja Alliance for Conservation and Development
Sarteneja Fisherman Association
Sarteneja Tour Guide Association
Sarteneja Beach Trap Pesca Tour Association
Sarteneja United Local Fishermen Association
Sarteneja Honey Producers
Las Sartenejeñas
Sarteneja Homestay Program
Sarteneja Farmers Association

COMMUNITY PERCEPTIONS OF COROZAL BAY WILDLIFE SANCTUARY

The key stakeholder communities have varying levels of awareness of the status of CBWS as a Wildlife Sanctuary / protected area. In Sarteneja, where SACD has been most active, 64% of respondents were aware of the protected status of the Wildlife Sanctuary, a 4% increase over the 2009 awareness (Figure 5; SACD data, 2009 and 2014). Chunox and Copper Bank both have lower levels of awareness – only 15% of respondents in Copper Bank were aware of the protected area status of the estuary, reflecting the reduced level of engagement by SACD and the more limited connection the community has with the Wildlife Sanctuary.

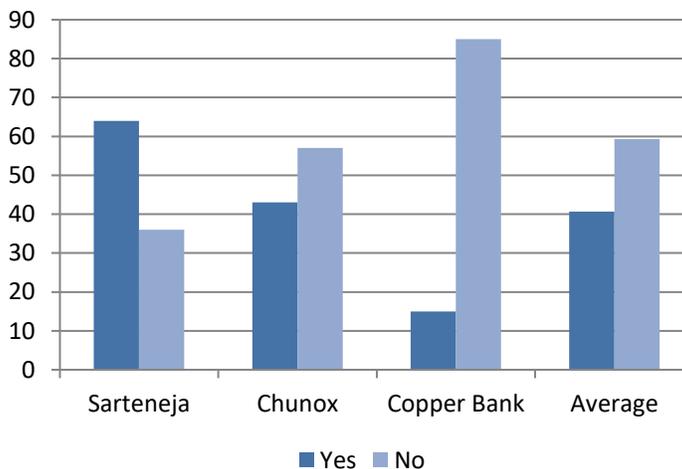


FIGURE 5: COMMUNITY AWARENESS OF CBWS STATUS AS A WILDLIFE SANCTUARY (SACD data 2009 and 2014)

All three communities rely on the ecosystem services of the Corozal Bay Wildlife Sanctuary – particularly the critical value of the area as a fish nursery. Fish consumption within all three communities is high, both as an essential protein source and as a cultural dietary preference, and is focused primarily on three target species – yellow fin ('chiwa'), striped mojarra (*Gerres cinereus* and *Eugerres plumieri*), and grey snapper (*Lutjanus griseus*). In all three communities, there is recognition of the need for good management to sustain fish stocks in Corozal Bay Wildlife Sanctuary. This is highest in Copper Bank, with 76% of respondents strongly agreeing and 18% agreeing (SACD, 2014). In Sarteneja, the community most reliant on the fish resources, 87% of respondents either agree or strongly agree (Figure 6; SACD data, 2014).

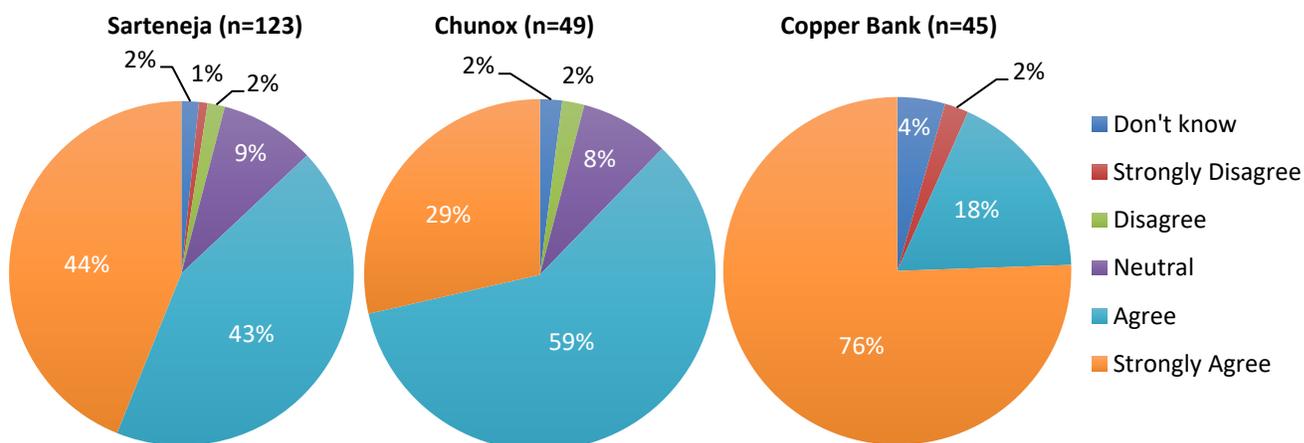


FIGURE 6: COMMUNITY PERCEPTION THAT GOOD MANAGEMENT WILL HELP SUSTAIN FISH STOCKS, (SACD data, 2014)

The value of mangroves is also recognized as important, with all three fishing communities identifying mangroves as critical fish nursery habitat, as well as its provision in storm protection and erosion control, as part of the natural protection of the coastline. Chunox, in particular, considers protection of mangroves as a high management priority, with 90% of household respondents strongly agreeing that mangrove should be protected (Figure 7; SACD data, 2014). Very few respondents disagreed (1% in Sarteneja and 2% in Copper Bank).

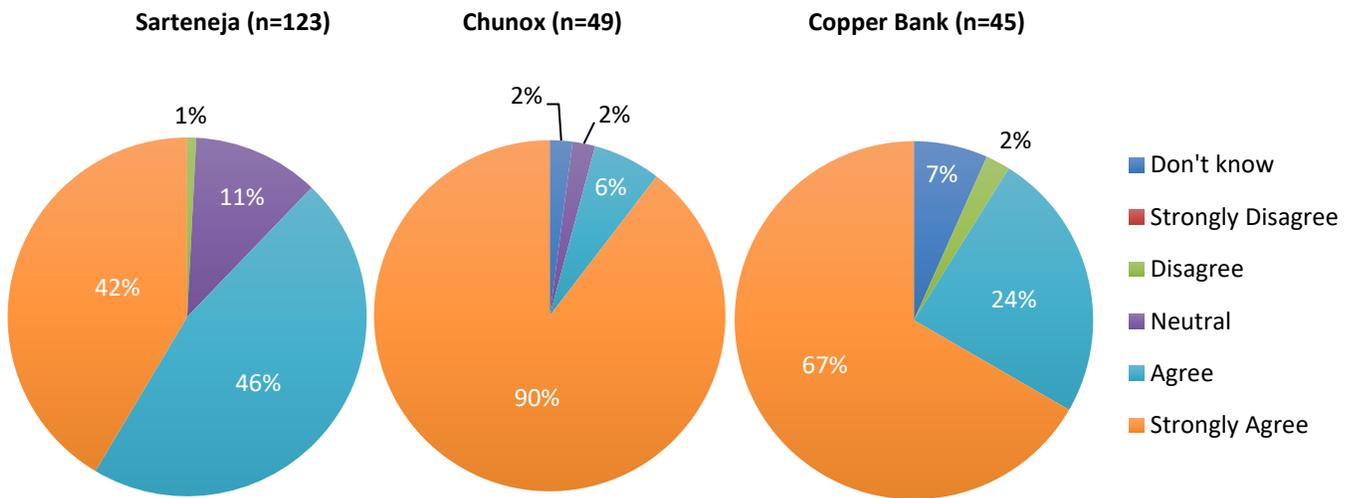


FIGURE 7: COMMUNITY PERCEPTION OF THE IMPORTANCE OF PROTECT MANGROVES OF COROZAL BAY WILDLIFE SANCTUARY (SACD data , 2014)

Climate Change Predictions and Community Perceptions

Modelling has predicted that Belize will be one of the country’s most at risk to the adverse impacts of climate change (UNFCCC). It is expected to face more frequent heat waves and droughts, rainfalls with increased intensity, and rising sea levels. These impacts will be at their greatest in the north east of Belize where annual rainfall has already decreased significantly over the last 30 years (local consultations), and is predicted to continue decreasing, with lengthened dry seasons and reduced predictability of rainfall.

Climate change is seen as a reality in the northern communities. Of the communities that border the Wildlife Sanctuary, three have been identified as the most vulnerable to the impacts of climate change – Sarteneja, Chunox and Copper Bank. These are the most reliant on fishing and small scale agricultural production – both industries predicted to face significant challenges in the future.

All three communities agree on the following four impacts as of most concern (Figure 8):

- Increased Frequency and Intensity of Tropical Storms
- Increased Flooding
- Increased Drought
- Increased Temperatures

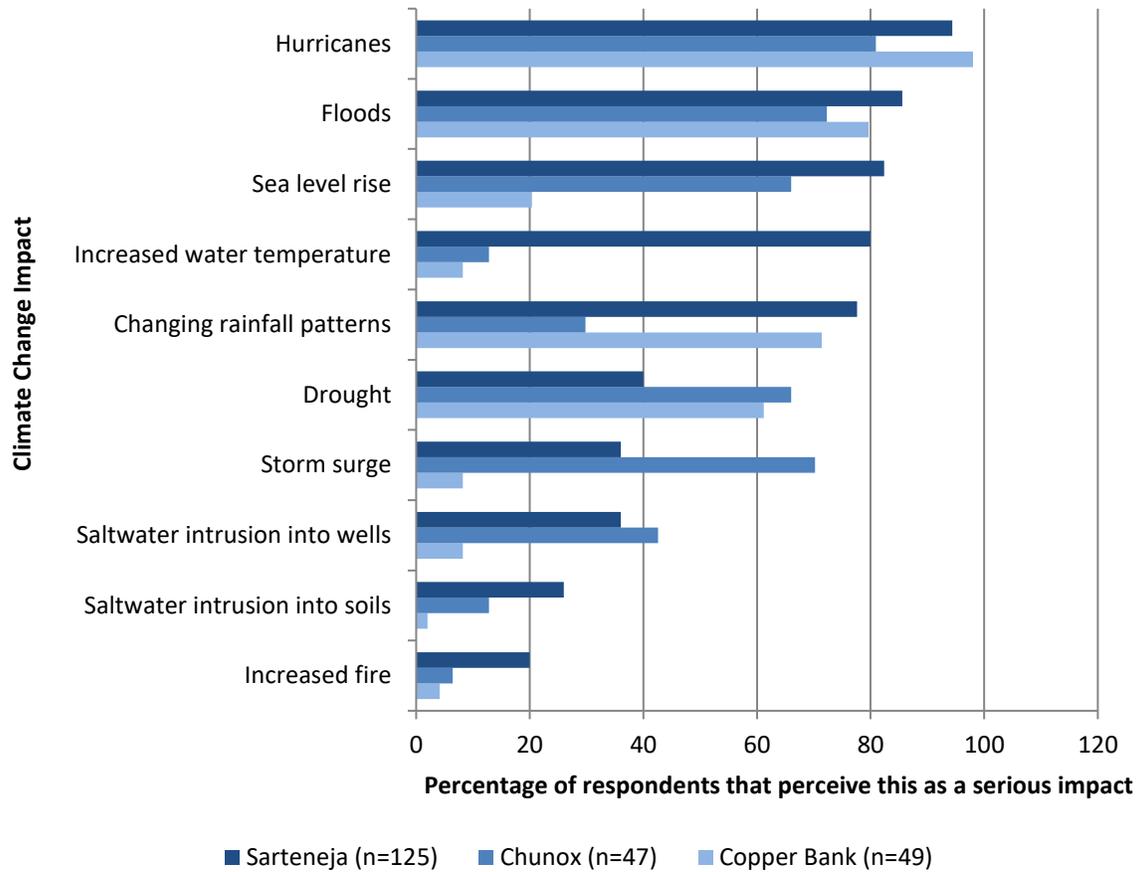


FIGURE 8: COMMUNITY PERCEPTIONS OF THE RELATIVE IMPACTS OF CLIMATE CHANGE (SACD DATA, 2014)

In the coming years, CBWS stakeholder communities will face the following predicted climate change impacts:

- Average accumulated precipitation during July, August and September is predicted to drop from 180 mm (the 2008 baseline) to 120 mm in 2020 – a reduction of 60 mm - over 33% (Anderson et al., 2008).
- Average July temperature along in north east of Belize is predicted to rise from 28°C in 2008 to 29°C in 2020...to 33°C in 2080 (Anderson et al., 2008), with associated risks to health, agriculture and fish stocks.
- The area’s location in the highest risk of tropical storm impacts, combined with the increased intensity of storms, increasing sea level (a potential rise of 0.18 to 0.56 meters by 2090).
- The low elevation (less than 2 m above sea level), is predicted to result in a drop in the availability of fresh water for household use and irrigation, with increased saltwater inundation and eventual salination of the shallow aquifer, with the combined influence of increased droughts and sea level rise.

Key Points

- All communities perceive the increased intensity of tropical storms / hurricanes to be the most significant climate change impact they face, with 80% or more of respondents from each of the communities identifying this as a concern.
- The two communities that focus on farming – Chunox and Copper Bank both identify drought as an important impact – this is considered less so in the more fishing-focused Sarteneja community.
- Sarteneja, with a population of 1,845 (2010 census), is considered the most vulnerable, with more than 69% of the 150 households surveyed in 2014 dependent on marine resource extraction from either Corozal Bay Wildlife Sanctuary and / or the Belize reef. Chunox and Copper Bank, with a combined population of 1,845 (1,375 and 470 respectively), have more diversified income bases, being in areas with deeper soils, and therefore supported by farming as well as fishing. These two communities also have greater access to job opportunities in Corozal and the adjacent Corozal Economic Free Zone, and are therefore considered slightly more resilient.

Community Perceptions and Resilience to Climate Change - Sarteneja

There has been extensive outreach to fishers and coastal communities about climate change, reflected in the high degree of acceptance that climate change is happening. Only 1% of the survey respondents disagreed with this view, and only 9% were unsure (Figure 9; SACD data, 2014). However, despite the strong recognition of the threat of climate change, it is only a discussion topic in 38.1% of households, and even less so with friends/ work colleagues (only 30.4% discuss climate change with friends).

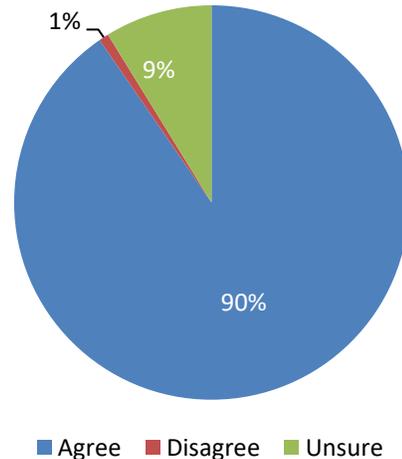


FIGURE 9: PERCENTAGE OF SARTENEJA THAT BELIEVE THAT CLIMATE CHANGE IS HAPPENING (SACD data, 2014)

In 2014, only 12.3% of 122 respondents considered that Sarteneja knows about and is prepared for climate change adaptation. Only 34% consider that there is sufficient coordination in Sarteneja for respond quickly to extreme climate change impacts, and whilst 19% consider that community members can work well with each other, 47% disagree, highlighting the deep divides that exist within the community and act as a barrier to progress.

Increased Intensity and Frequency of Storms

Perceived Impacts

- Flooded road prevents access for goods, materials – prices increase, some commodities hard to obtain – eg. butane for cooking, access to health care and medicine
- No electricity
- Lack of drinking water, or difficult to access
- Destroyed houses, damage to infrastructure (electricity posts etc.)
- Flooding, with a lot of mosquitoes (increased risk of malaria, dengue, water borne diseases)
- Contaminated wells – septic overflow into wells. Water is drained into the sea. Walking through contaminated water
- Small vendors can't go out and sell house to house / on the street, may not have supplies (fresh fruit, flour, sugar etc.) to make food to sell
- High risks to damage of small scale agriculture – subsistence farmers - bananas and plantains destroyed

Potential Strategies for Improvement

- Lobbying for improved access road maintenance and sufficient drainage to reduce pre- and post-storm issues
- Increased awareness of how to hurricane proof houses
- Increased awareness of hurricane preparation
- Improved drainage system for rainfall runoff in Sarteneja
- Community Hurricane Plan
- Response from post-emergency organizations
- Unbiased assistance from post-emergency organizations

*Sarteneja Community Consultation,
SACD data, 2014*

Community Resilience to Climate Change - Chunox

98% of community respondents consider that climate change is happening (Figure 10; SACD data, 2014). The topic is more widely discussed in households in Chunox than in Sarteneja, with 54.3% talking about it with their families, and 45.7% discussing with friends / work colleagues. 45.5% of the 44 respondents considered that Chunox, as a community, has the knowledge and is preparing for climate change adaptation - a much higher proportion than Sarteneja (though it should be noted that 30% disagree). 37% consider that there is sufficient coordination in the Chunox community for responding quickly to extreme climate change impacts, with only 14% in disagreement. However, only 46.7% consider that community members can work well with each other, with 35.6% disagreeing.

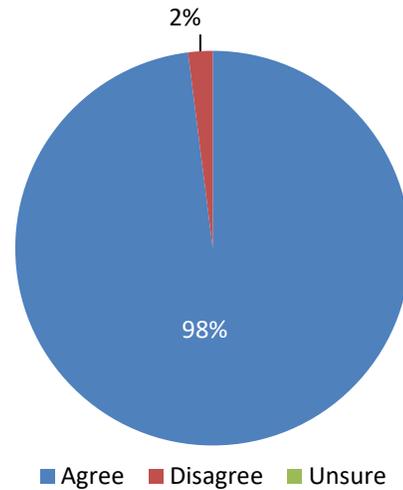


FIGURE 10: PERCENTAGE OF CHUNOX THAT BELIEVE THAT CLIMATE CHANGE IS HAPPENING (SACD DATA, 2014)

Increased Intensity and Frequency of Storms

Perceived Impacts

- Damage to houses and infrastructure
- Only “special people” are given food and other aid. But the impacts affect everyone
- Can’t reach schools, school closed, – have to pay for extra classes /extension of school year
- Destroys the road – no access to OW and Corozal towns and facilities... reduces income to the village, loss of employment
- Reduced access to local fish – fallen trees, turbid water, fish leave
- Erosion of coastline
- If access is cut off, can’t bring drinking water from outside
- No jobs, no money....need to have time to clean up and repair before can work
- Reef fishing no good – coral heads are turned over, covered with sediment and rubble, no holes / refugia - lobster disappear
- Can’t access farms (esp. in Cowpen area)
- Destroys the milpas, crops....particularly affects those who have microloans based on crops.
- Anyone who still has produce to sell can’t get out to sell it...no flow of money into community
- Government doesn’t send help

Potential Strategies for Improvement

- Build houses to withstand hurricanes
- Ensure there are medical supplies in the community
- Make an Emergency Plan, so that the community is ready for an emergency
- Lobby and advocate for the Government to fix the road – need to be able to pass to evacuate, to be able to get emergency supplies in afterwards
- Ensure families know NEMO advice before the hurricane arrives
- Improve drainage on the main road with culverts in key locations to prevent flooding

*Chunox Community Consultation,
SACD, 2014*

Community Resilience to Climate Change - Copper Bank

96% of survey respondents consider that climate change is happening (Figure 11; SACD data, 2014). However, despite the strong recognition of the threat of climate change, it is more widely discussed in households in Chunox than in Sarteneja, with 54% of families discussing the topic, and over 71% discussing with friends / work colleagues.

Over 53% of the 47 community respondents lack confidence in Copper Bank’s preparedness for climate change adaptation – only 14.9% consider the community ready. However, more than 79.6% consider coordination in Chunox is good when responding quickly to extreme climate change impacts. This is strengthened by the perception of 36.7% agreeing that the community can work well together, with only 18% disagreeing (however, 44.9% remain unsure either way).

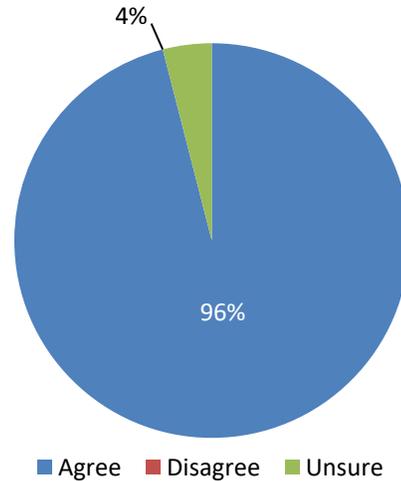


FIGURE 11: PERCENTAGE OF COPPER BANK THAT BELIEVE THAT CLIMATE CHANGE IS HAPPENING (SACD data, 2014)

Increased Intensity and Frequency of Storms

Perceived Impacts

- Increased expense
- Affects health
- No access to Corozal
- Damage to property
- A small number of households are flooded during heavy rains – not many. Good drainage, high land. Water doesn’t stand in the community.
- Water stands in the forest, milpas, cane farms...can’t access / harvest the farms
- Affects houses, roads, agriculture, some roads within the village are blocked
- Some people start taxi service by water – costs more
- Road is bad...vehicles break on flooded road – more expenses.
- Bad, muddy roads prevent access to and harvesting of the cane. The wet weather will also affect the quality of the cane harvest.

Potential Strategies for Improvement

- Fix road / upgrade road, build up and put in culverts to take water to sea / lagoon
- Mix planting of cane on higher land as well as lower land, so don’t lose the whole crop - spread the risk
- Provision of community skiff for emergencies – to provide access

*Copper Bank Community Consultation,
SACD data, 2014*

1.4 Physical Characteristics

1.4.1 Climate

Wind Systems

Belize is affected by three very distinct seasonal wind systems: trade winds, northers and tropical storms. All three have an influence on the rainfall and temperature patterns, on the sea level, and on the currents in Corozal Bay Wildlife Sanctuary.

The predominant winds are the **Trade Winds**, blowing from the east and north-east from April to October, interspersed by tropical storms. **Northers** - high-pressure fronts moving down from the north - occur between October and April, bringing cooler weather (Figure 12).

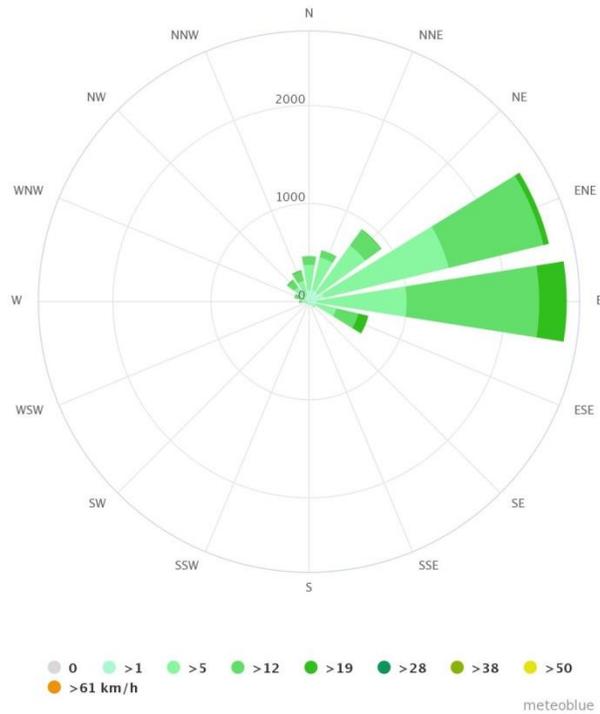


FIGURE 12: RAINFALL IN GRMR (METEOBLUE.COM)

Rainfall

Corozal Bay Wildlife Sanctuary lies within the lowest and second lowest rainfall belts, with between approximately 1000 and 2000 mm of rain per year (Figure 2). There is a pronounced dry season stretching from January through to the end of April, with total rainfall of 15 cm recorded in March, the driest month. This is followed by a wetter season (June to October) with total rainfalls in the region of 85 to 111 cm, associated with passing tropical storms, particularly between October and November. This is punctuated by a mini dry season in August.

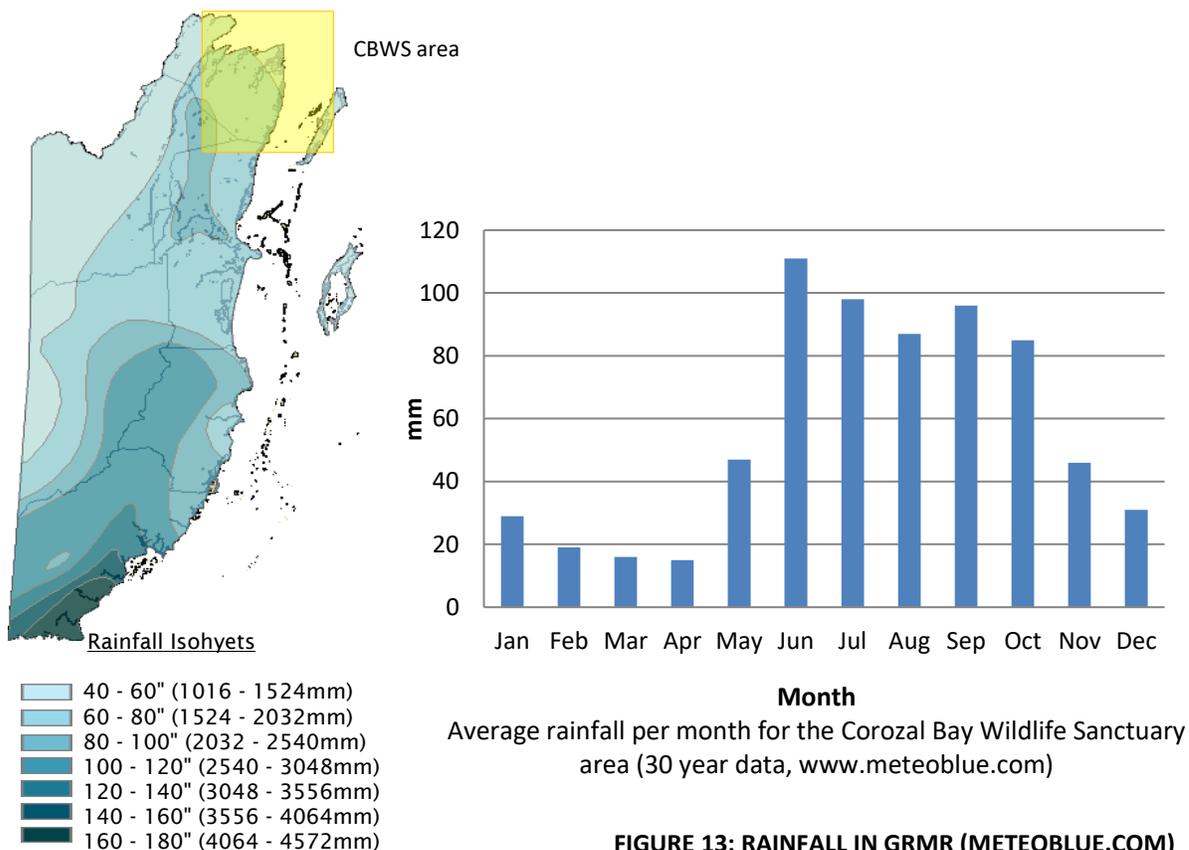


FIGURE 13: RAINFALL IN GRMR (METEOBLUE.COM)

Temperature

The annual mean temperature in the Corozal Bay area is 27.2°C, fluctuating throughout the year from a minimum monthly average of 22.5°C in January, during the cold fronts, and maximums in June and August of 27.0°C (Figure 14).

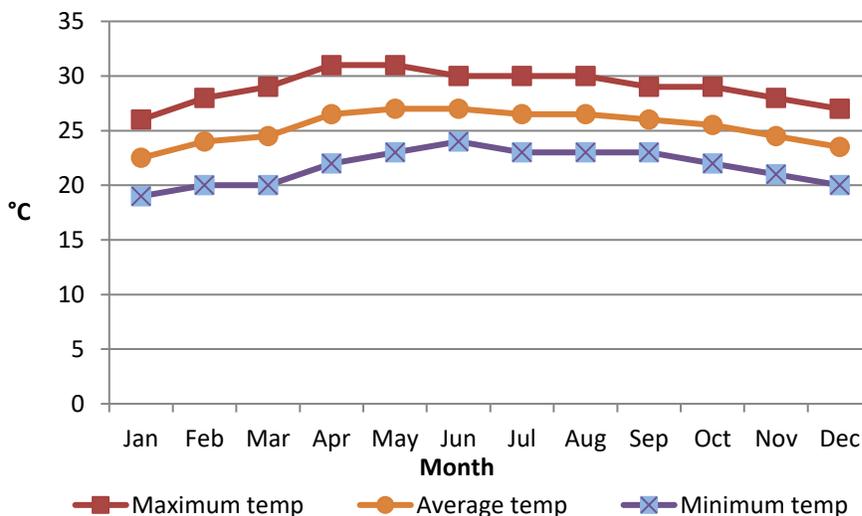


FIGURE 14: MAXIMUM, MINIMUM AND MEAN TEMPERATURE AVERAGE PER MONTH – COROZAL (METEOBLUE.COM)

Corozal Bay Wildlife Sanctuary – Management Plan 2020-2024

Tropical storms affect Belize every year between the beginning of June and end of November, with potential for landfall being particularly high in northern Belize. Originating in the Atlantic Ocean over warm, tropical waters, these storms are non-frontal, developing highly organized

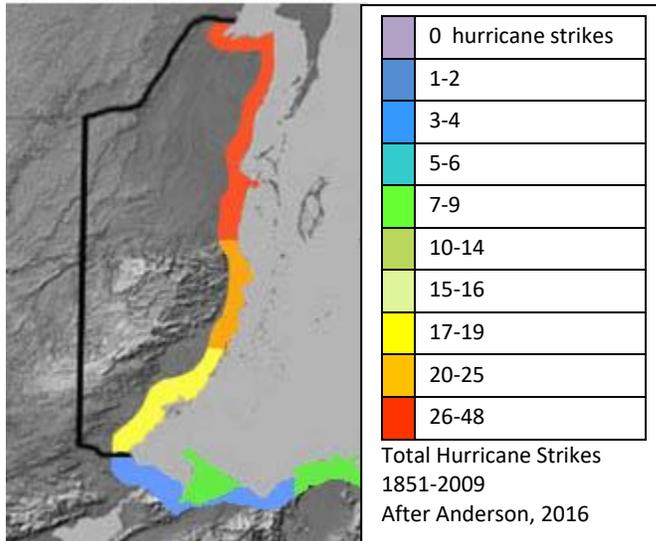
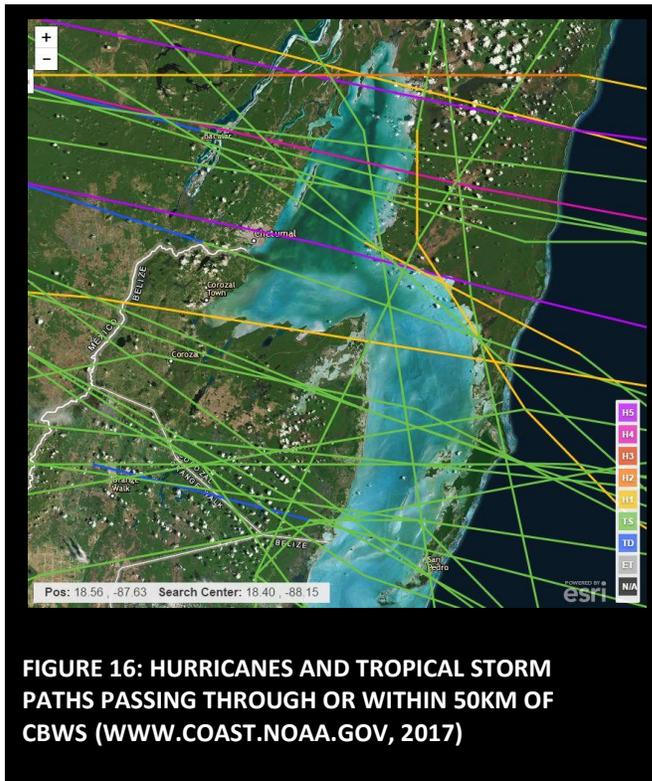


FIGURE 15: TOTAL HURRICANE STRIKES 1851 - 2009 (after Anderson, 2009)

circulations, and ranging in scale from tropical depressions and tropical storms (with sustained wind speed < 74 mph) to hurricanes (with sustained wind speed > 74 mph). These storms move westward towards the Caribbean and Central American coastline, gathering strength until they hit land. They generally bring extreme weather conditions – heavy rains, destructive winds. CBWS lies in northern Belize, with highest number of hurricane strikes between 1851 and 2009 (After Anderson, 2009).



Whilst many hurricanes have very focused paths of destruction, their effects are wide ranging, particularly in the marine and coastal environments. CBWS has been affected on an almost annual basis by tropical storms, some of these reaching hurricane strength (Figure 16). All tropical storms, even tropical depressions such as Katrina of 1999 can bring increased rainfall, causing extensive flooding of the coastal savannas, and water flow from the rivers, decreasing the salinity of the Corozal Bay system. Some of the stronger storms of most note in the region are Hurricane Janet (1955), Hurricane Keith (2000), and more recently, the Category Five Hurricane Dean (2007).

Historical records identify 49 tropical storms / hurricanes that have impacted CBWS between 1852 and 2014, either passing directly across the Wildlife Sanctuary, or coming within a 50 km radius

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of the area. This includes 32 tropical storms, 6 Category One hurricanes, 5 Category Two, 2 Category Four and 2 Category 5 (Table 10; Figure 17).

Name	Cat.	Date Passed <Kim of CBWS	Name	Cat.	Date Passed <50km of CBWS
Ernesto	H2	Aug 8, 2012	Not named	TS	June 17, 1921
Harvey	TS	Aug 20, 2011	Not named	TS	Sept 22 1920
Richard	H2	Oct 25, 2010	Not named	H2	Oct 15, 1916
Karl	TS	Sep 15, 2010	Not named	TS	Sept 1, 1916
Alex	TS	Jun 27, 2010	Not named	TS	Oct 15, 1906
Arthur	TS	May 31, 2008	Not named	TS	Oct 3, 1904
Dean	H5	Aug 21, 2007	Not named	TS	Nov 3, 1898
Chantal	TS	Aug 21, 2001	Not named	TS	Sept 16, 1898
Keith	TS	Oct 3, 2000	Not named	H2	Sept 4, 1898
Gert	TS	Sept 18, 1993	Not named	TS	Sept 27, 1895
Hermine	TS	Sept 22, 1980	Not named	H1	July 7, 1893
Carmen	H4	Sept 2, 1974	Not named	H1	July 7, 1893
Edith	TS	Sept 11, 1971	Not named	H2	Oct 12, 1892
Janet	H5	Sept 28, 1955	Not named	TS	Oct 20, 1889
Not named	TS	Aug 31, 1945	Not named	TS	Aug 3, 1887
Not named	TS	Oct 23, 1943	Not named	TS	June 9, 1880
Not named	H2	Nov 8, 1942	Not named	TS	Sept 16, 1879
Not named	TS	Sept 21, 1940	Not named	H1	July 21, 1876
Not named	TS	Oct 11, 1938	Not named	TS	Sept 25, 1874
Not named	H1	Sept 13, 1933	Not named	H1	Nov 1, 1870
Not named	TS	Oct 10, 1932	Not named	TS	Sept 26, 1867
Not named	TS	Nov 16, 1931	Not named	H1	Aug 16, 1866
Not named	TS	Sept 14, 1931	Not named	TS	June 22, 1859
Not named	H4	Sept 10, 1931	Not named	TS	Sept 23, 1852
Not named	TS	June 18, 1924			

TABLE 10: HURRICANES PASSING WITHIN 50KM OF CBWS (WWW.COAST.NOAA.GOV)

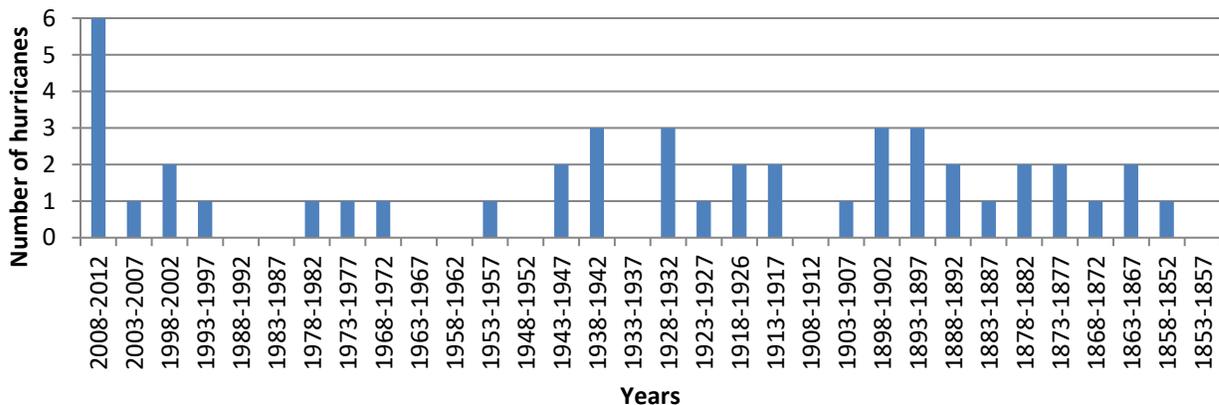


FIGURE 17: FREQUENCY OF HURRICANE EVENTS PASSING WITHIN 50KM OF CBWS (TROPICAL STORMS / HURRICANES; WWW.COAST.NOAA.GOV)

Hurricanes have had significant impacts on the water quality and biodiversity of the CBWS area, stirring up the water and reducing water clarity for a significant time after the storm event itself. Water clarity can be further reduced following tropical storms by the associated heavy rainfall, washing soil in from the watersheds, particularly in areas where riparian vegetation has been removed, and with soil erosion in coastal areas where mangrove clearance has taken place. These storm events can result in significant sediment load being carried through the estuary (Figure 18).

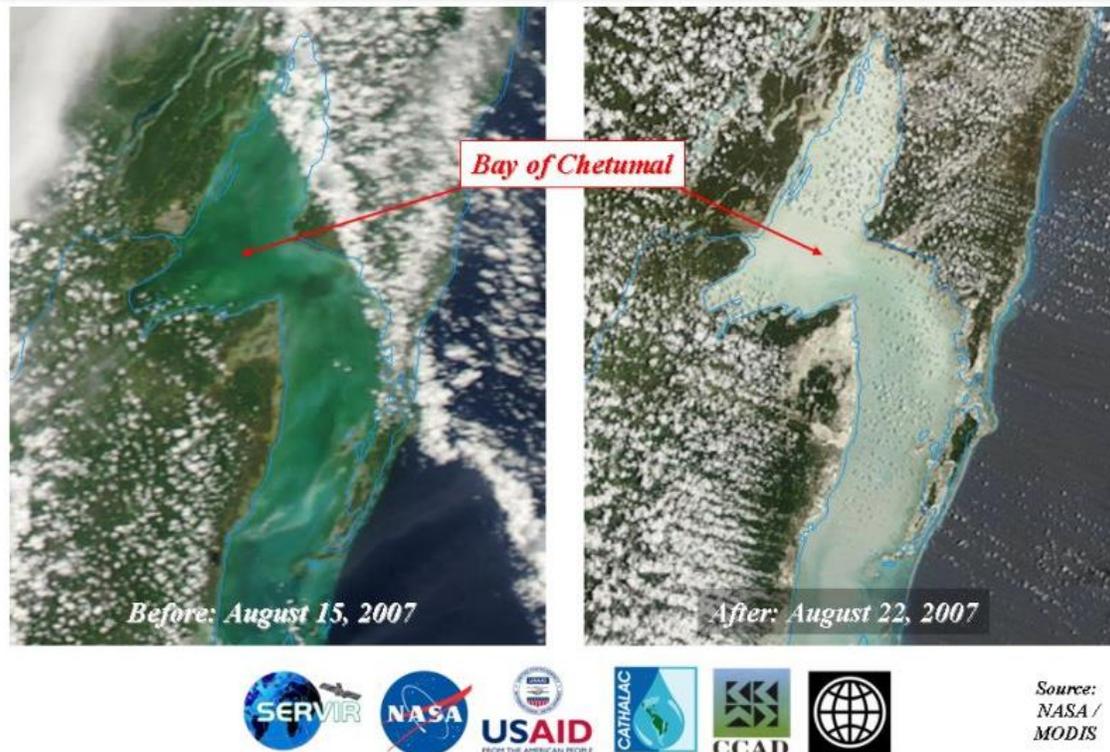


FIGURE 18: CHETUMAL BAY AND COROZAL BAY WILDLIFE SANCTUARY BEFORE AND AFTER HURRICANE DEAN IN 2007, DEMONSTRATING THE LEVEL OF TURBIDITY CAUSED BY THE CATEGORY 5 HURRICANE

Bird nesting colonies on the mangrove cayes have suffered from hurricane damage – the mangrove and littoral forest of Shipstern Caye was decimated and the littoral forest average height was reduced from 8 m to 4.5 m after extensive branch fall, reducing its value as a key nesting site.

Direct effects also include the storm surge associated with these events, with a local rise in sea level of several feet washing over the coastline and cayes, depending on the path of the storm, as demonstrated by mapping of inundation areas following Tropical Storm Arthur in 2008 (Figure 19; Meerman, 2011). Depending on the strength of the surge, and the duration of inundation under

water, this has the potential to remove vegetation cover, with salt contamination of ground water and soils.

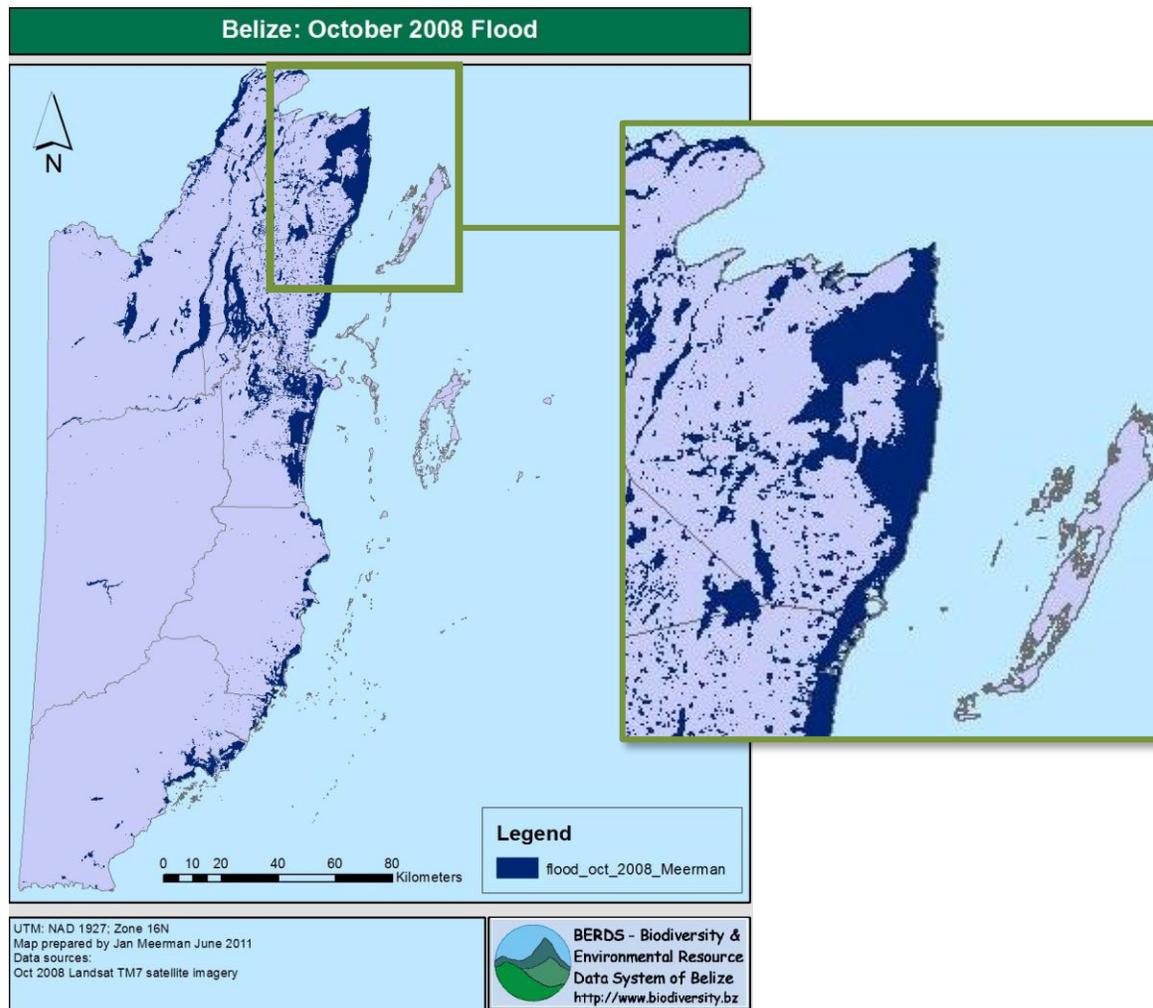


FIGURE 19: INUNDATION OF COASTAL LOW LYING AREAS ADJACENT TO COROZAL BAY WILDLIFE SANCTUARY FOLLOWING TS ARTHUR, 2008

Climate Change: Whilst these weather patterns have been relatively reliable over many years. They are now changing, with a shift in seasonality, with the dry season extending into June, and the mini-dry, which was traditionally in August, now extending into September. Climate change is having a very real impact on the health of the marine environment – with increasing sea temperatures, increasing intensity of storms. An assessment of potential climate change impacts is included in Section Two: Conservation Planning.

1.4.2 Geology

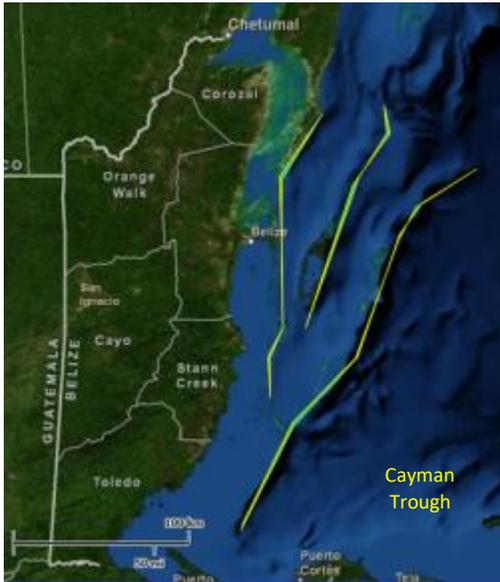


FIGURE 20: FAULT LINES / ESCARPMENTS RUNNING PARALLEL TO THE BELIZE COASTLINE, FORMING THE BASE OF THE BARRIER REEF AND ATOLLS (BASED ON PURDEY ET AL., 2003)

Corozal Bay was formed approximately 7,000 years ago, as rising sea levels caused by water from melting ice caps resulted in inundation of the lower areas of the Yucatan limestone platform. A series of SW-NE fault lines, caused by movement of the Caribbean plate against the North American plate in the Tertiary-Recent, resulted in the formation of Ambergris Caye on the most westerly of three offshore, east-tilted submarine escarpments, sheltering the waters of Corozal Bay Wildlife Sanctuary from storm events. This escarpment then continues southwards, supporting the barrier reef. Major waterways flowing into the Wildlife Sanctuary - Progresso Lagoon, New River and the Rio Hondo - are also believed to be located along more westerly SW-NE trending faults (Figure 20; King et al, 1992).

The upper bedrock under the Wildlife Sanctuary is formed from semi-continuous, well cemented, hard limestone layer (Cornec, 2002), composed of Tertiary limestones and dolomites that range in age from Paleocene to Pliocene and probably Pleistocene (Flores, 1952; King et al, 1992; MacLeod and Holland, 1998). Below this layer is a sequence of soft, conglomeratic marls - a carbonate mudstone, containing abundant hard limestone pebbles and cobbles, but no clay (Figure 21), that extends to almost 6,000 feet ((Placid Oil Company, 1982). In Corozal Bay, where the softer marl layers have been eroded away, semi-continuous patches of hard limestone bedrock is exposed on the sea floor.

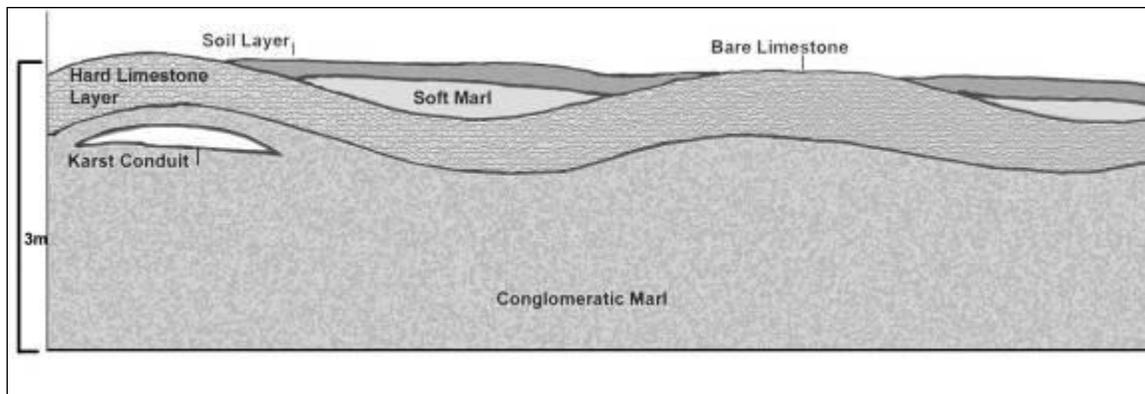


FIGURE 21: SCHEMATIC GEOLOGICAL CROSS SECTION OF BEDROCK OF THE AREA (INFORMATION COMPILED FROM SEVERAL QUARRIES AND TEST PITS IN AND AROUND THE AREA) (Holland, 2002)

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Corozal Bay Wildlife Sanctuary is bordered by the northern coastal plain of Belize, composed of the youngest limestones in Belize, formed in the Pleistocene. These limestones provide the parent material for the different soil types found in the area. Soil classification is based on a Land System/Suite-Subsuite system. Suites are defined in terms of parent materials although sometimes soil features such as colour and mineralization are also used. The Land Resources Assessment of Northern Belize categorized land types according to their potential productivity, and made recommendations as to the best land use that could be used within a specific land system. Four land system categories are found within the Corozal Bay Wildlife Sanctuary (King et al., 1992). Each land system has one or more soil types associated with it, each with its own distinctive sub-suites:

- Corozal Saline Swamp (ZY)
- Shipstern Plain (ZN)
- Consejo Plain (JI)
- Xaibe Plain (ZI)

None of these soils are considered particularly good for agriculture. Many areas have minimal soil depths, with limestone bedrock projecting above the soil surface. Much of the area is inundated during wet season, with waterlogged soils, and droughty during the dry season. These conditions limit options for diversification from fishing in the coastal communities unless farms are located near deeper alluvial river soils.

1.4.3 Bathymetry

Water depths in Corozal Bay Wildlife Sanctuary rarely exceed 2 meters (Map 5), and do so only where karst erosion has formed underwater caves and depressions in the bedrock. Depths are even shallower close to the coastline with bedrock just inches below the water surface. A central canal drains southwards, reaching depths of 5 meters in places (Figure 22).

The wide, shallow estuary acts as a settling pool, with sediment from the watersheds and coastal erosion settling out as the current slowly moves southwards. South of the protected area, a large mud bank – Bulkhead Shoals – extends from west to east, and acts as a barrier to sediment transport, slowing water movement and causing sedimentation of remaining particles before the water reaches the reef at Hol Chan (Figure 23).

1.4.4 Tides and Water Movement

The prevailing direction of water flow in the Wildlife Sanctuary is southerly, from the rivers to the coastal waters south of Ambergris Caye, with strong currents of up to 5 knots in river outlets especially during and after heavy rainfall (Majil et. al. draft).

Variations in sea level in the enclosed estuary, however, are controlled primarily by wind direction. During the norté season, strong winds from the north push water southward, out of the estuary, decreasing the water level and reducing the salinity and temperature. In the dry season, the north winds are replaced by strong south-easterly winds, pushing water into the estuary, increasing water depth. This is exacerbated by heavy rainfall during storm events, which increases sheet flow off the mangrove savannas and river flow into the area. During the norther season, the strong north winds push water southwards, out of the estuary,

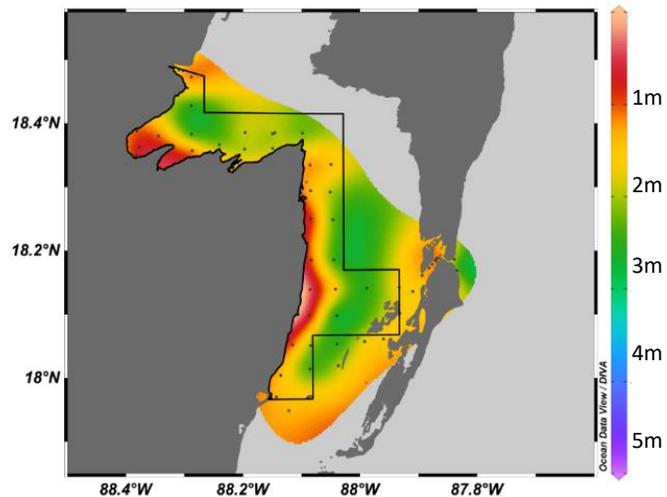


FIGURE 22: BATHYMETRY OF COROZAL BAY WILDLIFE SANCTUARY



FIGURE 23: THE BULKHEAD SHOALS MUD BANK SOUTH OF COROZAL BAY WILDLIFE SANCTUARY

lowering water levels not just in the Wildlife Sanctuary but also in the water table, as seen by lower levels in wells in Sarteneja.

1.4.5 Water Parameters

The target **“Physio-chemical environment”** covers the waters of the NBCC from the river mouths to the reef, and the physical characteristics – particularly temperature, salinity and dissolved oxygen.

Corozal Bay Wildlife Sanctuary is part of a larger transboundary estuarine system shared with Mexico, with the primary threats originating in the watersheds and coastal communities in Belize and Mexico. As water quality (temperature, salinity, dissolved oxygen, turbidity and pH) impacts the viability and health of all conservation targets, it is an important part of the biological monitoring programme. Monitoring began in 2012, with sites in the northern portion of the Wildlife Sanctuary, and was expanded in 2013 to the entire CBWS area and Bacalar Chico Marine Reserve, Rio Hondo and New River covering all seasons (norté, dry and rainy season) (Figure 24). Five parameters are measured (Table 11), and where possible, data is collected at 1 meter depth intervals until reaching the maximum depth.

More recently, SACD has expanded the water quality monitoring program to include contamination sampling, with points located throughout the bay, to establish a baseline for the level of contamination in CBWS and the impacts from the New River watershed. Sampling started in early 2017, informing management for the larger river-to-reef seascape of connected protected areas in northern Belize that stretch from the Rio Hondo, New River and the coastal lagoons that flow into the Corozal Bay Wildlife Sanctuary, to the reefs of Bacalar Chico (part of Belize’s World Heritage Site – the BBRRS-WHS), Hol Chan and Caye Caulker Marine Reserves. This was based on 12 physiochemical parameters, all of which have been within their normal range for brackish and

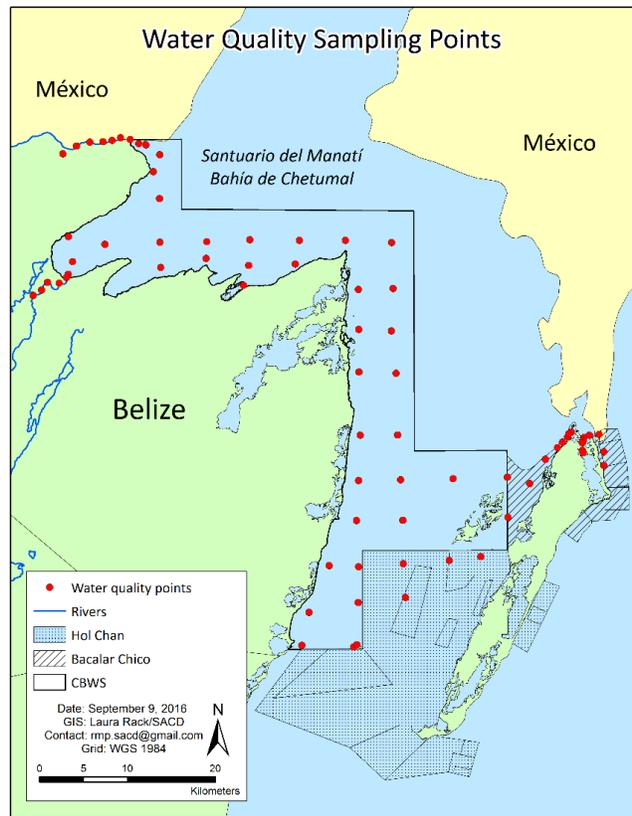


FIGURE 24: WATER QUALITY MONITORING POINTS IN CBWS.

CBWS Water Quality Parameters	
Marine	
Temperature	
Salinity	
Dissolved Oxygen	
pH	
Turbidity (vertical visibility)	

TABLE 11: CBWS WQM PARAMETERS

saltwater bodies, with seasonal fluctuation. However, there is still significant concern about contamination in the estuary.

Salinity

As a transitional zone between fresh and salt water, CBWS has a wide variety of rapidly changing environments, both over space and time. Salinity changes with distance from the river mouths (New River and Rio Hondo), discharging freshwater into the Wildlife Sanctuary into the north-west of the system, with decreasing gradient to the open coastal shelf to the south, opening to the saline waters of the Caribbean Sea. It also fluctuates with changing seasons, wind-driven water flow and rainfall. The health and distribution of conservation targets are linked to these changes, which impact, for example, the distance manatees must travel to reach a freshwater drinking source, affecting their travel patterns. During the rainy season, there is increased freshwater flow from the New River and Rio Hondo watersheds causing salinity levels to decrease. During and after storm events, the coastal lagoons also discharge freshwater into the southern portion of the Wildlife Sanctuary, reducing salinity (Figure 25).

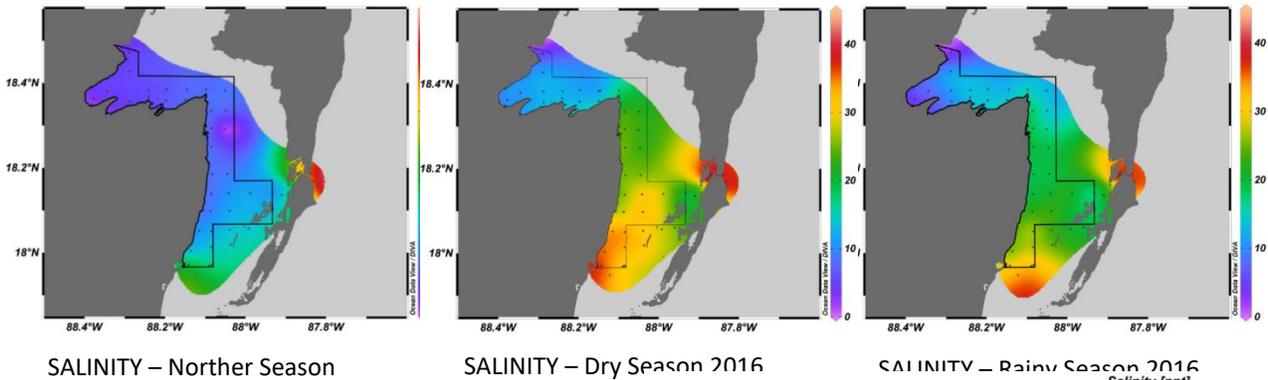


FIGURE 25: SALINITY WITHIN CBWS FOR THE NORTE SEASON (JANUARY), DRY SEASON (MAY) AND RAINY SEASON (AUGUST) 2016 (ODV, SACD DATA, 2017).

A distinct halocline forms during the rainy season, where the New River meets the Wildlife Sanctuary, with the less dense surface waters from the river lying on top of the denser seawater (Figure 26). During the dry season, the more saline estuary waters have a strong influence on the river,

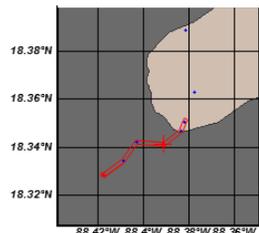
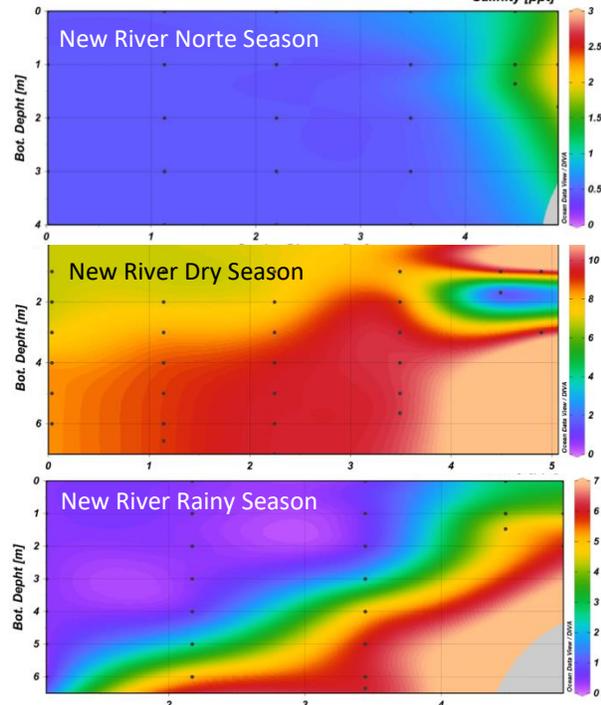


FIGURE 26: SALINITY WITHIN THE NEW RIVER FOR THE NORTE SEASON (JANUARY), DRY SEASON (MAY) AND RAINY SEASON (AUGUST) 2016 (ODV 2017).



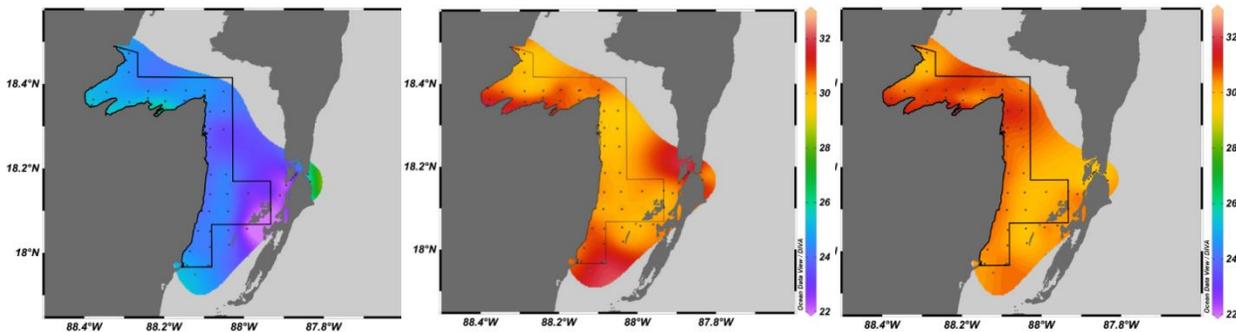
causing salinity to increase over a kilometer up river. In the norté season, salinity drops in the bay and the freshwater from New River flows out into the bay.

Temperature

Water temperature varies seasonally and across years, from an average of 24.5°C in the Norther Season to 30.6°C in the dry season, with more extreme weather events causing greater fluctuation (Figure 27). In general, the dry season and rainy season have the warmest water temperatures, with noticeable cooling throughout the entire bay during the norté season, when cooler rain arrives in cold, frontal systems from the north.

Season	Temperature °C		
	Mean ± SD	Minimum	Maximum
Norté	24.5 ± 0.76	21.9	26.4
Dry	30.57 ± 0.45	29.8	31.9
Rainy	30.50 ± 0.59	29.6	31.9

TABLE 12: TEMPERATURE RECORDS WITHIN THE BAY PROPER (EXCLUDING MEASUREMENTS TAKEN IN RIVERS AND BACALAR CHICO) FOR THE NORTÉ SEASON (JANUARY), DRY SEASON SURVEY (MAY) AND WET SEASON SURVEY (AUGUST), SACD data 2016



Temperature – Norte Season 2016 Temperature – Dry Season 2016 Temperature – Rainy Season 2016

FIGURE 27: TEMPERATURE WITHIN CBWS FOR THE NORTÉ SEASON (JANUARY), DRY SEASON (MAY) AND RAINY SEASON (AUGUST) 2016 (ODV 2017).

During the rainy season, the warm, fresh water from the rivers has a greater influence on conditions throughout the northern portion of the estuary, resulting in higher temperatures (Figure...). In the dry season, the area around the rivers and northern coast are still warm, but the influence from the warmer Caribbean waters can be seen to the south and east of the Wildlife Sanctuary.

Dissolved Oxygen

The productivity of CBWS is tightly linked to the level of dissolved oxygen in the water column, determining the abundance and diversity of organisms that can be supported. The level of dissolved oxygen is also linked to the temperature and salinity, with lower water temperatures and salinities supporting higher levels of

dissolved oxygen, and therefore greater productivity. The mixing of surface waters, such as happens during storm events, will also increase the level of dissolved oxygen in the surface waters.

Dissolved oxygen levels are highest during the norté season, and align with the lowest temperatures and salinity measured, with an average dissolved oxygen level of 7.72 mg/l throughout the bay proper and a high and low of 9.37 mg/l and 6.02 mg/l respectively (Table 13). Using the average temperature and salinity in the bay, the maximum average level of dissolved oxygen the water could hold is estimated at 8.07 mg/l, similar to the average of the 7.72 mg/l measured (Fondriest Environmental Inc. 2013).

Season	Surface Dissolved Oxygen (mg/l)			
	New River Mouth	New River (NEWC)	Rio Hondo Mouth	Rio Hondo (RIO4)
Norté	7.54	2.53	5.02	5.77
Dry	6.83	2.95	6.31	5.50
Rainy	4.56	2.06	4.94	4.58

TABLE 13: DISSOLVED OXYGEN RECORDS WITHIN THE NEW RIVER AND RIO HONDO FOR THE NORTÉ SEASON (JANUARY), DRY SEASON SURVEY (MAY) AND WET SEASON SURVEY (AUGUST) 2016.

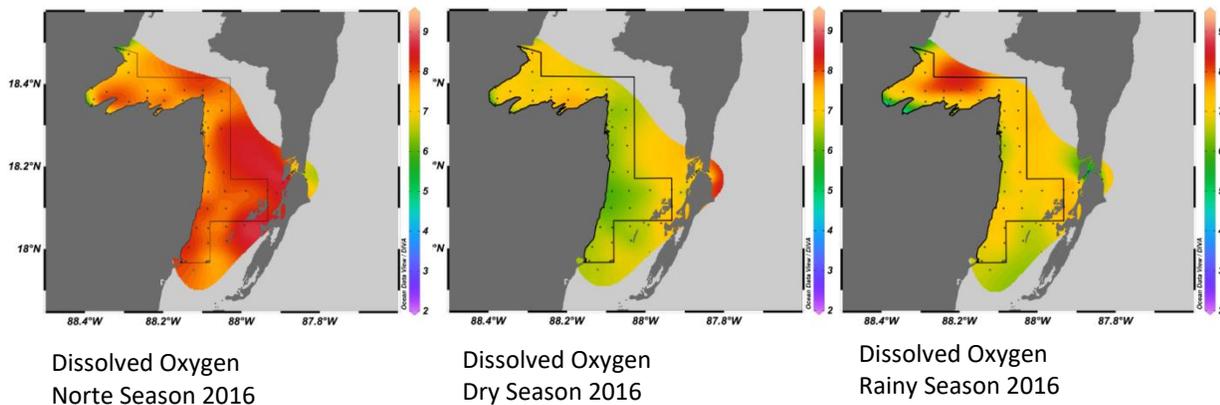


FIGURE 28: DISSOLVED OXYGEN WITHIN CBWS FOR THE NORTÉ SEASON (JANUARY), DRY SEASON (MAY) AND RAINY SEASON (AUGUST) 2016 (ODV 2017).

The dissolved oxygen levels are lower in the dry season in the eastern portion of the bay, with the greatest fluctuation occurring near the river mouths at the surface and at varying depths during the rainy season. This may be attributed to increased runoff from agricultural areas and other sources of pollution entering the river after the first rainfall. In general, the levels of dissolved oxygen remained low throughout the year in the New River, however, there is a steep gradient between the DO content at the river mouth and throughout the estuary proper, where the average DO is 7.11 ± 0.64 mg/l in the rainy season. There is distinct seasonal stratification of dissolved oxygen levels at depth at the mouth of the New River, with a strong stratification/wedge developing at the river mouth in the rainy season, and to a lesser degree in the dry season (Figure 29).

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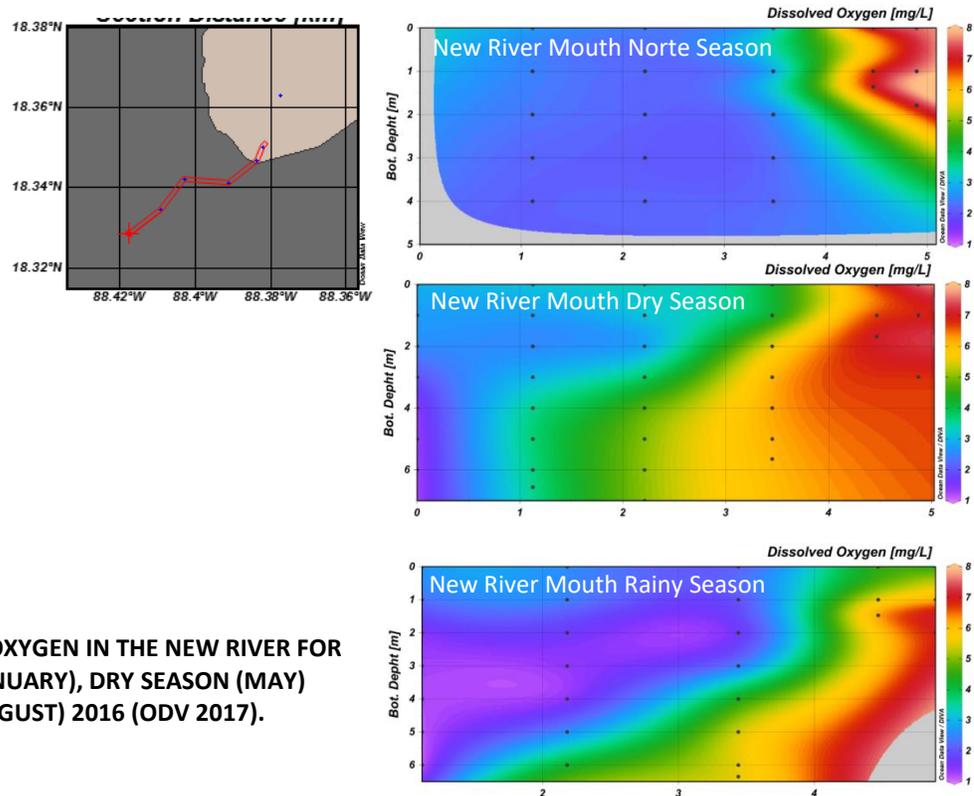


FIGURE 29: DISSOLVED OXYGEN IN THE NEW RIVER FOR THE NORTE SEASON (JANUARY), DRY SEASON (MAY) AND RAINY SEASON (AUGUST) 2016 (ODV 2017).

pH

CBWS acts as a settling basin for the waters flowing from the mainland, through the estuary, and out to the Belize Barrier Reef. The acidity of water can have serious implications on coral health and formation, especially with the global increase in ocean acidification. The pH in CBWS fluctuated seasonally between a minimum of 7.78 in the dry season to a maximum pH of 8.96 in the rainy season (Figure 30).

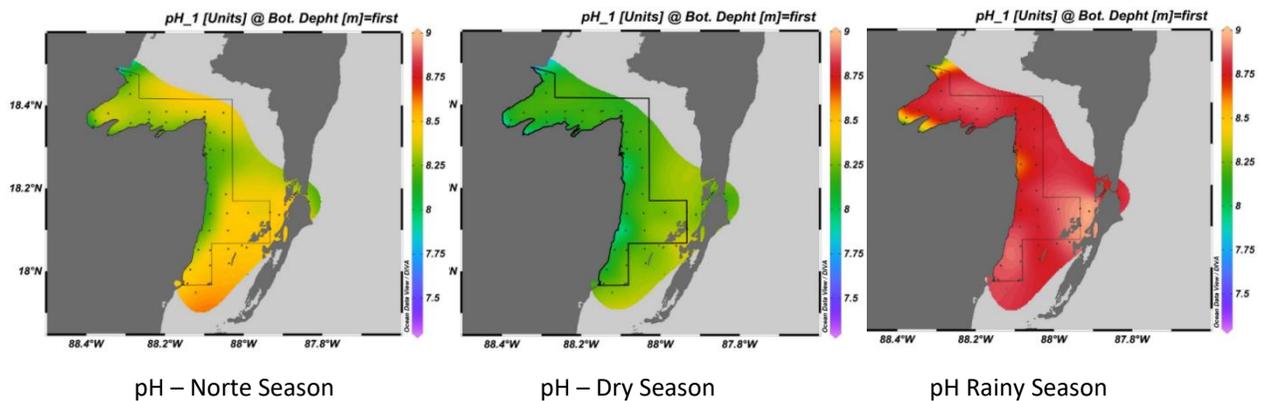


FIGURE 30: pH IN CBWS FOR THE NORTE SEASON (JANUARY), DRY SEASON (MAY) AND RAINY SEASON (AUGUST) 2016 (ODV 2017).

Turbidity

The turbidity or vertical visibility of the water column, is measured using a secchi disk and determines the amount of sunlight that can penetrate the water. This can influence the health and growth rate of seagrass and other aquatic vegetation. CBWS is known for its shallow, turbid environment, particularly when strong winds are stirring up the water, which also makes the use of in water surveys a challenge for monitoring fish species and aquatic vegetation in CBWS.

Turbidity varies across the seasons, with the highest turbidity measured around the mouth of the New River in the dry and rainy season. The lowest turbidity, particularly in the northern portion of the bay, is seen during the rainy season (Figure 31).

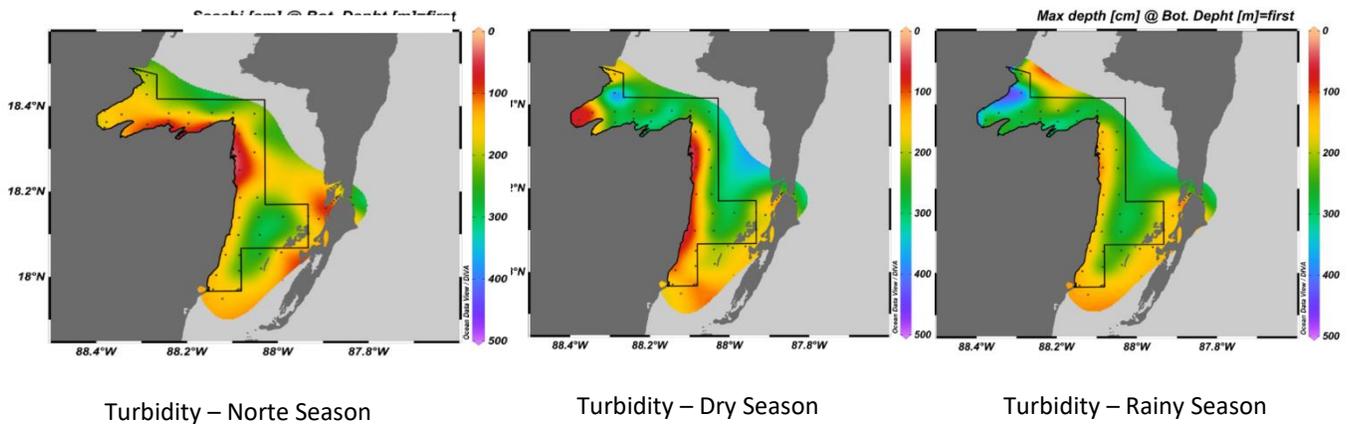


FIGURE 31: TURBIDITY IN CBWS FOR THE NORTE SEASON (JANUARY), DRY SEASON (MAY) AND RAINY SEASON (AUGUST) 2016 (ODV 2017).

1.4.6 Water Quality

SACD has been collaborating with ECOSUR to improve information on water quality in the estuary. Water quality assessment for 2017 and 2018 indicated that water quality was reduced primarily in sites close to human settlements, especially during the dry and rainy seasons. In addition to the water parameters discussed in section 1.4.5, the assessment also included nutrient indicators and Chlorophyll a (Álvarez Legorreta, 2019). Nutrients such as phosphates and nitrites / nitrates form important components of the natural estuarine water quality. Nitrogen is generally the primary limiting nutrient in the higher salinity portions of estuarine systems, where levels control the rate of primary production. If the system is supplied with high levels of nitrogen, algal blooms will occur. Similarly, in systems where phosphorus is the limiting factor, excess phosphorus may also trigger

eutrophic conditions. resulting in poor water quality, reduced oxygen availability, eutrophication and fish kills.

In the following assessment, the nutrient concentrations recorded during the surveys are compared with the Maximum Permissible Limits (MPL) for the protection of brackish and marine aquatic life, established under the Ecological Water Quality Criteria – known by the Spanish acronym ‘CECAs’ in Mexico (SEDUE, 1989). It should be remembered that nitrites and nitrates will fluctuate seasonally, and the analysis provides only a snapshot of conditions, which can be highly influenced by recent weather patterns (e.g. whether there has been rain or not immediately before the sample was taken).

Nitrogen

Nitrogen exists in a variety of chemical (e.g., ammonium, nitrate, and nitrite) and particulate and dissolved organic forms in the estuary environment. Bacteria transform ammonium into nitrite and then to nitrate through nitrification - a biological process that consumes oxygen. In anoxic conditions, where oxygen is not available, denitrification occurs, with bacteria converts nitrate to nitrite and then to nitrogen gas.

Nitrites: The mean annual concentration of nitrites in the Chetumal / Corozal System remained constant in 2017 and 2018 (0.003 mg / l ± 0.004). The wet (August) and norther seasons (November) for both years, presented both demonstrated mean values above the Maximum Permissible Limit (MPL) of 0.002 mg/l, established in the CECAs for the protection of the brackish and marine aquatic life (Álvarez Legorreta, 2019; Table 14).

NITRITES		2017			2018		
System	Statistics	Dry	Wet	Nortes	Dry	Wet	Nortes
Chetumal /Corozal Bay	Mean ± SD	0.002 ± 0.005	0.004 ± 0.004	0.003 ± 0.002	0.002 ± 0.002	0.003 ± 0.004	0.003 ± 0.005
	Min.	0.0001	0.001	0.001	0.0002	0.0001	0.0001
	Max.	0.027	0.016	0.010	0.011	0.015	0.022
	Percentage	16% (5)	50% (16)	32% (10)	25% (8)	35% (11)	32% (10)

TABLE 14. COMPARISON OF THE MINIMUM, MAXIMUM AND MEAN VALUE (± STANDARD DEVIATION) OF NITRITES (MG / L), IN CHETUMAL-COROZAL SYSTEM, 2017-2018 (Álvarez Legorreta, 2019)

The percentage of sites with levels exceeding the CECAs increased were highest in the wet season survey, with 50% of sites in 2017, though this decreased to 35% in 2018. The sites were located in the areas of highest human modification, from Calderitas to the Rio Hondo in Mexico, and Corozal Town to Sarteneja in Belize.

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The number of sites identified with values exceeding the CECAs were lower in the dry season, though increased from 16% in 2017 to 25% in 2018, primarily in front of population centres of Chetumal and Corozal (both shallow areas influenced by rainwater discharges and groundwater mixed with wastewater), and in front of Orchid Bay.

During the Norther season, 32% of sites had values exceeding the CECAs, near Chetumal and extending to the north of the Bay, associated with the resuspension of sediments with high organic matter content, influenced by the strong winds.

Nitrates: The mean annual concentration of nitrates decreased in the estuary from 0.037 mg/l ± 0.057 in 2017 to 0.028 mg/l ± 0.044 in 2018 in the dry and wet seasons (April and August). During the Norte season, however, the pattern reversed, with an increase from 0.012 mg/l ± 0.015 in 2017 to 0.032 mg/l ± 0.045 in 2018 (Table 15).

63% of sites sampled exceeded the CECA MPL of 0.04mg/l – all these sites were located along the west coastline, adjacent to both human settlements and wetlands with high organic contents, suggesting that the high nutrient levels are of both human and natural origin.

NITRATES		2017			2018		
System	Statistics	Dry	Wet	Nortes	Dry	Wet	Nortes
Chetumal /Corozal Bay	Mean ± SD	0.074 ± 0.077					
	Min.	0.002	0.002	0.002	0.002	0.002	0.002
	Max.	0.242	0.169	0.060	0.184	0.155	0.188
	Percentage	63% (19)	13% (4)	3% (1)	19% (6)	9% (3)	22% (8)

TABLE 15. COMPARISON OF THE MINIMUM, MAXIMUM AND MEAN VALUE (± STANDARD DEVIATION) OF NITRATES (MG / L), IN CHETUMAL-COROZAL SYSTEM, 2017-2018 (Álvarez Legorreta, 2019)

Ammonium: The mean annual concentration of ammonium decreased from (0.040 mg / l ± 0.028) in 2017 to 0.031 mg/l ± 0.020 in 2018, though both are above the CECAs MPL of 0.01 mg/l. In 2017, 100% of dry season (April) survey sites and 88% of wet season (August) sites had values above the CECAs MPL. In 2018, this decreased to 66% and 88% respectively. The norther results also showed levels above the CECAs MPL, with 66% of sites in 2017 and 100% of sites in 2018 (Table 16).

The sources of ammonia in the western coast of Chetumal Bay and the northern coast of Corozal Bay are considered to be related to leaking sewage from septic tanks and stormwater runoff, as well as from agricultural areas in the Rio Hondo and New River watersheds. Ammonium on the southern coast of Corozal Bay comes from the surface runoff of wetlands with high organic load.

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AMMONIUM		2017			2018		
System	Statistics	Dry	Wet	Nortes	Dry	Wet	Nortes
Chetumal /Corozal Bay	Mean ± SD	0.043 ± 0.021	0.057 ± 0.034	0.021 ± 0.012	0.034 ± 0.029	0.028 ± 0.016	0.032 ± 0.013
	Min.	0.022	0.022	0.022	0.022	0.022	0.022
	Max.	0.124	0.159	0.058	0.112	0.074	0.060
	Percentage	100% (32)	97% (31)	66% (21)	66% (21)	88% (28)	100% (32)

TABLE 16. COMPARISON OF THE MINIMUM, MAXIMUM AND MEAN VALUE (± STANDARD DEVIATION) OF AMMONIUM (MG/L), IN CHETUMAL-COROZAL SYSTEM, 2017-2018 (Álvarez Legorreta, 2019)

Phosphates

The mean annual concentration of phosphates in the Chetumal/Corozal System increased from 2017 (0.003 mg/l ± 0.003) to 2018 (0.004 mg/l ± 0.002), as a result of the increase recorded during the norte season (November). The mean monthly concentration in the dry (April) and wet seasons (August) decreased or remained unchanged (Álvarez Legorreta, 2019; Table 17).

The majority of sites (75% of sites in April, 2017 exceeded the CECAs phosphate recommended levels for estuarine / brackish water systems, decreasing to 63% in 2018, located primarily in front of Chetumal and Corozal, the Rio Hondo and New River mouths, and along the southern coast of Corozal Bay Wildlife Sanctuary, near Spanish Point. The sources of phosphates are associated with human settlements, superficial runoff of organic load of rivers and wetlands, as well as decomposition of organic matter in the estuarine bed.

PHOSPHATES		2017			2018		
System	Statistics	Dry	Wet	Nortes	Dry	Wet	Nortes
Chetumal /Corozal Bay	Mean ± SD	0.005 ±0.003	0.004 ±0.003	0.004 ±0.003	0.004 ±0.003	0.004 ±0.003	0.004 ±0.003
	Min.	0.001	0.001	0.001	0.001	0.002	0.001
	Max.	0.012	0.010	0.002	0.008	0.017	0.008
	Percentage	75% (24)	53% (17)	0%	63% (20)	66% (21)	53% (17)

TABLE 17. COMPARISON OF THE MINIMUM, MAXIMUM AND MEAN VALUE (± STANDARD DEVIATION) OF NITRITES (MG / L), IN CHETUMAL-COROZAL SYSTEM, 2017-2018 (Álvarez Legorreta, 2019)

Silicates

Silicates are used as tracer indicators of groundwater discharge into surface water bodies, to identify potential sources of contamination of surface water bodies. Silicate concentrations increase as water drains through the soil, it dissolves silicate minerals, increasing the silicate concentration of the water and transporting it to the aquifer (Stewart et al., 2007). These groundwater discharges can contain leachates with high organic content, indicative of inefficient septic tanks and sanitary landfills in human settlement areas.

The average annual concentration of silicates in the Chetumal / Corozal System increased from 2.75 mg/l ± 2.02 in 2017 to 5.44 mg/l ± 2.88) in 2018, thought to be explained by lower rainfall in April and August, 2018, compared to 2017 which favoured the predominance of silicate rich groundwater discharge for these seasons (Table 18).

SILICATES		2017			2018		
System	Statistics	Dry	Wet	Nortes	Dry	Wet	Nortes
Chetumal /Corozal Bay	Mean ± SD	5.80 ±	2.62 ±	2.83 ±	6.28 ±	7.34 ±	2.69 ±
		2.18	0.95	0.57	2.33	2.40	1.37
	Min.	0.98	0.48	1.44	0.74	1.07	0.52
	Max.	9.74	5.11	4.59	10.92	12.74	5.54

TABLE 18. COMPARISON OF THE MINIMUM AND MAXIMUM AND MEN VALUE (± STANDARD DEVIATION) OF SILICATES (MG / L), IN CHETUMAL-COROZAL SYSTEM, 2017-2018 (Álvarez Legorreta, 2019)

The highest concentrations of silicates were recorded at sites where the main groundwater inflows would be found - in front of Chetumal and Corozal, the mouth of the Rio Hondo, New River, and in front of Orchid Bay – all sites with high nitrate, nitrite and phosphorous readings.

Chlorophyll-a

Chlorophyll-a is the green pigment that is responsible for a plant's ability to convert sunlight into the chemical energy needed to fix CO2 into carbohydrates. Measurement is indicative of the phytoplankton abundance and biomass in the estuary, with low levels usually indicative of good conditions and high levels indicating poor water quality. In both years the highest chlorophyll a concentrations (4 to 6 µg/l) were registered in sites located in front of Corozal City, Orchid Bay, Sarteneja Town, where levels of phosphates and nitrites regulated the response of this indicator

CHLOROPHYLL a		2017			2018		
System	Statistics	Dry	Wet	Nortes	Dry	Wet	Nortes
Chetumal /Corozal Bay	Mean ± SD	3.21 ±	1.68 ±	3.46 ±	2.94 ±	3.86 ±	2.15 ±
		1.43	0.83	0.92	1.22	1.04	1.66
	Min.	0.79	0.51	1.99	1.30	2.18	0.00
	Max.	5.99	3.50	5.79	5.44	6.17	5.80

TABLE 19. COMPARISON OF THE MINIMUM AND MAXIMUM VALUE (\pm STANDARD DEVIATION) OF CHLOROPHYLL a ($\mu\text{g/l}$), IN CHETUMAL-COROZAL SYSTEM, 2017-2018 (Álvarez Legorreta, 2019)

The Trophic Index (TRIX) estimates the quality of the water body based on four variables: chlorophyll a, dissolved oxygen, dissolved inorganic nitrogen (nitrites + nitrates + ammonium) and dissolved inorganic phosphorus (phosphates). Outputs rate the condition of the water on four trophic levels:

1. **Oligotrophic:** High quality of unproductive waters,
2. **Mesotrophic:** Good quality of moderately productive waters
3. **Eutrophic:** Poor quality of waters between moderate and highly productive
4. **Hypertrophic:** Poor quality of highly productive waters.

Based on this, water quality is best in the norther season of both years, with more than 60% of the sites demonstrating oligotrophic conditions (high quality). The poorest water quality was recorded in the dry season of 2017 and the wet season of 2018, with approximately 80% of the sites demonstrating mesotrophic and eutrophic conditions. Sites located in front of Chetumal and Corozal, Río Hondo and the New River consistently showed lower water quality, reflecting the discharge of nutrients from Septic tanks and the watersheds (Figure 32).

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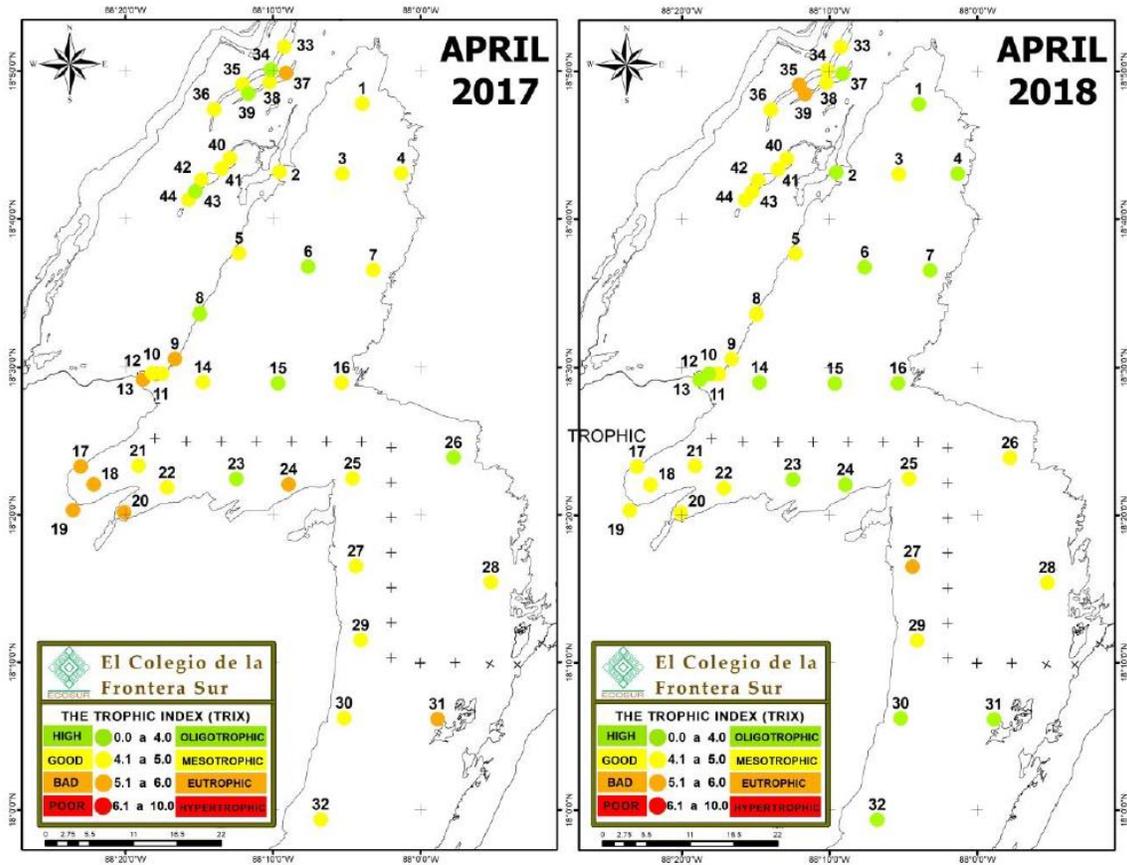


FIGURE 32: DRY SEASON TROPIC INDEX OUTPUTS FOR THE 32 SAMPLING SITES IN THE CHETUMAL / COROZAL BAY ESTUARY (APRIL 2017 AND 2018) (Álvarez Legorreta, 2019)

In the wet season (August) of 2017, poor water quality was associated with the decomposition of organic matter deposited in the sediments, and the surface runoff from nearby wetlands (Figure 33).

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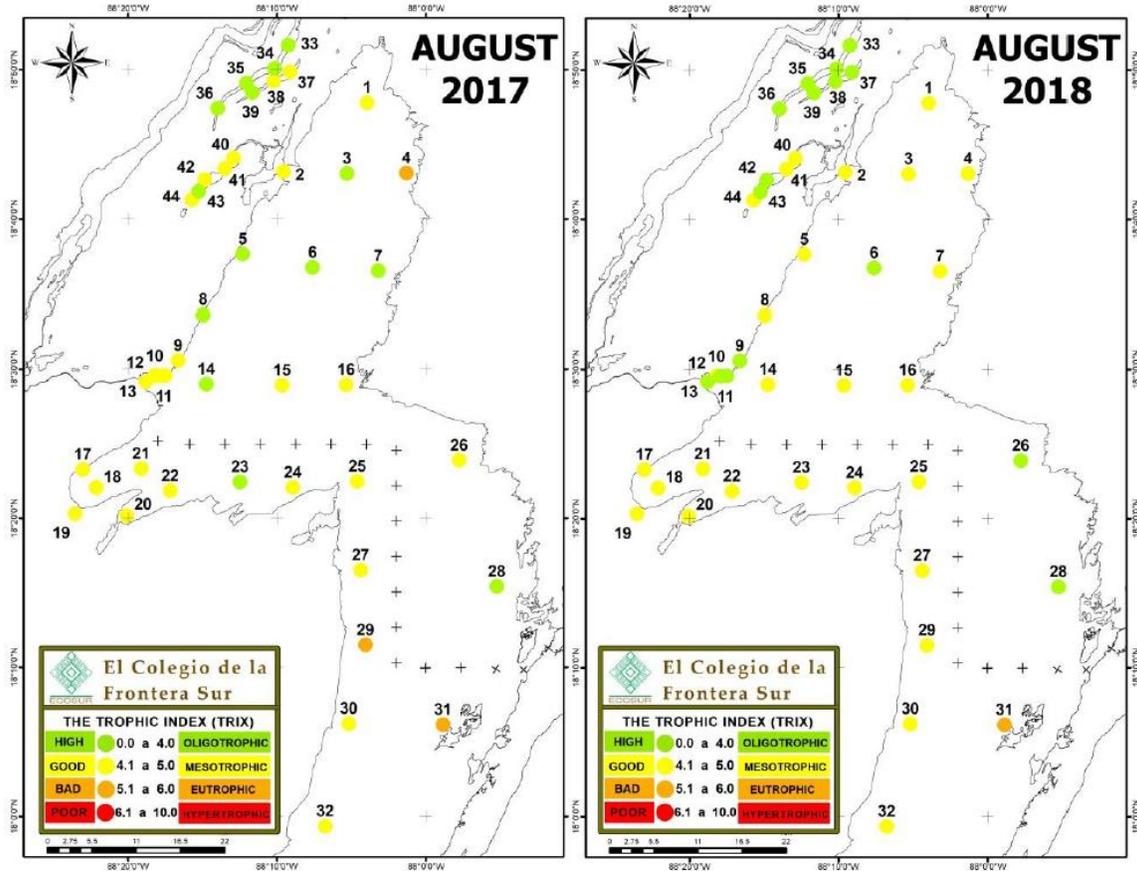


FIGURE 33: WET SEASON TROPIC INDEX OUTPUTS FOR THE 32 SAMPLING SITES IN THE CHETUMAL / COROZAL BAY ESTUARY (AUGUST 2017 AND 2018) (Álvarez Legorreta, 2019)

Overall, the norther season (November) demonstrated the best water quality in the system, but in a number of specific sites, there was a decrease in the trophic condition from 2017 to 2018 (Figure 34).

Two point-sources of contamination were identified:

1. Stormwater discharge potentially mixed with sewage, located at different points along the coastline of the Chetumal and Corozal cities;
2. Discharge of the Hondo and New rivers, with high nitrogen and phosphorus content as a result of the use of fertilizers in the agricultural areas of the Mexico and Belize watershed, as well as by septic tank filtrations of human settlements along the river courses.

Corozal Bay Wildlife Sanctuary – Management Plan 2020-2024

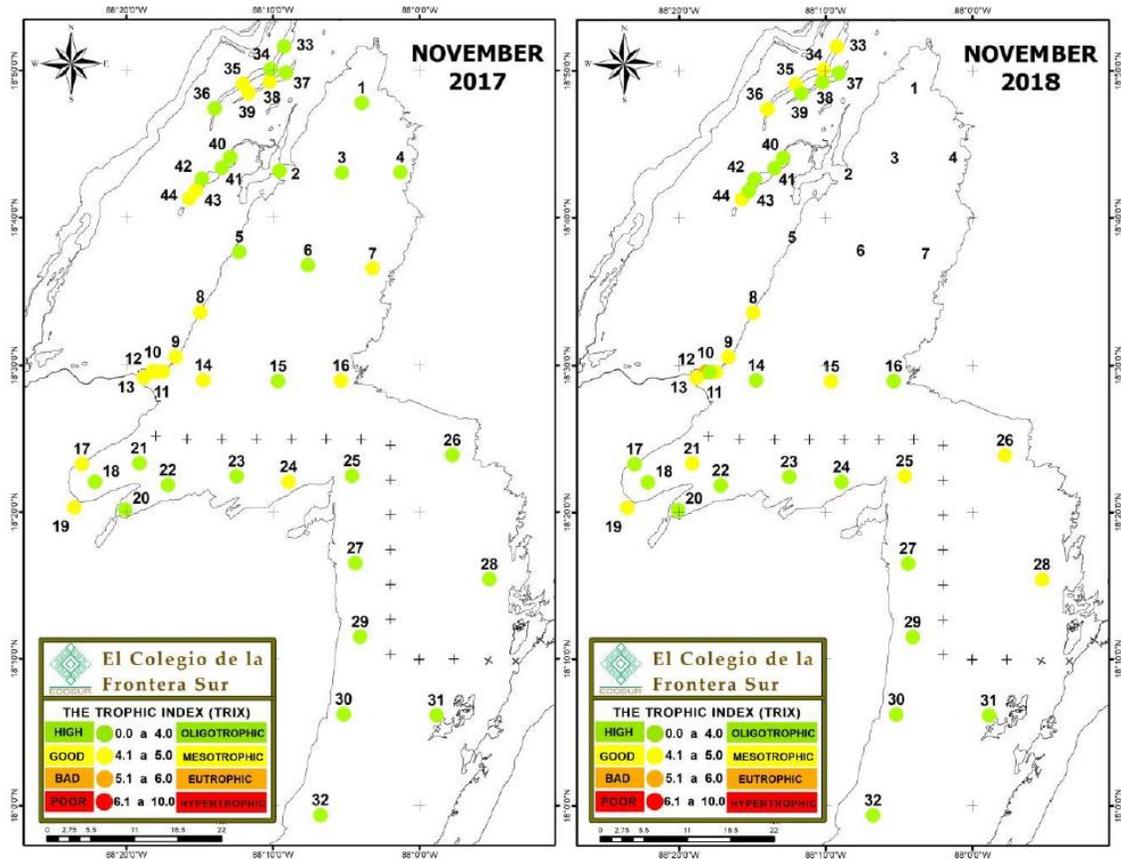


FIGURE 34: NORTHER SEASON TROPIC INDEX OUTPUTS FOR THE 32 SAMPLING SITES IN THE CHETUMAL / COROZAL BAY ESTUARY (NOVEMBER 2017 AND 2018) (Álvarez Legorreta, 2019)

Three non-point sources of contamination were identified throughout the system:

1. Surface runoff along the coastline, predominant during the rainy and northern seasons, that come from the extensive wetlands in southern Belize, and the Rio Hondo and New River watersheds, with agricultural areas with high fertilizer use and farms with animal husbandry where food and manure residues are generated. Urban and semi urban areas (Chetumal and Corozal, and the Calderitas and Sarteneja villages) also contribute, with rainwater carrying waste and pollutants from streets and buildings.

2. Groundwater leaks along the coastline and on the bay bed, with high nutrient content probably due to leachate from septic tanks and open dumps. 55% of the wastewater in Chetumal is managed in septic tanks, with 45% covered by the sanitation system (CAPA, 2019), whilst in Corozal, all wastewater is managed through latrines and septic tanks (Silva, 2015). Solid waste, Both countries have sanitary landfills for solid waste – though with their poor design (including the lack of membranes for retention of leachates) and management, it is more appropriate to refer to them as controlled landfills (Mojica, 2015). The highly permeable karst soil of the region

facilitates the infiltration of leachates from septic tanks and open dumps of towns and smaller communities throughout the watersheds into the aquifer.

3. Atmospheric deposition of nitrogen and phosphorus is also thought to come from gases released from fertilized agricultural soils, and the burning of coal and gasoline (ESA, 1998). The presence of polycyclic aromatic hydrocarbons has also been reported in sediments of the Rio Hondo and Chetumal Bay, derived from the burning of sugar cane in both Mexico and Belize (Alvarez Legorreta, 2014; Alvarez Legorreta and Sáenz Morales, 2005).

1.5 Biodiversity

Corozal Bay Wildlife Sanctuary occupies an important biogeographic position both within Belize, and within Mesoamerica, at the confluence of several major ecological regions – North American, South American and Antillean. This position demonstrates itself in the different elements that make up the land – Yucatan affinities mix with species more often associated with South America. This, along with the heterogeneity of the habitats and protection from major human impacts, leads to this area being one of the most species-diverse in the region.

1.5.1 Ecosystems

Ecosystems of the area fall within the ecosystem category of ‘Coastal and Marine’, a key ecosystem complex prioritized by IUCN for the Mesoamerican region. Whilst the Wildlife Sanctuary itself doesn’t include the coastal vegetation, the land has a major impact on the coastal waters and barrier reef, filtering water that enters the sea through large expanses of dwarf mangrove savannas and fringing mangroves, helping to remove agrochemicals and reducing sedimentation of the sea grass beds and reef. For these reasons, coastal ecosystems are included in this assessment.

Marine Ecosystems

Two key marine ecosystems are represented in CBWS – seagrass and the stromatolite reef, as well as the mud-bottomed estuarine system. The shallow nature of the estuary and oligotrophic conditions of the water, combined with low salinity, high turbidity and anoxic conditions in some sediments anoxia found in the sediments, play a large role in the species able to survive. There are also alterations to the natural ecosystems with the opening of the Zaragoza Canal, increasing the salinity of the bay, and the increasing nitrogen-phosphorus levels due to land-based contamination in areas adjacent to the coastal settlements of Chetumal, Corozal and Sarteneja (Álvarez Legorreta, 2019).

Seagrass

The most important component of marine flora within the protected area is the seagrass, a flowering plant growing in large, *Thalassia*-dominated patches on the shallow seabed, particularly to the south. Seagrass meadows are essential for maintaining the ecological health of the shallow marine ecosystems within the bay, with an important role in nutrient cycling and sediment stabilization.



**THALASSIA TESTUDINUM AND HALODULE WRIGHTII IN
CBWS**

Within Corozal Bay Wildlife Sanctuary, seagrass beds are essential for the maintenance of the West Indian manatee population, and also fill a critical role as a nursery area for many reef fish (including commercial species such as tarpon, hogfish, yellowtail snapper and great barracuda). The primary species is *Thalassia testudinum*, found throughout the Wildlife Sanctuary in densities ranging from sparse to dense. *Halodule wrightii* is found interspersed with the *Thalassia*, particularly in the less saline areas, and in shallow waters. A third species, manatee grass (*Syringodium filiforme*) is reported from the Blackadore Caye, adjacent to the southern end of the Wildlife Sanctuary, and widgeon grass (*Ruppia maritima*) has been reported from the brackish waters of a number of the coastal lagoons. The poor development of the seagrasses in the estuary, particularly in the northern area, is partially a reflection of the unstable sediments, which are stirred up by winds, particularly during the northers. Algae are also important components of the benthic flora. Where the substrate is hard rock rather than mud, the predominant species is *Batophora oerstedii*.

Marine Plant Species of Corozal Bay Wildlife Sanctuary		
Family	Species	Common name
Hydrocharitaceae	<i>Thalassia testudinum</i>	Turtle grass
Cymodoceaceae	<i>Syringodium filiforme</i>	Manatee grass
	<i>Halodule wrightii</i>	Shoal grass
Ruppiceae	<i>Ruppia maritima</i>	Widgeon grass
Dasycladaceae	<i>Batophora oerstedii</i>	
Polyphysaceae	<i>Acetabularia calyculus</i>	Mermaid’s wine glass

TABLE 20: MARINE PLANT SPECIES OF COROZAL BAY WILDLIFE SANCTUARY

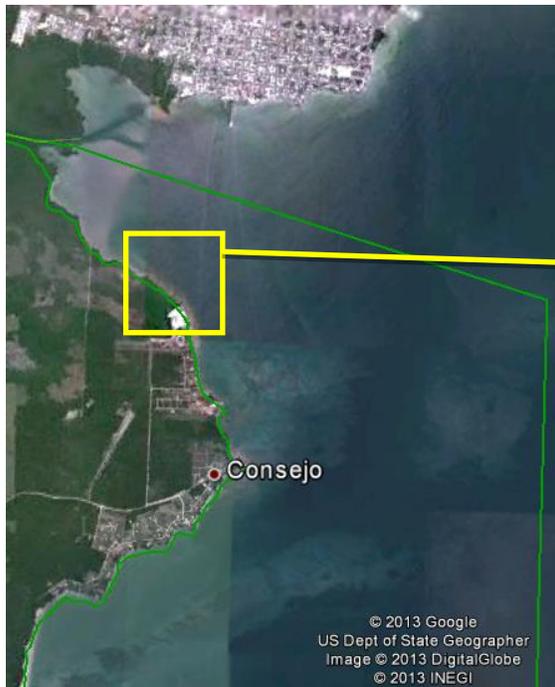
Stromatolite reef of Corozal Bay Wildlife Sanctuary

A 1.5 km stretch of reef-forming stromatolites occurs in Corozal Bay Wildlife Sanctuary, just south of the mouth of the Rio Hondo and the Mexican border (Figure 35). This stromatolite formation is composed of cyanobacteria (primarily of the *Scytonema* genus). Cyanobacteria are very ancient life forms first known from the Precambrian era 3.5 billion years ago, and were the first organisms to build reefs. These bacteria form a living microbial mat on the surface. Underneath this, the subsurface is stratified, representing former surface mats that have solidified to become sedimentary rock - the word “Stromatolite” comes from the Greek for “layered rock”. The Corozal Bay stromatolites are thought to have first become established 2,300 years ago.



**STROMATOLITE REEF AT
LOW WATER, DURING
NORTHER SEASON**

There is only very limited information available on the stromatolite formation, however it is recognized that they are sensitive to the quality of the groundwater and this, coupled with their very slow growth, results in their high vulnerability.



‘Until community awareness of the fragility of these structures is heightened, this ecosystem that has survived 3500 million years is in danger of being destroyed. As a guide to the health of this planet, there can surely be no better measure than this most ancient of all ecosystems.’

Ken McNamara

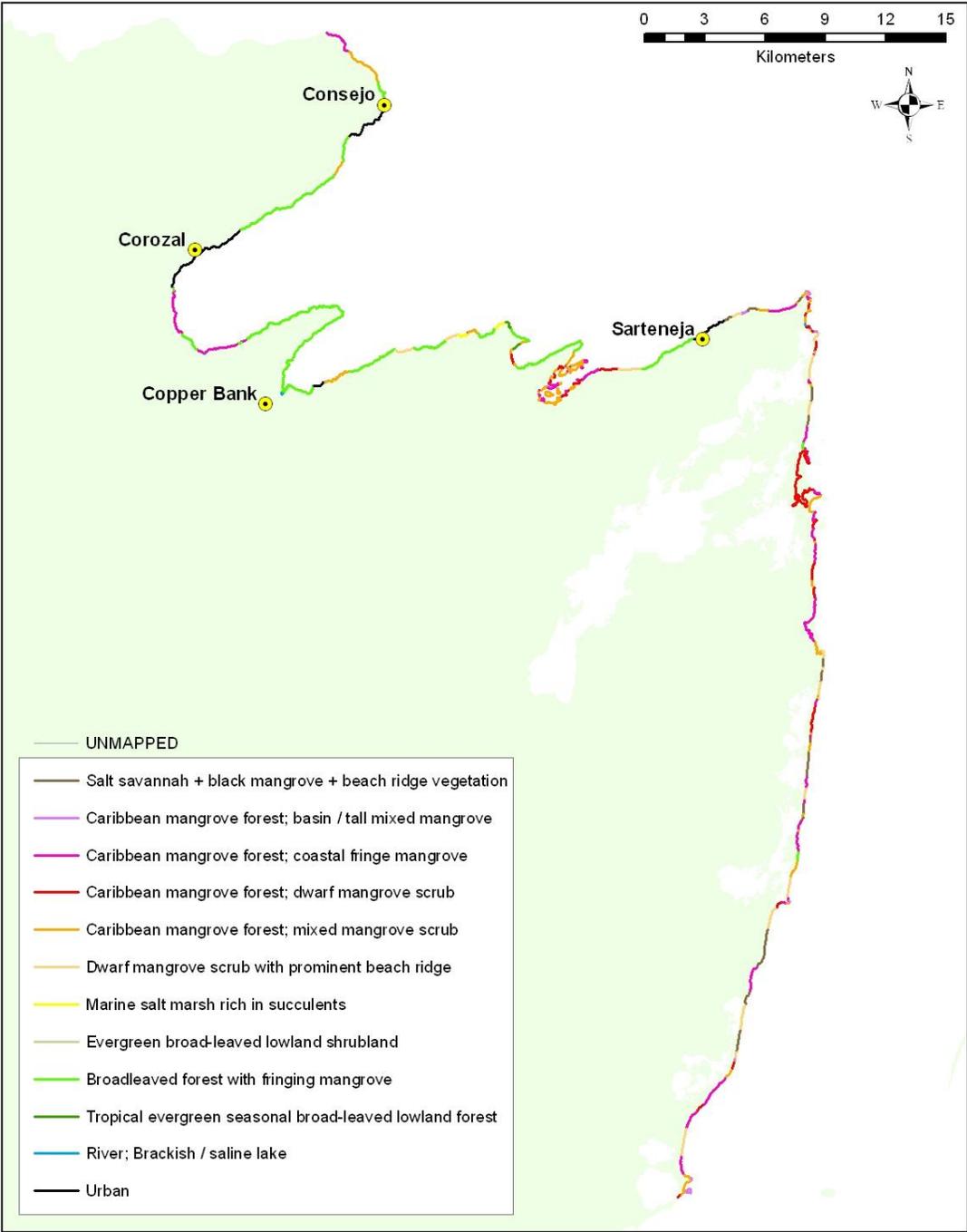
**FIGURE 35: STROMATOLITE FORMATIONS IN
COROZAL BAY WILDLIFE SANCTUARY**

Coastal Ecosystems: Within the coastal survey area, all habitats can be characterized as low-lying and saline with a spectrum running from permanently inundated habitats closer to the sea, to drier ones to the west. Boundaries and distinctions between one and the next are rarely discrete, more often merging together. Definitions and categorization of these habitats and their sub-units are reflected in various mapping work, from the early and comprehensive work of Wright et al (1959) to the most recent by Meerman & Sabido (2001, revised 2017).

Within this coastal survey, the habitats fall largely within 5 of the categories defined by the national ecosystem mapping (Lloyd et al., 2011):

- Dwarf mangrove scrub
- Mixed mangrove scrub
- Marine salt marsh with many succulent species
- Tropical littoral forest and beach communities
- Coastal fringe Rhizophora mangle – dominated forest

Corozal Bay Wildlife Sanctuary: Ecosystems (June 2011)



MAP 4: COASTAL ECOSYSTEMS OF COROZAL BAY WILDLIFE SANCTUARY (Lloyd et al., 2011)

One third of mangrove ecosystems in the Mesoamerican Reef are found in Belize. However, despite its extent, this ecosystem is considered under-represented within the Belize protected areas system, with only 12.9% under protection (Walker et al., 2013). Coastal mangroves of

Corozal Bay Wildlife Sanctuary – Management Plan 2020-2024

northern Belize are highly vulnerable ecosystems, frequently inundated and are predicted to become permanently so with climate change. Much of the mangrove within the NBCC is dwarf mangrove - significantly under-represented (<10% under protection), within the National Protected Areas System. Though Belize legislation prevents the clearing and dredging of mangroves without a permit, lack of enforcement makes it difficult to monitor the loss of mangroves. In the Corozal Bay Wildlife Sanctuary (CBWS), part of the largest estuary of the Mesoamerican Reef system, 90.47% of the coastline ecosystems contains a mangrove component, though 19.35% of this coastal habitat is already impacted by some form of anthropogenic disturbance (Lloyd et al., 2011). As mangroves play an important role in maintaining the health of CBWS, preventing large-scale removal of this habitat is considered a priority. The challenge, however, is that the majority of the coastal mangrove lies outside the CBWS footprint.

Tall riverine mangroves, as found at the mouth of the New River, also has limited protection, with only 11% within the National Protected Areas System. Fringing mangrove, which lines most of the coast of Corozal Bay Wildlife Sanctuary, is also significantly under-represented (12.5%) (Walker et al., 2013)). Despite these low coastal areas having low development potential, they are, never-the-less, at high risk, with the significant global interest in coastal development for both residential and tourism purposes. They are also at risk of inundation from sea level rise associated with climate change predictions for northern Belize.

CBWS / NBCC Indicators

- Extent of littoral forest system
 - % of area in natural condition
 - % of total area of 2004 littoral forest / sandy beaches that is now developed
 - Number of bird colony nesting cayes within the NBCC
-

At the national levels, it is recognized that there is a need for inclusion of greater protection of a representative sample of the northern coastal lagoons, with their critical mangrove areas and nursery functionality for marine species (Walker et al., 2013). This is being partially addressed through the CBWS realignment exercise, under the Fisheries Department MCCAP project. Justifications for this recommendation are as follows (Walker et al, 2013):

- Dwarf mangrove is significantly under-represented within the NPAS (<10%)
- Fringing mangrove is significantly under-represented within the NPAS (12.5%)
- Coastal lagoons and saline mudflats, with associated dwarf mangrove are highly vulnerable ecosystems, frequently inundated and will become permanently so with climate change, and have low development potential
- Inclusion of representative northern coastal lagoons and adjacent mudflats would also increase protection of Marine salt marsh
- Protection of this ecosystem would also protect critical fish nursery areas

It should be noted that the area of mangroves under protection has increased since the 2013 report, with the declaration of the Turneffe Atoll Marine Reserve.

The sheltered nature of the lagoons and the Corozal Bay / Bulkhead Shoals estuary provides ideal conditions for colony nesting birds on mangrove cayes scattered throughout the area. These provide important colony nesting sites for species such as magnificent frigatebirds, brown pelicans, roseate spoonbills, white ibis, reddish egrets, great egrets, boat-billed herons and other species, as well as one of Belize’s most important wood stork nesting colonies lies in Bulkhead Lagoon.

Of particular note is the reddish egret, a species of national and global concern that nests on the mangrove cayes of the Wildlife Sanctuary, and of the coastal lagoons. Realignment of the boundaries to include part of the coastal lagoon system – the northern part of Shipstern Lagoon. This would also protect nesting white ibis, roseate spoonbills, double crested cormorants, great egrets, boat billed and tricoloured herons.

Two distinct saline mudflat habitats are mapped in northern Belize: “dwarf mangrove scrub” and “marine salt marsh with many succulent species”. These can be considered as two ends of a spectrum within a single habitat: saline savanna, within the context of the NBCC. At one end of the spectrum is dwarf red mangrove growing in permanently inundated, sheltered coastal lagoons, in water less than approx. 10 cm deep; at the other end is an open sawgrass savanna, dotted with *Salicornia*, *Distichlis*, an array of other succulent and herbaceous species and occasional specimens of *Laguncularia racemosa* and stunted *Rhizophora mangle*. These two habitats are very distinct, but the two merge in areas as a two species assemblage of sawgrass (*Cladium jamaicense*) and dwarf red mangrove (*Rhizophora mangle*) that does not fit neatly into one category or the other. This overall habitat is that mapped as “saline savanna” by Wright (1959) and later by King et al (1992), and distinguished by King from the coastal fringe habitat.

Dwarf mangrove scrub

Located on the extensive coastal mudflats, this ecosystem is characterized by a single-species stand of stunted red mangrove (*Rhizophora mangle*) with a canopy of between 1m and 1.5m. Mangrove density varies considerably from very sparse to almost impenetrable, and appears to be directly correlated with water level. Areas that are dry for significant periods tend to have a sparse covering; areas that are seasonally inundated tend to be moderately dense, whereas areas that are permanently inundated (usually less than 10cm of inundation) tend to be extremely dense. This ecosystem is found along much of the eastern coastline, behind the coastal ridge.



Mixed mangrove scrub

All three species of mangrove occur on the coastal savannas (*Avicennia germinans*, *Laguncularia racemosa* and *Rhizophora mangle*), along with buttonwood (*Conocarpus erecta*), with a canopy height ranging from 3-6m and an understory of open sawgrass savanna. This ecosystem is found on fractionally more elevated (0.05 – 0.10m) terrain than the dwarf mangrove, in areas that are not permanently waterlogged, but which may be seasonally wet (but rarely inundated) for protracted periods. Many tracts of this habitat type are interspersed amongst the others.



Marine salt marsh with many succulent species

This habitat type is described as highly heterogeneous and containing patches dominated by different species, grouped to indicate one main salt marsh community type (Meerman et al.; 2001). It is typically located in areas that are seasonally partially inundated with brackish waters, and is represented as an assemblage of *Rhizophora mangle* with an often thick ground cover of sawgrass (*Cladium jamaicense*) and interspersed with occasional specimens of white mangrove (*Laguncularia racemosa*), buttonwood (*Conocarpus erecta*), and a few succulents.



Tropical littoral forest and beach communities

In the Corozal Bay area, littoral forest is typically located on a very narrow, higher coastal ridge, free from seasonal inundation, sandwiched between coastal fringing red mangrove (*Rhizophora mangle*) and the habitat behind. It is always usually a minimum of 0.3m above sea level with species less tolerant of the extreme salinities on both the seaward and landward sides. It is more species-rich than the coastal fringe – with black poisonwood (*Metopium brownei*), coastal dwarf bullet tree (*Bucida spinosa*), sea grape (*Coccoloba uvifer*), chit palm (*Thrinax radiata*), seaoxeye (*Borrichia frutescens*), coastal lantana (*Lantana involucrate*) and the introduced coconut



(*Cocos nucifera*). Coastal forests (littoral forests) and beach vegetation (Tropical coastal vegetation on very recent sediments, moderately drained), is considered one of the most vulnerable ecosystems, lying in areas targeted for tourism development. Only 14.4% of this ecosystem is protected in Belize (walker et al., 2013).

Coastal fringe Rhizophora mangle–dominated forest

A narrow single-species belt of red mangrove (*Rhizophora mangle*), located along the coastal beach. It develops in, or immediately adjacent to areas that are permanently waterlogged, with the characteristic stilt roots often projecting several meters into the sea.



Much of the east coast of Corozal Bay Wildlife Sanctuary is fringed with this ecosystem. The width of the mangrove from the landward side to the stilt roots projecting into the open water varies considerably, with *Rhizophora mangle* forming an almost impenetrable barrier in some places, but being relatively open in others. Only 12.6% of coastal mangrove in Belize is under protection.

KEY PLANT SPECIES OF THE CBWS COASTAL STRAND

White mangrove	<i>Laguncularia racemosa</i>	Turpentine shrub	<i>Solanum erianthum</i>
Red mangrove	<i>Rhizophora mangle</i>	Romero	<i>Suriana maritima</i>
Black mangrove	<i>Avicennia germinans</i>	Jaquinia	<i>Jaquinia macrocarpa</i>
Buttonwood	<i>Conocarpus erecta</i>	Cow-horn orchid	<i>Myrmecophila tibicinis</i>
Hulub	<i>Bravaisia berlandieriana</i>	Tillandsia	<i>Tillandsia sp.</i>
Black poisonwood	<i>Metopium brownei</i>	Casuarina	<i>Casuarina equisetifolia</i>
White poisonwood	<i>Cameraria latifolia</i>	Red fowl	<i>Sphinga platyloba</i>
Gumbolimbo	<i>Bursera simaruba</i>	Coastal madre de cacao	<i>Sophora tomentosa</i>
Spiny bulletwood	<i>Bucida spinosa</i>	Sword grass	<i>Juncus marginatus (?)</i>
Sapote	<i>Manilkara zapota</i>	Salt marsh sawgrass	<i>Distichlis spicata</i>
Zericote	<i>Cordia dodecandra</i>	Sedge	<i>Fimbristylis littoralis</i>
Sea grape	<i>Coccoloba uvifera</i>	Passionflower	<i>Passiflora foetida</i>
Chit palm	<i>Thrinax radiata</i>		
Sea ox-eye	<i>Borrchia arborescens</i>		
Canelita	<i>Gymnopodium floribundum</i>		

TABLE 21: PRELIMINARY LIST OF KEY PLANT SPECIES OF THE COASTAL STRAND

1.5.2 Mammals of Corozal Bay Wildlife Sanctuary

Mammal Species of the Corozal Bay Wildlife Sanctuary

Antillean Manatee	<i>Trichechus manatus manatus</i>
Bottlenose Dolphin	<i>Tursiops truncatus</i>
Northern Raccoon	<i>Procyon lotor</i>
Neotropical river otter	<i>Lontra longicaudis</i>

Corozal Bay Wildlife Sanctuary has two species of marine mammal recorded within its boundaries – the Antillean manatee (*Trichechus manatus manatus*) and the bottlenose dolphin (*Tursiops truncatus*) (Table 22). Northern raccoons (*Procyon lotor*) use the mangroves and coastlines, and

TABLE 22: MAMMAL SPECIES OF CBWS

local reports of the presence of the Neotropical river otter (*Lontra longicaudis*) suggests this species may venture into the mouths of the New River / Rio Hondo, where they flow into the estuary. This species is also reported from the more northerly coast of Sanctuario del Manati, to the north of the border with Mexico.

Belize is considered to be the stronghold for the Antillean manatee in the region (Quintana-Rizzo et al., 2010), with a population of between 700 – 1000, based on a maximum national population count of 507 manatees in 2012 (CZMAI, 2014). Whilst the global Antillean manatee population is estimated at 6,700, it is genetically fragmented, and the Mesoamerican sub-population (ranging from southern Mexico to

Priority Manatee Areas in Belize

- **Corozal Bay area** and Rio Hondo (including Four Mile Lagoon)
- a 25km radius around **Belize City** (including the Belize and Sibun Rivers and the cays).
- **Southern Lagoon** including Quashie Trap Lagoon
- **Placencia Lagoon**
- **Indian Hill Lagoon**
- **Port Honduras** (including Deep River and Seven Hills Lagoon)

Panama) is estimated at only 2,350 (Quintana-Rizzo, et al. 2010). Threats to the population have increased significantly in recent years – thought to be primarily from increasing incidences of watercraft collisions. Belize has witnessed a significant increase in manatee mortalities over the last 9 years with more than 270 manatees reported as stranded from 2010 to the end of 2018, (Galves, 2015; Galves pers. com., 2016, Galves pers. com., 2019), annual verified mortalities increasing from 18 in 2010, rising to 49 in 2018 (Galves, 2015; Galves pers. com., 2019). Over the same timeframe (2010 – 2018), there has been a 600% increase in the number of live strandings requiring rehabilitation (Walker pers. obs., 2018). Much of this increase is considered to be associated with the increasing tourism-related boat traffic.

The Forest Department (Ministry of Agriculture, Fisheries, Forestry, the Environment and Sustainable Development) is the national authority responsible for protection of the Antillean manatee in Belize. This sub-species is globally endangered, based on a predicted decline of more than 20% over the next two generations (IUCN, 2018; Deutsch et al., 2008), and is protected in Belize under the Wildlife Protection Act (1982), with inclusion in the schedule of protected

species. Corozal Bay Wildlife Sanctuary is one of three protected areas established specifically for their contribution towards the maintenance of a viable population of manatees at both national and regional levels. These three Wildlife Sanctuaries are all areas with extensive seagrass, available freshwater and space with sheltered, secluded waters, resulting in a high probability of animal presence.

At the lower Belize population estimate of 700 individuals, the 2018 mortality represents a 7.0% mortality of the national population, higher than the 5% level that population modelling indicates to be sustainable (Castelblanco et al., 2012). With the opening of another cruise ship port in November 2016, with all its land-based tours scheduled to be accessed by boat through another high density manatee area at the mouth of the Placencia Lagoon, conservation planning based on best available data indicates the potential for significant increased additional mortality (Walker et al., 2015).

Data on causes of manatee mortality demonstrate that throughout Belize, manatees face increasing anthropogenic threats (Galves, 2015):

- Watercraft collision fatalities
- Alteration and destruction of habitat e.g. by tourism activities or dredging
- Entanglement in fishing gear/ Incidental catch through poor fishing practices
- Illegal Hunting/Poaching
- Natural and man-made factors (e.g. agrochemical pollution)

The highest verified known cause of stranding is from watercraft collisions (Figure 36). Other causes include poaching, hunting, and drowning, as well as perinatal deaths (defined as occurring in the period around the time of birth from 5 months before to 1 month after). However, the majority of deaths remain undetermined.

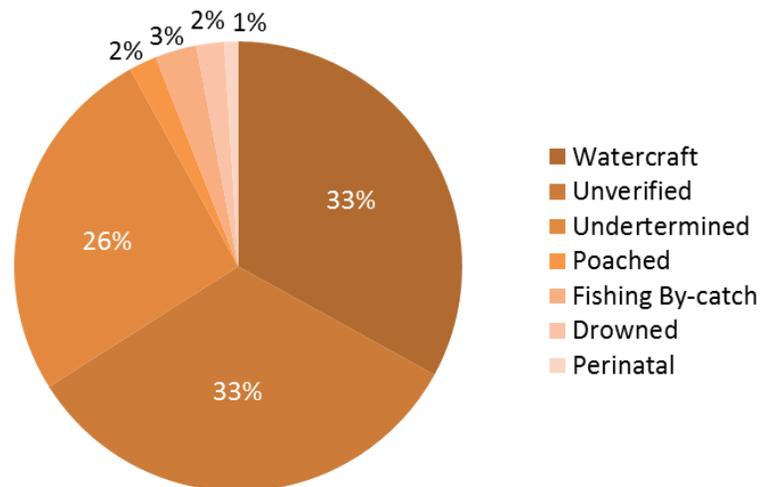
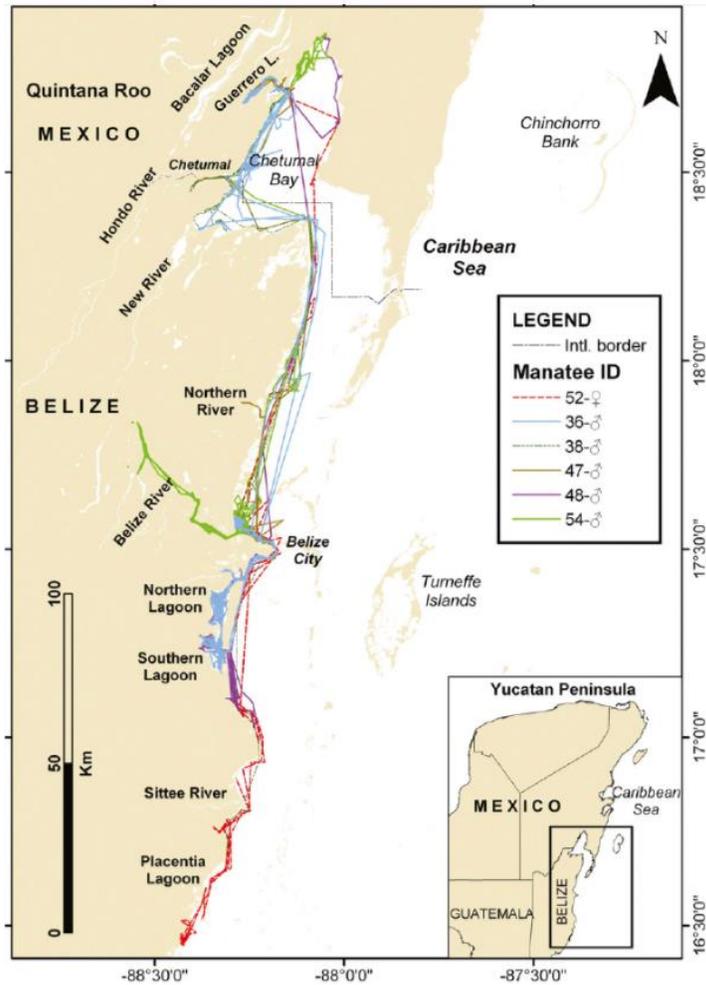


FIGURE 36: BELIZE MANATEE STRANDING DATA (LIVE AND DEAD) 2010 - 2014 (GALVES, 2015)

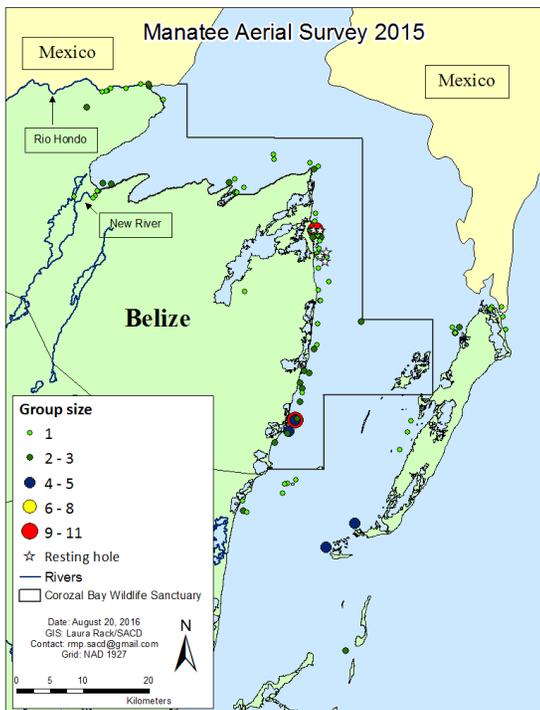
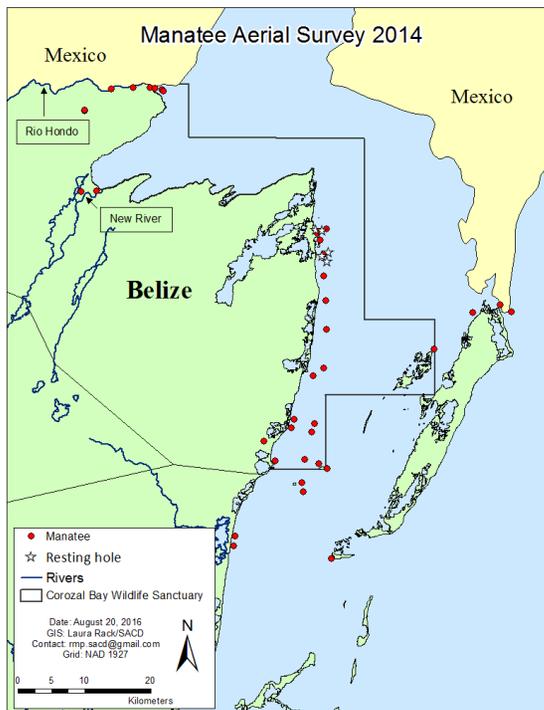
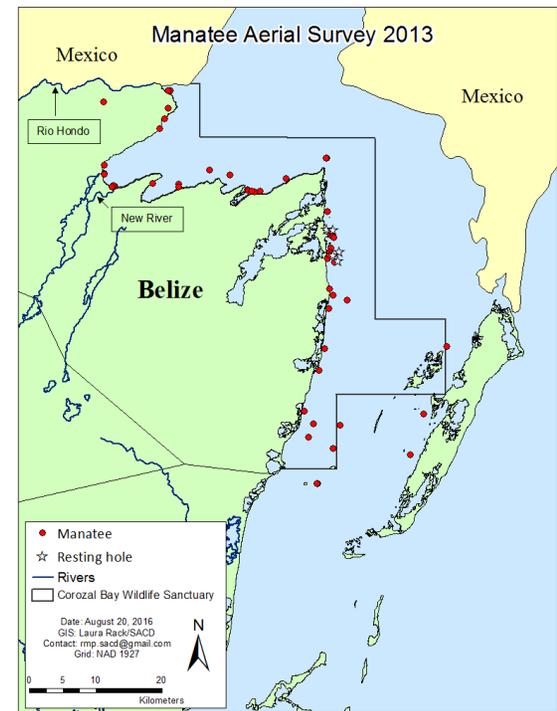
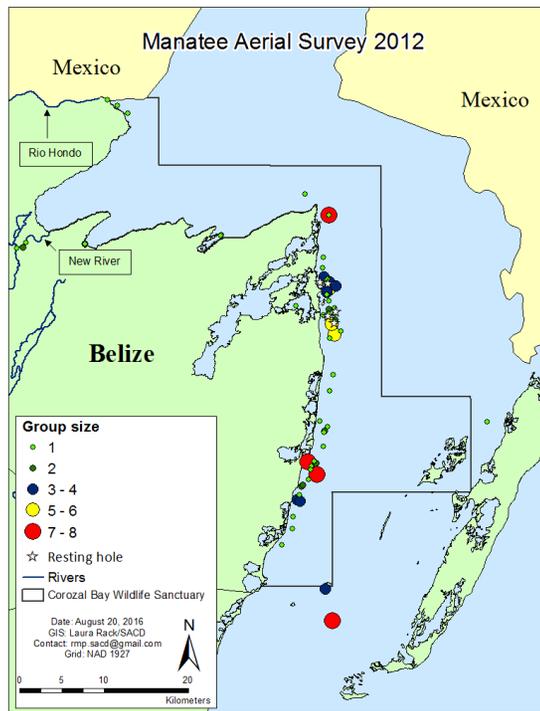
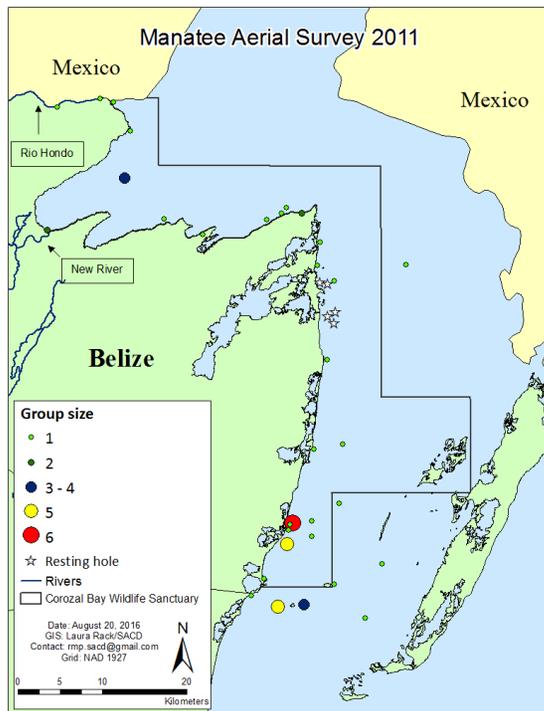
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Corozal Bay and the contiguous Chetumal Bay have consistently been highlighted as a priority transboundary area for manatees. The estuarine system is very shallow with numerous coastal lagoons and inlets, localized areas of seagrass beds, and scattered deeper ‘holes’ with cold-water



upwellings in the seabed. These habitats make the area important for feeding and resting of manatees. The estuary was estimated to have an average population of 49 adults and 1 calf in 1994/1995 (Morales-Vela *et al*, 2000). SACD has conducted annual aerial surveys from 2011 to 2017, with geo-referenced locations for all manatee sightings, to provide in depth information on the manatee population and distribution in the Wildlife Sanctuary (Figure 38). Six years of annual surveys demonstrate an average of 50-52 sightings per survey, with a maximum count of 70 animals, suggesting that the Wildlife Sanctuary has a population in the region of 100 animals (SACD data, 2011 – 2017), though this may vary seasonally, as animals travel along the coastline in both Belize and Mexico (Figure 37; Castelblanco *et al.*, 2013)

FIGURE 37: LONG DISTANCE TRACK LINES FROM SIX ANTILLEAN MANATEES TAGGED IN CHETUMAL BAY (CASTELBLANCO-MARTINEZ ET AL., 2013)



SACD and Wilttracks greatly value their collaborative partnership with LightHawk - making a difference in North East Belize

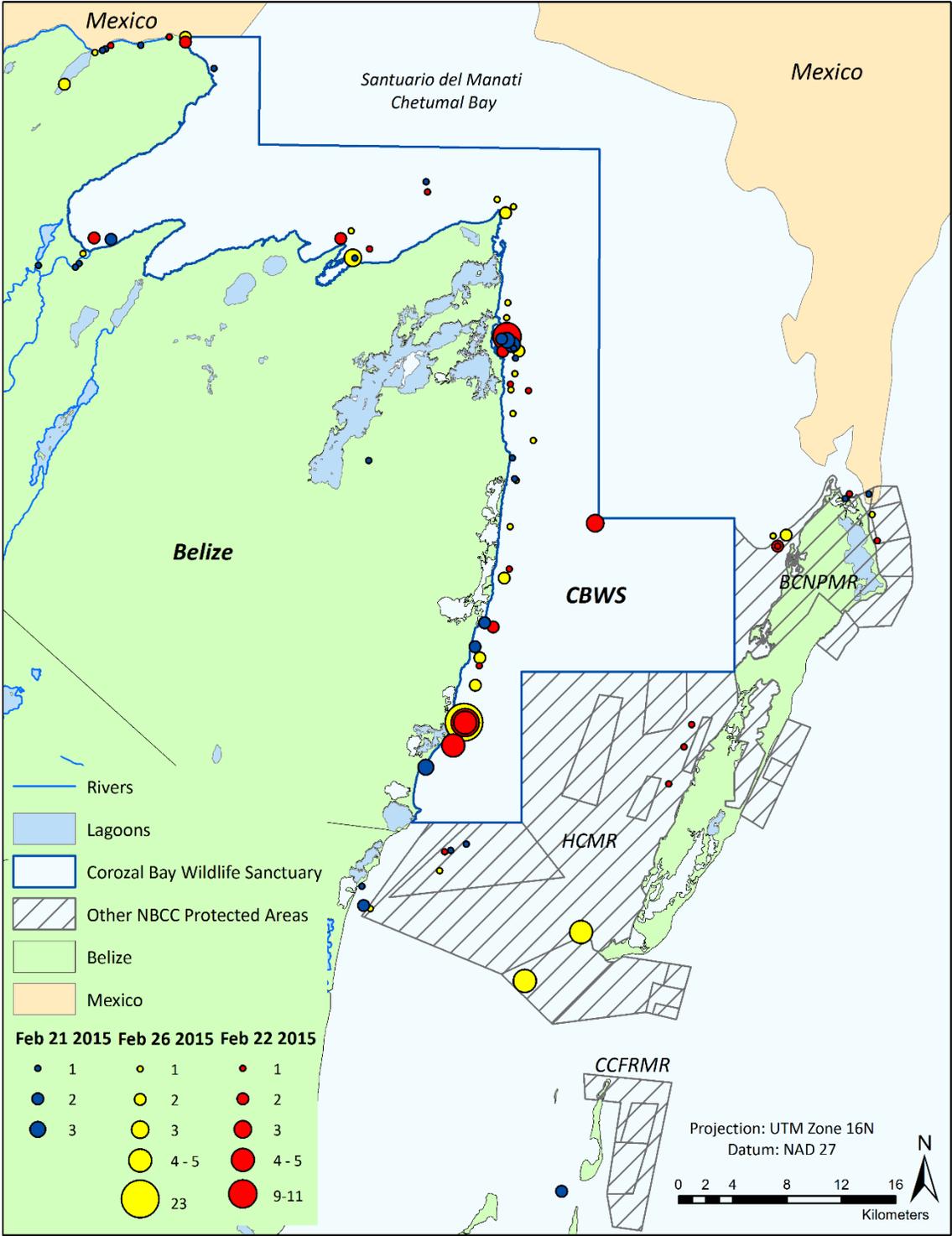
LIGHTHAWK

Lighthawk partners with conservation groups in the US, Canada, Central America and Mexico to employ flight to protect land and water for people and nature.

Lighthawk Mission: To accelerate conservation success through the powerful perspective of flight.

FIGURE 38: AERIAL SURVEY OUTPUTS, 2011 – 2015 (SACD / WILDTRACKS data)

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MAP 5: RESULTS FROM AERIAL SURVEYS CONDUCTED DURING THE NORTE SEASON, 2015 (SACD / WILDTRACKS data)

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Of the 178 manatees sightings over the 2011 - 2015 surveys of the NBCC seascape (CBWS, BCMR and HCMR), the majority (71%) were observed in CBWS, with 60% on the east coast of CBWS and 11% in the northern portion. However this may have been partly due to poor water clarity in the northern portion of the Wildlife Sanctuary during the surveys, resulting in low observations in the north and potentially low population estimate. Manatees were also recorded from rivers and coastal lagoons (7%), from Hol Chan Marine Reserve (10%), and Bacalar Chico Marine Reserve (6%) with a further 6% recorded in non-protected waters of the NBCC (Figure 39).

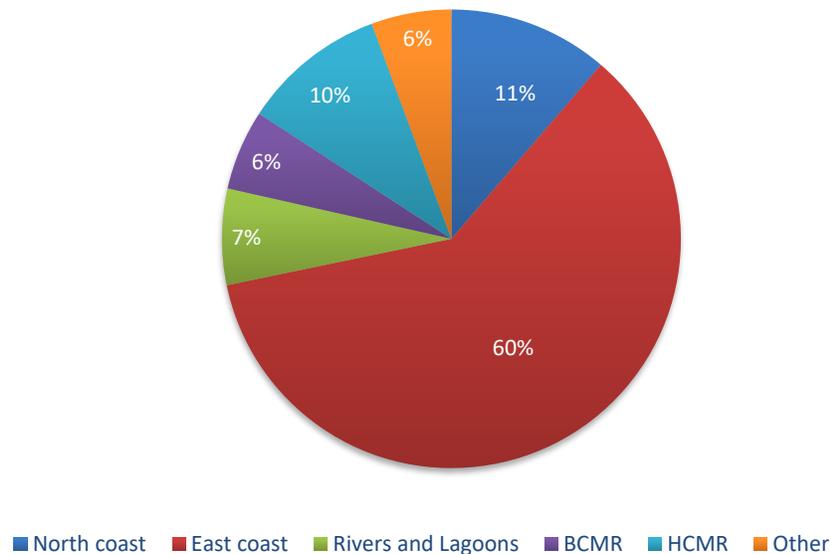


FIGURE 39. MANATEE SIGHTING DISTRIBUTION BY AREA FOR 2015 NORTH SEASON AERIAL SURVEY

It is anticipated that Corozal Bay Wildlife Sanctuary will become even more important in the future as threats further south increase, particularly with the increase in tourism-related activities in the Belize City area, resulting in increased boat activity and dredging, which may lead to manatees migrating further north towards Corozal Bay to escape such pressures.

A series of interviews conducted with fishermen and fishing families of Sarteneja, the primary stakeholder user of CBWS, showed a high level of knowledge on many aspects of the manatee, with 96% of respondents considering manatees important to Belize, and all respondents aware that manatee should no longer be hunted. Of the 78 people interviewed, only 2 had not seen a manatee and 74% had observed manatees in Corozal Bay. 11 of these interviewees had also caught manatees in the past for consumption, though all respondents agree that currently, manatee are not currently hunted by the community (Chan, 2007).

1.5.3 Fish of Corozal Bay Wildlife Sanctuary

Corozal Bay Wildlife Sanctuary supports near-shore estuarine species with tolerance for brackish / fresh water. Whilst the high temperatures generated in the shallow waters, and the reduced salinity prevent coral and coral reef communities establishing within the area, the shallow bays and inlets of Corozal Bay Wildlife Sanctuary provide an important protected nursery habitat for a variety of fish species common to the shallow coastal lagoons and estuaries of the Mesoamerican area. This includes six species of global concern (Table 23). The fish trap data provides information on the key commercial species and by-catch, but additional information is also available from other surveys. Fourteen species are regularly fished from Corozal Bay Wildlife Sanctuary for commercial or home-use purposes (Table 24), with stone bass (the striped and yellowfin mojarra), snapper (grey, lane and mutton), and barracuda, considered preferred fish species in the communities, and key targets for fishery management. The mojarra are present all year round, but the snapper are seasonal, moving into the bay with the first storms of the wet season in June / July. The area is also important for snook, which enter the lagoon systems in large numbers in September / October to January. The mangrove-lined coastal lagoons are critical spawning and nursery areas for many of these species. The structure of the lagoon systems, with narrow creeks linking them to the sea and each other, has led to unsustainable fishing practices, with nets set illegally across the creeks, catching the fish as they try to enter the lagoon to spawn.

Fish Species of International Concern of CBWS

Critically Endangered

Goliath Grouper	<i>Epinephelus itajara</i>
Smalltooth Sawfish	<i>Pristis pectinata*</i>

Endangered

Hammerhead Shark	<i>Sphyrna mokarran</i>
------------------	-------------------------

Vulnerable

Hogfish	<i>Lachnolaimus maximus</i>
Mutton Snapper	<i>Lutjanus analis</i>
Cubera Snapper	<i>Lutjanus cyanopterus</i>
Tarpon	<i>Megalops atlanticus</i>

TABLE 23: FISH SPECIES OF INTERNATIONAL CONCERN (IUCN, 2017)

* POTENTIALLY LOCALLY EXTINCT

Common Name	Local Name	Species Name
Horse eye jack	Jurel	<i>Caranax latus</i>
Crevalle jack	Jurel	<i>Caranx hippos</i>
Atlantic spadefish	La Vieja	<i>Chaetodipterus faber</i>
Striped mojarra	Chiwa	<i>Eugerres plumieri</i>
Yellowfin mojarra	Mojarra	<i>Gerres cinereus</i>
Blue Striped Grunt	Chac chi	<i>Haemulon sciurus</i>
Mutton Snapper	Pargo	<i>Lutjanus analis</i>
Grey snapper	Pargo	<i>Lutjanus griseus</i>
Lane snapper	Pargo	<i>Lutjanus synagris</i>
White Mullet	Mullet	<i>Mugil curema</i>
Striped Mullet	La Lisa	<i>Mugil cephalus</i>
Cero	La Ciera	<i>Scomberomonis regalis</i>
Great Barracuda	Picuda	<i>Sphyrnaea barracuda</i>
Mayan Cichlid	Xpinta	<i>Cichlasoma urophthalmus</i>

TABLE 24: SPECIES FISHED REGULARLY FROM COROZAL BAY WILDLIFE SANCTUARY (FISH TRAP DATA, 2011)

A rapid assessment of the Deer Caye (Cayo Venado) area was conducted in 2009 (Walker et al., 2009). This area is considered an important shallow-water nursery area with a series of narrow, shallow channels

dissecting low cayes, lined with fringing and inundated dwarf mangroves, and was studied in identifying the yellowfin mojarra (*Gerres cinereus*), grey snapper (*Lutjanus griseus*) and bonefish (*Abula vulpes*) as the most abundant species in the area. The bonefish, important for the fly-fishing tourism sector, tends to prefer shallow coastal waters, and was seen in large numbers (>500 individuals). All were juvenile, suggesting that this is an important nursery area, supplying the Bulkhead Shoal flats, favoured by the San Pedro sport fishermen. Bonefish are protected under Belize Fisheries Department regulations, with only catch and release fishing permitted. Also highlighted within the Deer Caye survey was the importance of the lower section of the mangrove-lined creek as a spawning area, with an extremely high density of fry and fingerlings. Large numbers of juvenile yellowfin mojarra, locally important as a commercial species, were also present further up the creek, as were Mayan cichlids (*Cichlasoma urophthalmus*), more frequently thought of as a freshwater / brackish water species.

Throughout the Deer Caye area, fish density was highest associated with limestone bedrock with its algal growth (*Batophora oerstedii*), and with the sparse seagrass patches (turtle grass (*Thalassia testudinum*) and shoal grass (*Halodule wrightii*). The exceptions are the shallow waters of the west-facing bays, which provide ideal habitat for the common southern stingray (*Dasyatis americana*), peacock flounder (*Bothus lunatus*), and chequered pufferfish (*Sphoeroides testudineus*).

At least five shark species are reported as present within Corozal Bay Wildlife Sanctuary, with bull sharks (*Carcharhinus leucas*) blacktip sharks (*C. limbatus*), nurse sharks (*Ginglymostoma cirratum*) and bonnethead sharks (*Sphyrna tiburo*) reported from the Wildlife Sanctuary (Bonfil, 1997) - particularly from the channels that dissect the Bulkhead Shoals area to the southern end of the Wildlife Sanctuary, and southeast of Deer Caye. Presence of bull sharks and nurse sharks have been confirmed during aerial surveys of the area (SACD / Wildtracks 2011 – 2015), and from beach trap catch monitoring. The channels in the Bulkhead Shoals area are thought to be important as a nursery area for these Elasmobranchs, and recent surveys have highlighted the presence of the only documented bull shark nursery in Belize (Figure 40; Graham, 2011).

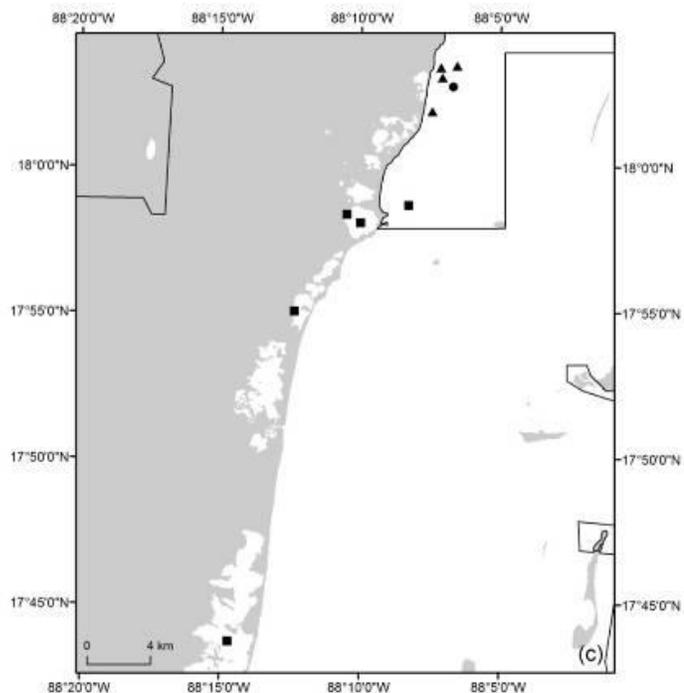


FIGURE 40. DISTRIBUTION OF CAPTURES OF SHARKS, *CARCHARHINUS LEUCAS* (▲) AND RAYS, *HIMANTURA SCHMARDAE* (●) AND *DASYATIS GUTTATA* (■) THROUGHOUT THE SPANISH POINT AND COASTAL LAGOON REGION (GRAHAM, 2010).

Bull sharks are a broadly distributed species found in the coastal and estuarine tropics and subtropics. Capable of tolerating a broad range of salinities from freshwater to the open sea (Thorsen, 1971), bull sharks are more vulnerable than most elasmobranch species due to its coastal and riverine habitats preferences and localized extirpations have been recorded in Nicaragua (Thorsen, 1982). With very late age at maturity (14-15 years for males and 18+ years for females (Branstetter and Stiles, 1987), longevity estimated at least 27 years and a low natural mortality of 0.166 year⁻¹ (Smith et al., 1998), bull sharks are highly vulnerable to exploitation. Pregnant females and juveniles prefer shallow coastal and estuarine areas with warm water, similar conditions to those encountered near Spanish Lagoon and nearshore coastal areas where the five individuals were captured. The size ranges of the bull sharks captured suggests that the animals were between 2-4 years old based on size birth of 56-81 cm (Compagno, 1984) and a conservative growth estimate of 16 cm a year during the first two years of life (Branstetter and Stiles, 1987).



A JUVENILE BULL SHARK (*CARCHARHINUS LEUCAS*) CAPTURED AND TAGGED WITH A CONVENTIONAL SPAGHETTI TAG PLACED AT THE BASE OF THE FIRST DORSAL FIN. BULL SHARKS ARE PAN-GLOBALLY DISTRIBUTED AND CONSIDERED NEAR THREATENED AND A SPECIES OF CONCERN DUE TO NOTED DECLINES IN ABUNDANCE IN SEVERAL COUNTRIES.

There are three criteria to be met for an area to be identified as a nursery (Heupel et al., 2007): (1) sharks are more commonly encountered in the area than other areas; (2) sharks have a tendency to remain or return for extended periods; and (3) the area or habitat is repeatedly used across years. It is thought that the Spanish Point area serves as an elasmobranch hotspot. No similar captures of bull sharks have been made during other surveys undertaken cross the previous five years in other parts of Belize by Graham and her team (Graham, 2010).

Juvenile Bonnethead sharks have also been caught in the Wildlife Sanctuary in the past (Walker, pers. com.), suggesting that they, too, have used the area for breeding. Recent DNA analysis has shown that whilst this hammerhead species looks like other bonnetheads, it may well be part of a fragmented group that stopped breeding with bonnetheads from the Bahamas, Mexico and the United States several million years ago. Since then, the group has accumulated enough genetic differences to warrant classification as a unique species (Champion, 2016).

Aerial surveys consistently highlight Corozal Bay Wildlife Sanctuary, especially the Spanish Point area and associated coastal lagoons, for the presence of numerous rays of three species, longnose stingray (*Dasyatis guttata*), southern stingray (*Hypanus americanus*) and the Caribbean whiptail stingray (*Himantura schmardae*). All three are prey for a range of sharks and are fished historically in Belize for shark bait, and as a substitute for shark meat as sharks become less common, though they are now protected under Belize's fisheries legislation. All are 'data deficient' (IUCN, 2019), with little information

available on their life habits, but are vulnerable to over-exploitation. The low reproductive rate makes the species highly vulnerable to overexploitation from fisheries and other impacts to their reproductive success as they are biologically incapable of replacing themselves rapidly.

The life cycle of this ray includes birth in relatively fresh water, migration to more saline waters and then occupation of areas with variable salinities as adults. A mixture of juvenile and adult longnose rays surveyed in the Spanish Point area and lagoons suggest that these are important for this species at its different life stages. The mixture of sizes further suggests that the lagoons serve as potential pupping grounds as large females were found inside the lagoons where the salinity is lowest, a key variable noted in pupping grounds in Brazil (Yokota and Lessa, 2000) and also recorded in the Placencia Lagoon (Graham, 2006). This little known species is often found on muddy bottoms and near mangroves, and has a tolerance for the broad salinity ranges of the estuarine environment during different stages of its lifecycles. Reaching up to 2 m in disc width, with females growing larger than males, longnose stingrays feed mainly on benthic invertebrates and small fish (Froese et al., 2010). Females can bear a litter of 1–2 pups every 5-6 months in March and November in Brazil (Yokota and Lessa, 2000), with similar seasonality in Belize (Graham, unpublished data).

Similar to the longnose stingray, the Caribbean whiptail stingray, it is thought that the nearshore coastal areas function as critical nursery habitats for the pups and young of the year. Although Caribbean whiptail rays and longnose stingrays seem to occupy a similar ecological niche and some overlap, there is a degree of segregation based on the substrate and life histories with young Caribbean whiptail stingrays preferring shallow mud and seagrass bottoms and sub-adults and adults of both sexes broadly distributed in areas with sandy and seagrass bottoms either close to the coast or near the barrier back reef and patch reefs.

Belize has become one of the most popular destinations for recreational fishing, important for its contribution to the country's revenues and employment. In particular, catch-and-release fishing for bonefish (*Albula* spp.), permit (*Tachinotus falcatus*), and tarpon (*Megalops atlanticus*) was estimated to have contributed approximately BZ \$ 56.5 million during 2007 in direct, indirect, and induced effects on the gross domestic product of Belize, and supporting employment in the industry (Fedler and Hayes 2008). Corozal Bay is known as a sport fishing area, with bonefish (*Albula vulpes*), permit (*Trachinotus falcatus*), tarpon (*Megalops atlanticus*), common snook (*Centropomus undecimalis*) and crevalle jack (*Caranx hippos*) all being targeted. Previously unregulated fishing, however, is thought to have severely reduced populations below former levels. Bonefish, tarpon and permit are all protected under Belize legislation.

1.5.4 Birds of Corozal Bay Wildlife Sanctuary

Corozal Bay is known to support numerous wetland birds, with small mangrove cayes, shallow water and areas of high vegetation providing nesting and foraging habitat. A number of bird surveys have been conducted over the years under SACD, Wildtracks and Blue Ventures, and by professional birders using e-bird, that show a range of species restricted to the open estuarine environment of CBWS (such as brown pelicans and magnificent frigatebirds), and others restricted to littoral forest or mangrove habitat, such

as the Clapper Rail (*Rallus longirostris*) and mangrove warbler, with a reliance on mangrove forest that makes them so sensitive to land use change for development in coastal areas.

CBWS TARGET INDICATOR SPECIES

- Blue winged Teal
- Lesser Scaup
- White Winged Dove
- American Coot
- Spotted Sandpiper
- Sandwich Tern
- Magnificent Frigatebird
- Neotropic Cormorant
- Double Crested Cormorant
- Anhinga
- Brown Pelican
- Great Egret
- Great Blue Heron
- Snowy Egret
- Little Blue Heron
- Tricolored Heron
- Reddish Egret
- Green Heron
- Boat-billed Heron
- White Ibis
- Roseate Spoonbill
- Black Vulture
- Osprey
- Tropical Kingbird
- Mangrove Swallow
- Tropical Mockingbird
- Black Catbird
- White-winged Dove
- Mangrove Warbler
- Great-tailed Grackle

SACD monitors a total of 30 waterbird / coastal bird species during surveys, and whilst an exhaustive species list has not yet been developed for the specific area, previous surveys by Wildtracks, SACD, and professional birders have contributed to an initial list of birds reported from the estuary and associated coastal vegetation (Table 17). Corozal Bay Wildlife Sanctuary is one for four locations included in the Central American Waterbird Census conducted by Belize Audubon Society. Site surveys during the migratory season demonstrated that the Wildlife Sanctuary and coastal lagoons host large numbers of waterfowl, with up to 8,000 Lesser Scaup recorded in a single raft (and a total of over 21,550 counted during the survey) along with large rafts of American coots, and flocks of blue winged teal, interspersed by other migrants (BAS, 2019).



TABLE 25: CBWS TARGET INDICATOR SPECIES

MANGROVE CAYES IN CBWS PROVIDE NESTING SITES FOR SOLITARY AND COLONY NESTING BIRDS, INCLUDING HERONS, EGRETS, CORMORANTS, FRIGATEBIRDS AND PELICANS

A number of nesting colonies are located within or adjacent to the Wildlife Sanctuary. The two small mangrove cayes of Cayo Falso provide the sheltered structure for a large magnificent frigatebird and

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pelican colony, with cormorants and great egrets, reddish egrets, roseate spoonbills, white ibis and boat billed herons also utilizing the cayes. Little Guana Caye, established as a bird sanctuary under the National Lands Act, in 1977, for the presence of the largest nesting colony of reddish egrets in the Caribbean and is also known to have nesting white ibis (*Eudocimus albus*), tricolored herons (*Egretta tricolor*), roseate spoonbills (*Platalea ajaja*) (Kramer et al., 2002) and boat-billed heron (*Cochlearius cochlearius*).

These colony nesting species are charismatic and a major tourism attraction to the area. When disbursing to feed, they populate not only the shallow coastal lagoons, and those of Deer Caye, but also those of Bacalar Chico National Park / Marine Reserve and are thought to travel as far inland as Crooked Tree Wildlife Sanctuary (established for its rich waterbird population), providing an important tourism resource. Because of the fragility of large breeding colonies such as these, these species appear on the national list of species of concern (Meerman, 2005; draft), and any increase in tourism and boat activity in the area should take into consideration their requirements for minimal disturbance for nesting success during the nesting season.

American White Pelicans (*Pelecanus erythrorhynchos*), while not observed during the survey period, are seen occasionally in January in groups of 6-10 (Z. Walker, pers. com.; SACD, 2019). Although still uncommon in Belize, sightings have been increasing in coastal areas north of Belize City over the past two decades (Jones, 2003).

The coastal savannah and forests area an important resting location or even overwintering ground for several species of Neotropical migratory warbler, vireo and other terrestrial species, with the density of migrants found to be highest in the black mangrove stands (Gomez-Montes and Bayly, 2009). The Yucatan Peninsula is highlighted as an important flyway for migrants crossing the Gulf of Mexico, with an estimated 14 to 20 million individuals passing through north-east Belize in the 2007 southward migration (Gomez-Montes and Bayly, 2009), including the Near Threatened olive-sided flycatcher (*Contopus cooperi*), golden-winged warbler (*Vermivora chrysoptera*) and painted bunting (*Passerina ciris*). Sixty-three species of migratory landbirds were recorded at Wildtracks, near Rocky Point, including a number of species of concern in the United States - the prothonotary warbler (*Protonotaria citrea*), willow warbler (*Empidonax traillii*), and small numbers of wood thrush (*Hylocichla mustelina*), bay-breasted warber (*Dendroica castanea*), Kentucky warbler (*Oporornis formosus*) and Canada warbler (*Wilsonia canadensis*). In general, migrants showed a preference for forested and mangrove habitats whilst avoiding open habitats such as savanna – forest clearance in stopover areas is therefore expected to have an adverse effect on migratory success (Bayly et al., 2008). Migrants also showed a preference for disturbed forest habitats, edge vegetation and more open ecosystems (Table 26).

Habitat	Total # Species	# Migrant Species	# Resident Species	Threatened / Endemic Species
Black Mangrove	71	17	54	6
Salt Marsh	50	10	40	5
Semi-deciduous disturbed forest	60	11	49	6

TABLE 26: SPECIES RICHNESS OF KEY COASTAL HABITATS IN THE CBWS AREA (GOMEZ-MONTES AND N. BAYLY, 2009)

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The large expanse of dwarf mangrove and mud flats provide feeding areas for many waders, both migrant and resident, and the low mangroves support large numbers of nesting white-winged doves (*Zenaida asiatica*). The Black Catbird (*Melanoptila glabrirostris*), a Yucatan endemic, is also limited primarily to coastal areas along the northern coast, and is threatened by development of coastal areas and conversion of adjacent ecosystems for agriculture (Jones et al., 2001). While it is locally common in the Corozal Bay area, its restricted range keeps total numbers low.

COASTAL BIRD SPECIES OF COROZAL BAY WILDLIFE SANCTUARY

SPECIES		ABUNDANCE AND SEASONAL STATUS
Blue-winged Teal	<i>Spatula discors</i>	c, T/W
Lesser Scaup	<i>Aythya affinis</i>	u l, T/W
Pied-billed Grebe	<i>Podilymbus podiceps</i>	u l, T/W
Least Grebe	<i>Tachybaptus dominicus</i>	u/f l, P
Plain Chachalaca	<i>Ortalis vetula</i>	u l, P
White-crowned Pigeon	<i>Patagioenas leucocephala</i>	u, V
White-winged Dove	<i>Zenaida asiatica</i>	v, T/W
Mangrove Cuckoo	<i>Coccyzus minor</i>	u, P
Vaux's Swift	<i>Chaetura pelagica</i>	c l, P
Ruddy Crake	<i>Laterallus ruber</i>	c l, P
Clapper Rail	<i>Rallus crepitans</i>	u/c l, P
Sora	<i>Porzana Carolina</i>	U, T/W
Russet-naped Wood-Rail	<i>Aramides albiventris</i>	c l, P
Purple Gallinule	<i>Porphyrio martinicus</i>	u l, P
American Coot	<i>Fulica Americana</i>	u l, P
Limpkin	<i>Aramus guarauna</i>	c l, P
Northern Jacana	<i>Jacana spinosa</i>	f, P
Black-necked Stilt	<i>Himantopus mexicanus</i>	u/c l, P/T/W
Black-bellied Plover	<i>Pluvialis squatarola</i>	c/u, T/W
Collared Plover	<i>Charadrius collaris</i>	u l, P
Semipalmated Plover	<i>Charadrius semipalmatus</i>	f, T/W
Wilson's Plover	<i>Charadrius wilsonia</i>	u/f l, P/W
Killdeer	<i>Charadrius vociferous</i>	u l, P/T/W
Solitary Sandpiper	<i>Tringa solitaria</i>	u/f, T/W
Lesser Yellowlegs	<i>Tringa flavipes</i>	f, T/W
Greater Yellowlegs	<i>Tringa melanoleuca</i>	f, T/W
Willet	<i>Tringa semipalmata</i>	u, T/W
Spotted Sandpiper	<i>Actitis macularius</i>	c, T/W
Ruddy Turnstone	<i>Arenaria interpres</i>	u, T/W
Sanderling	<i>Calidris alba</i>	c, T/W
Least Sandpiper	<i>Calidris minutilla</i>	f/u, T/W
Semipalmated Sandpiper	<i>Calidris pusilla</i>	c, T/W
Western Sandpiper	<i>Calidris mauri</i>	c, T/W
White-rumped Sandpiper	<i>Calidris fuscicollis</i>	u, T
Wilson's Snipe	<i>Gallinago delicate</i>	u/c l, W
Short-billed Dowitcher	<i>Limnodromus griseus</i>	c l, T/W
Long-billed Dowitcher	<i>Limnodromus scolopaceus</i>	u, T/W

COASTAL BIRD SPECIES OF COROZAL BAY WILDLIFE SANCTUARY

SPECIES		ABUNDANCE AND SEASONAL STATUS
Laughing Gull	<i>Leucophaeus atricilla</i>	c l, T/W
Black Tern	<i>Chlidonias niger</i>	u l, T/W
Least Tern	<i>Sterna antillarum</i>	u, T/V
Black Skimmer	<i>Rynchops niger</i>	u, W/V
Forster's Tern	<i>Sterna forsteri</i>	u, W/V
Common Tern	<i>Sterna hirundo</i>	u, T/W
Sandwich Tern	<i>Thalasseus sandvicensis</i>	u/f l, P/T
Royal Tern	<i>Thalasseus maximus</i>	f, T/V
Caspian Tern	<i>Hydroprogne caspia</i>	u, T/V
Magnificent Frigatebird	<i>Fregata magnificens</i>	c l, P
Neotropic Cormorant	<i>Phalacrocorax brasilianus</i>	c l, P
Double-crested Cormorant	<i>Phalacrocorax auritus</i>	f l, P
Anhinga	<i>Anhinga anhinga</i>	u/f l, P
Brown Booby	<i>Sula leucogaster</i>	u/f l, P
Brown Pelican	<i>Pelecanus occidentalis</i>	c l, P
American White Pelican	<i>Pelecanus erythrorhynchos</i>	c l, T/V
Least Bittern	<i>Ixobrychus exilis</i>	u l, P
Bare-throated Tiger Heron	<i>Tigrisoma mexicanum</i>	f, P
Great Egret	<i>Ardea alba</i>	c, T/W
Great Blue Heron	<i>Ardea Herodias</i>	l, P
Cattle Egret	<i>Bubulcus ibis</i>	c, P
Snowy Egret	<i>Egretta thula</i>	f, T/W
Little Blue Heron	<i>Egretta caerulea</i>	f, T/W
Tricolored Heron	<i>Egretta tricolor</i>	f, T/W
Reddish Egret	<i>Egretta rufescens</i>	u l, T/W
Green Heron	<i>Butorides virescens</i>	f l, T/W
Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	u/c l, W
Yellow-crowned Night-Heron	<i>Nyctanassa violacea</i>	u/f l, W
Boat-billed Heron	<i>Cochlearius cochlearius</i>	u l, P
White Ibis	<i>Eudocimus albus</i>	f l, P
Roseate Spoonbill	<i>Platalea ajaja</i>	u l, P
Wood Stork	<i>Mycteria Americana</i>	u/f l, P
Black Vulture	<i>Coragyps atratus</i>	v l, P
Turkey Vulture	<i>Cathartes aura</i>	c l, T/P
Lesser Yellow-headed Vulture	<i>Cathartes burrovianus</i>	u/f l, P
King Vulture	<i>Sarcoramphus papa</i>	f l, P
Osprey	<i>Pandion haliaetus</i>	u l, P
Common Black-Hawk	<i>Buteogallus anthracinus</i>	f, P
Great Black Hawk	<i>Buteogallus urubitinga</i>	u, P
Ringed Kingfisher	<i>Megaceryle torquata</i>	c l, P
Belted Kingfisher	<i>Megaceryle alcyon</i>	f, T/W
Green Kingfisher	<i>Chloroceryle americana</i>	c l, P
American Pygmy Kingfisher	<i>Chloroceryle aenea</i>	u l, P
Yucatan Woodpecker	<i>Melanerpes pygmaeus</i>	u/f l, P
Golden-fronted Woodpecker	<i>Melanerpes aurifrons</i>	c, P
Merlin	<i>Falco columbarius</i>	u, T/W

COASTAL BIRD SPECIES OF COROZAL BAY WILDLIFE SANCTUARY

SPECIES		ABUNDANCE AND SEASONAL STATUS
Peregrine Falcon	<i>Falco peregrinus</i>	u, T/W
Olive-throated Parakeet	<i>Eupsittula nana</i>	f, P
White-crowned Parrot	<i>Pionus senilis</i>	f, P
White-fronted Parrot	<i>Amazona albifrons</i>	c/u l, P
Yellow-lored Parrot	<i>Amazona xantholora</i>	u l, P
Social Flycatcher	<i>Myiozetetes cayanensis</i>	f, P
Great Kiskadee	<i>Pitangus sulphuratus</i>	c, P
Boat-billed Flycatcher	<i>Megarynchus pitangua</i>	f, P
Tropical Kingbird	<i>Tyrannus melancholicus</i>	c, P
Gray Kingbird	<i>Tyrannus dominicensis</i>	u, T/W
Eastern Kingbird	<i>Tyrannus tyrannus</i>	f, T
Yucatan Jay	<i>Cyanocorax yucatanicus</i>	u/f l, P
Brown Jay	<i>Psilorhinus morio</i>	c, P
Purple Martin	<i>Progne subis</i>	c l, T
Gray-breasted Martin	<i>Progne chalybea</i>	c, V
Tree Swallow	<i>Tachycineta bicolor</i>	c, T
Mangrove Swallow	<i>Tachycineta albilinea</i>	c, P
Northern Rough-winged Swallow	<i>Stelgidopteryx serripennis</i>	c, T
Cliff Swallow	<i>Petrochelidon pyrrhonota</i>	c, T/W
Barn Swallow	<i>Hirunda rustica</i>	c, T/W
Long-billed Gnatwren	<i>Ramphocaenus melanurus</i>	f, P
Blue-gray Gnatcatcher	<i>Poliotila caerulea</i>	f, P
Tropical Gnatcatcher	<i>Poliotila plumbea</i>	f, P
Tropical Mockingbird	<i>Mimus gilvus</i>	c, P
Gray Catbird	<i>Dumetella carolinensis</i>	c, T/W
Black Catbird	<i>Melanoptila glabirostris</i>	u/f l, P
Yellow-backed Oriole	<i>Icterus chrysater</i>	u/f, P
Yellow-tailed Oriole	<i>Icterus mesomelas</i>	u/f l, P
Black-cowled Oriole	<i>Icterus prothemelas</i>	c, P
Hooded Oriole	<i>Icterus cucullatus</i>	f, P
Baltimore Oriole	<i>Icterus galbula</i>	c, T/W
Orchard Oriole	<i>Icterus spurius</i>	f, T/W
Orange Oriole	<i>Icterus auratus</i>	u l, P
Altamira Oriole	<i>Icterus gularis</i>	f, P
Melodious Blackbird	<i>Dives dives</i>	c, P
Great-tailed Grackle	<i>Quiscalus mexicanus</i>	c l, P

Legend

v = very common
c = common
f = fairly common
u = uncommon
o = occasional
l = local
X = one or two records only

P = permanent resident
S = seasonal resident
V = visitor
T = transient (migrant)
W = winter resident
F = former resident

Reference: Valley A. C. and Dyer, D. Birds of Central America, Princeton Press, 2018
F. Canto Jr. (pers. com.)

TABLE 27: COASTAL BIRD SPECIES OF COROZAL BAY WILDLIFE SANCTUARY AND ADJACENT COASTAL BELT

1.5.5 Reptiles of Corozal Bay Wildlife Sanctuary

Two crocodile species are found in Belize - Morelet's crocodile (*Crocodylus moreletii*) and the American crocodile (*Crocodylus acutus*). Morelet's crocodile, listed as Least Concern (IUCN, 2019) inhabits primarily freshwater lakes, rivers, and wetlands, as well as brackish lagoons. Over-harvesting for skins in the early 1900s took both species to the edge of local extinction, with hunters from Sarteneja ranging as far afield as Mexico in search of skins (local hunters, pers. com.). A countrywide survey conducted between 2016 and 2019 by the Crocodile Research Coalition (CRC) demonstrated that this species has largely recovered with an estimated population of around 3,000 individuals. However, whilst conservation efforts are still warranted, mitigation of human-crocodile conflict is becoming increasingly important as human encroachment into its habitat continues to increase.

The American crocodile inhabits coastal cayes, estuaries, and brackish water mangrove wetlands, and is currently listed as "Vulnerable" throughout its range (IUCN, 2019). In Belize, however, it is considered Critically Endangered, with only 250 American crocodiles observed during the 1995-1997 countrywide survey, and with encounter rates among the lowest reported for the region (0.28 crocodiles/km surveyed) (Platt and Thorbjarnarson, 2000). More recent surveys suggest that the population may now be between 1,000 and 1,500 (Tellez, pers. com.), though the population status of *C. acutus* in Belize is still considered data deficient, and it is unknown to what extent populations have recovered since the original surveys or how much increased shoreline development and coastal pollution has impacted recovery (Tellez, pers. com.).

Corozal Bay Wildlife Sanctuary is one of a number of sites across Belize currently included in the current country-wide survey of this species by the Crocodile Research Coalition towards establishment of a conservation and management action plan for the species. Initial survey data suggests that the protected areas is good for juvenile, sub-adult, and adult recruitment. The Cayo Falso area, in particular appears to be important for juvenile American crocodiles - juveniles tend to disperse into the inundated mangrove habitat in which they can hide, as they are still vulnerable to predation by predators (large sports fish, sharks, other crocodiles, etc). The mouth of the New River and the habitat around this area were reported to have a high population of sub-adults and a few adults, also found along the coast. This habitat separation allows younger crocodiles to disperse, and hide from older adults that have defined territories, reducing conflict between the different age groups assisting in countrywide population recovery (Tellez, pers. com.).

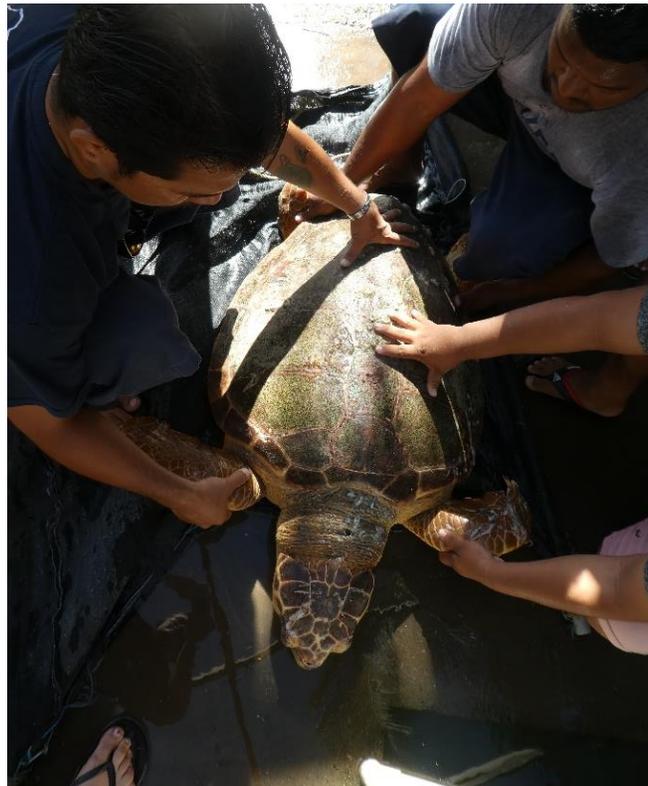
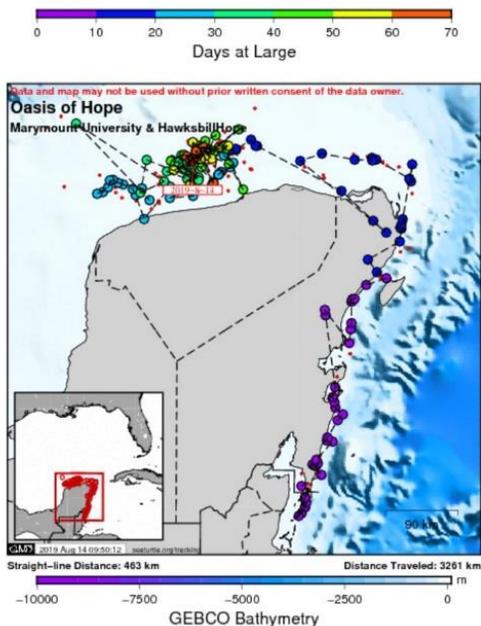
The Laguna Seca / Progreso system appears to be a recruitment area for Corozal Bay Wildlife Sanctuary, with good nesting habitat and juveniles and sub-adults observed. Lobbying for sustainable development in these areas will be important to ensure the population of CBWS remains stable. In Mexico, the conservation status of the American crocodile has recently been downgraded following its successful recovery, and Santuario del Manati is considered to have reached carry capacity for the American

crocodile population in Mexico. It is thought likely sub-adults and adults will begin dispersing further south into Corozal Bay Wildlife Sanctuary (Tellez, pers. com.).

A few crocodiles appear to share both American and Morelet's features, however further analysis would be needed to assess the rate of hybridization. Given the amount of habitat remaining along the coast and at the mouth of rivers and other bodies of fresh water, CBWS may be a location in which Morelet's and American crocs may not hybridize at a high rate compared to southern Belize. This is particularly important for further conservation efforts of the American crocodile. Given that the American crocodile population in southern Belize is low, this immigration from Mexico could assist the recovery of Belize's population (Tellez, pers. com.).

Threats to the crocodile populations include drowning in gill nets as part of bycatch, killing out of fear and as a result of human / wildlife conflict, and development of the high coastal ridges favoured for nesting.

Two of Belize's four species of sea turtle have been observed within the Wildlife Sanctuary during aerial surveys – the critically endangered hawksbill (*Eretmochelys imbricata*) and the endangered loggerhead turtle (*Caretta caretta*) (SACD/Wildtracks data). Recently, a number of turtle strandings have occurred within Corozal Bay Wildlife Sanctuary, with a hawksbill turtle stranding in front of Corozal (R. Rivera, pers. com.), and a loggerhead turtle rescued from one of the Sarteneja beach traps. The loggerhead turtle was



POST-RELEASE TRACKING OF LOGGERHEAD SEA TURTLE FROM COROZAL BAY WILDLIFE SANCTUARY (MAPPING:SEATURTLE.ORG/MARYMOUNT UNIVERSITY & HAWKSBILLHOPE).

released in Hol Chan Marine Reserve, and is currently being tracked by satellite, providing information on the range of this individual. Following release, it headed north into Mexican waters, and has been active in the coastal waters north of Progreso, near Merida, in the Campache Bank / Granville Shoal area. This

species is known to nest from Holbox to southern Belize, and past tracking studies of a female show that she followed a similar activity pattern, settling into the same area north of the Yucatan.

1.5.6 Past and Present Research

Whilst there have been few studies focused on Corozal Bay Wildlife Sanctuary, those that do exist provide important information on the species and ecosystems of the area.

- Morales-Vela B, D. Olivera-Gomez, J. E. Reynolds III, and G. B. Rathbun (2000). Distribution and habitat use by manatees (*Trichechus manatus manatus*) in Belize and Chetumal Bay, Mexico. *Biological Conservation* 95: 67-75
- Castelblanco-Martínez D. N., B. Morales-Vela, H. A. Hernández-Arana and J. Padilla-Saldivar (2009). Diet of the Manatees (*Trichechus manatus manatus*) In Chetumal Bay, Mexico. *Latin American Journal of Aquatic Mammals*: 7(1 – 2): 9 – 46
- Gomez-Montes C. and N. J. Bayly (2009). Habitat use, abundance, and persistence of Neotropical migrant birds in a habitat matrix in northeast Belize. *Journal of Field Ornithology* 81(3):237-251
- Rasmussen K. A., I G. Macintyre and L. Prufert (1993). Modern Stromatolite Reefs Fringing a Brackish Coastline, Chetumal Bay, Belize. *Geology* March, 1993 v. 21, No. 3.
- Mazzullo, S. J., C. S. Teal, W. D. Bischoff, K. Dimmick-Wells And B. W. Wilhite (2003). Sedimentary architecture and genesis of Holocene shallow-water mud-mounds, northern Belize. *Sedimentology* (2003) 50, 743–770

Corozal Bay Wildlife Sanctuary has also been included in a number of wider research studies:

- ECOSUR / Alvarez Legorreta: Transboundary Integral Diagnosis of the Water Quality of the Chetumal/Corozal Bay System, 2017 2018
- Belize Audubon Society: Central American Waterbird Census
- Crocodile Research Coalition: National surveys of American and Morelet’s crocodiles
- Eric Ramos: Dolphin ID
- MAR Alliance: Elasmobranchs

The Mexican side of the estuary, Santuario del Manati, however, has been studied in detail by researchers of El Colegio de la Frontera Sur (ECOSUR) in Chetumal, with the production of a volume of research papers focusing on both physio-chemical and biotic aspects of the estuary, as well as the fishery, water contamination and other threats.

**Corozal Bay Wildlife Sanctuary – Management Plan
2020-2024**

- El Sistema Ecológico de la Bahía de Chetumal / Corozal: Costa Occidental del Mar Caribe.
Editors: J. Espinoza Ávalos, Gerald Alexander Islebe and Héctor Abuid Hernández Arana

1.6 Cultural and Socio-Economic Values

1.6.1 Commercial Fishing

The majority of the commercial users of Corozal Bay Wildlife Sanctuary are fishermen – either fishing for commercial finfish species for sale, or involved in the sport fishing industry. A baseline has been developed for the traditional finfish fishermen, considered the primary users of the marine resources. Fish trap data, a socio-economic survey of Sarteneja (the focal community of this plan) and community consultations with fishermen of Sarteneja and the other stakeholder communities, have provided extensive information on targeted fish species and fishing activities within Corozal Bay Wildlife Sanctuary.

An estimated 33 to 35 fishermen are considered to be dependent or largely dependent on the small scale fishery of Corozal Bay Wildlife Sanctuary (Table 28). The majority of these (50% +) are from Sarteneja, with the highest dependency, followed by Chunox and Copper Bank, whilst those from Corozal and Consejo have greater opportunities for employment in other areas.

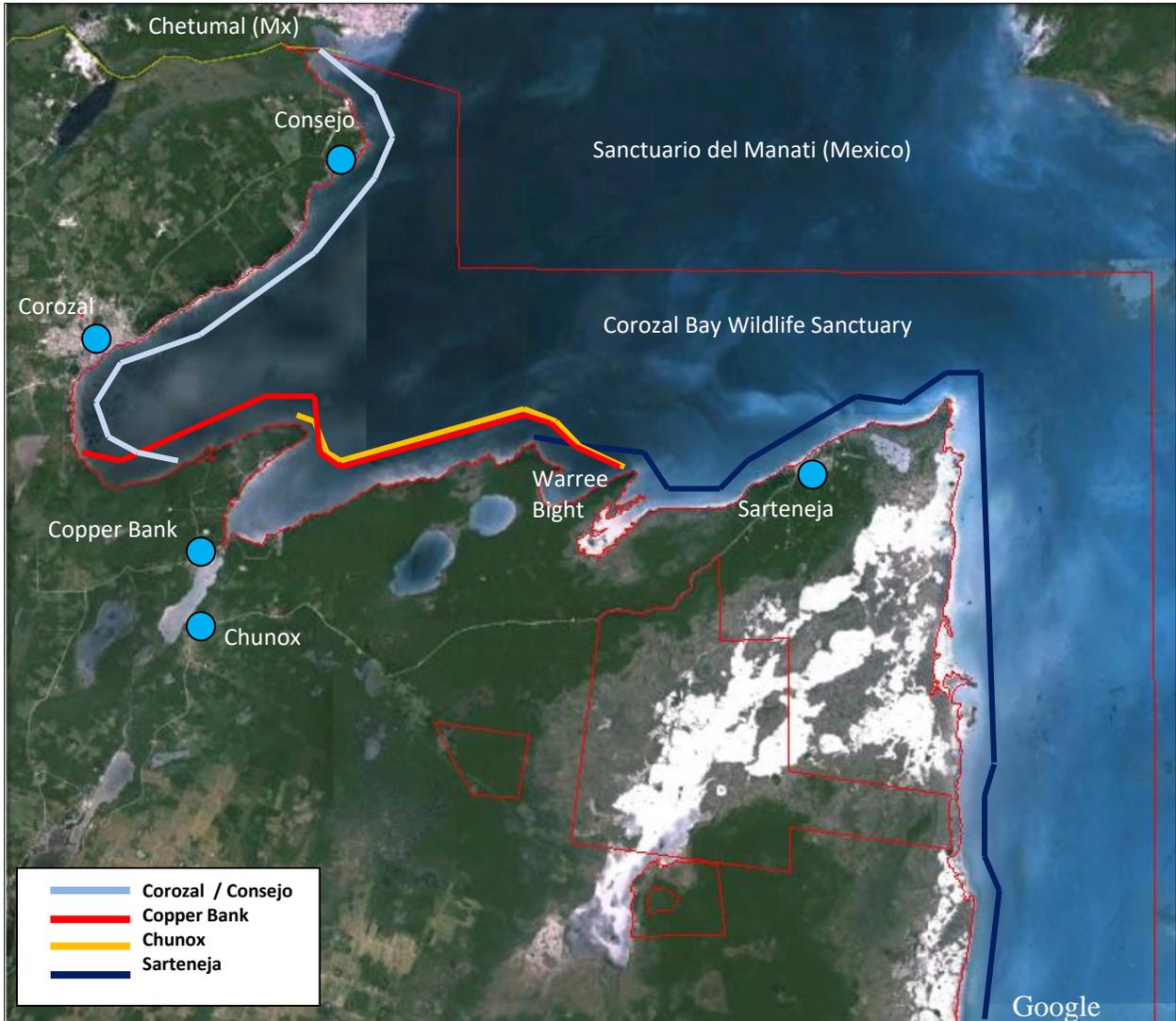
COMMUNITY	ESTIMATED NUMBER OF FISHERMEN*	FISHING METHODS	RELATIVE DEPENDENCY
Sarteneja	15	Beach traps, gill nets, cast nets	High
Chunox	4 - 5	Gill nets, cast nets	High
Copper Bank	4 - 5	Gill nets, cast nets	Medium
Consejo	7	Gill nets, cast nets	Low
Corozal	3	Gill nets, cast nets	Low

* Traditional fishermen considered dependent on fishing in Corozal Bay Wildlife Sanctuary for the majority of their income

TABLE 28: ORIGIN OF FISHERMEN OF COROZAL BAY WILDLIFE SANCTUARY

Fishing Areas

Mapping exercises in the stakeholder communities demonstrate that there is a loose division of the fishing area per community, with Sarteneja using the largest percentage of the Wildlife Sanctuary (Map 6). Fishing activities are almost exclusively within 300m of the shore, focused on catching species that move up and down the coastline, using a variety of fishing methods and equipment. The area of highest overlap is Warree Bight, a sheltered bay accessed by Sarteneja, Chunox and Copper Bank fishermen.



MAP 6: FISHING AREAS PER COMMUNITY (SACD COMMUNITY CONSULTATIONS, SARTENEJA, CHUNOX, COPPER BANK AND COROZAL, 2009 – 2011)

Target Species

Fourteen species are regularly fished from Corozal Bay Wildlife Sanctuary for commercial or home-use purposes (Table 29), with four of these considered key targets for fishery management.

COMMON NAME	LOCAL NAME	SPECIES NAME
Horse eye jack	Jurel	<i>Caranax latus</i>
Crevalle jack	Jurel	<i>Caranx hippos</i>
Atlantic spadefish	La Vieja	<i>Chaetodipterus faber</i>
Striped mojarra	Chiwa	<i>Eugerres plumieri</i>
Yellowfin mojarra	Mojarra	<i>Gerres cinereus</i>
Blue Striped Grunt	Chac chi	<i>Haemulon sciurus</i>
Mutton Snapper	Pargo	<i>Lutjanus analis</i>
Grey snapper	Pargo	<i>Lutjanus griseus</i>
Lane snapper	Pargo	<i>Lutjanus synagris</i>
White Mullet	Mullet	<i>Mugil curema</i>
Striped Mullet	La Lisa	<i>Mugil cephalus</i>
Cero	La Ciera	<i>Scomberomonis regalis</i>
Great Barracuda	Picuda	<i>Sphyraena barracuda</i>
Mayan Cichlid	Xpinta	<i>Cichlasoma uprothals</i>

TABLE 29: SPECIES FISHED REGULARLY FROM COROZAL BAY WILDLIFE SANCTUARY (SACD DATA, 2011)

A profile of the demand for different species of fish by Sarteneja for both home and for commercial purposes was assessed through a survey of 150 households (SACD, 2009), providing information on species considered culturally important to the diet of the community (Table 30).

FAMILY	% RESPONDENTS (OF 150)	SPECIES	
Stone Bass (Gerridae)	55	Striped Mojarra	<i>Eugerres plumieri</i>
		Yellowfin Mojarra	<i>Gerres cinereus</i>
Snapper (Lutjanidae)	23	Grey Snapper	<i>Lutjanus griseus</i>
		Lane Snapper	<i>Lutjanus synagris</i>
		Mutton Snapper	<i>Lutjanus analis</i>
Barracuda (Sphyraenidae)	15	Great Barracuda	<i>Sphyraena barracuda</i>
Jack (Carangidae)	4	Horse-eye Jack	<i>Caranax latus</i>
		Crevalle Jack	<i>Caranax hippos</i>

TABLE 30: PREFERRED TARGET SPECIES (SARTENEJA SOCIO-ECONOMIC SURVEY, 2009)

Two fish families were highlighted as preferred species within the community, and therefore targeted by local fishermen. There is a clear cultural preference for striped mojarra ('chiwa' or 'stone bass' - *Eugerres plumieri*), as well as the closely related yellowfin mojarra ('mojarra' - *Gerres cinereus*), this family being favoured by 55% of respondents. The Lutjanidae – the snapper, particularly the grey (or mangrove) snapper ('pargo' - *Lutjanus griseus*) is favoured by 23% of respondents) (Figure 41).

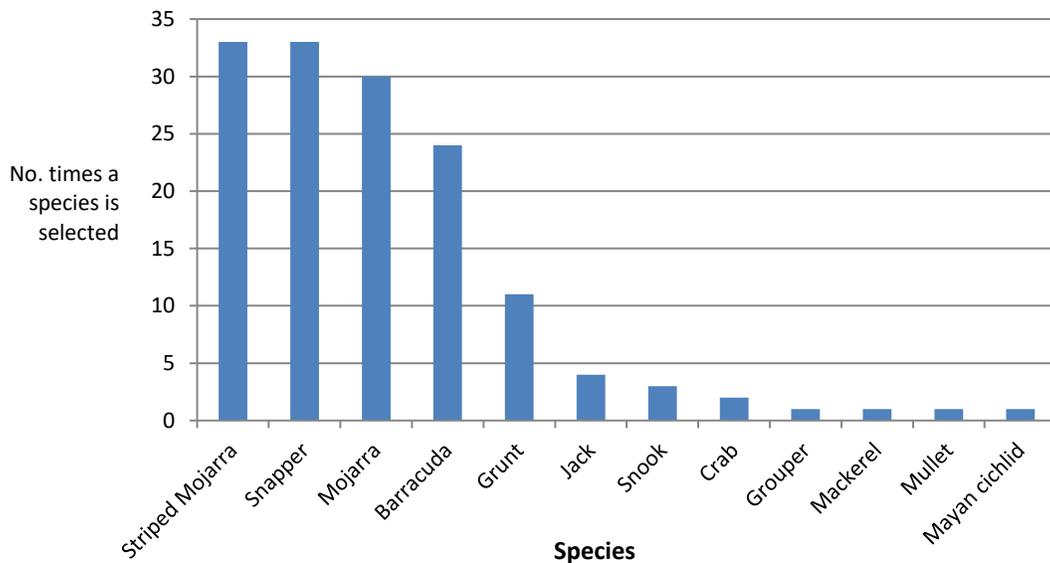


FIGURE 41: PREFERRED FISH SPECIES TARGETED BY FISHERMEN IN COROZAL BAY WILDLIFE SANCTUARY (SACD, 2009)

An assessment of the beach trap catch data demonstrates that the preferred species are also those that have the greatest representation in the catch. Whilst these results are specifically for Sarteneja, community participants in management planning workshops in Chunox, Copper Bank and Corozal (March - June, 2009) also agreed with these preferences. Community consultations with fishermen suggest that not all these species are available throughout the year... some enter the estuarine system in large numbers only seasonally, to spawn (Figure 42), generally running during the first north wind of the north front season and at the start of the first tropical storm.

SPECIES	J	F	M	A	M	J	J	A	S	O	N	D
Striped mojarra - <i>Eugerres plumieri</i> (Chiwa)												
Striped Mullet - <i>Mugil cephalus</i> (Lisa)												
Crevalle Jack - <i>Caranx hippos</i> (Jurel)												
Mackerel - <i>Scomberomonis regalis</i> (Cero)												
Yellowfin mojarra - <i>Gerres cinereus</i> (Mojarra)												
Grey snapper - <i>Lutjanus griseus</i> (Pargo)												
Lane Snapper – <i>Lutjanus synagris</i> (Pargo)												
Mutton Snapper - <i>Lutjanus analis</i> (Pargo)												
White Mullet – <i>Mugil curema</i> (Mullet)												
Snook - <i>Centropomus undecimalis</i> (Robalo)												
Blue-striped grunt - <i>Haemulon sciurus</i> (Chac chi)												

FIGURE 42: SPECIES SEASONALITY WITHIN COROZAL BAY WILDLIFE SANCTUARY (SACD / LOCAL FISHERMEN, 2009)

Types of Fishermen

Five types of Sarteneja fisherman were identified as using the Wildlife Sanctuary, some for commercial purposes, others for home use (Table 31)

Each has a specific set of equipment, dependent on the type of fishing and distance travelled to reach the fishing area, and target a specific suite of species.

TYPES OF FISHERMEN	
Commercial	<ul style="list-style-type: none"> ▪ Beach Trap ▪ Gill Net ▪ Seasonal Gill Net ▪ Sport Fishing
Non-Commercial	<ul style="list-style-type: none"> ▪ Cast Net

TABLE 31: TYPES OF FISHERMEN IN SARTENEJA (SACD, 2009)

The consistent primary commercial users of CBWS in Sarteneja are the 15 or so commercial fishermen who use traditional beach traps or gill nets, along with their assistants. Fishing with a cast net is considered a traditional recreational activity by the majority of men, generally in the shallow waters in front of the community, with the catch providing additional food for the family. Community consultations in other communities show a much lower dependence on the fish resources.

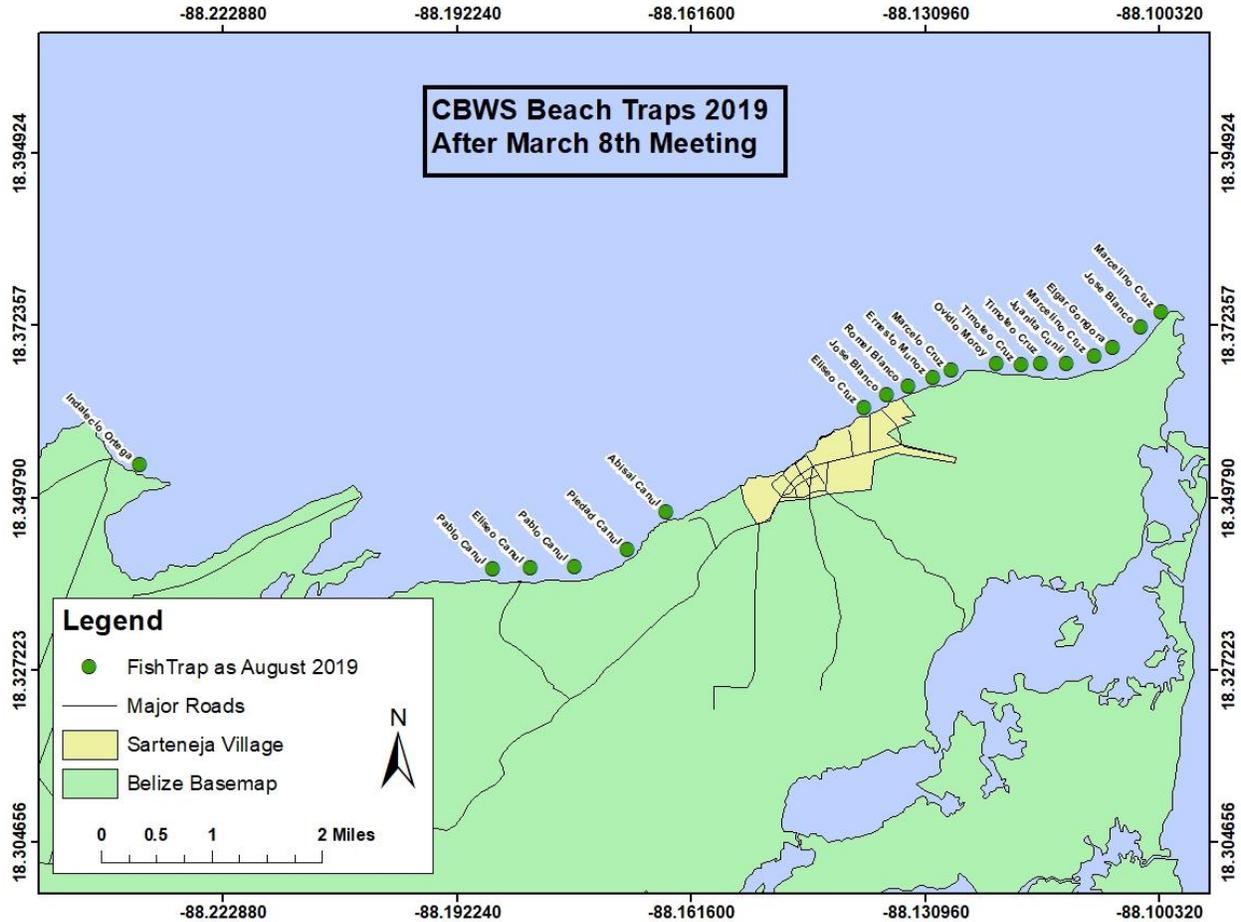
Additionally, CBWS is the target of incursions primarily by Mexican fisherman, with illegal gill net fishing and, in the past, opportunistic manatee poaching. Honduran and Guatemalan fishermen are also known to frequent the southern end of the Wildlife Sanctuary.

Beach Trap Fishermen: Sarteneja is the only community of CBWS to have beach traps, consist of a line of wooden sticks spaced 2ft apart extending 250-300ft from shore, leads into a circle 25-30ft in diameter, and target species that move parallel to the shore. This is considered a traditional fishing method for the area, with traps being passed from father to son. 10 trap fishermen man 15 traps, set in permanent locations along the coastline east and west from Sarteneja (Map 7). Fishing is seasonal, with traps opened in mid-April and removed in mid-November. The take is very discriminatory, with fish netted live and sorted at point of capture. By-catch (non-commercial species / undersized) is thrown back alive.



The beach trap functions by corralling fish (cola), into a storage area (corazón). The cola is set perpendicular to the shoreline and serves as a barrier for fish coming from both directions. The corazón is located offshore. It has small entrances that allow fish to enter the storage area, whilst making it difficult for them to exit. Extracting the fish requires the use of a secondary net called a “copo.”

Rosado, draft



MAP 7: LOCATION AND OWNERSHIP OF BEACH TRAPS (SACD, 2019)

Commercial gill net / cast net: 4 teams of between 2 to 3 people from Sarteneja use gill nets on the East Coast, behind Deer Caye / Cayo Negro or on the north coast, depending on the time of year and water conditions (Table 32). Nets are set in the evening and pulled in early morning. These nets are not discriminatory, and kill by-catch and undersized fish as well as those targeted. Cast nets are then used during the day – sometimes within the coastal lagoons and creeks.

TEAM	NUMBER OF TEAM MEMBERS	EQUIPMENT
Fisherman 1	2	Gill net, 60/75HP engine, 25 ft skiff
Fisherman 2	3	Gill net, 60/75 HP engine, 25 ft skiff
Fisherman 3	2	Gill net, 40 HP engine, 12 ft skiff
Fisherman 4	3	Sink net, 30 HP engine 20 ft sailboat, 8 HP 9 ft skiff

TABLE 32: GILL NET FISHERMEN (SACD, 2009)

Seasonal gill nets

A number of Sartenejans, whilst not fishing in CBWS as their primary source of income, use gill nets commercially during peak fish movement times in front of Sarteneja or on the East Coast (primarily October / November, with the first north fronts. These nets are not discriminatory, and kill by-catch and undersized fish as well as those targeted. Species targeted are jack, snook, and snapper.

Cast Net Fishing: Cast nets (or throw nets - 8-12ft circular nylon nets with a mesh size of 1.5 inches and about 20 small lead weights around the outer edge) are used by many fishermen in the shallow waters in front of Sarteneja when the lobster season is closed, for relaxation and to catch fish for the table. Cast nets are normally used in the early morning or evening, for better lighting, and to avoid the heat of the day. There are seldom more than four or five fishermen active at any one time, and the catch is small (generally between 10 and 20 fish). Approximately 10 people from Sarteneja use cast nets on a regular basis (once every two weeks or more) throughout the year in front of Sarteneja, at Warree Bight and Rocky Point, in the creeks, both for recreation and for the table. Species targeted are striped and yellowfin mojarra (chiwa and mojarra) and the sailfin catfish (vaca).



Sport Fishing: Sport fishing in the Wildlife Sanctuary is primarily catch and release, but guides will sometimes keep a fish for the tourist / family to eat. Four sport fishing guides fish from Sarteneja, in addition to an unknown number from Corozal and San Pedro, using specific areas of the Wildlife Sanctuary, such as the Punta Caul sink hole for tarpon, and the Spanish Point and Deer Caye areas for bonefish. Sport fishermen are far more selective, with a narrower range of target species, primarily focused on tarpon, permit, bonefish, snook, and barracuda, driven by market demand from the sport fishing industry.

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TYPE OF FISHERMAN	SPECIES TARGETED
Commercial Beach Trap	Striped mojarra (chiwa), yellowfin mojarra, grey snapper, lane snapper, mutton snapper (rare), schoolmaster (rare), blue striped grunt, crevalle jack, horse-eye jack, Atlantic spadefish, great barracuda, white mullet, snook, needlefish, cero Bonefish and permit are also caught within the beach traps, but are generally released following the legislation banning the possession of these species.
Cast net	Chiwa, mojarra, la vaca,
Commercial gill net	Grey snapper, lane snapper, mutton snapper (rare), school master (rare), crevalle jack, horse eye jack, barracuda, white mullet, snook, mackerel, cero, young sharks (casson), cobia
Sport fishing	Tarpon, bonefish, barracuda, jacks, snook (a little), permit
Seasonal gill nets	Grey snapper, striped mojarra, yellowfin mojarra

TABLE 33: SPECIES CATCH PER FISHERMAN TYPE

Profile of the Beach Trap Fishery

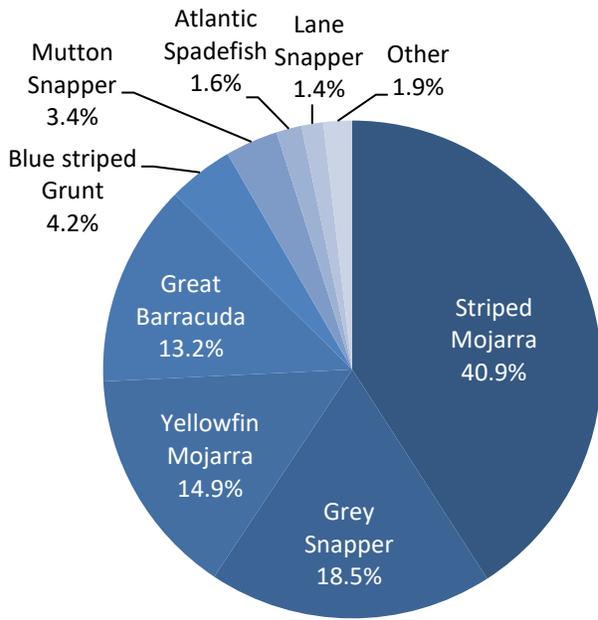
The beach trap fishery of Sarteneja has been the focus for community sampling of current fish catch and fishing effort during 2011, to provide a baseline for improved planning for sustainable use. The survey covered 9 of the 15 traps (65%) between June and November, with sampling of catch at point of extraction by the sampling team (SACD and local fishermen, assisted by Wildtracks and Blue Ventures). 32 catch samples were conducted (Table 34), with each trap being sampled between 1 and 9 times during the trapping season. Unfortunately external conditions resulted in sampling gaps occurring in April and May, and again in September and October, when sampling was not feasible.

MONTH	NO. SURVEYS CONDUCTED
April	-
May	-
June	2
July	10
August	4
September	-
October	-
November	16
Total	32

TABLE 34: TEMPORAL SPREAD OF SURVEYS

All catches were mixed, with 1,343 individual fish over a range of 15 commercial species. The most abundant species was the striped mojarra ('chiwa' – *Eugerres plumieri*), with a total of 549 individuals sampled (representing 40.9% of the total catch), followed by the grey snapper ('pargo' – *Lutjanus griseus*) with 248 (18.5%), the yellowfin mojarra ('mojarra' – *Gerres cinereus*) with 200 individuals (14.9%), and great barracuda ('picuda' – *Symphaena* with 177 (13.2%) (Figure 43 and 44). The remaining species were represented by less than 100 individuals each. Blue swimming crabs (*Callinectes sapidus*) were also frequently caught in the traps and sold commercially. 2016 data showed a similar pattern (Figures 45 and 46).

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(SACD beach trap data, 2011)

FIGURE 43: PERCENTAGE CATCH PER SPECIES (2011)

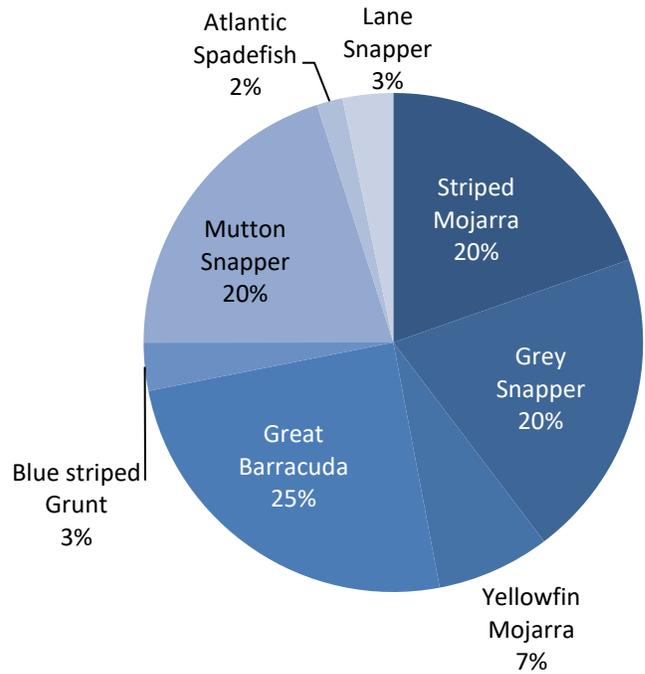
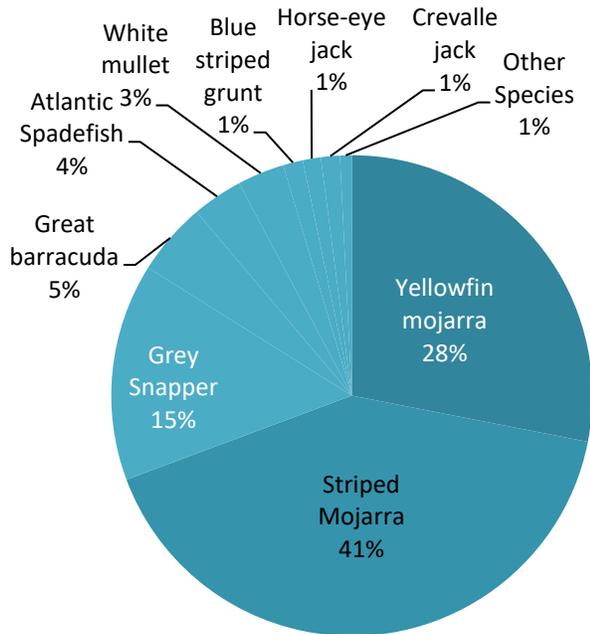


FIGURE 44: PERCENTAGE CATCH BIOMASS PER SPECIES (2011)



(SACD beach trap data, 2016)

FIGURE 45: PERCENTAGE CATCH PER SPECIES (2016)

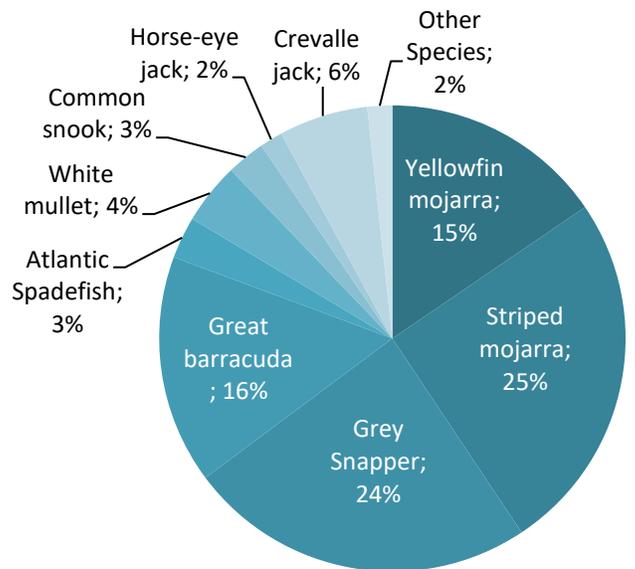


FIGURE 46: PERCENTAGE CATCH BIOMASS PER SPECIES (2016)

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The catch data provides an indication of the total number, biomass and % catch that meets or exceeds the L₅₀ criteria (Table 35)

SPECIES		TOTAL NUMBER	TOTAL BIOMASS (G)	% OF CATCH MATURE (L ₅₀)	MEAN LENGTH	MODE LENGTH
Striped Mojarra	<i>Eugerres plumieri</i>	549	93,530.0	88.5%	23.3	23.0
Yellowfin Mojarra	<i>Gerres cinereus</i>	200	35,037.7	99.0%	24.1	22.5
Grey Snapper	<i>Lutjanus griseus</i>	248	95,686.1	88.7%	28.9	27.6
Mutton Snapper	<i>Lutjanus analis</i>	46	15,600.2	0.0%	26.9	28.0
Lane Snapper	<i>Lutjanus synagris</i>	19	8,662.0	94.7%	30.2	31.4
Great Barracuda	<i>Sphyrna barracuda</i>	177	118,545.8	2.26%	45.2	43.0
Blue-striped Grunt	<i>Haemulon sciurus</i>	57	14,8772.6	100.0%	23.6	23.0
Atlantic Spadefish	<i>Chaetodipterus faber</i>	22	7,973.6	-	20.7	20.0
Striped Mullet	<i>Mugil cephalus</i>	7	2,682.9	42.9%	34.7	33.0
White Mullet	<i>Mugil curema</i>	7	1,713.5	100.0%	29.5	25.0
Crevalle Jack	<i>Caranx hippos</i>	4	8,006.3	0.0%	53.8	51.0
Horse Eye Jack	<i>Caranx latus</i>	3	740.0	100.0%	26.4	23.0

TABLE 35: CATCH SAMPLE SUMMARY (SACD BEACH TRAP DATA, 2011)

The by-catch consisted of ten species. Three of these are sport fish species (permit, bonefish and palometa), two are stingrays (southern stingray and longnose stingray), and the lookdown, catfish, chequered puffer, burrfish, redfin needlefish and yellow tail jack, as well as undersized commercial fish - all by-catch was returned live to the water, where possible. There were incidental mortalities caused by a small number of fish being caught in the chicken wire wall of the trap (generally barracuda), or becoming prey to brown pelicans or magnificent frigatebirds as they were being thrown back into the water.



THE LOOKDOWN (SELENE VOMER), PART OF THE BEACH TRAP BY-CATCH, THOUGH OCCASIONALLY TAKEN FOR HOME USE

Catch per Species

Percentage catch per species can be estimated from the total catch, as can species length frequency and seasonality of catch. Mojarra (striped mojarra (*Eugerres plumieri*) and yellowfin mojarra (*Gerres cinereus*)) and snapper (grey snapper (*Lutjanus griseus*)) made up the majority of the catch, with catch analysis being focused primarily on species of these families.



MIXED MOJARRA CATCH

Striped Mojarra ('Chiwa' - Eugerres plumieri)

The locally preferred striped mojarra or 'chiwa' (*Eugerres plumieri*) is also the most frequently caught species, with 549 individuals, representing 40.9% of the sampled catch. Striped mojarra catch ranged from 15cm to 32.2cm in length, with a mean total length of 23.3cm and mode of 22cm (Figure 47). The total sampled catch is estimated at 93.6kg for 32 trap events, 23.7% of the total catch biomass, and an average of 2.9kg per trap. All fish under 15.0cm are returned live to the water at point of capture, during the catch sorting process, as part of the traditional fishing practice.



STRIPED MOJARRA (*EUGERRES PLUMIERI*)

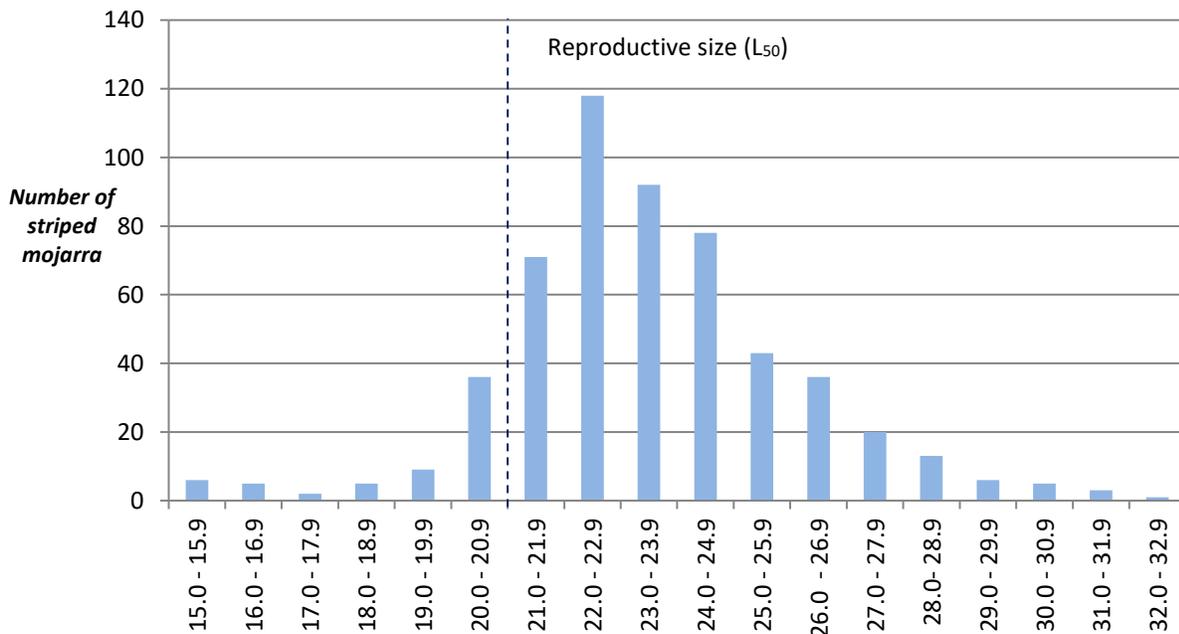


FIGURE 47: SIZE RANGE OF STRIPED MOJARRA (*EUGERRES PLUMIERI*) SAMPLED FROM BEACH TRAPS, TOTAL CATCH DATA, 2011

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This species matures at a total length of between 18.0 cm and 22.0 cm (7.0 to 8.5 inches). Based therefore on an estimated average maturity at 20.0cm total length, the majority of individuals in the catch (88.5%) are reported to be in the range where at least 50% of the population is thought to be sexually mature (L_{50}).

Striped mojarra are present throughout the beach trap season (Figure 48), but has a very seasonal abundance, peaking in July, with 47.9% of the sampled catch being caught in one trap event (Trap 3) on 8/7/2011. July brings the first major rains of the wet season, reducing the salinity of the estuarine system.

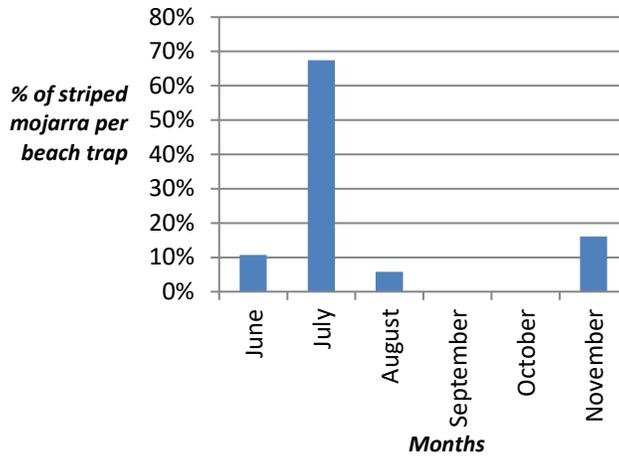


FIGURE 48: STRIPED MOJARRA ('CHIWA' – EUGERRES PLUMIERI) - SEASONALITY OF CATCH. (N=56.2)

NB: NO DATA FOR SEPTEMBER OR OCTOBER

The yellowfin mojarra (*Gerres cinereus*), the second preference as a food fish in Sarteneja, represents 14.9% of the total sampled catch. Yellowfin mojarra ranged from 19.0cm to 44.9cm in total length, with a mean size of 24.1cm and mode of 22.0cm (Figure 26). The total sampled catch is estimated at 35.0kg for 32 trap events, an average of 1.1kg per trap. All fish under 19.0cm are returned live to the Bay as by-catch, as part of the traditional fishing practices. Total length at maturity is estimated at between 17.0 cm and 20.0 cm (approximately 7.0 to 8.0 inches). Based on an averaged length at maturity of 19.0cm, 99.0% of individuals in the catch are reported to be in the range where at least 50% of the population is thought to be sexually mature (L_{50}).



YELLOWFIN MOJARRA (*GERRES CINEREUS*)

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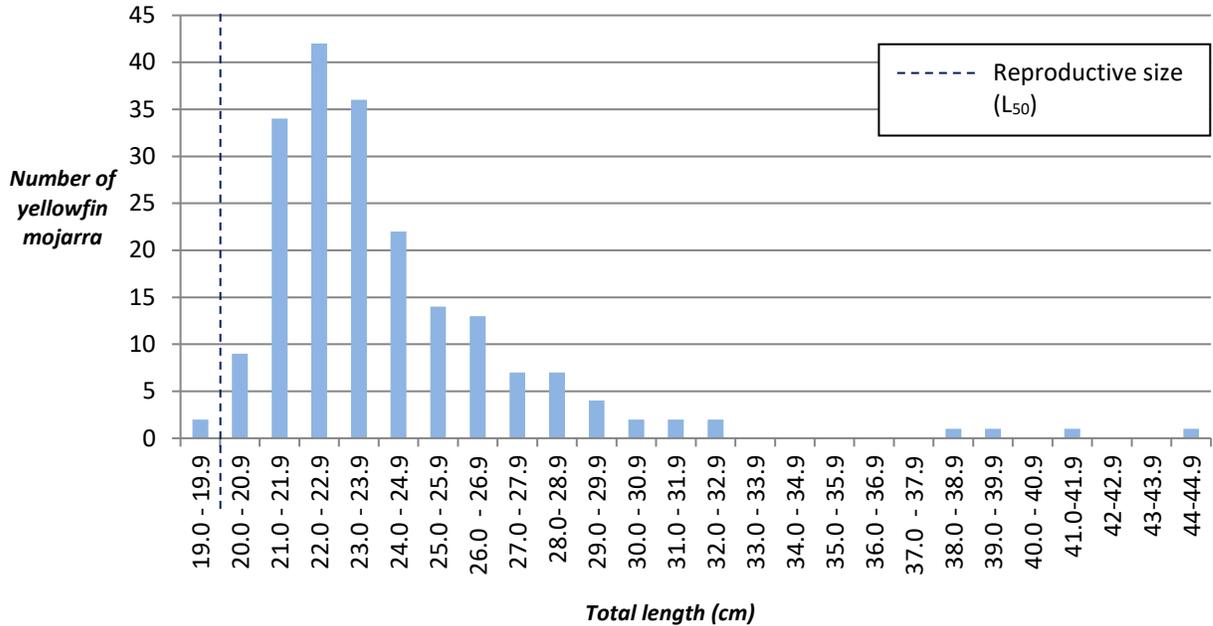
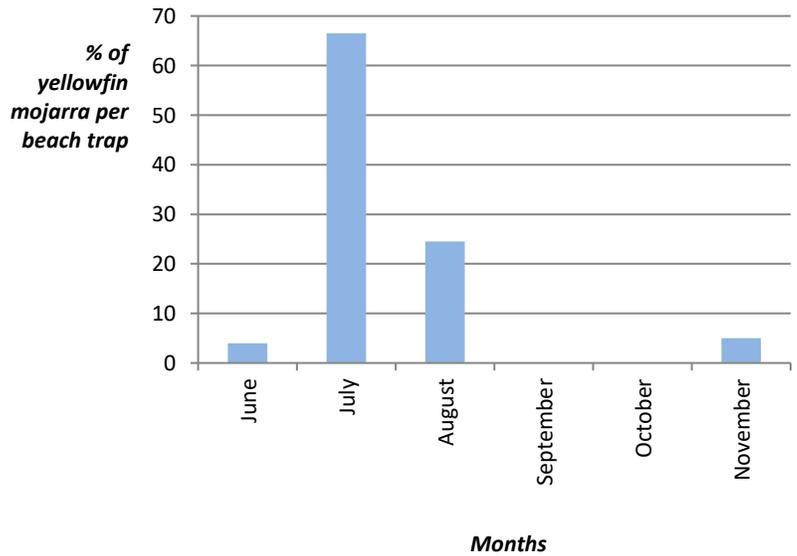


FIGURE 49: SIZE RANGE OF YELLOWFIN MOJARRA (*EUGERRES PLUMIERI*) SAMPLED FROM BEACH TRAPS, TOTAL CBWS CATCH DATA, 2011.

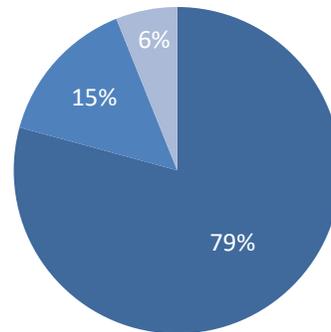
The yellowfin mojarra, like the striped mojarra is present throughout the beach trap season (Figure 50), but is very seasonal in abundance, peaking in July with the advent of the first major rains of the wet season.



**FIGURE 50: YELLOWFIN MOJARRA - SEASONALITY OF CATCH
NB: NO DATA FOR APRIL, SEPTEMBER OR OCTOBER (N=200)**

Grey Snapper ('Pargo' – *Lutjanus griseus*)

Three species of snapper were represented within the catch, with the majority (248 individuals, - 79.0% of the snapper catch) being grey snapper (*Lutjanus griseus*). 15.0% of the snapper catch was mutton snapper (*Lutjanus synagris*), with the remaining 6.0% being lane snapper (*Lutjanus analis*) (Figure 51). Lane and mutton snapper were not caught in the same catches – mutton snapper were the most seasonal, all individuals being caught in November, whilst lane snapper occurred in catches from June to August.



■ Grey Snapper ■ Mutton Snapper
■ Lane Snapper

FIGURE 51: RELATIVE ABUNDANCE OF SNAPPER SPECIES IN CATCH SAMPLES

The Grey snapper catch ranged from 20.0cm to 40.3cm in total length, with a mean size of 29.0cm and mode of 28.0cm (Figure 52). The total sampled catch is estimated at 95.7kg for 32 trap events, an average of 3.0kg per trap. This species matures at a size of 18.0 – 33.0 cm (7.0 – 13.0 inches; Allen, 1985). Based on a length at maturity of 25.0cm, the majority of individuals in the catch (88.7%) are reported to be in the range where at least 50% of the population is thought to be sexually mature (L_{50}).

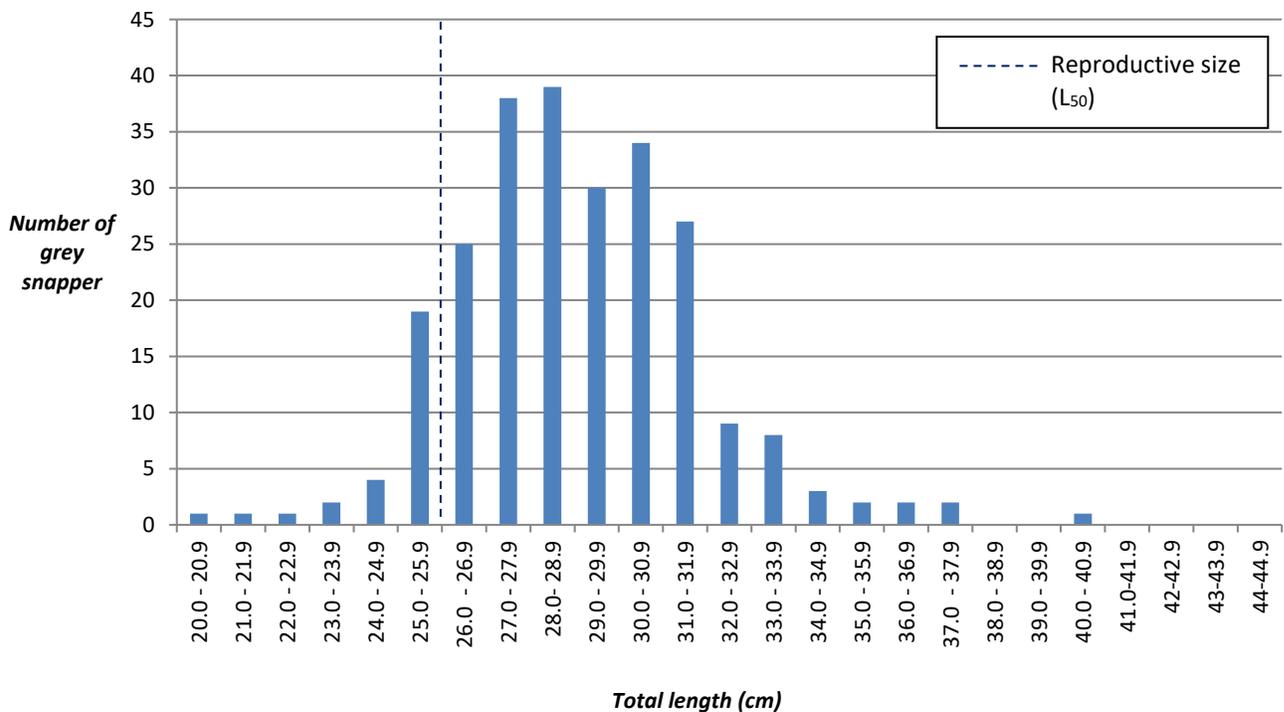


FIGURE 52: SIZE RANGE OF GREY SNAPPER (*LUTJANUS GRISEUS*) SAMPLED FROM BEACH TRAPS, TOTAL CBWS CATCH DATA (SACD DATA, 2011)

Whilst present throughout the beach trap season, grey snapper are more abundant in the catch towards the start of the season, with the average number of fish caught per trap event gradually reducing through the year (Figure 53).

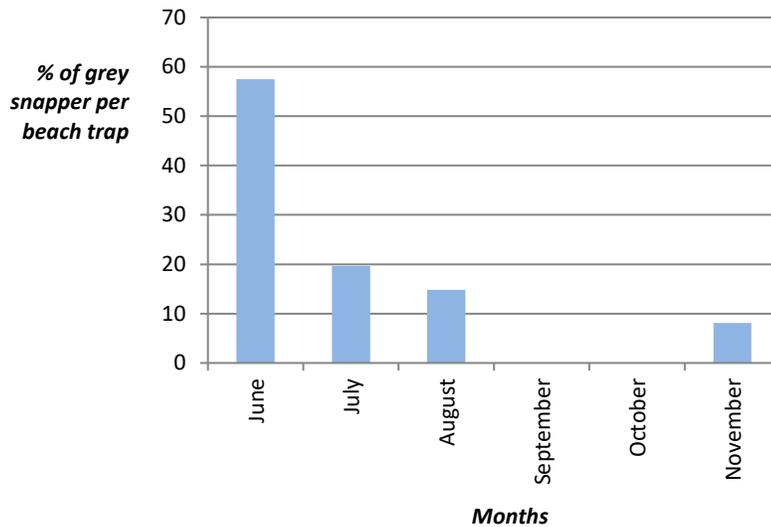


FIGURE 53: GREY SNAPPER (*LUTJANUS GRISEUS*) – SEASONALITY OF CATCH (NB: NO DATA FOR APRIL, SEPTEMBER OR OCTOBER)

1.6.2 Archaeological Sites, Cultural and Historical Values

Signs of Maya settlements and activity are found along much of the coastline of Corozal Bay Wildlife Sanctuary, including Cerros, an archaeological site managed by the Institute of Archaeology. Thought to have started as a small hunting, fishing and trading village. Cerros expanding around 50 B.C., becoming a regionally important trading centre, with the construction of large stone pyramids with stucco mask façades and a boat dock (Vidala and Milbrath, 2014). was a very important trading port for the Maya. It is thought to have served as a strategic location for fishing and travel during the late Preclassic (200 B.C. - A.D. 200). By A.D. 250, however, Cerros was in decline, and by A.D. 375 it was abandoned. The site was resettled in the Terminal Classic (ca. A.D. 800-900), when a small refugee population migrated north from central Guatemala, remaining a small fishing and trading community up until colonial times.

Maya pottery shards can be found on most high points along the coast, some with designs of local fish and birds, and many carved into the form of weights for nets (Walker, pers. com.). There are indications of nine potential stone fish



RENDERING OF PRE-HISPANIC MAYA FISH TRAP AND POTENTIAL STRUCTURES IN CBWS (ROSADO, DRAFT; HERRERA PAVON)

traps in the shallow waters of the Wildlife Sanctuary, as documented on the Chetumal Bay portion of the estuary. (Rosado, draft; Herrera Pavon).

During the Early Postclassic, there is evidence that the Maya began to move towards the coast and the cayes, to develop a complex trading network, with trans-shipment points along established sea trade routes, that peaked in the Late Postclassic (1300 – 1500 A.D.) (Awe J.J. et. al., 2001). It is thought that large ocean-going canoes from the Yucatan would come through the Bacalar Chico canal, reputed to have been excavated by hand between 700 and 900 A.D. in order to reduce travel time (Garber, 1986), avoiding the risk of travelling in the open sea associated with crossing the seaward Rocky Point area to reach the mainland. This shortcut would save 56 miles or more and provide access to the sheltered Corozal Bay and Chetumal / Corozal settlements, as well as those settlements further inland, accessed through the coastal lagoons and rivers.

The sea-going canoes are thought to have stopped at San Juan (Bacalar Chico Marine Reserve) to offload cargo onto smaller canoes capable of negotiating the shallow waters of the upper reaches of the inland river systems. The presence of pottery from the Yucatan, the south coast of Belize, the Peten region of Guatemala and Campeche, the relatively large quantities of green obsidian from Pachuaca in central Mexico, along with basalt grinding tools from the Guatemala highlands, support this theory, with the long distance trade creating wealth for this small coastal settlement (Driver et al. 1995; Guderjan 1995a; Guderjan and Garber 1995).

1.6.3 Tourism and Recreation Use

With its idyllic views of the Bay, coastal Corozal District has the potential for excelling in provision of conservation-focused experiences, with increased investment for ecotourism development. Corozal Town is the first point of entry for many visitors travelling from Mexico by road. Exit survey data shows that over half of the tourists visiting Corozal are either American (45%) Canadian (10%), or British (8%), with the remainder being a diverse mix from European, South and Central American countries, South Africa, Taiwan, India and Australia.

Only 10% of visitors surveyed, however, considered that they had visited Corozal Bay Wildlife Sanctuary, though the majority would have seen and enjoyed the Bay if staying in Corozal or Sarteneja (though maybe not realizing its status as a protected area). More people visit the archaeological sites of the area, with 40% of people visiting Corozal District visiting Cerros.

Sarteneja is banking on tourism to relieve some of the pressures of dependence on a single income source – the lobster and conch fishery. Tourism visitation is increasing, despite the poor state of the road, and SACD are supporting a number of initiatives that are helping Sarteneja to move in this direction. In 2009, they formed a partnership with the Sarteneja Tour Guide

Association to work with local participants to develop the Sarteneja Tourism Development Plan. This identified a vision for tourism in Sarteneja:

Sarteneja is the recognised community-based tourism destination in northern Belize, rich in culture, traditions and natural resources... a unified, environmentally aware community ensuring shared sustainable economic opportunities for its people

...but also identified a number of key challenges to tourism in the area. These included:

- limited accommodation and restaurant options
- limited access
- limited understanding of tourist requirements
- limited availability of tours
- limited marketing opportunities

Since then, SACD has worked with its partners to address these challenges, through the following steps:

- support to the Sarteneja Homestay Group in the set-up phase, with location of funding to provide women with the training required, and ability to upgrade their homestay accommodation
- support to the Sarteneja Tour Guide Association in upgrading the water taxi and reinstate runs to Corozal, with capacity building for business management
- training for fishers, women and youths as tour guides
- support of the Sarteneja Beach Traps Pesca Tour Association as they establish Pesca tourism activities associated with the local beach traps and cultural, traditional fishing activities, with investment in their kitchens to be able to provide added value to the catch through preparing the fish as a meal
- establishing a business arm to cater for expedition groups, both as a financial sustainability mechanism for the organization and as improved tourism visitation to the community

Sarteneja has changed as well, with additional restaurants opening up, but there is still limited use of the Wildlife Sanctuary itself for tourism activities, and those that do exist are generally ad-hoc and poorly marketed.

Section Two

Conservation Planning



2. Conservation Planning

Conservation planning is a structured process that identifies and assesses the species and ecosystems of concern, the threats that impact them, and the strategies that can be used within the management of the area to mitigate these threats. Conservation planning has been conducted at two different levels – the first is at the seascape level, during the Management Action Planning process for the Northern Belize Coastal Complex, which identified the targets and threats over the larger seascape. The second is at the site level – for the protected area. As part of the larger seascape, it is important that Corozal Bay Wildlife Sanctuary is managed for maintenance of seascape targets – not just those of the site. This is particularly relevant for the seascape target Coral Reef. Whilst CBWS does not, itself, encompass the coral reef ecosystem, its role in maintaining water quality for the reef as part of the river to reef connectivity is critical. This is critical not just for the health of the reef at Bacalar Chico and Hol Chan Marine Reserves, but also for supporting the national economy - Hol Chan Marine Reserve being one of Belize’s premier tourism destinations.

2.1 Management Targets

Management (or Conservation) targets are species, species assemblages or ecosystems that have been selected as representing the biodiversity of a protected area – such that strategic actions, taken to ensure their continued viability and reduce the pressures impacting them, will adequately address the conservation management needs of the protected area as a whole.

2.1.1 Identification of Management Targets

Targets were identified at the seascape level, as part of the Northern Belize Coastal Complex Management Action Planning process. Site level targets have then been integrated into this framework, based on the conservation targets of the CBWS Management Plan 2013 – 2017, and on updated information.

Northern Belize Coastal Complex: Management Targets

Seven Management Targets (species, species assemblages or ecosystems) were chosen to represent and encompass the biodiversity values of the Northern Belize Coastal Complex, and to provide a basis for setting goals, developing strategies and actions, and monitoring success.

- **Coastal Ecosystems**
- **Seagrass**
- **Coral Reefs**
- **Commercial /Recreational Species**
- **Charismatic Marine Megafauna**
- **Ancient Formations**
- **Physio-chemical Environment**

For the purposes of the Management Action Planning process, the selected biodiversity targets were required to meet the following criteria, where possible (adapted from TNC, 2007):

- **Targets should represent the biodiversity of the site.** The focal targets should represent or capture the array of ecological systems, communities, and species of importance at the project area and the multiple spatial scales at which they occur.
- **Targets reflect ecoregion or other existing conservation goals.** Focal targets should reflect efforts at the regional and national level where they exist, such as TNC and CI Ecoregional Assessments, the National Protected Areas System Plan, the NPAPSP Rationalization recommendations, and the National Biodiversity Action Plan. Focal targets that are grounded in the reasons for the project area's current status of protection, and the identification of the Belize Barrier Reef as one of the regions key marine areas of ecological, biological and social importance, of Bacalar Chico Marine Reserve and National Park as a global World Heritage Site, and of Corozal Bay Wildlife Sanctuary as a priority area under the MAR initiative (Kramer and Kramer, 2002).
- **Targets are viable or at least feasibly restorable.** Viability (or integrity) indicates the ability of a conservation target to persist for many generations. If a target is on the threshold of collapse, or conserving a proposed target requires extraordinary human intervention, it may not represent the best use of limited conservation resources.
- **Targets are highly threatened.** All else being equal, focusing on highly threatened targets will help ensure that critical threats are identified and addressed through conservation actions.
- **Physio-chemical Environment**

Specific site-level Management Targets for Corozal Bay Wildlife Sanctuary

In 2013, a series of 8 specific site-level Management Targets were selected to represent the Wildlife Sanctuary, to guide management decisions and focus research and monitoring. These targets have now been aligned to those of the larger NBCC.

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Each of these eight CBWS targets has a series of associated nested targets – species or species assemblages considered of particular conservation importance that are represented by the target (Table ..).

Conservation Targets for Corozal Bay Wildlife Sanctuary

- Coastal Ecosystems
- Seagrass
- Native Commercial Fish Species
- Elasmobranchs
- Bird Nesting Colonies
- Antillean Manatee
- Stromatolites
- Physio-chemical Environment

CONSERVATION TARGETS AND NESTED TARGETS FOR THE COROZAL BAY WILDLIFE SANCTUARY AND NORTHERN BELIZE COASTAL COMPLEX		
NBCC Conservation Target	CBWS Target	Nested Target
Coastal Ecosystems Mangrove Coastal lagoon Littoral Forest (NR) Sandy Beach (NR)	Coastal ecosystems Bird Nesting Colonies	Juvenile fish species Nesting bird species Mangroves Littoral Forest (NR)
Seagrass	Seagrass	Seagrass species Algae species Juvenile fish Crustaceans
Coral Reef	Not relevant	
Commercial / Recreational Species	Native Commercial Species Elasmobranchs	Finfish Sport fish Sharks and rays
Charismatic Marine Megafauna	Antillean manatee	Antillean manatee Bottlenose dolphin American and Morelet's Crocodiles Marine turtles
Ancient Formations	Stromatolites	
Physio-chemical Environment	Physio-chemical Environment	Water quality

TABLE 36: NBCC CONSERVATION TARGETS AND KEY NESTED TARGETS

Note: Two scenarios were developed through the Management Action Planning process – the first with Sharks, Crocodiles and Turtles nested under Charismatic Species, the second with these species nested under Commercial Marine Species (sharks) and Coastal Ecosystems (crocodiles and turtles). Of the two, the second scenario is considered to better represent the status of the Northern Belize Coastal Complex.

Management Targets of Corozal Bay Wildlife Sanctuary

Ecosystem Level Targets: Ecological communities that occur together, share common ecological processes, and have similar characteristics. One coastal and one marine ecosystems have been selected:

- *Coastal ecosystems*
- *Seagrass*
- *Stromatolites*

Species Assemblages: Groups of species that share common natural process or have similar conservation requirements:

- *Native Commercial Fish Species*
- *Elasmobranchs*
- *Bird Nesting Colonies*

Species: One species–level target has been selected:

- *Antillean manatee (the regional sub-species of the West Indian manatee)*

One target has been selected to cover water quality:

- *Physio-chemical Environment*

2.2 Assessing Biodiversity Viability

The Viability Assessment, as conducted under the Conservation Planning process, provides:

- A means for determining changes in the status of each focal target over time, to measure success of conservation strategies, compare the status of a specific conservation target with future conditions, and with other projects in Belize / Central America that focus on that target
- A basis for the identification of current and potential threats to a target and identification of past impacts that require mitigation actions
- A basis for strategy design and the foundation for monitoring

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Each Conservation Target was assessed using the following viability ratings:

- **Very Good** – The Indicator is considered to have an ecologically desirable status, requiring little or no intervention for maintenance.
- **Good** – The indicator lies within the acceptable range of variation, though some intervention is required for maintenance.
- **Fair** – The indicator lies outside the acceptable range of variation, and human intervention is required if the viability of the target is to be maintained
- **Poor** – Restoration of the conservation target is increasingly difficult, and impacts may result in extirpation from the conservation area

Northern Belize Coastal Complex: Viability Assessment for Management Targets

The overall viability rating for the overall Northern Belize Coastal Complex is **FAIR**, with six targets rating as **FAIR**, and one target (seagrass) rating as **GOOD**. No target rates as **VERY GOOD**.

Conservation Target	Landscape Context	Condition	Size	Viability Rank
Coastal Ecosystems	Good	Good	Fair	Fair
Seagrass	Fair	Good	Good	Good
Coral Reef	Fair	Poor	Fair	Fair
Commercial /Recreational Species	Good	Poor	Poor	Fair
Charismatic Marine Megafauna	Poor	Fair	Good	Fair
Physio-chemical Environment	Fair	Fair	Good	Fair
Ancient Formations	Fair	Fair	Good	Fair
Project Biodiversity Health Rank				Fair
Very Good	Ecologically desirable status. Requires little or no intervention for maintenance			
Good	Within acceptable range of variation. Some human intervention required for maintenance			
Fair	Outside acceptable range of variation. Requires human intervention			
Poor	May result in local extinction. Restoration difficult / impossible			

TABLE 37: VIABILITY ASSESSMENT OF NBCC TARGETS (SACD / WILDTRACKS DATA, 2017)

SITE SPECIFIC -VIABILITY ASSESSMENT FOR COROZAL BAY WILDLIFE SANCTUARY

NBCC Management Targets	CBWS Management Target	Landscape Context	Condition	Size	Viability Rank
Coastal Ecosystems	Mangrove	Good	Good	Good	Good
	Bird Nesting Colonies	Fair	Fair	Fair	FAIR
	Littoral Forest	Fair	Good	Fair	FAIR
Seagrass	Seagrass	Very Good	Fair	Fair	FAIR
Commercial /Recreational Species	Native Commercial Fish Species	Fair	Good	Fair	FAIR
	Elasmobranchs	Poor	Fair	Fair	FAIR
Charismatic Marine Megafauna	Antillean Manatee	Fair	Good	Good	GOOD
Physio-chemical Environment	Physio-chemical Environment	Fair	Fair	Very Good	FAIR
Ancient Formations	Stromatolites	Fair	Good	Good	GOOD
CBWS Biodiversity Health Rank					
Very Good	Ecologically desirable status. Requires little or no intervention for maintenance				
Good	Within acceptable range of variation. Some human intervention required for maintenance				
Fair	Outside acceptable range of variation. Requires human intervention				
Poor	May result in local extinction. Restoration difficult / impossible				

TABLE 38: VIABILITY ASSESSMENT OF SITE SPECIFIC CBWS TARGETS (SACD / WILDTRACKS DATA, 2017)

Ecosystems: Coastal Ecosystems: Mangroves			
Current Status	NBCC Status	Goal	<i>Objectives:</i>
GOOD	GOOD	GOOD	<ul style="list-style-type: none"> ▪ <i>To encourage improved stakeholder stewardship of critical mangroves of CBWS</i>
Justification		Species / ecosystems nested in this target	
<p>Mangroves are important for the long term health of the wildlife Sanctuary, its biodiversity, and its fishery. They are a major contributor to the CBWS marine environment, supporting a diverse range of birds, mammals, crustaceans and fish. In their multifunctional capacity, they provide breeding habitat, protect maturing offspring in the shallow, coastal lagoons, stabilizing bottom sediments, and protecting shorelines from erosion. They also play an important role in maintaining water quality, filtering suspended material and assimilating dissolved nutrients. The north east of Belize has some of the most extensive mangrove habitat in Belize, important to the integrity of the ecosystem functionality of Corozal Bay Wildlife Sanctuary. Very little of it, unfortunately, lies within the protected area – the protected area boundaries only reaching the high water mark. The protected area also does not include the fragile coastal lagoon systems, with their large expanses of inundated dwarf mangrove.</p> <p>Much of the mangrove within CBWS is dwarf mangrove - significantly under-represented (<10% under protection), within the National Protected Areas System. Riverine mangroves is found at the mouth of the New River and Rio Hondo. Fringing mangrove, which lines most of the coast of Corozal Bay Wildlife Sanctuary, is also significantly under-represented (12.5%) within the NPAS. Despite these low-lying coastal areas having low development potential, they are, never-the-less, at high risk, with the significant global interest in coastal development for both residential and tourism purposes.</p>		<p>Red mangrove (<i>Rhizophora mangle</i>) Black mangrove (<i>Avicennia germinans</i>) White mangrove (<i>Laguncularia racemosa</i>) Mangrove associates Juvenile fish species</p> <ul style="list-style-type: none"> ▪ Yellow-fin mojarra ▪ Striped mojarra ▪ Snapper ▪ Snook ▪ Permit 	

Ecosystems: Coastal Ecosystems: Bird Nesting Colonies			
Current Status	NBCC Status	Goal	Objectives:
FAIR	GOOD	GOOD	<ul style="list-style-type: none"> ▪ <i>To protect and maintain bird nesting colonies within the Wildlife Sanctuary and larger NBCC at the current level or improved</i>
Justification		Species / ecosystems nested in this target	
<p>A number of nesting bird colonies in the CBWS have been identified as of national conservation importance (Meerman, 2005). Cayo Falso, with one of the few remaining magnificent frigatebird nesting colonies in Belize, also provides a nesting site for roseate spoonbills, boat-billed herons, brown pelicans, cormorants, reddish and great egrets, whilst other cayes within and adjacent to the protected area host white ibis, tricoloured herons and, two of the most important Wood Stork colonies within the entire region.</p> <p>Nesting colonies are still persisting on the majority of cayes. The white ibis colony on Shipstern cay (Cayo Conejo) has never recovered following the destruction of nests and collection of eggs by a local fisherman more than ten years ago. Recently, natural disasters have had a huge impact on the nesting islands, with Hurricane Dean, in particular, doing structural damage to mangrove canopies, temporarily reducing nest site availability.</p> <p>These colony nesting species are charismatic and a major tourism attraction to the area. When disbursing to feed, they populate not only the shallow coastal lagoons, and those of Deer Caye, but also those of Bacalar Chico National Park / Marine Reserve and are thought to travel as far inland as Crooked Tree Wildlife Sanctuary, providing an important tourism resource. Because of the fragility of large breeding colonies such as these, these species appear on the national list of species of concern (Meerman, 2005; draft).</p>		<p>Mangrove cayes throughout CBWS, BCMRNP and HCMR support nesting colonies for a variety of waterbirds. The two small mangrove cayes of Cayo Falso provide the sheltered structure for a large multi-species colony. Little Guana Caye was established as a bird sanctuary under the National Lands Act, in 1977, for the presence of the largest nesting colony of reddish egrets in the Caribbean. Smaller cayes also support smaller numbers of nesting and roosting birds. Species include:</p> <ul style="list-style-type: none"> ▪ Magnificent frigatebirds (<i>Fregata magnificens</i>) ▪ Brown pelican (<i>Pelecanus occidentalis</i>) ▪ White ibis (<i>Eudocimus albus</i>) ▪ Tricolored herons (<i>Egretta tricolor</i>) ▪ Roseate spoonbills (<i>Platalea ajaja</i>) ▪ Boat-billed heron (<i>Cochlearius cochlearius</i>). ▪ Double crested cormorants (<i>Phalacrocorax auritus</i>) ▪ Great egrets (<i>Ardea alba</i>) ▪ Reddish egrets (<i>Egretta rufescens</i>) 	

Ecosystems: Seagrass			
Current Status	NBCC Status	Goal	Objectives:
FAIR	GOOD	GOOD	<ul style="list-style-type: none"> ▪ To protect and maintain seagrass within the Wildlife Sanctuary and the larger NBCC at the current level or improved
Justification		Species / ecosystems nested in this target	
<p>Seagrass meadows are essential for maintaining the ecological health of the shallow marine ecosystems, with an important role in nutrient cycling and sediment stabilization. Seagrass beds are especially important as a nursery habitat for many species, and are a critical ecosystem for many fish and invertebrate species - an acre of sea grass has been shown to support up to 40,000 fish and 50 million small invertebrates (Seagrass Ecosystems Research Laboratory, 2005).</p> <p>Seagrass meadows are found throughout Corozal Bay Wildlife Sanctuary, with a reduction in density from the more saline southern end to the north eastern portion, where the influence from the New River and Rio Hondo reduces salinity. There has been a gradual, historical reduction in seagrass area thought to be associated with increased sediment load in the water column (community consultations).</p>		<p>Three species of seagrass are present in Corozal Bay Wildlife Sanctuary – turtle grass (<i>Thalassia testudinum</i>), manatee grass (<i>Syringodium filiforme</i>) and shoal grass (<i>Halodule wrightii</i>).</p> <p>Seagrass beds are essential for the juveniles of many commercial fish species. It is a critically important ecosystem within the Wildlife Sanctuary, serving as a nursery area, refuge and feeding ground for many faunal species, including the Antillean manatee, marine turtles, and commercial and sport finfish species.</p>	

Species Assemblages: Native Commercial Marine Species			
Current Status	NBCC Status	Goal	<i>Objectives:</i>
FAIR	FAIR	GOOD	<ul style="list-style-type: none"> ▪ <i>To maintain and improve the viability of the commercial species of Corozal Bay Wildlife Sanctuary</i>
Justification		Species / ecosystems nested in this target	
<p>Commercial finfish species support a local traditional fishing industry on which families in each of the coastal stakeholder communities depend. The role of many of the target finfish species as top predators is also essential in the maintenance of the estuary ecosystem. Most commercially important marine species have complicated life cycles that rely on the health and connectivity of the entire marine ecosystem – utilizing not just the seagrass beds and the mangroves, but also the reef and, for some, deep oceanic waters during their lives.</p> <p>The estuarine system of CBWS is important for the maintenance of local, culturally preferred finfish species – particularly the mojarra and snapper. Many of these reproduce in the estuary and rely on the inundated mangroves of the shallow coastal lagoons in their juvenile stage.</p> <p>Sport fish species – permit, tarpon, bonefish, jack, barracuda and (to a lesser extent) snook – are all fished in the Wildlife Sanctuary, and support a small sport fishing industry. This is primarily (but not entirely) catch and release.</p>		<p>Goliath Grouper (<i>Epinephelus itajara</i>) Striped mojarra (<i>Eugerres plumieri</i>) Yellowfin mojarra (<i>Gerres cinereus</i>) Grey snapper (<i>Lutjanus griseus</i>) Mutton snapper (<i>Lutjanus analis</i>) Lane snapper (<i>Lutjanus synagris</i>) Great barracuda (<i>Sphyraena barracuda</i>) Striped Mullet (<i>Mugil cephalus</i>) Crevalle Jack (<i>Caranx hippos</i>) Horse-eye jack (<i>Caranax latus</i>) Cero (<i>Scomberomonis regalis</i>) Snook (<i>Centropomus undecimalis</i>) Blue-striped grunt (<i>Haemulon sciurus</i>) Blue swimming crab Permit (<i>Trachinotus falcatus</i>) Tarpon (<i>Megalops atlanticus</i>) Bonefish (<i>Albula vulpes</i>) Snook (<i>Centropomus undecimalis</i>)</p>	

Species Assemblages: Elasmobranchs (Sharks and Rays)			
Current Status	NBCC Status	Goal	<i>Objectives:</i>
POOR	FAIR	FAIR	<ul style="list-style-type: none"> ▪ <i>To maintain and improve the viability of sharks and rays using Corozal Bay Wildlife Sanctuary</i>
Justification		Species / ecosystems nested in this target	
<p>Sharks are top predators in the marine environment – wide ranging species that require large, healthy seascapes for viable populations. Nationally, sharks are under increasing fishing pressure, with demand for shark meat from neighbouring countries, especially during the Lenten season, and growing international demand from countries such as China for both the shark meat and fins.</p> <p>The CBWS estuarine system is reported to have at least four shark species within the general area (Bonfil, 1997), with bull, blacktip, nurse and bonnethead sharks reported from the Bulkhead Shoals area to the southern end of the Wildlife Sanctuary, southeast of Deer Caye. The channels in this area are thought to be an important nursery area for these Elasmobranchs, and recent surveys have highlighted the presence of one of the few documented bull shark nurseries in Belize, in the southern section of the Wildlife Sanctuary (Graham, 2010).</p> <p>The shallow, sheltered waters of the Corozal Bay Wildlife Sanctuary and the adjacent coastal lagoons, are important as a pupping area for a number of species of sharks and rays (Graham, 2010), particularly in the Bulkhead Shoals area to the southern end of the Wildlife Sanctuary, southeast of Deer Caye.</p> <p>Note: The ratings are based more on the shark population viability than that of the rays.</p>		<p>Bull shark (<i>Carcharhinus leucas</i>) Black tip shark (<i>Carcharhinus limbatus</i>) Nurse shark (<i>Ginglymostoma cirratum</i>) Bonnethead shark (<i>Sphyrna tiburo</i>) (no recent sightings) Longnose stingray (<i>Dasyatis guttata</i>) Southern stingray (<i>Dasyatis americana</i>) Caribbean whiptail stingray (<i>Himantura schmardae</i>)</p>	

Species Assemblages: Charismatic Marine Megafauna			
Current Status	2007 Status	Goal	Objectives:
GOOD	GOOD	GOOD	<ul style="list-style-type: none"> ▪ To maintain and improve the viability of Antillean manatee populations within Corozal Bay Wildlife Sanctuary
Justification		Species / ecosystems nested in this target	
<p>This target covers larger charismatic species that require large seascapes and/or are of touristic value. The key target is the Antillean manatee – the species for which the Wildlife Sanctuary was first designated.</p> <p>Corozal Bay Wildlife Sanctuary is estimated to have a population of approximately 100 individual manatees based on a maximum count of 70 (SACD / Wildtracks data, 2017). It is an important calving and nursery area, with mating herds and mothers with calves. Reports of boat strikes are infrequent, though manatee mortality is increasing (though some of these deaths are occurring outside the protected area, in the New River and Rio Hondo).</p> <p>Some individuals are transient, with males in particular using the coastal waters of both Santuario del Manati and Corozal Bay Wildlife Sanctuary...and travelling south the length of Belize (Castelblanco-Martinez et al., 2013).</p> <p>A turtle rescued from a Corozal Bay beach trap travelled over 1,000 km north after release, to coastal waters north of Merida in the northern Yucatan, demonstrating the level of connectivity in the Mesoamerican Reef region.</p>		<p>Antillean manatee (<i>Trichechus manatus manatus</i>) Common bottlenose dolphin (<i>Tursiops truncatus</i>) American crocodile (<i>Crocodylus acutus</i>) Morelet’s crocodile (<i>Crocodylus moreletii</i>) Hawksbill turtle (<i>Eretmochelys imbricata</i>) Loggerhead turtle (<i>Caretta caretta</i>)</p>	

Physio-chemical Environment			
Current Status	2007 Status	Goal	<i>Objectives:</i>
FAIR	FAIR	GOOD	<ul style="list-style-type: none"> ▪ <i>To improve the water quality of Corozal Bay Wildlife Sanctuary</i>
Justification		Species / ecosystems nested in this target	
<p>The water quality of the transboundary estuarine system is considered to be fair to good, but with significant local impacts by organic contaminants (nitrates / nitrites and phosphates) in waters adjacent to coastal communities / coastal developments, and where the Rio Hondo and New River empty into the system.</p> <p>Testing for silicates shows that not only do the contaminants enter from direct runoff from coastal areas and the rivers, but also from the watersheds through the groundwater, with contaminants dissolving in water that percolates through the soil and limestone rock to enter the aquifer.</p>		<p>All CBWS and NBCC targets, including the coral reef</p>	

Ancient Formations			
Current Status	2007 Status	Goal	<i>Objectives:</i>
FAIR	GOOD	GOOD	<ul style="list-style-type: none"> ▪ <i>To improve the knowledge and status of Ancient Formations of Corozal Bay Wildlife Sanctuary</i>
Justification		Species / ecosystems nested in this target	
This target covers both stromatolites and pre-Hispanic archaeological sites.		<ul style="list-style-type: none"> ▪ Stromatolites ▪ Pre-hispanic fish traps ▪ Coastal Maya sites 	

2.3 Assessment of Critical Threats

2.3.1 Assessment of Critical Threats

The Threat Assessment workshop for the NBCC was conducted in 2014, with input from a broad range of stakeholders. It focused on the assessment of stresses and threats affecting the key ecological attributes and the targets, and providing each focal target with a threat status rating.

Outputs from the MAP2 workshop identified and assessed stresses and sources of stress, allowing prioritization of management actions and resources towards the most critical threats. This was achieved through analyzing the stresses in terms of scope and severity, and the sources of stress through assessment of contribution and irreversibility (Table 39, 40).

Four targets have threat ratings of **High**:

- **Coastal Ecosystems**
- **Coral Reefs**
- **Commercial Marine Species**
- **Physio-chemical Environment**

One target has a threat rating of **Medium**:

- **Seagrass**

One target is rated as having a threat status of **Low**.

- **Charismatic Marine Megafauna**

The target **Ancient Formations** is yet to be assessed, needing further input from experts. The MAP process assesses the stress and source of stress for each management target).

Identified Threats to the Northern Belize Coastal Complex (pre-consolidation)

High

- Coastal / Caye Development
- Climate Change
- Unsustainable Fishing Pressure
- Land-based / Industrial Pollution

Medium

- Invasive Species: Lionfish
- Marine Habitat Loss
- Oil Spills
- Inadequate Sewage Treatment

Low

- Oil Drilling And Exploration
- Poor Tourism Practices
- Aquaculture
- Fires In Littoral Forest
- Hunting In Littoral Forest
- Improper Disposal Of Contaminated Water (Pool Water, Hyper saline Reverse Osmosis Water)
- Improper Disposal Of Waste (Cruise Ships, Leachate, Anti-Fouling Paint)
- Large Vessel Grounding
- Marine Garbage
- Sedimentation (River / Coastal Erosion)
- Watercraft / Marine Mammal Collision

Definitions for Stress and Source of Stress

Stress – The impaired aspects of conservation targets that result directly or indirectly from human activities (e.g., low population size, reduced extent of littoral forest; increased sedimentation; lowered groundwater table level). Generally equivalent to degraded key attributes / characteristics (e.g., habitat loss).

Source of Stress (Direct Threat) – The proximate activities or processes that directly have caused, are causing or may cause stresses and thus the destruction, degradation and/or impairment of focal conservation targets (e.g., Unsustainable caye development).

TNC, 2007

Rating Criteria for Stresses

Severity - The level of damage to the conservation target that can reasonably be expected within 10 years under current circumstances (i.e., given the continuation of the existing situation).

- **Very High:** The threat is likely to destroy or eliminate the conservation target over some portion of the target's occurrence at the site.
- **High:** The threat is likely to seriously degrade the conservation target over some portion of the target's occurrence at the site.
- **Medium:** The threat is likely to moderately degrade the conservation target over some portion of the target's occurrence at the site.
- **Low:** The threat is likely to only slightly impair the conservation target over some portion of the target's occurrence at the site.

Scope - The geographic scope of impact on the conservation target at the site that can reasonably be expected within 10 years under current circumstances (i.e., given the continuation of the existing situation).

- **Very High:** The threat is likely to be widespread or pervasive in its scope and affect the conservation target throughout the target's occurrences at the site.
- **High:** The threat is likely to be widespread in its scope and affect the conservation target at many of its locations at the site.
- **Medium:** The threat is likely to be localized in its scope and affect the conservation target at some of the target's locations at the site.
- **Low:** The threat is likely to be very localized in its scope and affect the conservation target at a limited portion of the target's location at the site.

TNC, 2007

Rating Criteria for Sources of Stress

Contribution - The expected contribution of the source, acting alone, to the full expression of a stress (as determined in the stress assessment) under current circumstances (i.e., given the continuation of the existing management/conservation situation).

- **Very High:** The source is a very large contributor of the particular stress.
- **High:** The source is a large contributor of the particular stress.
- **Medium:** The source is a moderate contributor of the particular stress.
- **Low:** The source is a low contributor of the particular stress.

Irreversibility - The degree to which the effects of a source of stress can be restored.

- **Very High:** The source produces a stress that is not reversible (e.g., wetlands converted to a shopping centre).
- **High:** The source produces a stress that is reversible, but not practically affordable (e.g., wetland converted to agriculture).
- **Medium:** The source produces a stress that is reversible with a reasonable commitment of resources (e.g., ditching and draining of wetland).
- **Low:** The source produces a stress that is easily reversible at relatively low cost (e.g., off-road vehicles trespassing in wetland).

Threats Across Targets	Coastal Ecosystems	Coral Reefs	Seagrass	Commercial Marine Species	Marine Mammals	Physio-chemical Environment	Ancient Formations	Overall Threat Rank
Climate Change	Very High	High	Low	High	Low	Medium	Very High	Very High
Coastal /Caye Development	Very High	High	Medium	Medium	Low	Medium	Very High	Very High
Land-based Pollution		High	Low		Low	High	Very High	High
Unsustainable /Illegal Fishing Pressure		High	Medium	High	Low			High
Oil drilling, Exploration and Spills	Low	High	Low		Low	High	Low	High
Lionfish		High		Medium				Medium
Improper disposal of waste (cruise ships, leachate, anti-fouling paint)		Medium				Low	Medium	Medium
Poor Tourism Practices		Low			Low		Medium	Low
Poor Boating Practices		Low	Low		Low			Low
Illegal Activities in Littoral Forest	Low							Low
Overall Threat Status for Targets	Very High	Very High	Medium	High	Low	High	Very High	Very High

TABLE 39: PRIORITIZATION OF IDENTIFIED THREATS

Rating Critical Threats

Rating Critical Threats (adapted from WCS)					
Criteria	Score		Criteria	Score	
AREA	4	Will affect throughout >50% of the area	RECOVERY	3	100+ years or never
	3	Widespread impact, affecting 26 – 50% of the area		2	11 – 100 years
	2	Localized impact, affecting 11 – 25% of the area		1	1 – 10 years
	1	Very localized impact, affecting 1 – 10% of the area		0	Immediate
SEVERITY					
SEVERITY	3	Local eradication of target possible	PROBABILITY	1.00	0.76 - 1.00
	2	Substantial effect but local eradication unlikely		0.75	0.51 – 0.75
	1	Measurable effect on density or distribution		0.5	0.26 – 0.50
	0	None or positive		0.25	≤ 0.25
URGENCY					
URGENCY	3	The threat is occurring now and requires action			
	2	The threat could or will happen between 1 – 3 years			
	1	The threat could happen between 3 – 10 years			
	0	Will not happen in > 10 years			

TABLE 40: RATING CRITICAL THREATS

2.4 Planning for Climate Change

2.4.1 Site Resilience Assessment

When planning management strategies for climate change, it is important to determine areas of resilience and vulnerability, and to identify adaptive strategies that can assist in maintaining the viability of biodiversity whilst increasing social resilience at both site and stakeholder community level. This assessment of the predicted implications of climate change has been conducted for Corozal Bay Wildlife Sanctuary), based on the **conservation targets** identified during conservation planning, and on the **environmental services** provided by the protected, identified during the management planning process.

The following assessment has been based on Belize's "Guidelines for Integrating Climate Change Adaptation Strategies into Protected Areas Management Plans" management planning framework, and provides a mechanism for assessing the implications of climate change through a series of steps:

1. Understanding climate change projections for CBWS
2. Identifying vulnerability factors and resilience features
3. Identifying focal targets threatened by climate change
4. Assessing, rating and prioritizing the threat of climate change for each focal target
5. Situation Analysis and baseline
6. Development of adaptation objectives and strategies

Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems. Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen.

IPCC, 2014

2.4.2 Identified Resources of Corozal Bay Wildlife Sanctuary

The following resources have been identified as important for Corozal Bay Wildlife Sanctuary:

The Fisheries Sector consisting primarily of a traditional capture fisheries focused on snapper, stone bass (mojarra and chiwa) and other local finfish species.

Resource	Comment
<ul style="list-style-type: none"> ▪ Snapper and other finfish 	<p>CBWS supports a number of local traditional fishing families, based primarily on use of beach traps and gill nets. These supply local communities with culturally important species (chiwa and mojarra).</p> <p>The mangroves of the estuary provide important nursery habitat for economically important snapper, snook and other fish species.</p>
<ul style="list-style-type: none"> ▪ Subsistence fishing 	<p>Community use of cast nets in Corozal Bay, adjacent to the communities, provides a protein source for families.</p>

The Tourism Sector Corozal Bay Wildlife Sanctuary is a locally important recreational resources for communities, but has not yet fully developed as a tourism resource. It is known for its population of charismatic manatee, though these are only seen opportunistically. There is, however, a growing sport fishing industry based on tarpon, permit and bonefish, as well as trolling for barracuda, jacks and other sport species.

Resource	Comment
<ul style="list-style-type: none"> ▪ Wildlife 	<p>The Wildlife Sanctuary is a huge wilderness area with significant wildlife attractions – nesting bird cays with frigatebirds, herons, egrets, spoonbills and ibis, Antillean manatees, bottlenose dolphins, and Morelet’s crocodiles</p>
<ul style="list-style-type: none"> ▪ Scenic Beauty 	<p>The spectacular sunrises and sunsets over the wildlife Sanctuary are enjoyed by residents and visitors. The uninterrupted scenic vistas of the bay and the coastal lagoons are valued for their wilderness-aspects</p>
<ul style="list-style-type: none"> ▪ Fly-fishing / sport fishing 	<p>Sport fishing is an important income source for a small number of families from the local communities (predominantly Sarteneja and Corozal / Consejo), and for sport fishing guides from San Pedro. The mangroves provide important nursery areas for sport fish species</p>

Ecosystem Service: The health of the marine environment is critical to the social and economic health of Belize. The ecosystem services provided by the mangroves and seagrass cannot be over-estimated.

Ecosystem	Ecosystem Services
<ul style="list-style-type: none"> ▪ Mangroves 	<p>The mangroves provide a highly productive nursery habitat for juvenile commercial species (both extractive species supporting fishermen livelihoods and sport fish species). It buffers and protects life and property on the coastline, reducing shore erosion and filtering land based pollutants before they reach the estuary.</p>
<ul style="list-style-type: none"> ▪ Seagrass 	<p>The seagrass beds, with high connectivity to mangrove, provide productive nursery habitat for juvenile commercial species, as well as foraging sites for threatened species such as marine turtles, and commercial species. Seagrass is also recognized for its value in CO₂ absorbing qualities.</p>
<ul style="list-style-type: none"> ▪ Coastal Ecosystems 	<p>The coastal ecosystems adjacent to Corozal Bay Wildlife Sanctuary support some of the last, and most important, remnants of extensive littoral forest, considered one of the most threatened ecosystems in Belize. The coastal strand vegetation is important for stabilizing turtle and crocodile nesting beaches, and maintaining the caye.</p>

2.4.3 Identification of the Primary Climate Change Elements

The primary climate change elements associated with Corozal Bay Wildlife Sanctuary are identified as:

- Sea level rise
- Increased sea surface temperature
- Increased intensity of storms
- Ocean Acidification
- Decreased precipitation
- Increased air temperature

For each target, the impacts of the identified primary climate change elements (sea level rise, increased sea surface temperature, increased intensity of storms, ocean acidification, decreased precipitation, increased air temperature), were identified (Table 41) Ratings took into consideration factors such as the severity, scope, contribution and irreversibility of each climate change element (Table 42), and the impacts on each management target (Table 43).

Table 41: Climate Change Predictions (B2 Scenario) for Corozal Bay Wildlife Sanctuary			
Climate Change Impacts	Current Status	25 - 50 yrs	100 yrs
Sea level rise	Increased global average sea level rise rate of 1.8mm per year from 1961 – 2003 (IPCC, 2007). Current average increase in sea level rise in the Mesoamerican region is estimated at 3.1mm per year (IPCC, 2007).	The Hadley Centre’s Unified Global Climate Model (GCM), HadGEM2-ES provides additional data to the IPCC reports (IPCC 2007, 2013) for the three Representative Pathways Projection scenarios ¹ . In all three, the coastal sea level is projected to exceed 10 cm by the 2030s; 22, 23, and 38 cm respectively are projected for the low, medium and high emission scenarios by 2050 (NCCPSAP 2015).	By the end of the Century, the Hadley Centre’s Unified GCM, HadGEM2-ES projects coastal seal level to rise by 34, 56, 120 cm respectively for the low, medium and high emission scenarios (NCCPSAP 2015).
Sea surface temperature rise	Water temperature has increased by 0.74°C between 1906 and 2005 Current levels of increase are estimated at 0.4°C per decade (Simpson et al., 2009)		Predicted regional increase of temperature by up to 5°C by 2080, with the greatest warming being experienced in the north-west Caribbean (including Belize) (WWF, 2009).
Increased intensity and frequency of storms	Increased storms from 1999 onwards, with annual fluctuations. More storms during El Nina, fewer during El Nino. Stronger storms >Cat 4 / 5	Extreme precipitation events over most of the mid-latitude land masses and over wet tropical regions predicted to become more intense and more frequent.	Extreme precipitation events over most of the mid-latitude land masses and over wet tropical regions predicted to become more intense and more frequent.
Increased Air Temperature	Mean annual temperature has increased in Belize by 0.45°C since 1960, an average rate of 0.10°C per decade. Average number of ‘hot’ days per year in Belize (days exceeding 10% of current average temperature) has increased by 18.3% between 1960 and 2003 (NCSP/UNDP).	Warming is occurring throughout Central America; up to 1°C since the mid-1970s (IPCC, 2014). Both seasonal and annual air temperatures are predicted to increase by approximately 2°C.	Temperatures are expected to increase between 1.6°C to 4.0°C by 2100 (IPCC, 2014).

¹ RCP 2.6 (low emission), RCP 4.5 (medium emission), and RCP 8.5 (high emission) scenarios

Climate Change Predictions (B2 Scenario) for Corozal Bay Wildlife Sanctuary / 2			
Climate Change Impacts	Current Status	25 - 50 yrs	100 yrs
Changes in rainfall regime	Mean annual rainfall over Belize has decreased at an average rate of 3.1mm per month per decade since 1960 (NCSP/UNDP)	<p>Predictions suggest that 2020/2030 may show a slight increase in the early and late parts of the wet season (May and Oct-Nov). The dry season and the mid-wet season decreases in rainfall (June), on the other hand, will be characterized by further decreases. Between 2030/2040, the entire country will be characterized by reduced precipitation, with exceptions only in early and late parts of the wet season (May and Nov). 2050/2060 projections are for an enhancement of the 2030s pattern of reduced rainfall (-1 to -4 mm/day) in the dry season (December – April). Increased precipitation of 2-7 mm/day is projected during the early and late (Oct May - Nov) parts of the wet season (NCCPSAP 2015). These predictions are based on predictions for the mainland – Stann Creek District.</p> <p>Predicted ecological shifts may alter the catchment functionality important for maintaining rivers in dry season in the south of Belize, and providing nutrients to the reef environment.</p> <p>Increased concentration and seasonality of agrochemical delivery</p>	During the 2070s and 2090s predictions suggest that the Belize landscape is marked by reduced rainfall from December through to September. The largest reduction of up to -7 mm/day is projected in the Stann Creek District during the mid-wet season dip in June. The end of the wet season (Oct - Nov) maintains increased rainfall of 2 – 5 mm/day in the western Toledo, Stann Creek, Orange Walk and Corozal Districts (NCCPSAP 2015)

Climate Change Predictions (B2 Scenario) for Corozal Bay Wildlife Sanctuary / 3			
Climate Change Impacts	Current Status	25 - 50 yrs	100 yrs
Ocean acidification (molluscs and crustaceans)	Atmospheric CO ₂ concentration has increased from 280 parts per million (ppm) in 1880 to 385 ppm in 2008 - 35% increase in hydrogen (Simpson et al., 2009). 48% of all atmospheric CO ₂ resulting from burning of fossil fuels has been taken up by the ocean (Hartley, 2010)	Predicted atmospheric CO ₂ levels of 450 by 2040 (Simpson et al., 2009). Predicted 30% decrease in pH. Predicted decrease in calcification rate by 20 - 50% by 2050	Some experts predict a 35% reduction in coral growth by 2100 (Simpson et al., 2009) Decrease of between 0.3 and 0.5 units by 2100 (Hartley et. al. 2010).

TABLE 41: CLIMATE CHANGE PREDICTIONS (B2 SCENARIO) FOR COROZAL BAY WILDLIFE SANCTUARY

2.4.4 Climate Change Assessment Outputs

Target	Threat (based on Climate Change phenomena)	Certainty : The certainty that the effect of Climate Change will occur or the cause of the described impact will affect the target	Severity: Level or damage to this key element, which can destroy it in 50 years	Scope: Geographical coverage of the target that will be impacted in 50 years	Irreversibility : The impact is permanent or cannot be reversed naturally or through human action
Corozal Bay Wildlife Sanctuary	Sea level rise	Very High	Medium	Very High	Very High
	Sea temperature rise	Very High	High	Very High	Very High
	Increased strength of storms	High	High	Very High	High
	Ocean acidification	Very High	High	Very High	Very High
	Decreased Precipitation	Very High	Medium	Very High	Very High
	Increased Air Temperature	Very High	Medium	Very High	Very High

TABLE 42: ASSESSMENT OF CLIMATE CHANGE IMPACTS ON COROZAL BAY WILDLIFE SANCTUARY

Climate Change Impacts	Ecosystems		
	Coastal Ecosystems	Seagrass	Mangrove
Sea level rise	In CBWS, the coastal ecosystems, primarily the rapidly disappearing littoral forest, lie outside the protected area on the low beach ridge. In the short term, the increasing salinity of the groundwater will lead to a shift in species composition to those that are more salt tolerant. In the longer term, these ridges will be inundated by sea level rise, with littoral forest gradually being replaced by mangroves. The cayes may become inundated, with loss of vegetation.	Over the medium term, seagrass should be able to survive in increased water depth, and may do better in the shallow estuarine area. Increases in water depths may reduce wind influence on the sediment, and increase water clarity. Shifts in distribution of seagrass beds – may expand in the area.	Greatest climate change challenges that mangrove ecosystems face are inundation, habitat loss, distribution shift. Greater inundation of fringing mangroves lenticels in aerial roots can cause the oxygen concentrations in the mangrove to decrease, resulting in death. Inland migration will occur, as saline savannahs become inundated. Increase in salinity of ground water – more saltwater intrusion may also affect distribution. Changes in dispersal patterns for mangrove propagules
Sea surface temperature rise		Temperature stress on seagrass will result in distribution shifts, changes in patterns of sexual reproduction, altered seagrass growth rates, metabolism, and changes in carbon balance. When temperatures reach the upper thermal limit for individual species, the reduced productivity will cause plants to die (above 35°C for <i>T. testudinum</i>). Higher temperatures may increase epiphytic algal growth, reducing available sunlight.	Reduced oxygen content in water in mangrove areas. Loss of reef may reduce protection from erosion and storm events, increasing risk to mangroves.

TABLE 43: ASSESSMENT OF CLIMATE CHANGE IMPACTS ON MANAGEMENT TARGETS OF COROZAL BAY WILDLIFE SANCTUARY

Climate Change Impacts	Ecosystems		
	Coastal Ecosystems	Seagrass	Mangrove
Increased frequency and intensity of storms	Removal of some or all natural vegetation with less time for regeneration between storms, lower scrubby vegetation, change in forest structure / reduced species diversity. Increased erosion of coast, changes in beaches. Arrival of opportunistic species. Impacts on ability to provide structural support for bird colonies (nesting / roosting) and provisioning of migratory species	Massive sediment movements that can uproot or bury seagrass. It may also become harder for seagrasses to become re-established. Would be exacerbated by anthropogenic impacts – primarily dredging and landfill	Destruction, inundation, changes in sediment dynamics. Possible increase in nutrients / growth. Large storm impacts result in mass mortality. Projected increases in the frequency of high water events could affect mangrove health and composition due to changes in salinity, and inundation. More frequent inundation is also projected to decrease the ability of mangroves to photosynthesize.
Ocean acidification (corals, lobster / conch)		Possible direct positive effect on photosynthesis and growth, as in some situations, seagrass is carbon limited. Higher CO ₂ levels may also increase the production and biomass of epiphytic algae on seagrass leaves, which adversely impact seagrasses by causing shading. The acidification of seawater could counter the high pH formed by photosynthesis in dense seagrass stands, thus increasing seagrass photosynthesis and productivity.	Positive increase in growth. However, damage to coral reefs may adversely impact mangrove systems that depend on the reefs to provide shelter from wave action. May affect mangrove root communities – especially invertebrates, such as molluscs.
Decreased Precipitation	Drier conditions, leading to a shift in species composition, to lower diversity, and more drought-tolerant plants species. Reduced value for migratory birds. Effects on carbon uptake, photosynthesis and productivity	Potential increase in extent of seagrass beds in CBWS as the freshwater influence decreases	Reduction of freshwater lens, effect on carbon uptake and photosynthesis. Decreased precipitation results in a decrease in mangrove productivity, growth, and seedling survival, and may change species composition favouring more salt tolerant species and shrubby growth forms.

Climate Change Impacts	Ecosystems		
	Coastal Ecosystems	Seagrass	Mangrove
Increased Air Temperature	Higher air temperature could cause more arid conditions – drier soils Potential change in species composition favouring more heat tolerant species.		May alter phenological patterns - timing of flowering and fruiting. At temperatures above 25°C, some species show a declining leaf formation rate. Above 35°C have led to thermal stress affecting mangrove root structures and establishment of mangrove seedlings. At leaf temperatures of 38-40°C, almost no photosynthesis occurs (IUCN, 2006). Possible localized changes in distribution.

Climate Change Impacts	Resources		
	Commercial Species / Elasmobranchs	Antillean manatees	Colony Nesting Birds
Sea level rise	Snapper / grouper / chiwa / mojarra and other finfish: Shift in range / habitat loss of both adult and juvenile lobster – linked to inundation of mangrove, shift in seagrass distribution,	Potential for improved habitat for manatees in CBWS, supported by improved seagrass productivity. Deeper water buffering against reduced temperature ranges	The nesting cayes may become inundated, Salt incursion of water table altering terrestrial vegetation cover, with changes in species presence / diversity, reducing structural support of nesting colony and availability of nesting sites.
Sea surface temperature rise	Reduced capacity for holding oxygen - Increased potential for fish kills in high temperature peaks. May affect physiological processes, and disease may become more prevalent. Possible impacts from new invasive species and algal blooms. Changes in currents and larval dispersal	Temperatures exceeding 33°C may result in manatees moving out of the estuary to seek cooler waters, but may be buffered by increased water depth. Temperatures exceeding 35°C will result in decreased productivity of seagrass	Potential impacts on food sources
Increased frequency and intensity of storms	Seagrass and mangrove destruction, increased sedimentation, affecting larval and juvenile habitat Possible impacts on larval dispersal / survival (potential for wider dispersal of larvae)	Direct mortality of manatees (low). Short term destruction of seagrass beds, and increased sediment load impacting seagrass productivity.	Habitat destruction and increased sedimentation; Possible impacts on dispersal / survival. Inundation of nests from higher groundwater

Climate Change Impacts	Resources		
	Commercial Species	Antillean manatee	Colony Nesting Birds
Ocean acidification	<p>Potential impacts on larval viability and adult growth rates</p> <p>Unknown how fish respond to changes in pH balance</p> <p>Potential decrease in egg viability</p> <p>Potential decrease in viability of eggs and juveniles</p>		Possible impacts on food sources
Decreased Precipitation	<p>Possible changes in salinity impacting larval dispersal.</p> <p>Lobster migration patterns and times will change.</p> <p>More frequent, higher salinity pulses before equalization with main seawater body.</p> <p>There is a hypothesis that increased algal bloom may be attributed to reduced precipitation</p>	<p>Increased presence in rivers as estuary becomes more saline, with increased potential for watercraft collisions</p> <p>Improved seagrass productivity.</p>	Possible changes in littoral forest species composition to more drought tolerant species may impact structural suitability of littoral forest for supporting nesting colony
Increased Air Temperature	Potential impacts on mangroves as a nursery habitat		Potential impact on hatch success

Climate Change Impacts	Resources
	Physio-chemical Environment
Sea level rise	Deeper, more stable water with reduced wind impact stirring up sediments. More stable water temperatures – reduced fluctuation. Improved conditions for seagrass, improving filtration of water, reduced turbidity. Reduced efficiency of Bulkhead Shoals in retaining water, with increased water flow through estuary
Sea surface temperature rise	Potential for reduced oxygen content, reducing support for fish and other species in high temperature peaks – however, offset by increased water depth
Increased frequency and intensity of storms	Damage / destruction of coastal vegetation with increased erosion of coast and cayes, increasing sediment load in water. Stirring up of sediments laid down at the river mouths, releasing stored contaminants into the estuary. Increased agro-chemical contamination following storm events, with agrochemicals washing into the rivers, then flowing into the estuary (both Rio Hondo and New River). Increase pollution from communities, with overflowing septic systems washing into the rivers and estuary.
Ocean acidification	Increased pH of water
Decreased Precipitation	A trend of increased salinity
Increased Air Temperature	

TABLE 43: ASSESSMENT OF CLIMATE CHANGE IMPACTS ON MANAGEMENT TARGETS OF COROZAL BAY WILDLIFE SANCTUARY

Each target is then assessed for the impacts of the identified primary climate change elements (increased intensity of storms, decreased precipitation, increased air temperature and increased water temperature), each element being rated on a scale of 1 to 4 (Table 44). Ratings took into consideration factors such as the severity, scope, contribution and irreversibility of each climate change element (Table 45).

Rating		Description
Very High	4	The climate change element is (or is predicted to be) the major contributing factor to the reduced viability, or possible local extinction, of the target over the majority of its extent within the project area over the next 50 years, and cannot be reversed
High	3	The climate change element is (or is predicted to be) a significant contributing factor to the reduced viability of the target over a significant part of its extent within the project area over the next 50 years, but can be reversed at high cost or over a long time period
Medium	2	The climate change element is (or is predicted to be) a moderate contributing factor to the reduced viability of the target over part of its extent within the project area over the next 50 years, and can be reversed at moderate cost
Low	1	The climate change element is (or is predicted to be) a minor contributing factor to the reduced viability of the target in localized areas within the project area over the next 50 years, and will reverse naturally or at limited cost
Positive	0	The climate change element is (or is predicted to be) a positive impact on target viability

TABLE 44: RATINGS FOR SELECTION OF PRIORITY CONSERVATION TARGETS

Notes:

Stromatolites have not been included as there is little known about them.

Physio-chemical Environment is included as a selected target

Coastal Ecosystems aren't included as a target as they are outside the control of SACD.

Strategies focus on mangroves

<i>Predicted climate change element</i>	<i>Conservation Targets</i>					
	<i>Coastal Ecosystems</i>	<i>Seagrass</i>	<i>Mangroves</i>	<i>Commercial Species</i>	<i>Antillean Manatee</i>	<i>Colony Nesting Birds</i>
<i>Increased sea level</i>	Very High (4.00)	Positive (0)	High (3)	Low (1)	Positive (0)	High (2)
<i>Increased sea temperature</i>	Low (1)	High (2)	High (2)	High (2)	High (2)	Low (1)
<i>Decreased Precipitation</i>	High (3)	Positive (0)	High (2)	Low (1)	Low (1)	Low (1)
<i>Increased frequency of storms</i>	High (3)	High (2)	High (3)	Low (1)	High (2)	High (3)
<i>Ocean acidification</i>	Low (1)	Positive (0)	Low (1)	High (3)	Low (1)	Low (1)
<i>Increased air temperature</i>	High (3)		High (2)		Low (1)	Low (1)
<i>Averaged Rating</i>	2.50	0.80	2.17	1.60	1.17	1.50
			Selected	Selected		Selected

TABLE 45: RATINGS FOR PRIORITIZATION OF CONSERVATION TARGETS

Selected Targets:

- *Mangroves*
- *Commercial Fish Species*
- *Colony Nesting Birds*
- *Physio-Chemical Environment*

2.4.5 Climate Change-Related Threat Assessment

A threat assessment was conducted highlighting the highest current anthropogenic threats to each of the selected management targets. Potential threats that may evolve as a result of climate change have also been identified (Table 46). These threats were then assessed using a series of ratings (Table 47; Table 48).

Key Conservation Target	Current Anthropogenic Threats	Potential Climate Change-Related Anthropogenic Threats
Mangroves	<ul style="list-style-type: none"> ▪ Clearance for coastal and caye development ▪ Clearance for aesthetics 	<ul style="list-style-type: none"> ▪ Increased mangrove clearance for construction of seawalls to address sea level rise and increased erosion
Native Commercial Fish Species	<ul style="list-style-type: none"> ▪ Unsustainable fishing ▪ Clearance of mangrove nursery areas for development 	<ul style="list-style-type: none"> ▪ Increased focus on farmed fish species as reef fishing declines, with potential for new / increased invasives
Colony Nesting Birds	<ul style="list-style-type: none"> ▪ Clearance of nesting caye vegetation caye development ▪ Increased tourism impacting nesting success 	<ul style="list-style-type: none"> ▪ Clearance of mangroves supporting nests for caye development, with construction of seawalls and dredging for fill to address sea level rise and increased erosion ▪ Increased focus on tourism in CBWS as increased climate change impacts affect fishing and agriculture
Physio-chemical Environment	<ul style="list-style-type: none"> ▪ Agrochemical pollution from watersheds ▪ Sewage contamination from urban areas – both on coast of CBWS and on rivers 	<ul style="list-style-type: none"> ▪ Increased pesticide / herbicide use as climate change brings increased agricultural diseases ▪ Increased urban populations as fishing and agriculture decline ▪ Increased landfill on coastal and caye properties to combat sea-level rise

TABLE 46: CURRENT ANTHROPOGENIC THREATS AND POTENTIAL, CLIMATE-CHANGE RELATED ANTHROPOGENIC THREATS

Ranking Criteria	Rating		Rating Definitions
Certainty: The certainty that the effect of Climate Change will occur or the cause of the described impact will affect the target	Very High	4	Confirmed
	High	3	Considered very probable but not confirmed
	Medium	2	Considered probable
	Low	1	Considered a limited probability, much debate
Severity: Level or damage to this key element, which can destroy it in 50 years	Very High	4	Destroys the ecosystems or its production activities
	High	3	Seriously degrades the target
	Medium	2	Moderately degrades the target
	Low	1	Slightly impairs the target
Scope: Geographical coverage of the target that will be impacted in 50 years	Very High	4	75% - 100% of the geographic coverage
	High	3	50% - 75% of the geographic coverage
	Medium	2	25% - 50% of the geographic coverage
	Low	1	<25% of the geographic coverage
Irreversibility: The impact is permanent or cannot be reversed naturally or through human action	Very High	4	Not reversible, even with human intervention
	High	3	Reversible but at high cost or very long term (> 100 yrs)
	Medium	2	Reversible with human intervention
	Low	1	Naturally reversible or with little human intervention and / or little cost

TABLE 47: RATING CRITERIA FOR ASSESSING CLIMATE CHANGE ADAPTATION THREATS PER TARGET (AFTER TNC)

Table 48: Assessment of Climate Change Adaptation Threats

	Certainty	Severity	Scope	Irreversibility	Averaged Score
Mangroves					
Increased mangrove clearance for construction of seawalls	Very High (4): Current coastal development favours construction of seawalls. A small number follow best practices	Very High (4): Will replace mangrove in areas where development occurs and sea walls are used	Medium (2): Increasing on the northern coastline, especially adjacent to urban areas (Corozal, Consejo and Sarteneja)	High (3): Not easily reversible - there would be resistance from developers. Addressed through engagement of developers in best practices, surveillance and enforcement of developments, and use of the EIA process.	3.25
Native Commercial Fish Species					
Increased focus on farmed fish species as reef fishing declines, with potential for new / increased invasives	High (3): Some fishers have already started experimenting with diversification into <i>Tilapia</i> . This will probably increase as fishing becomes less productive. The low terrain and increasing storm events suggests a high probability of escaped farmed fish into the system	Low (1): The increasing salinity is not conducive for reproduction of <i>Tilapia</i> (the primary species farmed in Belize) – even at current salinity, <i>Tilapia</i> has been unable to invade the estuary on a permanent basis	Medium (2): <i>Tilapia</i> is confined to the lower salinity areas of the estuary, nearest the rivers. However, if a new farmed species was introduced with a greater tolerance for saline water, there would be the potential for it to spread throughout the estuary	Very High (4): It would be difficult to impossible to remove an aquatic invasive species	2.50
Colony Nesting Birds					
Increased focus on tourism, impacting nesting success	High (3): There is a push to improve tourism in the area, based on its natural values – including the bird nesting colonies	Medium (2): The nesting colonies are relatively sensitive to increased human presence unless best practices can be put in place	Medium (2): The primary nesting colonies in the northern portion of the estuary will be targeted	Medium (2): Engaging tour guides and ensuring best practices are in place and legislation protecting nesting birds is enforced.	2.25
Clearance of mangroves supporting nests for caye development	High (3): Cayes supporting nesting colonies already have survey lines indicating intent to purchase. Will then require seawalls and dredging for fill	Very High (4) Clearance of the vegetation will remove the nesting colony	High (3): All cayes are targeted for development unless they can be integrated into CBWS	Very High (4): Once the vegetation has been cleared, it will take many years for it to return to a state where it can support a nesting colony again – and may be prevented by sea level rise	3.5

Table 48: Assessment of Climate Change Adaptation Threats					
	Certainty	Severity	Scope	Irreversibility	Averaged Score
Physio-chemical Environment					
Increased pesticide / herbicide use as climate change brings increased agricultural diseases	Very High (4): Farmers in the watersheds are heavy users of agrochemicals, and will increase use to tackle diseases	High (3): Contamination will reduce the quality of the water	Very High (4): Contamination will be transported throughout the watershed, though will be highest nearer the rivers	Very High (4): Agrochemical use will continue. Whilst agrochemical contamination cannot be completely reversed, there is a move towards best practices to reduce use	3.5
Increased urban populations (and therefore sewage / industrial contamination) as fishing and agriculture decline	High (3): Urban areas are growing as farming and agriculture become increasingly difficult. This is exacerbated by economic refugees from other Central American countries. (This includes Chetumal)	High (3): Contamination will reduce the quality of the water. Within Belize, this is relatively low scale, but the presence of Chetumal is an issue	Very High (4): Contamination will be transported throughout the watershed, though will be highest nearer the rivers	High (3): Will need significant investment in sewage systems and flood control drainage systems in urban areas	3.25
Increased landfill on coastal and caye properties to combat sea level rise	Very High (4): Already happening in coastal communities	Medium (2): Most filled coastal and caye properties will be protected by seawalls, reducing runoff	Medium (2): Increasing on the northern coastline, especially adjacent to urban areas (Corozal, Consejo and Sarteneja)	High (3): Not easily reversible - there would be resistance from developers. Addressed through engagement of developers in best practices, surveillance and enforcement of developments, and use of the EIA process. However where filling has been for speculation, it is possible that the area may revert to natural vegetation in the long term	2.75

TABLE 48: ASSESSMENT OF CLIMATE CHANGE ADAPTATION THREATS

2.5.6 Ranked Outputs

The assessment provides a prioritisation for potential threats that may occur as a result of changes in climate, based on the level of impact they would have on the specific targets (Table 49).

As climate change impacts increasingly affect the economic resources of the CBWS stakeholder communities, a predicted result would be a potential increase in illegal fishing at the spawning aggregation sites, and of species such as parrotfish and marine turtles, both of which have a market with the Honduran transboundary fishing vessels.

Climate Change Related Threat	Averaged Score
Increased pesticide / herbicide use as climate change brings increased agricultural diseases	3.50
Clearance of mangroves supporting nests for caye development	3.50
Increased mangrove clearance for construction of seawalls	3.25
Increased urban populations (and therefore sewage / industrial contamination) as fishing and agriculture decline	3.25
Increased landfill on coastal and caye properties to combat sea level rise	2.75
Increased focus on farmed fish species as reef fishing declines, with potential for new / increased invasives	2.5
Increased focus on tourism, impacting nesting success	2.25

TABLE 49: SUMMARY OF CLIMATE CHANGE-RELATED THREAT ASSESSMENT OUTPUTS

2.5.7 Building Resilience to Climate Change

A series of climate change adaptation strategies were then developed based on the assessment outputs, and including performance indicators for measuring success of implementation.

Priority Threat 1	Land based pollution – agriculture
Objective 1	<i>Reduce the use of agrochemicals in the watersheds</i>
Strategy 1	Baseline information on use of agrochemicals in the watersheds
Strategy 2	Baseline information on levels of agrochemicals in the water
Strategy 3	Collaborate with and support stakeholders and organizations in the watershed towards improving water quality of the New River, Rio Hondo and Progreso Lagoon system

Priority Threat 2	Clearance of mangroves supporting nests for caye development
Objective 1	<i>To maintain nesting colonies in CBWS</i>
Strategy 1	Baseline information on location of all nesting colonies, and identification of those with potential for development
Strategy 2	Lobby for inclusion of nesting cayes within CBWS as part of realignment process

Priority Threat 3	Increased mangrove clearance for construction of seawalls
Objective 1	<i>To engage landowners and communities in maintaining mangroves as natural shoreline protection</i>
Strategy 1	Update baseline information on % coastline cleared coastline under seawall
Strategy 2	Include monitoring of mangrove clearance in key areas in the surveillance and enforcement activities in CBWS
Strategy 3	Improve knowledge of coastal landowners and developers of mangrove legislation and best practices
Strategy 3	Develop collaborative partnerships with DoE and Forest Department for enforcement of mangrove legislation and EIA / ECP guidelines of coastal developments

Section Three

Management Planning



3. Management Planning

3.1 Management and Organizational Background

Regulatory authority for Corozal Bay Wildlife Sanctuary lies with the Forest Department (Ministry of Agriculture, Forestry, Fisheries, Environment and Sustainable Development). As with many national protected areas in Belize, site management lies with a co-management organization, the Sarteneja Alliance for Conservation and Development (SACD). The Sarteneja Alliance for Conservation and Development is a community-based organization guided by a multi-sectoral Board of Directors, advised by the Corozal Bay Advisory Committee of local stakeholders and resource users, and led by an Executive Director. Program strategies are implemented by the six local staff. Effective organizational management is achieved through a framework of internal policies and procedures.

In the ten years since its establishment in 2008, SACD has grown from a small community alliance of interested local organizations to a respected protected area co-management, and is currently transitioning to registration as a Non-Governmental Organization. With a vision and a mission that reflects the need for sustainable management of natural resources and a balance between people and the environment, SACD focuses on providing not only protection for wildlife and the environment, but also ecosystem services and benefits to its stakeholder communities and other resource users.

GOAL

Corozal Bay Wildlife Sanctuary

Promoting conservation actions that benefit biodiversity and people.

Sarteneja Alliance for Conservation and Development

VISION

A healthy, biodiverse Corozal Bay Wildlife Sanctuary in the larger northern seascape that supports and nurtures communities and sustainable livelihoods.

MISSION

SACD, as a community-oriented NGO, is dedicated to ensuring effective management and good stewardship of Corozal Bay Wildlife Sanctuary in the larger seascape, in partnership with its stakeholder communities.

Co-management

The Sarteneja Alliance for Conservation and Development (SACD) has a five-year co-management agreement with the Forest Department for Corozal Bay Wildlife Sanctuary, signed on December, 2013. Under this agreement, SACD is responsible for:

“the day-to-day management and administration of the protected area(s), preparation and implementation of management and operational plans for the protected area(s), and the management and development of the finances of the protected area(s), as detailed in the National Protected Areas Co-Management Framework.

a) Day-to-day management and administration of the protected area(s) shall include, but not be limited to, the following: staff recruitment and retention, staff supervision and development, expenditures and accounting, equipment and procurement, and management and financial audits with oversight provided by the Regulatory Agency.

b) The management and operational plans shall be developed as per the Management Plan template in conjunction with the Regulatory Agency.

c) The management and development of finances of the protected area(s) shall include, but not be limited to, the following: identifying and securing grant funding, and working to diversify financing mechanisms jointly with the Regulatory Agency and in partnership with other third parties.

The Forest Department (Government of Belize), as the regulatory agency, is responsible for:

“... providing management oversight with respect to the management of the protected area(s) and patrolling and law enforcement support.

a) Management oversight shall include, but not be limited to, the following: technical input in the development of protected area management and development plans, approval of management plans, training in legal proceedings and monitoring and evaluation of protected area management activities.

b) Patrolling and law enforcement support shall be in collaboration with the national law enforcement agencies and shall include the following: participation in protection patrols when requested by the Manager, including leading search, seizure and arrest operations when necessary; and the necessary support for the prosecution of offenses.

c) Financing support shall include to the extent possible, but not be limited to, the following: budget appropriations, project funding, and fiscal incentives such as tax exemptions.”

Sarteneja Alliance for Conservation and Development

In the last eight years, SACD has gained national respect, and a reputation for being an active and effective protected area management organization, with a clear mandate, consultative leadership and management. Community consultation is considered the starting point for planning, and community participation is woven into project development, implementation and monitoring and evaluation.

The governing body, the SACD Board of Directors, is formed from stakeholders with the technical capacity to provide oversight and effectively guide the organization in its development, and in its management of Corozal Bay Wildlife Sanctuary. SACD has also established the Corozal Bay Advisory Committee, composed of community and sector representatives, providing an effective mechanism for communication, collaboration and networking between individuals, associations and organizations in the CBWS area.

SACD's Strategic Plan provides a comprehensive roadmap that sets the direction of the organization's work over the past five years (SACD Strategic Plan, 2012 - 2017), and will be revised in 2017. The current strategic Plan focuses on four focal areas, considered critical to the effectiveness of the organization.

SACD 2019 STRATEGIC PLAN FOCAL AREAS

- **Financial Sustainability**
 - **Institutional Strengthening**
 - **Natural Resource Management**
 - **Communication and Engagement**
-

Day to day management of Corozal Bay Wildlife Sanctuary is the responsibility of the Executive Director and senior management staff. The Executive Director oversees the Program Directors, who are in turn responsible for the effective implementation of the program activities at site level (Figure 54).

Management objectives for Corozal Bay Wildlife Sanctuary as part of the North East Coastal Complex seascape

- To ensure the effective conservation and sustainable use of natural resources of Corozal Bay Wildlife Sanctuary
- To contribute towards the health and effective management of the larger Northern Belize Coastal Complex seascape
- To ensure adequate knowledge for biodiversity and human resource use management
- To increase community engagement, awareness and participation in the conservation of the natural resources of Corozal Bay Wildlife Sanctuary
- To ensure public use is conducted in an environmentally aware and sensitive manner

These are supported by the fifth objective:

- To provide SACD with an effective administration structure with mechanisms to promote financial sustainability
-

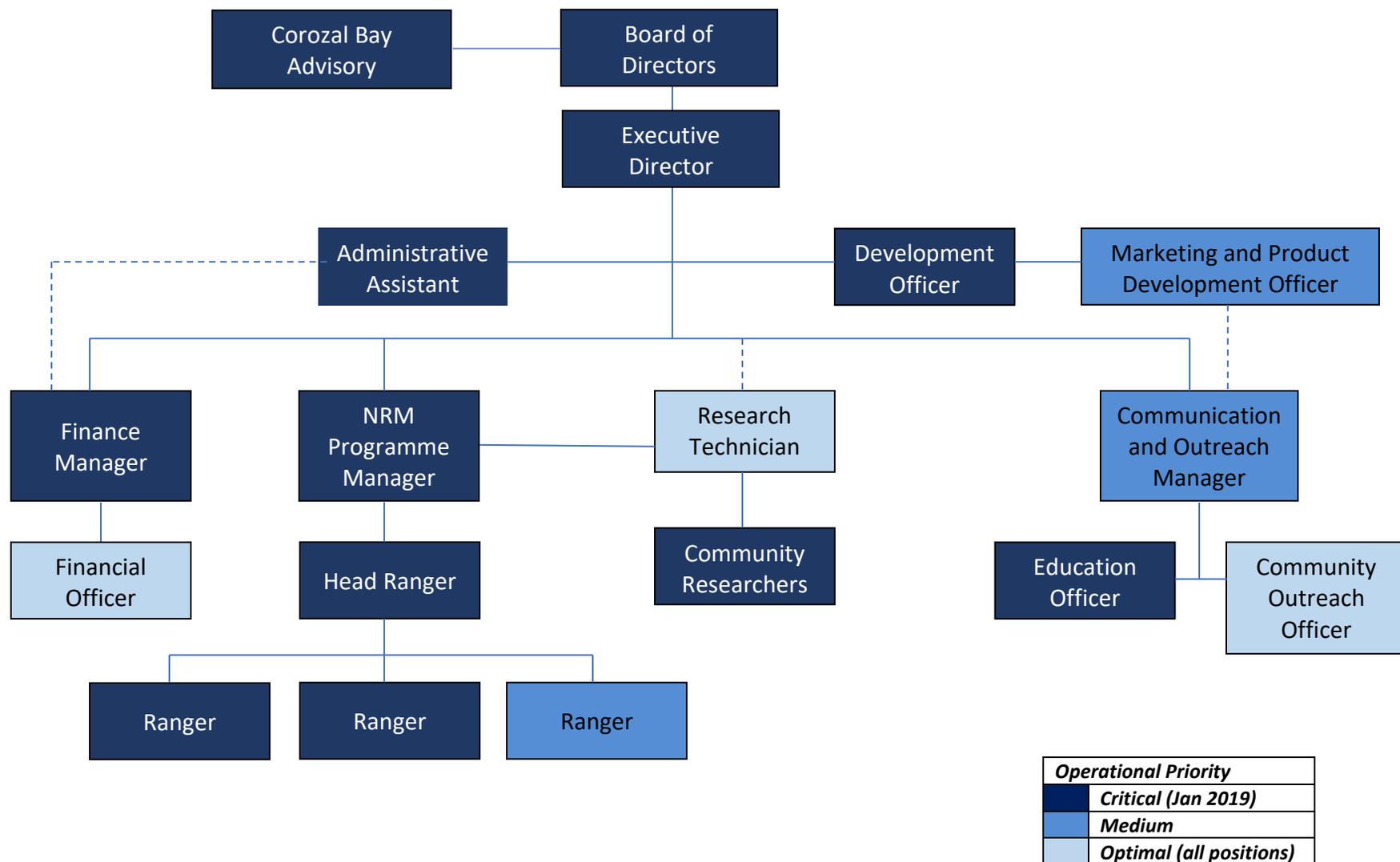


FIGURE 54: SACD ORGANIZATIONAL DIAGRAM

3.2 Review of Previous Management Plan

Implementation of the previous management plan (2013 To 2018) was evaluated in 2017 based on the Programmes and activities. Each activity was rated for the level of implementation on the following scale:

1. No implementation
2. Implementation has started, but there are no successful outputs to date
3. Partial success of implementation and outputs
4. The objective and expected outputs have been successfully achieved

A rapid review of the management programmes suggests that of the 93 action points identified within the 2013 management plan, 28% have been implemented successfully, 50% have resulted in an improvement in the situation (partial implementation) and 22% showed no change (Table 50). No area showed a decrease in status.

Table 50: Programme Rating Table for Implantation of 2003 Management Plan					
Programme	Total no. Action Points	<i>The objective and expected outputs have been successfully achieved</i>	<i>Partial success of implementation and outputs</i>	<i>Implementation has started, but there are no successful outputs to date</i>	<i>No implementation</i>
Natural Resource Management Programme	28	9	9	5	3
Research and Monitoring Programme	24	11	10	4	0
Interpretation and Education Programme	13	1	13	9	0
Public Use Programme	9	0	8	4	0
Administration and Maintenance Programme	26	10	13	0	0
Total no. Objectives / Actions	93	26	47	20	0
% of total		28%	50%	22%	0%

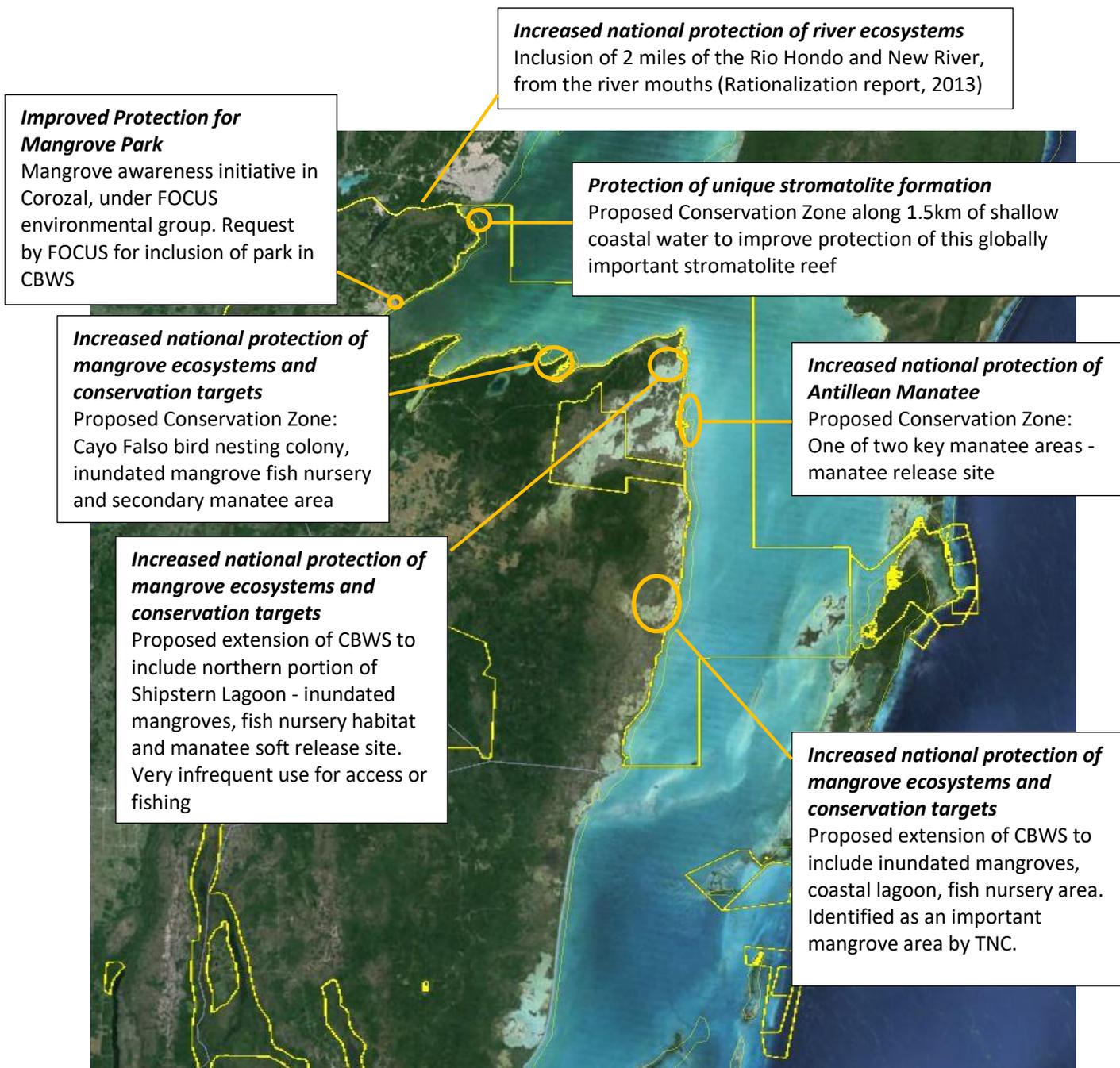
3.3 Management Strategies

3.3.1 Management Zones

The following recommendations were made for the realignment of boundaries of Corozal Bay Wildlife Sanctuary based on the:

1. reason for establishment of the protected area (transboundary protection of the Antillean manatee,
2. wish to ensure a continued, sustainable, traditional fishery in the CBWS and
3. national recommendations for the protected area's role in strengthening of Belize's National Protected Areas System through:
 - Increasing coverage of under-represented ecosystems within the National Protected Areas System
 - River
 - Mangrove and Marine Salt Marsh Ecosystems
 - Increasing species-specific protection for:
 - West Indian (Antillean) Manatee
 - Goliath Grouper
 - Bird Nesting Colonies
 - Improving fisheries management and fish nursery functionality (both commercial and sport fish species)
 - Building climate change resilience and improving ecosystem services in the Northern Belize Coastal Complex seascape
4. baseline data developed by SACD over the last five years, and community input towards developing a sustainable fishery in the Wildlife Sanctuary, with the emphasis on long term viability of conservation targets, both of the Wildlife Sanctuary itself, and in the larger river to reef Northern Belize Coastal Complex seascape.

Identification and mapping of priority management areas formed the foundation for the information-based zoning recommendations (Maps 8 and 9)



MAP 8: KEY REALIGNMENT AND ZONING RECOMMENDATIONS FOR CBWS TO STRENGTHEN NATIONAL SYSTEM-LEVEL AND LOCAL CONSERVATION OUTCOMES

DEFINING PRIORITY ZONES



— Coastal fishing zone (would recommend 2km, but 2 miles is OK – most fishermen use nets from the shore)

▨ Conservation / Protection

MAP 9: DEFINING PRIORITY ZONES FOR MEETING CBWS OBJECTIVES

A draft management zone plan has been developed for Corozal Bay Wildlife Sanctuary during 2017 - 2018 as part of the MCCAP project (Map 10). The initiative involved significant consultation with resource users, with the development of a series of five conservation zones and one special management zone to better manage the Wildlife Sanctuary and improve sustainability of the local fishery and viability of the CBWS conservation targets.

Conservation Zones:

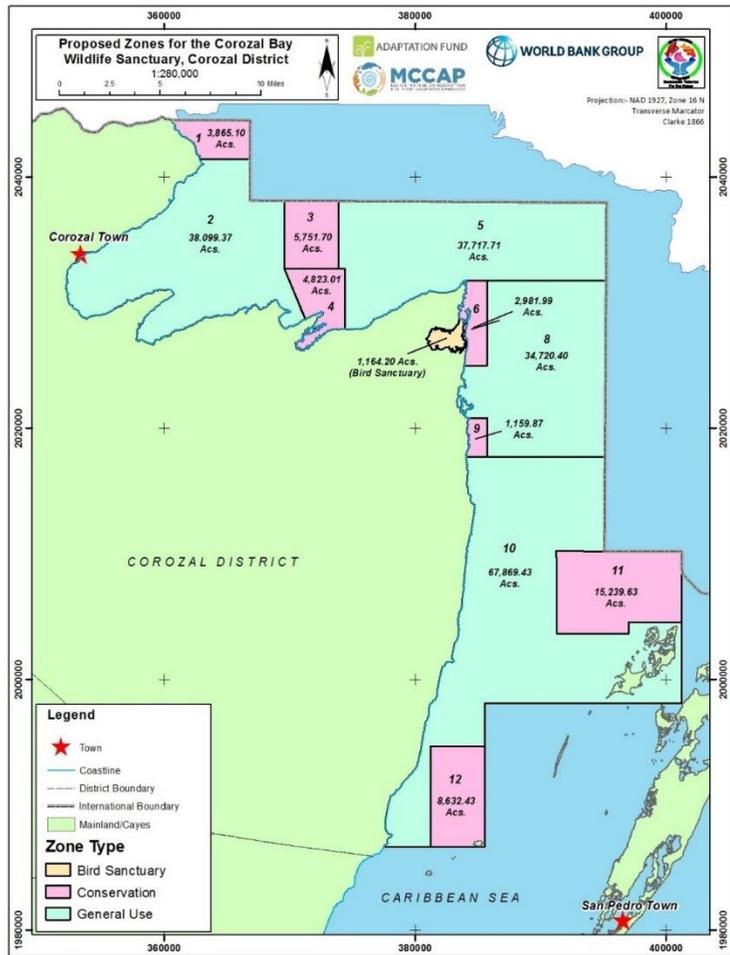
Zone 1 encompasses the stromatolite area, with regulations that protect the integrity of the structures. It also encompasses a key transboundary area of conflict, to improve ease of management in an area with continued transboundary incursions.

Zones 3 and 4 provide strict protection for the mangroves and bird nesting colony of the Cayo Falso area, as well as extending north to include one of the key manatee holes in the Wildlife Sanctuary.

Zones 4 and 8 are both designated as conservation zones, protecting shallow coastal ecosystems. These zones are still under negotiation and still to be finalized.

Zones 3, 11 and 12 focus on protection of deeper, off-shore areas of the Wildlife Sanctuary, providing representation for these areas within the designated non-extractive zones.

All other zones are designated for General Use, with regulated fishing managed under the CBWS Sustainable Fishery Plan and Managed Access framework, with integration into the Wildtracks Sanctuary (2) framework.



MAP 10: DRAFT ZONATION FOR COROZAL BAY WILDLIFE SANCTUARY (MCCAP, 2017)

3.3.2 Management Effectiveness

The most recent management effectiveness assessment for Corozal Bay Wildlife Sanctuary was conducted in 2019 as part of the evaluation of the national protected areas system. Management of the protected area rated as **VERY GOOD**, overall, with a percentage effectiveness of **81.3%**. This continues a steady trend of increasing management effectiveness since the first assessment in 2006 (Figure 55; Table 50). All Indicator Categories rated as **VERY GOOD**.

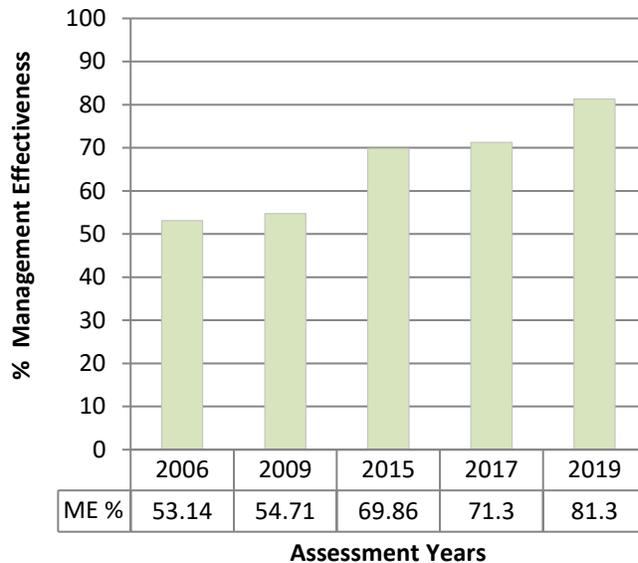


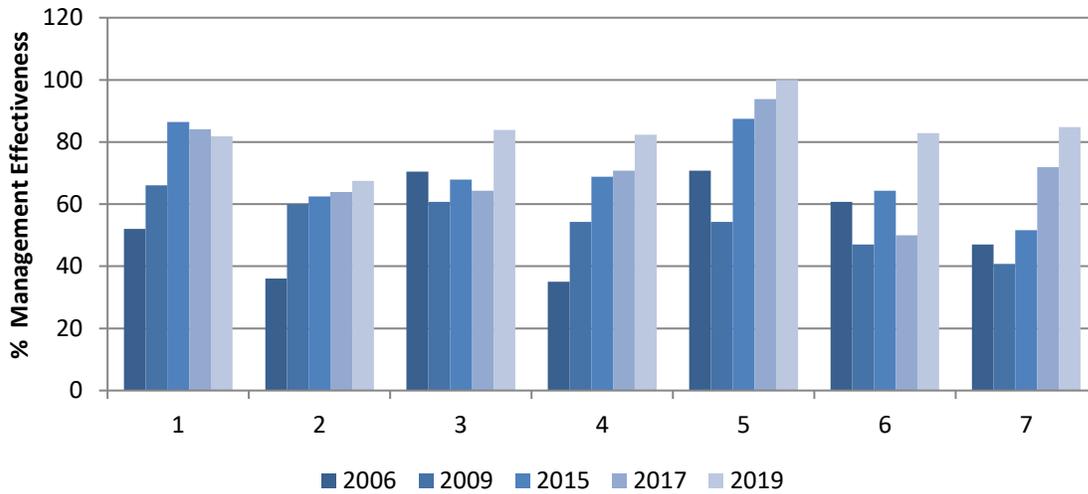
FIGURE 55: COROZAL BAY WILDLIFE SANCTUARY – COMPARISON OF 2006 / 2009 / 2015 / 2019 MANAGEMENT EFFECTIVENESS ASSESSMENTS

All Indicator Categories have increased ratings since the 2006 assessment (Figure 56), with management being particularly strong in the areas of **Governance** (following finalization of the organizational policies and procedures and formation of an active Advisory Committee), for **Financial and Capital Management** and in Community Participation and Benefit (with recognition of traditional rights and engagement of the traditional users). The category most in need of strengthening is **Resource Administration, Management and Protection** (Table 50, Figure 56).

RATINGS PER INDICATOR CATEGORIES, 2006 - 2017					
Indicator Category	2006	2009	2015	2017	2019
1. Resource Information	52	65.9	86.4	84.1	81.8
2. Resource Administration, Management and Protection	36	60	62.5	63.9	67.5
3. Community Participation and Benefit	70.5	60.75	67.9	64.3	83.9
4. Management Planning	35	54.25	68.8	70.8	82.3
5. Governance	70.75	54.25	87.5	93.8	100.0
6. Human Resources	60.75	47.0	64.3	50.0	82.8
7. Financial and Capital Management	47	40.75	51.6	71.9	84.8
Overall	53.14	54.71	69.86	71.3	83.3

TABLE 50: MANAGEMENT EFFECTIVENESS RATINGS PER INDICATOR CATEGORY FROM 2006 TO 2019

**Corozal Bay Wildlife Sanctuary
Average % Management Effectiveness
Per Indicator Category, 2006 - 2017**



Indicator Categories

- | | |
|--|-------------------------------------|
| 1. Resource Information | 4. Management Planning |
| 2. Resource Administration, Management and Protection | 5. Governance |
| 3. Participation, Education and Socio-Economic Benefit | 6. Human Resources |
| | 7. Financial and Capital Management |

FIGURE 56: COROZAL BAY WILDLIFE SANCTUARY – COMPARISON OF 2006 / 2009 / 2015 / 2017 / 2019 RESULTS BY INDICATOR CATEGORY

Four indicators are identified as in particular need of strengthening:

- 2.6 Natural Resource Management
- 2.9 Visitor Management
- 2.10 Visitor Monitoring
- 3.11 Extent of Local Benefits

There is no current need for active natural resource management interventions at the moment (e.g. mangrove replanting). With limited visitation in the area, there is no current visitor management framework in place. This is, however, an area requiring strengthening as visitation increases, and does not address the need for improved management and monitoring of sport fishing / recreational fishing in the area, nor the need for an assessment of the feasibility of implementing a visitor fee system.

Extent of local benefits was considered weak, though is based on the low percentage of the population that uses the natural resources, and doesn't take into account the added value benefits from increasing tourism in both Sarteneja and Corozal, based on the scenic values of the Wildlife Sanctuary.

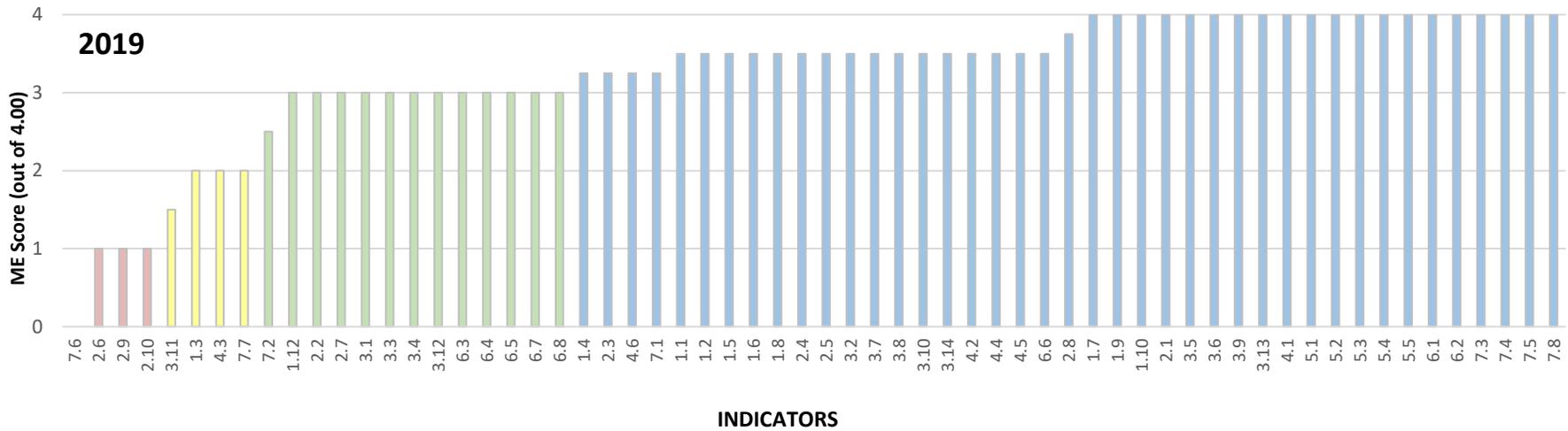
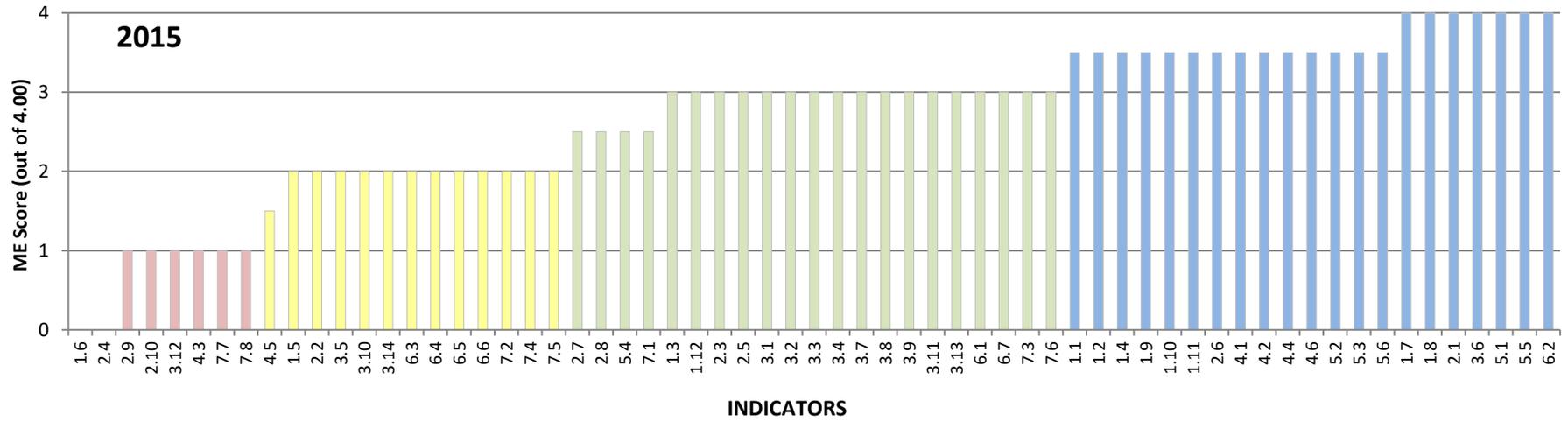


FIGURE 58: RESULTS IN ORDER OF RATINGS FOR 2015 AND 2019

3.3.3 Guidelines for Sustainable Fisheries Management

The revised National Protected Areas Act allows for sustainable fishing within areas designated as Wildlife Sanctuary 2, but only if supported by a viable sustainable fishery plan. For fishing to be termed "sustainable", it must meet the following criteria (FAO, 1998):

- Be caught from a well-managed fishery with scientifically based quota's
- Be caught using responsible fishing methods
- Be species that are not regarded as threatened (or protected under national legislation)

...and can be variously described as:

- ...using resources in such a manner that they will continue to be available to future generations.
- ...fishing conducted over the long-term at an acceptable level of biological and economic productivity without leading to declines that close options for future generations.

Fish are considered renewable resources, with the expectation that they reproduce at a faster rate than they die, whether this death is through fishing or natural causes. Ensuring that fishing is sustainable is based on two basic concepts:

- If there are too few large (old) fish, the stock is over-fished and fishing pressure should be reduced
- If there are very many large (old) fish, the stock is under-fished and more fish can be taken

The fish caught should therefore be of neither too young (pre-reproduction) nor too old. A fish that is just large enough to be included in the catch is known as a '*recruit*', and all fish of that size and age are considered to represent a single '*cohort*' – a group of fish born at the same time, of the same age. A stock assessment for the fishery was completed to better understand how sustainability can be achieved, to provide information on:

- The input: the fishing effort in terms of the amount of time spent fishing
- The output: the catch
- The processes that describe and link the input and output - the biological processes and fishing operations, represented by mathematical models

As it is not possible to sample the entire commercial fish population of the Wildlife Sanctuary, an initial snapshot of the fishery was developed in 2012 to provide an understanding of population dynamics of the commercial species being extracted, and to inform management strategies that can be implemented to improve long term catch security. Catch sampling has been used, providing data on the number of species caught, seasonality, relative contribution

of species to the catch, recruit size, and maximum, mean and mode length. However, it is important to recognise that the data has some limitations, with bias, as it:

- excludes all fish smaller than recruits (these are returned to the water as the catch is sorted)
- is not sampling a static fish stock, but one where many species harvested migrate into and out of the area, and is therefore affected by more than just the management regime of the area
- is focused primarily on fish species that move up and down the coastline
- much of the life history information available to assist with stock assessments (eg. age-length and length-weight conversions, mortality) is based on data collected in Florida, rather than site specific to Corozal Bay Wildlife Sanctuary

Sustainable management can only be achieved if based on scientific information from CPUE monitoring and stock assessments, and since then, data collection has continued to support information on the fishery, and now follows the national Managed Areas framework, with the completion of catch log books. A collaborative effort integrating fisher / stakeholder input in the development of draft zones to protect spawning and nursery grounds within the Wildlife Sanctuary is in the final stages of planning.

A number of recommendations were developed in the 2012 report:

Step 1: Develop a Management Committee

- A management committee should be established, chaired by SACD, and consisting of representatives from each of the fishing sectors of Corozal Bay Wildlife Sanctuary, and with representation from fishermen of each of the other stakeholder communities. Each fishing sector may need its own sub-committee. (the Beach Trap Advisory Committee (BTAC) has developed from the recommendations of the 2019 fisher consultations)
- The committee should meet once every quarter to identify and discuss management issues, and additional regulations (whether permanent or temporary) for implementation by SACD that could improve the sustainability of the fishery – either through changes in fishing gear, limits or seasons for target species, or other mechanisms, with group commitment to adhering to the regulations
- High priority areas requiring zoning for protection should be identified and integrated into SACD management activities (this has been completed as part of an MCCAP project, SACD, 2019)

- The fishery management group should also investigate mechanisms for reducing by-catch through adaptation of fishing gear, fishing times or management of catch (this is being discussed under the Pesca Tourism initiative, SACD, 2019)
- At the end of the first year, the regulations should be reviewed and amended by the management group where necessary, and presented within a Sustainable Fishery Plan (this is being drafted, SACD, 2019)

Step 2: Beyond a Snapshot

- Whilst this assessment has provided the initial data required to give an insight into the fishery, there are many identified gaps that still need to be filled. Data collection on beach trap catch should continue on an ongoing basis to provide the information required to guide management (this has been achieved, and now integrates the Fisheries Department log books required under the Fisheries legislation, SACD, 2019)
- By-catch of small fish should be included in subsequent assessments to provide more information on population structure (though needs to address the concerns of the fishers about increased mortality of juveniles if kept out of water for longer for data collection)
- Information on the other fishery sectors – the gill net fishers and cast net fishers, and on fishers from other communities – also needs to be collected (this is being drafted, SACD, 2019)

Step 3: Development of a Sustainable Fishery Plan for Corozal Bay Wildlife Sanctuary

- A fully participatory process for the development of the Sustainable Fishery Plan should be implemented, with input from all fishing sectors using CBWS, and open communication during the planning process (this is ongoing, SACD, 2019)
- The results of data collection need to be incorporated into a Sustainable Fishery Plan for Corozal Bay Wildlife Sanctuary, with finalized zones and regulations, and produced in full collaboration with the management group, the fishers and technical advisors (this is ongoing, SACD, 2019)
- Technical input and recommendations should be sought from the Fisheries Department and Wildlife Conservation Society once the final draft has been developed

- The Sustainable Fishery Plan then needs to be submitted approval by the Forest and Fishery Departments
- A monitoring and evaluation mechanism should be integrated into the Sustainable Fishery Plan to measure success of the Plan on an annual basis for an initial period of five years.

In 2018 - 2019, SACD focused on re-engaging local fishers in the development of guidelines for management of the local fishery, to ensure best practices for sustainability and to provide the framework required for continued traditional fishing within the Wildlife Sanctuary, supporting a shift in designation to Wildlife Sanctuary 2, to allow for traditional sustainable fishing.

An initial set of guidelines and standards developed collaboratively by SACD and fishers in 2012 (SACD, 2012), have been re-confirmed in 2019 through a fisher engagement process that identifies three phases in the engagement of the fishers (Rosado, draft):

Phase 1: Engage the fisher groups and promote the artisanal fishing practices. Confirm that traditional fishing practices align with local regulations and relevant scientific literature.

Phase 2: Provide support to the fisher groups, engaging and providing capacity building for leadership and good stewardship of the traditional fishery.

Phase 3: Promote fisher stories that recognize and respect local traditions, and rights in collaboration with the fishers, and in a culturally sensitive manner

A series of guidelines were agreed on for the different fisher sectors using the Wildlife Sanctuary (Rosado, draft):

BEACH TRAP GUIDELINES

1. Only registered traps are allowed— ownership is non-transferable
2. Open season is March to November with traps removed completely in the closed season
3. Traps must be checked regularly to reduce bycatch
4. All fishers must participate in catch monitoring
5. All fishers must abide by the Fisheries Regulations

BEACH TRAP STANDARD SPECIFICATIONS

Mesh size:	1.25 inch
Material:	Galvanized chicken wire
Structural Support:	Wooden stakes
Length of cola:	Varies by location
Size of corazón:	150 feet perimeter
Copo (extraction net):	0.5 inch mesh



SACD

BEACH TRAP ADMINISTRATION

SACD has maintained a georeferenced database of information on the beach trap locations and ownership, running from 2012 to 2019. It is recommended that each beach trap owner be granted an exclusive traditional permit subject to the beach trap meeting standard specifications, with renewal on an annual basis, with the establishment of a Beach Trap Advisory Committee (BTAC), with the role of making recommendations for permit renewal, based on proof of the following:

1. Possession of Belize Fisher Folk License (Zone 1)
2. Installation and operation of trap at traditional site
3. Adherence to Beach Trap Standards
4. Adherence to all CBWS monitoring efforts
5. Submission of catch log data
6. Recommendation of Good Standing from the BTAC

PROBATION FOR NON-COMPLIANCE

- Failure to meet permit requirements will result in a 1-year probation period
- A fisher clan must commit to full compliance during probation period
- Failure to meet requirements during the probation period will result in revocation of traditional permit
- Renewal of the permit to non-probation status requires a majority vote of the BTAC
- Grievances are to be presented to the BTAC for consideration and subsequent recommendation for action to SACD

An evaluation of the 2012 plan for the development of a Sustainable Fishery has been completed in 2019 (Table 51).

2-Year Plan for Development of a Sustainable Fishery				
Management Actions		Baseline Status (2012)	Desired Status	Current Status (2019)
1	Establish a community management committee for the fishery resources of the Wildlife Sanctuary	SACD working towards engagement of fishermen but there is no structured fisher representation organization	An active management committee is established with representation from the local fishers, providing management recommendation to SACD for management of CBWS fish resources, meeting at least once a quarter, as per guidelines to be presented in the Final Sustainable Fishery Plan	The fishers are represented on the Corozal Bay Advisory Committee (CBAC). The beach trap fishers are working together as the Sarteneja Beach Trap Pesca Tours Association (SBTPTA). The net fishers are organized under the Sarteneja United Local Fishermen Association (SULFA)
2	Resolve traditional resource use issue	Local fishermen are extracting fish from CBWS in contravention to the current Forest Department Wildlife Sanctuary legislation	Recognition by Forest Dept / Fisheries Dept and GoB of traditional use for local community members, with training towards greater sustainable use	The new NPAS Act provides for a shift to Wildlife Sanctuary 2, permitting traditional extraction when supported by a sustainable fishery plan.
3	Integrate local fishermen of other stakeholder communities into the planning process	Fishermen of other communities have been identified and consulted, but have not yet been integrated into planning for a sustainable fishery	Fishermen of other communities have been integrated into planning for a sustainable fishery and are represented on the management committee	SACD has been successfully engaging beach trap fishers in the development of the Sustainable Fishery Plan, both through the CBAC and through the planning process itself (Rosado, draft). Net fishers are being engaged through the process as well, though are more reluctant to engage. Fishers from other communities have also been identified and are being engaged through the CBAC, as well as being consulted as part of the planning process.

TABLE 51: ASSESSMENT OF STATUS OF SUSTAINABLE FISHERY PLAN

2-Year Plan for Development of a Sustainable Fishery

Management Actions		Baseline Status (2012)	Desired Status	Current Status (2019)
4	Develop permitting system for local fishermen	No formal recognition or permitting of local fishermen is in place	A permitting system is established and being implemented with local fishers formally recognized as traditional fishers through site specific permits	Traditional fishers are recognized informally by SACD. This will be formalized during the shift to Wildlife Sanctuary 2
5	Develop registration system for nets and traps	No system is in place for registration of nets. Traps have been identified and mapped	A system is place for registration of fishing equipment owned by fishermen of CBWS and allowed to be used in the MPA	Forest Department recognizes registration of the nets and traps by the Fisheries Department and SACD though no formal, legislated registration process exists. SACD has the relevant data for the beach traps for effective enforcement. Net registration data is more limited, and not currently available to SACD.
6	Develop a baseline and guidelines for sustainable traditional fishing within Corozal Bay Wildlife Sanctuary	Only preliminary baseline or guidelines exist, and are not based on scientific information	Baseline and guidelines for sustainable fishing have been developed based on sound scientific research	SACD is implementing a consultancy to ensure the fishery is managed based on sound scientific data
7	Monitor fishing activity	At present there is no formalized monitoring of level of fishing activity	Monitoring is ongoing. A fishing impact monitoring programme with output of findings presented in annual report and guiding decision-making processes for a sustainable fishery	SACD conducts ongoing monitoring of fishing activity and catch data, through the capture logbooks completed by the fishers. but not so much for the gill netters.

2-Year Plan for Development of a Sustainable Fishery

Management Actions		Baseline Status (2012)	Desired Status	Current Status (2019)
8	Identify critical areas and times of peak fishing pressure to increase efficiency of patrol effort	Only limited information on fishing activity within CBWS, though knowledge is available, and is guiding surveillance activities	Accurate mapping of fishing activity within CBWS, using community knowledge of the area Patrolling driven by knowledge of when and where patrolling needs to be carried out	SACD is implementing a consultancy to ensure the fishery is managed based on sound scientific data. Patrols are conducted based on information on fishing activities and illegal hotspot areas, and use the SMART system to document fishing activities. The Surveillance and Enforcement Plan has been updated and will serve to increase patrol effectiveness.
9	Promote greater participation in surveillance and enforcement by traditional fishermen	Whilst discussion has started, very few fishermen are fully engaged in the protection of CBWS	Traditional fishermen actively protect their resources and assist SACD with surveillance activities through an effective system of response to reports.	Fishers are reporting illegal fishing activities to SACD, primarily through the CBAC.
10	Liaise with Forest and Fisheries Dept. for assistance with enforcement activities	Training of rangers as Fisheries Officers, but no mechanism set up for assistance from Hol Chan or Bacalar Chico if needed	SACD in constant communication with Forest and Belize Fisheries Departments	SACD rangers are trained Fisheries Officers and Special Constables, with power of arrest. Joint patrols are conducted monthly with Forest Department and assisting Bacalar Chico)
11	Demarcate nursery areas and spawning grounds for zoning and protection	No zoning currently in place	Zoning (spatial / temporal) of CBWS for protection of nursery areas and spawning grounds	Zoning has been defined under the MCCAP project, as well as additional realignment of boundaries to include part of the inundated mangroves of the Shipstern Lagoon system. There are still concerns over a specific recommended zone around the Shipstern Caye key manatee area.

2-Year Plan for Development of a Sustainable Fishery

Management Actions		Baseline Status (2012)	Desired Status	Current Status (2019)
12	Conduct four full seasons of catch monitoring for the beach trap fishery	A partial survey of the beach trap fishery of 2011 has been completed	Four full seasons of catch monitoring for the beach trap fishery	SACD has multi-year data sets of fish catch for the beach trap fishery
13	Conduct assessment of gill net fishery	No assessment has been conducted of gill net catches	A baseline assessment has been completed on the gill net fishery	SACD is implementing a consultancy to ensure the fishery is managed based on sound scientific data, to include a baseline for the gill net fishery
14	Conduct assessment of impact of cast net fishing in Sarteneja	No assessment has been conducted on the impacts of cast net fishing in Sarteneja	Information is available on the impacts of cast net fishing in front of Sarteneja	SACD is implementing a consultancy to ensure the fishery is managed based on sound scientific data, to include an assessment of the impacts of cast net fishing
15	Conduct assessment of importance of subsistence fishing in Sarteneja	No assessment has been conducted on the importance of subsistence fishing in Sarteneja	Information ensures that mechanisms are in place to ensure families dependent on subsistence resource extraction are not affected by CBWS regulations	Some data is available from the socio-economic assessments of all three fishing communities. SACD is implementing a consultancy to ensure the fishery is managed based on sound scientific data.
16	Develop a Sustainable Fishery Plan	SACD has conducted a rapid assessment – a first snapshot of the beach trap fishery	An effective Sustainable Fishery Plan has been developed based on good scientific information and with full participation from the fishermen	SACD is implementing a consultancy to develop a full Sustainable Fishery Plan, based on good scientific information and with full participation from the fishermen

2-Year Plan for Development of a Sustainable Fishery

Management Actions		Baseline Status (2012)	Desired Status	Current Status (2019)
17	Implementation of mechanisms identified under the Sustainable Fishery Plan	The Sustainable Fishery Plan is still to be developed	SACD and the local fishermen are implementing an effective Sustainable Fishery Plan	SACD is implementing a consultancy to develop a full Sustainable Fishery Plan, based on good scientific information and with full participation from the fishermen. Needs to be approved by the Forest and Fisheries Departments before implementation
18	Conduct a Market Survey to inform a Marketing Plan for added value for products	Only initial market data has been collected	A full market survey has been conducted with the fishermen, with data feeding into the development of a marketing plan	WCS conducted a market survey in the Corozal town the majority of the fish in the Corozal Market comes from Sarteneja.
19	Develop a Marketing Plan, integrating information from the market survey	Fishermen are marketing independently, and not necessarily for maximum gain	Fishermen are able to increase their income through better marketing of their product	The Beach Trap fishers identified beach trap tourism as their preferred added value option. SACD is now supporting the development of this initiative
20	Characterize the role of women in the fishery	There is no information on the role of women in the fishery	Information is available on the role of women in the fishery, and integrated into the Sustainable Fishery Plan	The women's role is to process and sell the fishery products.
21	Engagement of the women involved in the local fishery	There is no information on the role of women in the fishery	Women understand the need for the Sustainable Fishery Plan, are fully supportive and play a role in its implementation	SACD has an ongoing project s that integrates women into beach trap tourism initiative, and has increased their understanding of and supportive of a sustainable fishery

2-Year Plan for Development of a Sustainable Fishery				
Management Actions		Baseline Status (2012)	Desired Status	Current Status (2019)
22	Implementation of mechanisms identified under the Sustainable Fishery Plan	There is no current effort to engage the women of the local fishing families	Women are engaged and participators	SACD has an ongoing project with the beach trap fishers that integrates women into beach trap tourism initiative as an added value income for the fishers
23	Identification and implementation of income diversification mechanisms linked to reduced fishing pressure	Fishermen are too dependent on the state of the fish resources and need to diversify their income base if they are going to reduce their fishing impact	Fishermen are willing to integrate sustainable fishing practices into their fishing as their income base has diversified	The Beach Trap fishers identified beach trap tourism as their preferred added value option. SACD is now supporting the development of this initiative
24	Monitor climate conditions affecting fish stocks	No weather data is being collected	SACD has a weather station and is collecting weather data to identify trigger points for fish movements	SACD has a weather station, with ongoing recording of weather data. Initial analysis suggests that fish movements correlate most tightly to wind conditions associated with storms
25	Monitor water parameters affecting fish stocks	Characterization of the water parameters of CBWS has started (2012) and is ongoing	SACD has information on annual water parameter changes, and has identified trigger points for fish movements	SACD is collaborating with ECOSUR for ongoing monitoring of water conditions

TABLE 51: ASSESSMENT OF STATUS OF SUSTAINABLE FISHERY PLAN

3.3.4 Management as part of the Northern Belize Coastal Complex

The Northern Belize Coastal Complex (NBCC) is a river-to-reef seascape of connected protected areas in northern Belize that stretch from the Rio Hondo, New River and coastal lagoons that flow into the Corozal Bay Wildlife Sanctuary, out to the reefs of Bacalar Chico, Hol Chan and Caye Caulker Marine Reserves (Table 52). The area is important for the ecosystem services it provides for the coastal communities, the reef formations, shallow coastal seagrass beds, extensive inundated mangroves, its importance in maintaining a healthy, viable population of threatened species such as the critically endangered hawksbill turtle and Goliath grouper, and the Antillean manatee. The terrestrial components of Bacalar Chico National Park and Caye Caulker Forest Reserve are important for the large extent of unimpacted mangroves and littoral forest, the latter recognised as a significantly under-represented ecosystem at national level, at high risk of disappearing. To the north, the protected areas are contiguous with the Sanctuario del Manati and Parque Nacional Arrecifes de Xcalak, in Mexico.

The NPAPSP / Rationalization recommendations for the National Protected Areas System call for strengthening management at system level, with greater planning, communication and

NAME	MANAGEMENT AGENCY	ACRES
Corozal Bay Wildlife Sanctuary	Forest Dept.	180,500
Bacalar Chico Marine Reserve	Fisheries Dept.	15,766
Bacalar Chico National Park	Forest Dept.	11,145
Hol Chan Marine Reserve	Fisheries Dept.	3,813
Caye Caulker Marine Reserve	Fisheries Dept.	9,670
Caye Caulker Forest Reserve	Forest Dept.	94
AREA (ACRES)		220,9960

TABLE 52: MPAS OF THE NBCC

collaboration for more effective system-level management of marine protected areas within the same seascape. The Northern Belize Coastal Complex Management Action Planning (MAP) process identified mechanisms for strengthened management at the system level, increasing management and cost effectiveness of the individual MPAs. Corozal Bay Wildlife Sanctuary is strengthened by being a part of the Northern Belize Coastal Complex, working in collaboration with other MPA management partners to ensure the continued health of the wider seascape in which it is operating. As a part of this collaborative partnership, a series of system level objectives and strategies have been developed as part of the NBCC Management Action Planning process, and have been integrated into this management plan (Table 53):

Whilst the scope of the Northern Belize Coastal Complex MAP is not transboundary, the NBCC Task Force also worked closely with the Mexican counterparts, with participation in the series of MAP workshops being conducted, providing the basis for transboundary coordination and collaboration.

TABLE 53: INTEGRATION OF SEASCAPE NBCC STRATEGIC ACTION

NBCC OBJECTIVE	NBCC STRATEGIC ACTION	CBWS MP LINK
1. By 2020, the management effectiveness of each of the marine protected areas of the Northern Belize Coastal Complex will have increased by at least 15% beyond the 2015 baseline levels	1.1 Formation of the Northern Belize Coastal Complex working group for implementation of the NBCC management plan	E19
	1.2 Identification of effective mechanisms for communication, collaboration, and information sharing within and among organizations working in the NBCC (including transboundary partners)	E20
	1.3 Develop a collaborative strategic enforcement plan for the NBCC that is fully funded, encompasses stakeholder participation and is fair and equal for all sectors (development, tourism and fishing alike)	A4
	1.4 Build system level capacity for surveillance and enforcement through the National Ranger Training programme, Fisheries Officer training opportunities and ranger exchanges	A6
	1.5 Locate funding for implementation of cost effective, system level management plan implementation	
	1.6 Increase financial sustainability mechanisms at system level (including financial sustainability planning and business planning) for cost effective, system level management plan implementation	E17; E18
	1.7 Explore opportunities for diversification of funding at system level (biodiversity offsets, blue carbon, conservation easements etc.)	E16; E17
	1.8 Develop a system level community volunteer / environmental stewardship programme for increased community participation	C6; C7; C20; E14

TABLE 53: INTEGRATION OF SEASCAPE NBCC STRATEGIC ACTION

<p>2. By 2020, rights-based fishing regimes will be in place and implemented effectively in 100% of marine protected areas in the Northern Belize Coastal Complex, with populations of commercial and recreational species increased by 10% or more above the 2015 / 2016 stock assessment baselines</p>	<p>2.1 Roll out the “Managed Areas” regime in the Marine Reserves of the NBCC, with engagement of traditional fishermen</p>	<p>A16; A17</p>
	<p>2.2 Develop and implement a rights-based sustainable fishery plan in Corozal Bay Wildlife Sanctuary, with the participation of traditional fishers of the area</p>	<p>A16, A17, A19; E5</p>
	<p>2.3 Reduce illegal, unreported, unregulated "illegal" fishing across the NBCC by 10% in the next 5 years</p>	<p>A4</p>
	<p>2.4 Increase the technical capacity of MPA staff and rangers to be able to address illegal fishing activities in the NBCC</p>	<p>A6; A8</p>
	<p>2.5 Engage fishermen in reporting illegal activities within the NBCC</p>	<p>A17; A18</p>
<p>3. By 2020, protected area managers will have increased their knowledge of water quality and contamination levels within the Northern Belize Coastal Complex, and will have implemented at least one strategy targeted at reducing water contamination in the Northern Belize Coastal Complex</p>	<p>3.1 Develop a comprehensive baseline of basic water parameters for the NBCC</p>	<p>B15</p>
	<p>3.2 Implement a system-level water quality monitoring programme in the NBCC, aligned with transboundary monitoring efforts</p>	<p>B15</p>
	<p>3.3 Strengthen collaboration with ECOSUR for effective monitoring of water quality and contaminants</p>	<p>B15</p>
	<p>3.4 Develop baseline of pollution levels in the Northern Belize Coastal Complex and set feasible pollution reduction targets</p>	<p>B15</p>
	<p>3.5 Improve knowledge and mapping of current land use in the watershed and along rivers</p>	<p>B16, B17</p>
	<p>3.6 Strengthen partnership with Department of the Environment and mechanisms for communication and collaboration towards effective enforcement of developments</p>	<p>E22</p>
	<p>3.7 Develop collaborative partnerships with NGOs working on the transboundary Rio Hondo watershed to reduce land based pollution</p>	<p>E22</p>
	<p>3.8 Develop collaborative partnerships with NGOs working on the New River watershed to reduce land based pollution and promote more sustainable land use practices in the northern watersheds</p>	<p>E22</p>

TABLE 53: INTEGRATION OF SEASCAPE NBCC STRATEGIC ACTION

4. Objective: By 2020, impacts to coastal ecosystems (littoral forests, sandy beaches and mangroves) within the protected areas of the Northern Belize Coastal Complex will have been reduced to 10% of 2015 impact levels	4.1 Support the adoption and implementation of the Integrated Coastal Zone Management Plan by all relevant authorities by the year 2016	
	4.2 Establish a baseline of development occurring in the littoral forest / mangroves and sandy beach environments of the NBCC	B7
	4.3 Increase the technical capacity of MPA staff and rangers to be able to address illegal activities in the coastal ecosystems	A7; A19
	4.4 Launch a large scale awareness campaign focused on best development practices in the coastal zone	C12
	4.5 Maintain the 66 feet reserve, and ensure that minimum setbacks from property lines and beaches, and minimum distances between buildings are enforced	A7
	4.6 Sensitize politicians to the need for improved management of the coastal zone	
	4.7 Improve public awareness of the importance of maintaining the viability of turtle nesting beaches	
	4.8 Provide guidelines for coastal landowners on ways to minimise impacts to turtle nesting beaches	
	4.9 Improve surveillance and enforcement of coastal development projects and Environmental Compliance Plans	A7, A19; A28
5. By 2020, the extent and condition of seagrass within Corozal Bay Wildlife Sanctuary will have improved above the 2015 baseline	5.1 Map baseline seagrass extent in the Northern Belize Coastal Complex	B4
	5.2 Identify key fish nursery areas and collaborate with Forest Department and the Department of Mines and Minerals to ensure that dredging is not permitted within these areas	A22
6. Between 2015 and 2020, the average condition of coral reef communities in the Northern Belize Coastal Complex will be maintained at 2015 levels or better, as measured by the Simplified Integrated Reef Health Index	6.1 Build capacity in Natural Resource Managers and protected area managers for effective management of coral reefs in the NBCC	B3; B4; B5
	6.2 Continue monitoring health of the coral reef communities in the Marine Reserves of the NBCC	B3; B4; B5
	6.3 Implement targeted enforcement of replenishment zones identified as including corals with greater resilience to climate change	A4

TABLE 53: INTEGRATION OF SEASCAPE NBCC STRATEGIC ACTION

<p>6. Between 2015 and 2020, the average condition of coral reef communities in the Northern Belize Coastal Complex will be maintained at 2015 levels or better, as measured by the Simplified Integrated Reef Health Index</p>	<p>6.4 Discourage dredging in the Bulkhead Shoals area, in recognition of its critical role in settling the turbidity and contaminants of Corozal Bay estuarine system before entry into the Belize Barrier Reef</p>	<p>A28</p>
<p>7. Between 2015 and 2020, marine mammal populations in the Northern Belize Coastal Complex will be maintained at, or above, 2015 levels</p>	<p>7.1 Lobby with BTB for strengthening enforcement of wildlife protection legislation in the tourism sector, including guidelines for not swimming with manatees and dolphins</p>	<p>A23</p>
	<p>7.2 Ensure that the Wildlife Protection Act for strengthened protection of marine mammals, sea turtles and crocodiles, with credible fines</p>	<p>A23</p>
	<p>7.3 Continue and expand monitoring of marine mammal populations within the Northern Belize Coastal Complex</p>	<p>A23; B4</p>
	<p>7.4 Ensure adequate no-wake signage in key manatee areas</p>	<p>A23; D9</p>
	<p>7.5 Increase boat captain awareness of no wake zones and marine mammals within the NBCC.</p>	<p>A23; C21;</p>
	<p>7.6 Increase awareness of tour guides, boat captains and visitors of the Wildlife Protection Act and its protection of manatees</p>	<p>A23; C21; D10</p>
	<p>7.7 Reduce to zero the incidents of negative tourism impacts on marine mammals</p>	<p>A23</p>
<p>8. By 2020, stromatolites, underwater caves and archaeological sites within the Northern Belize Coastal Complex will be managed effectively, with targeted management strategies identified through technical input</p>	<p>8.1 Increase knowledge of the status of, and conditions required by, stromatolites in Corozal Bay Wildlife Sanctuary</p>	<p>B18; C21</p>
	<p>8.2 Improve awareness of stromatolites – general public</p>	<p>C22</p>
	<p>8.3 Ensure effective surveillance and enforcement of development adjacent to stromatolite reef</p>	<p>A20</p>
	<p>8.4 Facilitate the development of a cave management plan and best practice guidelines for underwater caves in the NBCC Strategic action: Maintain and protect archaeological sites within the NBCC</p>	<p>B9</p>

TABLE 53: INTEGRATION OF SEASCAPE NBCC STRATEGIC ACTION

9. By 2020, 100% of marine protected areas of the Northern Belize Coastal Complex will have improved resilience to climate change through implementation of collaborative adaptation strategies, with integration of strategies into site level management plans	9.1 Strategic action: Conduct climate change adaptation planning for the NBCC and implement the identified strategies	B8
	9.2 Strategic action: Increase the technical capacity of MPA managers to facilitate protected area adaptation to climate change	
	9.3 Strategic action: Integrate climate change adaptation strategies into all NBCC MPA management plans	B8

3.3.5 Recommendations from the NPAS Rationalization exercise

A gap analysis and subsequent protected area rationalization exercise ensures that the protected areas within the system, and the system as a whole, are well planned and functional in their roles of biodiversity protection and protection of ecosystem services (Walker and Walker, 2013). It provides strengthened planning for ecosystem representation, species protection, and key forest connectivity, as well as an assessment of protected area importance, priority and resilience to climate change. The findings, and the recommendations developed from them, have provided the foundation for building on the current network of protected areas, improving functionality, connectivity and socio-economic benefit as Belize moves into a future with increasing anthropogenic pressures, overshadowed by the need to adapt to current and predicted climate change impacts.

Re-Designation: The Rationalization exercise recognized that, whilst the Wildlife Sanctuary designation is non-extractive, in reality a number of Wildlife Sanctuaries have ongoing traditional fishing activities important for local communities and supporting community livelihoods. It therefore recommended that there be two types of Wildlife Sanctuaries to align the designation with the reality: Wildlife Sanctuary (1), which is non extractive and fills the original letter of the Wildlife Sanctuary designation; and Wildlife Sanctuary (2), which allows for continued traditional community use, but calls for a sustainable use plan and use agreements to be in place. It recommends that Corozal Bay Wildlife Sanctuary be re-designated as Wildlife Sanctuary (2), under the National Protected Areas System Act. This re-designation would also impact the alignment to the IUCN categories, shifting from the current category of IV to category VI, allowing for ‘conservation of ecosystems and habitats, together with associated cultural values and traditional natural resource management systems (Table ...; Dudley, 2008).

IUCN CATEGORIES	
CATEGORY	PRIMARY OBJECTIVE
<p>CATEGORY IV: Protects particular species or habitats and management reflects this priority. Many category IV protected areas will need regular, active interventions to address the requirements of particular species or to maintain habitats, but this is not a requirement of the category.</p>	<p>Primary Objective: To maintain, conserve and restore species and habitats.</p>
<p>CATEGORY V: A protected area where the interaction of people and nature over time has produced an area of distinct character with significant ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values.</p>	<p>Primary Objective: To protect and sustain important landscapes /seascapes and the associated nature conservation and other values created by interactions with humans through traditional management practices.</p>
<p>CATEGORY VI: Conserve ecosystems and habitats, together with associated cultural values and traditional natural resource management systems. They are generally large, with most of the area in a natural condition, where a proportion is under sustainable natural resource management and where low-level non-industrial use of natural resources compatible with nature conservation is seen as one of the main aims of the area.</p>	<p>Primary Objective: To protect natural ecosystems and use natural resources sustainably, when conservation and sustainable use can be mutually beneficial.</p>

TABLE 54: IUCN CATEGORIES

During the prioritization exercise, Corozal Bay Wildlife Sanctuary ranked as a high priority area for MPA to MPA connectivity, ecosystem status and for its very high value in protection of coastal communities from storm surges. It was also considered to have a high value for its importance to artisanal / subsistence fishers, conservation of species of national and international concern, and for its tourism / recreational values (focused primarily on sport fishing).

A series of recommendations were developed for Corozal Bay Wildlife Sanctuary as an output of the process (Table 55).

RATIONALIZATION RECOMMENDATIONS		
PRIMARY PROTECTED AREA VISION / GOAL		
The conservation and sustainable use of the natural resources of the Corozal Bay Wildlife Sanctuary, with particular focus on West Indian manatee		
RECOMMENDED IUCN CATEGORY	2005: IV	2012: VI
RATIONALE		
<p>Established to protect West Indian manatee, management focus has extended to ecosystem protection. There is transboundary connectivity and it is contiguous with the Bacalar Chico Marine Reserve. It is also an important shark nursery area, has key bird nesting cayes (that should be integrated into the protected area). Some dependence on traditional fishing in stakeholder communities. The current Wildlife Sanctuary designation is in conflict with traditional community resource extraction.</p> <p>Recommendations:</p> <ul style="list-style-type: none"> ▪ Area is important for traditional community resource extraction – designation as Wildlife Sanctuary (2). ▪ Should be aligned with Category VI. ▪ Needs an approved sustainable fishery plan, with use agreements ▪ All other activities must be non-extractive as per the Wildlife Sanctuary designation ▪ Include the two Cayo Falso cayes and other bird nesting cayes within the Wildlife Sanctuary ▪ Extend the Wildlife Sanctuary for 2 miles up the Rio Hondo and New River ▪ Evaluate potential to include coastal lagoon / mangrove ecosystem (northern Shipstern?). <p>Management Unit: Northern Belize Coastal Complex</p>		

TABLE 55: RATIONALIZATION RECOMMENDATIONS FOR COROZAL BAY WILDLIFE SANCTUARY (Walker and Walker, 2013)

3.3.6 Long Term Management Needs

SACD has identified its long term management needs as follows:

High Priority Actions

- Transition of Wildlife Sanctuary (2)
- Finalization and implementation of realignment, zonation and regulations, as socialised under the MCCAP project, with installation of buoys and signs
- Finalization and implementation of the CBWS Sustainable Fishery Plan
- Implementation of financial sustainability mechanisms
- Improved coordination and collaboration within the NBCC

Infrastructure

- Ranger / research station (funding not yet located)
- Expedition hosting facility (funding located)
- Docking facility and ramp (funding located)

Equipment

- Second patrol vessel (funding located)
- Second vehicle (funding not yet located)
- Lab equipment (funding located)

3.4 Management Programmes and Objectives

Management Programmes are a means of grouping management objectives within related areas – for example, those related to natural resource management, or to community development. The strength of the combined programmes is greater than the sum of the individual Programmes, as each supports the others over space and time, with areas of overlap that strengthen the overall management of the protected area. The inclusion of strategies is also important to strengthen communication and collaboration between Program areas, with inter-Program collaboration mechanisms for greater adaptive management effectiveness.

Six general Management Programmes are identified:

- A. Natural Resource Management and Protection**
- B. Monitoring and Research**
- C. Community Development and Outreach**
- D. Tourism and Recreation**
- E. Management and Administration**
- F. Facility Operations and Maintenance**

The conservation strategies outlined for Corozal Bay Wildlife Sanctuary in the conservation planning section of this management plan are integrated into the management programmes, contributing towards the adaptive management process. The NBCC strategic activities are also integrated into the management plan programs, as are the recommendations from the site specific Management Effectiveness outputs.

NBCC Cross Cutting Strategies

Strategy: Implement / enforce policies and regulations across the NBCC

Strategy: Develop and implement a system-level public awareness and communication programme

Strategy: Implement system-level standardized monitoring and data management

Strategy: Ensure all strategies are resilient to climate change

Programme Areas

Natural Resource Management					
Protection	Monitoring and Research	Community Development and Outreach	Tourism and Recreation	Management and Administration	Facility Operations and Maintenance
<ul style="list-style-type: none"> ▪ <i>Surveillance and Enforcement</i> ▪ <i>Zoning and Boundaries</i> ▪ <i>Fishing (Marine Resource Extraction)</i> ▪ <i>Habitat and Species Management</i> ▪ <i>Cultural Resource Management</i> ▪ <i>Addressing Specific Threats</i> 	<ul style="list-style-type: none"> ▪ <i>Biodiversity Monitoring</i> ▪ <i>Biodiversity Research</i> ▪ <i>Dissemination of results</i> 	<ul style="list-style-type: none"> ▪ <i>Environmental Education</i> ▪ <i>Public Outreach and Information</i> ▪ <i>Alternative Livelihoods</i> ▪ <i>Community Capacity Building</i> 	<ul style="list-style-type: none"> ▪ <i>Visitor Safety and Protection</i> ▪ <i>Visitor Education and Interpretation</i> 	<ul style="list-style-type: none"> ▪ <i>Planning</i> ▪ <i>General Management and Administration</i> ▪ <i>Financial Management</i> ▪ <i>Concessions / Commercial Uses</i> ▪ <i>Partnership Relations</i> ▪ <i>Information Technology</i> ▪ <i>Monitoring and Evaluation</i> 	<ul style="list-style-type: none"> ▪ <i>Docking Facilities</i> ▪ <i>Administration and Operational Infrastructure</i> ▪ <i>Tourism Infrastructure</i> ▪ <i>Fleet Operations and Management</i>

TABLE 56: MANAGEMENT PLAN PROGRAMME AREAS

3.4.1 NATURAL RESOURCE MANAGEMENT PROGRAMME

Programme Objective: To ensure the effective conservation and sustainable use of natural resources of Corozal Bay Wildlife Sanctuary

Current Status (2019)

Personnel:

NRM Programme Manager
3 rangers

Equipment:

1 fully equipped patrol vessel
1 smaller patrol vessel
Surveillance equipment
Use of technology (SMART, GPS)



In 2018, SACD conducted 158 patrols focused on addressing identified threats and targeted towards protection of key CBWS conservation targets – an average of 3 patrols a week. Highest activity was during the fish trap season from May through to August, key for ongoing regulation of traditional fishing activity in the Wildlife Sanctuary (Figure 59). Patrols are strengthened through collaborative partnerships with the Belize Coastguard, Belize Fisheries Department, the Forest Department and the surveillance and enforcement teams from Hol Chan and Bacalar Chico Marine Reserves (Figure 59).

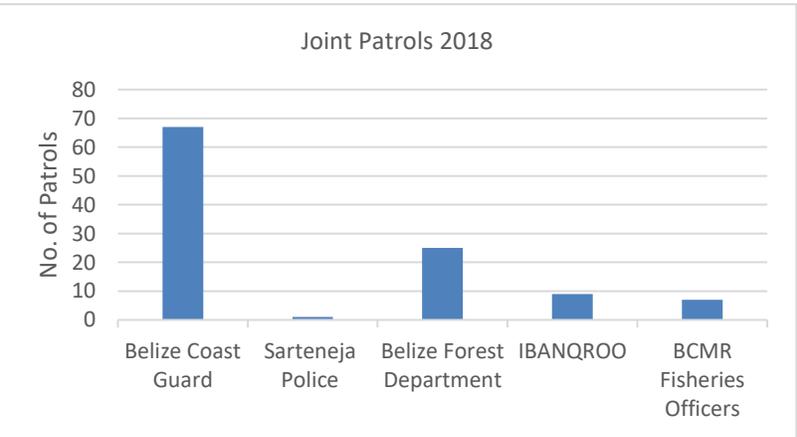
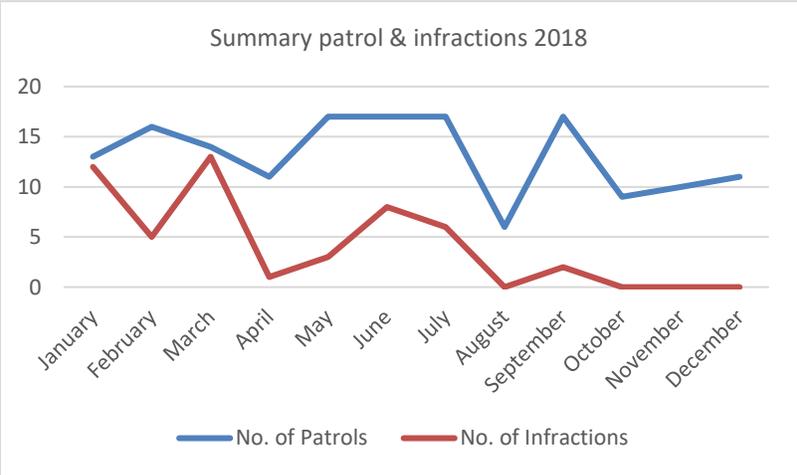


FIGURE 59: PATROL STATISTICS FOR 2018 (SACD DATA, 2018)

SACD significantly strengthened its patrols through partnerships / joint patrol activities. 67 patrols were conducted in partnership with the

Coastguard in the first half of 2018. 25 system-level patrols were conducted with the Forest Department and Fisheries Officers from Bacalar Chico Marine Reserve, and 9 transboundary patrols were conducted with El Instituto de Biodiveridad y Areas Naturales de Quintana Roo (IBANQROO). A Mexican national was arrested and charged for fishing without a valid Fisher Folks License and for fishing without a valid boat license to fish. In January, the majority of infractions were related to boaters without valid Sea Worthiness Certificates and / or Boat Master’s License (Figure 60). No infractions were related to gillnets – with the constant patrol presence and one-on-one communication with the fishermen resulting in a positive change of attitudes, and adherence to the gillnet regulations - legal mesh size, net length size and tagging - all gillnets inspected were registered and tagged according to the Fisheries Regulations.

- 49 infractions were reported during the year.
- 1 person was taken to court

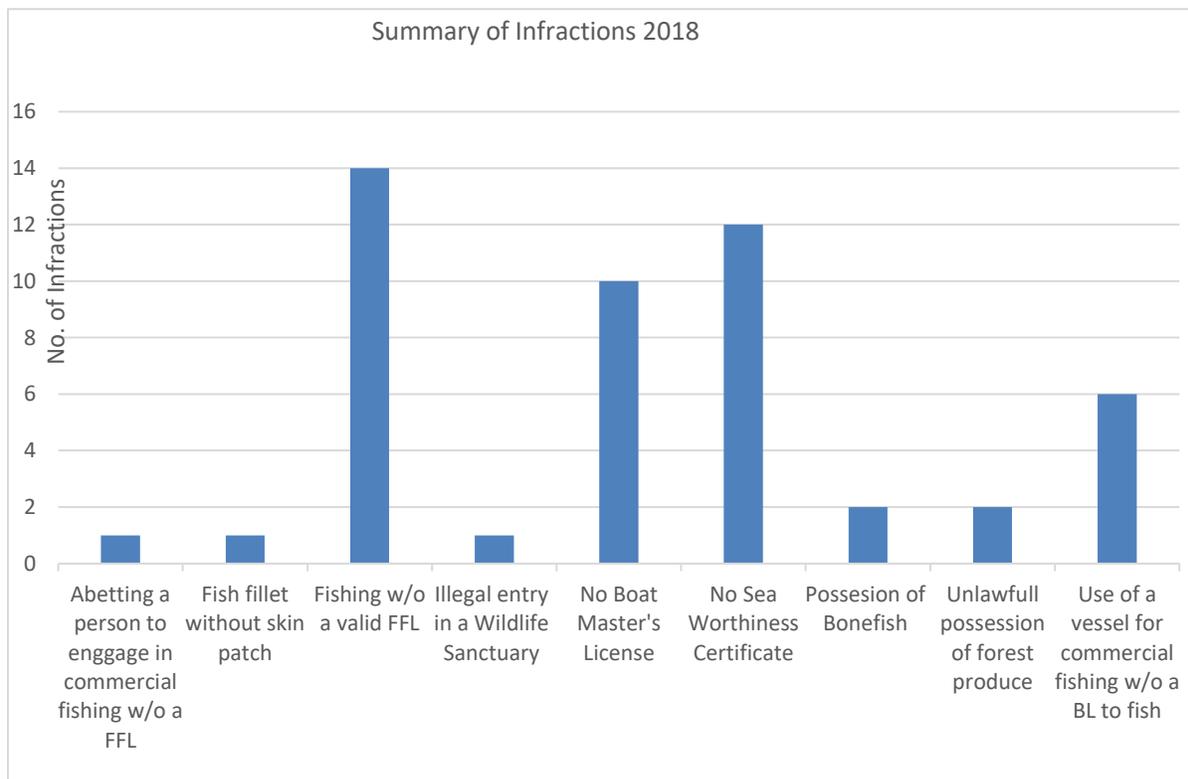


FIGURE 60: SUMMARY OF INFRACTIONS, 2018 (SACD DATA, 2018)

As part of its system-level collaboration, SACD also assisted BCMR during the opening of the conch season, with coordinated patrols reducing the number of illegal fishing in the BCMR. Several fishing vessels were warned and asked to leave the Wildlife Sanctuary as they were not holders of valid Fisher Folks licenses for Area, 1 in accordance to the Managed Access regulations.

KEY CHALLENGES (2019)

- Resolution of protected area re-designation category.
- Finalization and implementation of the rights-based fishery in CBWS following the Managed Access framework.
- Finalization and demarcation of revised boundaries and zonation in Corozal Bay Wildlife Sanctuary.
- Updating the Surveillance and Enforcement Plan
- Improve response to community / stakeholder reports.
- The size of CBWS - effective patrolling of the entire area (178,000 acres) would require a second surveillance vessel, radio communications and two more rangers.
- Improving ability to launch the vessel, particularly in north winds – docking facility and launching ramp.
- Improve safety for rangers.
- The need to strengthen collaboration with transboundary and other NBCC protected areas for patrols.
- Improved communication with Forest Department and Department of the Environment for addressing relevant threats.

RELEVANT SACD STRATEGIC PLAN TARGETS

- Within five years, SACD will have increased representation of important mangrove ecosystem within its management scope by 10%.

A. Natural Resource Management Programme								
Objective: Ensure the effective conservation and sustainable use of natural resources of Corozal Bay Wildlife Sanctuary								
Management Actions		Present Status (2018-2019)	Desired Status	Year		Responsible Party	Notes	
Surveillance and Enforcement								
A1	Ensure CBWS has the skilled human resources and equipment for effective surveillance and enforcement	3 rangers, One surveillance vessel and one support vessel also used for monitoring activities.	1 head ranger, 4 fully trained rangers, second fully equipped surveillance vessel, second SMART system, boat-based radios.				Executive Director	Special Constable, Fisheries Officer training, navigation / GPS, SMART, basic /advanced engine maintenance, oxygen kit, first aid, bullet proof vests, weapon handling(?)
A2	Update CBWS Surveillance and Enforcement plan	In process of updating, with inclusion of mechanisms for improved response and reporting and integrates partner collaboration	Updated plan integrating / transboundary collaboration				NRM Manager	Already have the funding for this activity. Integrate collaboration in the seascape, with multi-enforcement patrols
A3	Implement regular surveillance and enforcement patrols based on updated Surveillance and Enforcement Plan	Regular, scheduled patrols including weekends, but no based on a Surveillance Enforcement Plan 3.5 patrols average per week	Coordinated patrols following the surveillance and enforcement plan, with informed decision making based on the data available				NRM Manager	SMART data collection –on resource use in the area – commercial boat traffic, commercial / sport fishing, and tourism, biodiversity monitoring, enforcement hotspots and database of community users
A4	Collaborative enforcement within the NBCC and transboundary seascape, with effective communication, standard operating procedures and sharing of information.	Monthly patrols with Forest Department / BCMR / HCMR following SoP Monthly patrols with SEMA – no SoP (but also not an enforcement agency). Good sharing of information. Not currently conducting joint patrols with Coastguard	Maintain current collaborative patrols (transboundary and BCMR / HCMR), strengthened collaboration with Coastguard. Strengthened collaborative partnerships in the NBCC seascape				NRM Manager	NBCC 1.3; NBCC 2.3

A. Natural Resource Management Programme

Objective: Ensure the effective conservation and sustainable use of natural resources of Corozal Bay Wildlife Sanctuary

Management Actions	Present Status (2018-2019)	Desired Status	Year	Responsible Party	Notes	
Surveillance and Enforcement						
A5	Ensure CBWS has effective data management for evaluation of surveillance and enforcement outputs to answer key management questions and inform adaptive management	No standardized, updated information, no system in place for data management, difficult to access data as required. No backup system.	Standardized, updated information system in place for data management (SMART), easy to access data as required to answer key questions. Weekly / monthly patrol reporting as required and as defined in the S+EP. Infraction reports. Incident reports. Backup SMART system.		NRM Manager	Report formats defined in the Surveillance and Enforcement Plan Socialization of SMART process and reporting within SACD
A6	Ensure enforcement personnel have the knowledge required for effective enforcement procedures and maintaining the required chain of custody to enable a case to be prosecuted successfully if required.	Current rangers have the training and knowledge, but any future rangers will need training	All rangers have the capacity to build a case for environmental related infractions. All are training and knowledge for the enforcement process to support successful prosecution – a solid case.		NRM Manager	Annual refresher courses with Fisheries Department, Green Laws (FD). Linked to national Surveillance and Enforcement Working Group. Identifying potential environmental infractions and training required for successful gathering of evidence NBCC 1.4; NBCC 2.4
A7	Increase the technical capacity of SACD staff to be able to address illegal activities in the coastal ecosystems	SACD has limited capacity for addressing mangrove clearance, maintenance of the 66', overwater structures and other coastal development issues	SACD is collaborating with FD and DoE to address issues impacting coastal ecosystems		NRM Manager	NBCC 4.3; NBCC 4.5; NBCC 4.9

A. Natural Resource Management Programme

Objective: Ensure the effective conservation and sustainable use of natural resources of Corozal Bay Wildlife Sanctuary

Management Actions	Present Status (2018-2019)	Desired Status	Year	Responsible Party	Notes	
Surveillance and Enforcement						
A8	Build ranger capacity for surveillance and enforcement through ranger exchanges	Exchange with TIDE in 2018, also did Special constable training and Green laws traing	Rangers participate in exchanges at least every 2 years		NRM manager	Especially for new rangers NBCC 2.4
A9	Improve ranger safety in conflict situations, and build capacity to respond to protect / save lives	Some conflict resolution practices in place in patrol team. More training required	Rangers trained and equipped for conflict resolution, hand to hand combat,		NRM manager	Combat training, through the US Parks Services – enforcement programme for NPA rangers. Boat to boat approach (BAS)
A10	Build ranger capacity as first responders to protect / save lives	No first response training offered to rangers	Rangers trained and equipped for first response situations		NRM manager	Advanced First Aid, search and rescue
Zoning and Boundaries						
A11	Liaise with GoB for finalization of zones and realignments to manage the fishery and protect critical ecosystems/ species	Proposed realignment / zone description has been approved by Government. There are, however, continuing issues with Zones 6 and 9	New zones and boundaries are legally established, with resolution of the issue with Zones 6 and 9. National shapefile accurately represents MPA boundaries and zones		Executive Director	Final consultations not yet completed. CZ 6 and 9 do not cover the key manatee area they were designated to protect. Issues with boundary adjacent to HCMR.
A12	Ensure CBWS shape file accurately represents the international border with Mexico and southern border with Hol Chan Extension	There are some discrepancies in the CBWS boundaries. Ensure an official, corrected set of shapefiles is maintained and backed up	CBWS has an official, corrected set of shapefiles is maintained and backed up		NRM manager	Work with LIC and FD

A. Natural Resource Management Programme

Objective: Ensure the effective conservation and sustainable use of natural resources of Corozal Bay Wildlife Sanctuary

Management Actions		Present Status (2018-2019)	Desired Status	Year	Responsible Party	Notes
A13	Design, install and maintain boundary and zone signs where required	Signs have not yet been developed as zones and boundaries not yet finalized	Signs in key locations informing of the boundaries, zones and zone regulations		NRM Manager	
Zoning and Boundaries						
A14	Install and maintain boundary and zone marker buoys	Boundaries and zones not yet finalized. Have buoys, but not final maps of zones	100% of buoys installed and maintained in all key locations		NRM Manager	
A15	Socialization of zones and boundaries in stakeholder communities	Stakeholders have been involved in the zones / boundary realignments, but not advised of final outputs.	Stakeholders are informed and aware of boundaries, zones and regulations		NRM Manager	In collaboration with Outreach officer and CBAC, Facebook, presentations, printed materials
Fisheries Management						
A16	Finalise the CBWS Sustainable Fisheries Plan, MPA regulations, aligned with the Managed Access framework	Sustainable Fishery Plan is being developed but not yet finalized.	The Sustainable Fishery Plan has been endorsed, is being implemented, and regularly evaluated		Executive Director	To be evaluated in the 3 rd year, and reviewed and revised in the 5 th year. NOTE: to include sport fishing / recreational fishing? NBCC 2.1; NBCC 2.2
A17	Implement the CBWS Sustainable Fisheries Plan, with engagement of fishers and protection of traditional fisher rights	Sustainable Fishery Plan is being drafted	Sustainable Fishery Plan is being effectively implemented, evaluated and revised as necessary		NRM Manager	NBCC 2.1; NBCC 2.2; NBCC 2.5
A18	Provide assistance to CBWS fishers for managed access reporting - species identification / completion of log books / landing reporting	Sustainable Fishery Plan is being drafted	Fishers have assistance with MA reporting – species identification, completion of log books / landing reporting		NRM Manager	Community Researchers / SACD Interns NBCC 2.5

A. Natural Resource Management Programme

Objective: Ensure the effective conservation and sustainable use of natural resources of Corozal Bay Wildlife Sanctuary

Management Actions	Present Status (2018-2019)	Desired Status	Year	Responsible Party	Notes	
Fisheries Management						
A19	Lobby for re-designation of CBWS following the recommendation of the PA Rationalization report	Current designation does not support traditional fisher rights. No clear plan of action to lobby for re-designation	CBWS is designated as a protected area that supports traditional fisher rights		Executive Director	Wildlife Sanctuary (2) Develop a plan of action for next steps for re-designation, with FD NBCC 2.2; NBCC 4.3; NBCC 4.9
Habitat and Species Management						
A20	Effective signs and surveillance of stromatolite area and adjacent coast	Signage being designed and printed. Adjacent coast in targeted for development	Signs are in place. People are aware of the unique nature and value of, demonstrating good stewardship		NRM Manager	NBCC 8.3
A21	Lobby to ensure that coastal developments follow the recommendations of the CZM plan through the EIA / ECP process	Not currently being addressed. No strong partnership with CZMAI or DoE	SACD stays informed of potential developments and provides inputs into all relevant coastal development through participation in the EIA process, to ensure alignments with the CZM Plan recommendations		Executive Director	Need improved communication with Department of the Environment and Forest Department to ensure SACD is aware of potential EIAs NBCC 4.6; NBCC 4.9
A22	Increase protection area of priority fishery nursery areas to improve support of the commercial fish species of CBWS	SACD is investigating options for increasing protection of key mangrove nursery areas	Increased key mangrove nursery area coverage in CBWS and SACD management scope		Executive Director	Needs to be based on good data NBCC 5.2

A. Natural Resource Management Programme

Objective: Ensure the effective conservation and sustainable use of natural resources of Corozal Bay Wildlife Sanctuary

Management Actions	Present Status (2018-2019)	Desired Status	Year	Responsible Party	Notes	
Habitat and Species Management						
A23	Collaborate with Wildtracks for effective management of Antillean manatees in CBWS	Collaboration with Wildtracks ongoing, but could be strengthened. CBWS is the release site for the rehabilitation programme	Strong collaborative partnership with Wildtracks for effective management of Antillean manatees in CBWS and the seascape		NRM Manager	NBCC 7.1; NBCC 7.2; NBCC 7.3
A24	Ensure adequate no-wake signage in key manatee areas	Have five signs, but haven't been installed yet	Adequate no-wake signage in key manatee areas. Needs permission from Port Authority and socialization with stakeholders		NRM Manager	This is independent of zone designation NBCC 7.4; NBCC 7.5; NBCC 7.6; NBCC 7.7
A25	Resolve the zone issues on the east coast for improved protection of manatees in CBWS	The current proposed zones 6 and 9 do not cover the key manatee area identified during the aerial surveys	Zones 6 and 9 are revised to cover the key manatee area (Manatee Hole 1)		Executive Director NRM Manager	This issues was brought up during the MCCAP zoning process in 2017 / 2018 but hasn't yet been resolved
A26	Develop best practices for tourism and fishing sectors	Some basic guidelines developed under the STGA but this has not been addressed recently	CBWS has best practices guidelines for the tourism sector, including guidelines for beach trap and sport / recreational fishing and best practices around manatees and dolphins, aligned with the revised Wildlife Protection Act		NRM Manager	including guidelines for beach trap and sport / recreational fishing, sharks and rays, best practices around manatees and dolphins, aligned with the revised Wildlife Protection Act Pesca Tours best practices

A. Natural Resource Management Programme

Objective: Ensure the effective conservation and sustainable use of natural resources of Corozal Bay Wildlife Sanctuary

Management Actions	Present Status (2018-2019)	Desired Status	Year	Responsible Party	Notes	
Addressing Specific Threats						
A27	Targeted protection of key bird nesting sites	Current mapping of key bird nesting sites and species. A focus on Reddish Egrets	Increased viability of key species nesting in CBWS through improved protection		NRM Manager	Protection from development, poaching, tourism disturbance. Removal of predators (e.g. boas) from cayes. Best tourism practices NBCC
A28	Lobby against dredging in the Bulkhead Shoals area,	As required	SACD continues to lobby against dredging of Bulkhead Shoals		Executive Director	Critical role in settling turbidity and contaminants of CBWS estuarine system before entry into the BBRRS NBCC 4.9; NBCC 6.4
A29	Engage land owners/ developers, residents etc. adjacent to and in CBWS in ensuring best management practices for water and chemical management, maintenance of mangroves	Have development representative on CBAC...CBAC reps are informed of water quality. Initial contact for engagement, but no promotion of best practices	Best practices recommendations are developed and distributed to land owners, outputs of WQM / mangrove clearance impacts etc. are presented		NRM Manager	Through CBAC With assistance from Outreach. Based on WCS Best Practices output (early 2000's)
A30	Support strategies for improving knowledge on state of rivers and reducing impacts in the NBCC watershed	Supported Friends of New River in 2017 / 2018, provision of information, conducted water sampling in partnership with ECOSUR	Key points of contamination and partners have been identified and engaged to support addressing of issues in the watersheds		Executive Director	

A. Natural Resource Management Programme

Objective: Ensure the effective conservation and sustainable use of natural resources of Corozal Bay Wildlife Sanctuary

Management Actions	Present Status (2018-2019)	Desired Status	Year	Responsible Party	Notes	
Addressing Specific Threats						
A31	Provide a Status of River report to industries, village / town councils adjacent to the river, and Government	Collecting information	State of the River report for the New River		NRM Manager	Potential MSc research project. Current focus is for New River – need to also access information for Rio Hondo
A32	Lobby with authorities for improved sewage and solid waste management in Sarteneja and Corozal	2018 / 2019 surveys show signs of contamination in front of Sarteneja and Corozal	Improved sewage and solid waste management reduces contamination levels in front of Sarteneja and Corozal		NRM Manager	Álvarez Legorreta, 2019
A33	Provide coastal developments with best practice guidelines for sewage management	One coastal development is attributed to contamination near the “laguna seca” ferry	Coastal developments have good sewage management that has limited / no impact on water quality		NRM Manager	Álvarez Legorreta, 2019
A34	Include protection of identified pre-Hispanic fish traps in patrol objectives	Nine potential pre-Hispanic fish traps have been identified but not yet confirmed	Pre-Hispanic fish traps are protected from disturbance (movement of rocks, dredging etc.)		NRM Manager	Identified in Rosado, 2019 draft)

3.4.2 RESEARCH AND MONITORING PROGRAMME

Programme Objective: To ensure adequate knowledge to support informed decision making for biodiversity and human resource use management

Management and Administration

Research and monitoring are at the core of all of SACD’s management activities. The Research and Monitoring Programme ensures that SACD has adequate knowledge of the key conservation targets, including manatees, bird nesting colonies, commercial fish species, mangroves, and water quality, in order to develop appropriate management strategies. With accurate baseline data on the quality of CBWS and its natural resources, SACD is able to be strategic in its use of resources for maximum Conservation return, with the greatest benefits to biodiversity, giving the organization a better understanding and appreciation of the ecosystem services that CBWS provides to its stakeholder communities, and to the larger Northern Belize Coastal Complex (NBCC).

- *Biodiversity Monitoring*
 - *Biodiversity Research*
 - *Dissemination of Results*
-

SACD is utilizing new technologies such as the use of drones and development of its in-house GIS systems. It focuses on maintaining strong partnerships to develop appropriate research methods that will best capture data in CBWS, with training sessions for staff members and the community research team, ensuring that data is not only collected, but that SACD has the knowledge and tools to also analyze that data effectively.

SACD also strongly values collaborative work in the NBCC to ensure there is a clear understanding of the status of the conservation targets and their significance within the larger seascape. SACD participated in the Regional Connectivity Exercise for the Mesoamerican Reef countries (ECOME 7) along with the Bacalar Chico Marine Reserve (BCMR) staff. This nine-day long exercise was to determine the patterns of fish post-larvae (juvenile fish) dispersal and recruitment, contributing to an existing database on larval connectivity in the wider Caribbean region. In 2017/2018, SACD continued to expand its dataset on water quality in CBWS, helping the organization to monitor the impacts of pollution

SACD has ongoing monitoring of six Conservation Targets:

- West Indian manatee
- Commercial fish species
- Bird nesting colonies / waterbirds
- The estuarine environment – water quality

Baseline data / mapping for four Conservation Targets

- Seagrass
- Stromatolites
- Sharks and rays
- Mangroves and other coastal ecosystems

Additional monitoring for contribution to regional monitoring efforts

- Reddish egrets
- Post-larval reef fish
- Ichthyoplankton
- Seagrass
- Water contamination sampling

in Corozal Bay in collaboration with ECOSUR. SACD has also participated in collaborative research activities to collect data on fish recruitment and spawning in CBWS, To identify important areas for recruitment and spawning, piloting the use of light traps, in collaboration with Dr. Lourdes Vásquez Yeomans from ECOSUR. The organizations also participated in the National Morelet's Crocodile Survey, supporting the Crocodile Research Coalition (CRC) in a survey of crocodile species present in the surrounding rivers, building further knowledge of the area and its biodiversity.

Current Status (2019)

Personnel:

NRM Programme Manager
6 Community researchers

Equipment:

Monitoring equipment

Strengths:

- Long-term monitoring of CBWS priority conservation targets
- Established water quality monitoring protocol shared with other organization through NCRMN
- Committed, equipped and trained community research team
- Technical support from, and collaboration with, ECOSUR and trans-boundary partners
- Conservation monitoring protocols laid out in Research and Monitoring Plan
- Technical support of Wildtracks and Blue Ventures

Challenges:

- Time availability and available capacity (in-house or through partnerships) to analyse data and integrate into management
 - Limited human resources for the research programme – need a Research Coordinator
 - The need to upgrade some of the monitoring equipment (primarily YSI)
 - The need to continue contamination sampling in partnership with ECOSUR – very expensive
 - Inclusion of storm event sampling – needs to be implemented at short notice
 - Improved dissemination of results
-

Monitoring and Research Programme								
Programme Objective: To ensure adequate knowledge to support informed decision making for biodiversity and human resource use management								
Management Actions	Present Status (2018-2019)	Desired Status	Year			Responsible People	Notes	
Biodiversity Monitoring								
B1	Ensure the biodiversity monitoring programme has the necessary human resources	The programme operates under the NRM Programme and has no dedicated staff. Activities rely heavily on skilled Community Researchers	SACD has a Research Coordinator and at least one researcher, supported by skilled Community Researchers				Executive Director	
B2	Ensure the biodiversity monitoring programme has the necessary equipment	SACD has 75% of equipment required for effective implementation of the biodiversity monitoring programme	SACD has 100% of equipment required for effective implementation of the biodiversity monitoring programme				NRM Manager / Research Coordinator	Upgrade and maintain equipment
B3	Continue to build the capacity of SACD for effective monitoring and research outputs that inform management decisions	SACD has the capacity for effective monitoring, but would benefit from increased capacity in data management and analysis, to ensure outputs are accessible for management decisions	SACD has the capacity for effective data management, analysis and use, aligned with standardized data management practices for national protocols				NRM Manager / Research Coordinator	Drone use and mapping, use of GIS Build the capacity of SACD to monitor CBWS / NBCC targets NBCC 5.1; NBCC 7.3
B4	Strengthen monitoring of current conservation targets	SACD has a monitoring programme in place that is providing 75% of information for management	SACD monitoring programme provides 100% of information required for management				NRM Manager / Research Coordinator	See SACD Research and Monitoring Handbook NBCC 5.1; NBCC 7.3
B5	Review and revise the NBCC and site level conservation targets and threat assessments in 2019 / 2020	SACD led the first NBCC CAP – this needs to be u for implementation and output success, including tracking of conservation target and threat indicators	SACD has conducted an assessment of implementation success, and updated the conservation target and threat indicator status				Executive Director NRM Manager	Build the capacity of the CBAC to provide information on CBWS targets from experience as traditional users NBCC 5.1; NBCC 7.3

Monitoring and Research Programme						
Programme Objective: To ensure adequate knowledge to support informed decision making for biodiversity and human resource use management						
Management Actions		Present Status (2018-2019)	Desired Status	Year	Responsible People	Notes
Biodiversity Monitoring						
B6	Ensure consistent information on fish catch for fish traps, gillnets and cast nets	SACD is monitoring beach trap catches in collaboration with the local fishers	SACD monitors all catch as recommended by the Sustainable Fishery Plan and as part of the MA framework			NRM Manager Catch information is used to support sustainable fishery / Wildlife Sanctuary 2 transition
B7	Update coastal mapping and identify rate of land use change	SACD have a baseline for coastal mapping and can update using drone mapping	SACD has information on the rate of land use change for each coastal ecosystem for CBWS			NRM Manager NBCC 4.2
Biodiversity Research						
B8	Work closely with national / international partners to consolidate climate change impact information and monitor identified gaps	SACD project to build climate change resilience / awareness in the CBWS communities. SACD is contributing data towards a national climate change vulnerability model	SACD has capacity to integrate informed climate change resilience into its activities beyond project-based activities			Executive Director NRM Manager Current activities include weather monitoring, WQM, collaboration with WWF on coastal resilience project NBCC 9.1; NBCC 9.3
B9	Identify, map and document historical cultural resources of CBWS	SACD has limited information on historical and cultural resources of CBWS. Nine Maya fish trap sites to be confirmed	SACD has information on the historical and cultural resources of CBWS			NRM Manager / Research Coordinator Maya fish traps (Rosado, draft, 2019), Maya settlements on east coastline and cayes
B10	Document significance of CBWS as a trading route for the Maya	SACD has limited information on historical and cultural resources of CBWS	SACD has information on the significance of CBWS as a trading route for the Maya			NRM Manager / Research Coordinator Master student or longer term partnership with university
B11	Develop baseline mapping and information on public use (commercial, recreational / sport fishing, and tourism)	SACD is using SMART to gather data on commercial, recreational and sport fishing, public and tourism use	SACD maintains updated, accessible information on commercial, recreational and sport fishing, public and tourism use.			NRM Manager / Research Coordinator An annual report with maps summarizes outputs

Research and Monitoring Programme

Programme Objective: To ensure adequate knowledge to support informed decision making for biodiversity and human resource use management

Management Actions		Present Status (2018-2019)	Desired Status	Year	Responsible Party	Notes
Biodiversity Research						
B12	Identify and improve knowledge of critical fish nursery areas in CBWS for commercial fish species (including sport species)	Assumption is that inundated mangrove have highest value as fish nursery areas based on qualitative information and fisher feedback - limited quantitative for identification of the most important areas	SACD management strategies for ensuring long term viability of key nursery areas are based on validated information through an active ichthyoplankton monitoring program		NRM Manager / Research Coordinator	Nursery areas that maintain local fish stocks – chiwa, mojarra, snook, snapper, tarpon...
B13	Implement research activities defined by the sustainable fishery plan	SACD has activities defined in the Preparatory document and is developing the Sustainable Fishery Plan	SACD is managing its fishery based on validated information		NRM Manager / Research Coordinator	Identify spawning sites, reproductive cycles for commercial and sport fishing species
B14	Improve knowledge of sharks and rays for CBWS to have a better understanding of their use of the estuary	SACD has initial data on the sharks and rays using the estuary, but still has information gaps	SACD has addressed information gaps on shark and ray use of CBWS and consolidated information into an accessible report		NRM Manager / Research Coordinator	MSc student Opportunistic assessments through collaboration with partners e.g. MarAlliance and NBCC PA managers
B15	Continue research into pollution levels in CBWS and identify sources	SACD has partnered with ECOSUR to develop a baseline of water-borne contaminants in CBWS as part of the WQM programme	SACD has baseline information on contamination levels in CBWS, has identified the sources and is using this information to encourage action in the watershed to address issues		NRM Manager / Research Coordinator	NBCC 3.1; NBCC 3.2; NBCC 3.3; NBCC 3.4;
B16	Improve knowledge and mapping of current land use in the watershed and along rivers	SACD has mapped riparian vegetation and level of human disturbance along the New River	SACD has mapped land use in the watersheds draining into CBWS		Research Coordinator	Intern research project – remote sensing NBCC 3.5

Research and Monitoring Programme						
Programme Objective: To ensure adequate knowledge to support informed decision making for biodiversity and human resource use management						
Management Actions	Present Status (2018-2019)	Desired Status	Year	Responsible Party	Notes	
Biodiversity Research						
B17	Improve knowledge and mapping of current land use in the watershed and along rivers	SACD has mapped riparian vegetation and level of human disturbance along the New River	SACD has mapped land use in the watersheds draining into CBWS		Research Coordinator	Intern research project – remote sensing NBCC 3.5
B18	Develop baseline mapping and information on the status of, and conditions required by, stromatolites in Corozal Bay Wildlife Sanctuary	Preliminary mapping has been conducted using the drone, but has not yet been completed. There is little knowledge or information of the stromatolites available to SACD or available for dissemination	SACD has mapped the stromatolites and has accessible information available on them		NRM Manager / Research Coordinator	May need MSc student NBCC 8.1;
B19	Maximise collaborative opportunities to improve knowledge of other CBWS species	SACD is collaborating with other organizations and researchers to improve information on non-target species in CBWS	SACD continues to collaborate with other organizations and researchers to improve information on non-target species in CBWS, where information is considered useful for management		NRM Manager / Research Coordinator	Crocodiles, dolphins, goliath grouper, sharks and rays, turtles, migratory waterbirds. Ensure data and reports are shared with SACD following data sharing agreements
B20	Build collaborative partnerships with other organizations active in the CBWS watersheds	There are few organizations active in the watersheds. SACD can strengthen communication with those that do exist	SACD has strong collaborative partnerships with organizations active in the watersheds		Executive Director / NRM Manager	CSFI has information on Progresso Lagoon Rio Hondo project

Research and Monitoring Programme						
Programme Objective: To ensure adequate knowledge to support informed decision making for biodiversity and human resource use management						
Management Actions	Present Status (2018-2019)	Desired Status	Year	Responsible Party	Notes	
Dissemination of Results						
B19	Strengthen dissemination of research and monitoring information	SACD is achieving good outcomes in terms of biodiversity information, but is limited in its effectiveness in informing others of its work and results	SACD has an active presence at symposia and research / monitoring meetings and conferences, sharing data through presentations, papers, articles, Facebook, the SACD newsletter and through annual reporting		Executive Director / NRM Manager	Communities Research, monitoring and funding partners Symposiums and conferences Annual reporting
B20	Develop a data sharing policy	SACD does not yet have a data sharing policy, but data sharing issues have arisen	SACD has a data sharing policy that still follows the organizations policy of sharing of information, but protects SACD data ownership		Executive Director / Board of Directors	
B21	Strengthen accessibility of research and monitoring information to local communities	SACD is achieving good outcomes in terms of biodiversity information, but is limited in its effectiveness in informing community stakeholders of its work and results	SACD has an is disseminating information on its research and monitoring outputs in a manner that is accessible to local stakeholders		Executive Director / NRM Manager	
B22	Develop a data sharing policy	SACD does not yet have a data sharing policy, but data sharing issues have arisen	SACD has a data sharing policy that still follows the organizations policy of sharing of information, but protects SACD data ownership		Executive Director / Board of Directors	

3.4.3 COMMUNITY DEVELOPMENT AND OUTREACH

Programme Objective: Engaged, resilient communities demonstrating good stewardship of the environment, with improved socio-economic benefits.

Education is at the heart of behavioural and attitudinal changes in community members, and the first step towards making a difference in reducing anthropogenic threats. Through this programme, SACD implements targeted educational activities towards fishermen and their families, local schools, and tourists visiting the area. Increasingly effective education and outreach activities delivered across a diverse range of community, stakeholder, and industry members will lead to the community awareness and participation desired for the successful management of CBWS, supported by the communities that live beside it.

SACD recognizes the importance of educating and training youths – the next generation of resource users and future leaders of our communities. For this reason, SACD continues to focus much of its efforts in engaging schools in the three key stakeholder communities: Sarteneja, Chunox, and Copper Bank. Over 250 students were engaged in 2018 through presentations on the importance of the marine protected areas, aligned with the school curriculum. By encouraging youth participation in hands-on activities and learning opportunities through unique experiences in the natural environment, they form a meaningful connection to nature and gain a greater appreciation for the value of CBWS.

The Internship Programme being piloted in 2018 provides youths the opportunity to gain a more in-depth and hands-on experience in the field of conservation and seeks to engage motivated youths who are interested in developing their technical skills set and expanding their knowledge of natural resource management. The Internship Program will help youth prepare for their future careers while generating funding for their tertiary education.



Assisting stakeholders in diversifying their income and reducing their dependence on the protected area is also a key strategy for CBWS. An intensive nine-week long tour guide course was provided for fishermen and their families from the communities of Sarteneja, Chunox, and Copper Bank.

COMMUNITY DEVELOPMENT AND OUTREACH

- *Environmental Education*
 - *Public Outreach and Information*
 - *Alternative Livelihoods*
 - *Community Capacity Building*
-

Opportunities such as these ensure that fishers and their families are well-equipped to become future environmental stewards for CBWS.

The Corozal Bay Advisory Committee (CBAC) continues to be the lead advocate for effective management of CBWS. The CBAC members, drawn from the community stakeholder sectors, have been actively involved in recommending the process of the realignment and the re-designation of the protected area. They are active in their participation in management decisions for the protected area, ensuring that there is equal recognition of the values of the protected area and the livelihoods of people that depend on the resources. During 2017 -2018, SACD was able to maintain an average of 80% participation in the series of CBAC meetings that are held every quarter, alternating between each of the CBWS stakeholder communities.

Community Engagement and Investment Strategy

SACD developed a joint Community Engagement and Investment Strategy with the Belize Audubon Society in 2018 to guide collaborative activities in the stakeholder communities of CBWS. It identified a series of five outcomes that, when achieved, support SACD's Programme Objective:

- Community groups with sustained, active partnerships with BAS and SACD
- Communities improving their livelihoods and reducing their impacts on the natural resources
- Communities that are engaged and participating in the protection of ecosystem services
- Communities that support conservation and sustainable use
- Communities that understand and are adapting to climate change

Strategies are grouped under four Key Strategic Themes:

- **COMMUNITY ENGAGEMENT:** Improving communication, collaboration, capacity and engagement within communities, and ensuring accurate information and perceptions for decision making
- **INVESTMENT LINKED TO STRATEGIC OUTCOMES:** Ensuring structures and processes are in place for successful income diversification projects in the communities
- **RESILIENT COMMUNITIES:** Improving community resilience to climate change
- **BAS / SACD SUPPORTING COLLABORATIVE FRAMEWORK:** Providing a solid foundation for a long term working partnership towards implementation of the Community Engagement and Investment Strategy

...and linked to five SMART objectives:

Objective One: By 2028, at least 75% of community partner groups in the three target communities have sustained, active partnerships with BAS and SACD

Objective Two: By 2028, at least 20% of direct users in each of the communities have benefited either directly or indirectly from income diversification strategies, with reduced impacts on the protected areas

Objective Three: By 2028, at least 50% of households in the three target communities understand and support the concepts of conservation and sustainable use

Objective Four: By 2028, at least 30% of households in the three target communities are actively engaged and participating in the protection of ecosystem services

Objective Five: By 2028, at least 50% of households in the three target communities understand and are taking steps to adapt to climate change

KEY RECOMMENDATIONS

A series of Key Recommendations were also developed, to be implemented through this management plan:

PREPARATORY PHASE

- Ensure BAS and SACD develop an agreement that clearly defines roles and responsibilities during the establishment of the collaborative partnership
- Develop and implement an initial 1-year BAS / SACD Communication and Collaboration Plan to ensure adequate communication
- Ensure clearly defined framework for management of micro-loan funds (joint or separate) during preparatory phase
- Identify and engage other public and private sector partners towards achieving the identified outcomes and strategic activities
- Develop the implementation frameworks:
 - Community Engagement Strategy (including the Student Education and Awareness Strategy),
 - Northern Fishing Communities Communication Plan,
 - Northern Fishing Communities Investment Strategy and project selection criteria
 - Monitoring and Evaluation Framework and baseline,
 - the framework and staffing for the establishment of the Community Resource Hub, ...with the participation of relevant stakeholders

COMMUNITY OUTREACH AND ENGAGEMENT

- Implement the structured, collaborative Student Education and Awareness Strategy that provides opportunities for class and field activities (including Reef Protectors) from infant through high school, ensuring students are immersed in conservation experiences throughout their school life.
- Implement the Communication Plan for the northern fishing communities that identifies mechanisms for maintaining consistent contact with community groups, leaders and key individuals
- Strengthen the SACD Community Researcher programme
- Continue on-water, boat-to-boat communication with fishers and other users in all three marine protected areas
- Implement and participate in outreach events that will increase communication with people in the communities, and engage them through participatory conservation activities

INCOME DIVERSIFICATION INVESTMENTS LINKED TO STRATEGIC OUTCOMES

- Invest in projects with individuals and groups that show a high level of engagement, commitment, interest and motivation during training opportunities, are supportive of and willing to participate in extra-curricular conservation activities with the protected area managers, and have projects that fit within the project criteria
- Focus on investments and engagement activities that build the enabling environment in each of the communities for increasing employment opportunities. A key focus has been identified for each community:
 - Sarteneja: Tourism
 - Chunox: Climate-Smart Agriculture
 - Copper Bank: Climate-Smart Agriculture

This does not preclude investment in these areas in all three of the communities, but provides guidance for the primary focus of strategies and activities for maximum return

- Identify and invest in projects that add value to both agricultural products and tourism
- Identify and investigate options for mission-related business impact investment opportunities by BAS / SACD, providing community partners with access to small grants and low-interest microloans and profit sharing for improving markets, and adding value to both agricultural products and tourism
- Ensure all business investments are based on sound business plans
- Ensure all investments are climate-smart, build community resilience and have the potential to reduce pressures on the natural resources
- Ensure sufficient support, follow-up and oversight is provided to community investments by collaborating partners and through the establishment of the Community Resource Hub
- Where feasible, provide multiple-year (3 year) investments to improve success

BUILDING COMMUNITY CAPACITY AND RESILIENCE

- Provide continuous on-site support for smaller community-based organizations through the Community Resource Hub, hosted under SACD, offering a range of services to build capacity, assistance with locating potential funding sources, project application, management and implementation, financial management, business planning and marketing
- Continue to encourage community networking, collaboration and communication through community planning workshops and meetings towards the goals for each community - but balance this with issues of meeting fatigue

MEASURING SUCCESS

- Measure progress at the end of every three years, throughout the 10-year strategic timeframe, integrating recommended additions / amendments to strategies as part of the adaptive management cycle

RELEVANT SACD STRATEGIC PLAN TARGETS

The SACD Strategic Plan (2019 – 2023) identifies four targets that support the Strategic Plan objective:

Within the next five years, stakeholder understanding, appreciation and support of SACD's work and purpose will have increased.

TARGETS

- SACD has updated and is executing its Communication Plan
- At least 50% of stakeholders identified in the Communication Plan know and understand SACD's role and functions.
- Improved stakeholder community awareness of the values of ecosystem services provided by the Northern Belize river-to-reef seascape, and their importance in supporting local livelihoods.
- 100% of students in the northern fisher communities have a good understanding of key conservation concepts defined in the Community Engagement and Investment Strategy.

Community Development and Outreach

Objective: Improving communication, collaboration, capacity and engagement within communities, and ensuring accurate information and perceptions for decision making

Management Actions		Present Status (2018-2019)	Desired Status	Year				Responsible Party	Notes
C1	Ensure the Community Engagement and Investment Strategy is socialized across SACD and is integrated into SACD workplans	A joint strategy has been developed in collaboration with BAS	The strategy is being implemented in collaboration with BAS and other partners, and achieving the required outcomes and impacts					Executive Director	There needs to be an understanding across the organization that this is relevant to and supports activities in all programmes, not just the Community Development and Outreach Programme
C2	Prioritize implementation of the Preparatory Phase actions of the Community Engagement and investment Strategy	The joint Community Engagement and Investment Strategy has been developed in collaboration with BAS	SACD and BAS have developed an effective framework for implementation of the joint Community Engagement and Investment Strategy					Executive Director / Community Outreach Programme Manager	
C3	Ensure the Community Development and Outreach Programme has the human resources and equipment required for effective implementation	SACD currently has an Education Officer – there is no Programme Manager / Community Liaison officer	The Development and Outreach Programme has skilled staff and equipment for effective implementation of the Community Engagement and Investment Strategy					Executive Director	
Environmental Education									
C4	Develop the joint Student Engagement and Awareness Strategy in collaboration with BAS and other partners	There is no strategic framework to guide long term engagement of youths / students and teachers in stakeholder schools	A joint Student Education and Awareness Strategy has been developed with BAS and other partners for schools in the northern fishing communities					Community Outreach Programme Manager / Education Officer	Requires collaboration with BAS (BAS may want to lead the planning for this output)

Community Development and Outreach

Objective: Improving communication, collaboration, capacity and engagement within communities, and ensuring accurate information and perceptions for decision making

Management Actions	Present Status (2018-2019)	Desired Status	Year	Responsible Party	Notes	
Environmental Education						
C5	Implement the Student Engagement and Awareness Strategy with BAS and other partners	The Community Engagement and Investment Strategy includes the need for a joint collaborative plan for engaging schools / students	A School Engagement Strategy has been developed in collaboration with partners and is being implemented effectively		Community Outreach Programme Manager / Education Officer	Collaboration with BAS, Blue Ventures, WCS, Wildtracks, TASA, MCCAP, FD, FiD, Coastal Zone and other partners working in the area
C6	Develop a revised framework for the SACD scholarship and internship programme	SACD implemented the scholarship programme from 2010 to 2018 – need to evaluate it. Internship programme started in 2018	SACD has a defined framework for the Scholarship and Internship programme based on a report evaluating the activities to date		Executive Director / Community Outreach Programme Manager	Executive Director for defining the framework and specific Programme Manager for implementation NBCC 1.8
C7	Implement the revised framework for the SACD scholarship and internship programme	SACD is evaluating the outputs of the Scholarship and Internship activities to date to inform the revised strategy	SACD is implementing its revised framework for the Scholarship and Internship programme		Community Outreach Programme Manager	NBCC 1.8
Public Outreach and Information						
C8	Review, revise the CBWS Communication Strategy to strengthen communication and engagement activities	The current strategy is outdated, not used and needs to be revised	SACD has a strong Communication Strategy that strengthens its communication with its stakeholders and ensures effective dissemination of information		Community Outreach Programme Manager / Community Liaison Officer	See Community Engagement and Investment Plan Key Strategy Theme One: Community Engagement In collaboration with BAS

Community Development and Outreach

Objective: Improving communication, collaboration, capacity and engagement within communities, and ensuring accurate information and perceptions for decision making

Management Actions	Present Status (2018-2019)	Desired Status	Year	Responsible Party	Notes	
Public Outreach and Information						
C9	Prioritize and strengthen capacity, communication and engagement of CBAC	Active CBAC, meeting every quarter – limited follow up / communication outside of meetings	Effective two way, consistent communication with CBAC, with follow up on recommendations		NRM Manager / Community Liaison Officer	Need to prioritize hiring of Community Liaison Officer
C10	Strengthen framework, capacity and engagement of Conservation Researchers	6 active CRs, 4 are fully engaged and good stewards of CBWS. Strategy going forward is to be synergized with BAS Reef Protectors	Continue strengthening the Conservation Researcher programme, synergizing with BAS Reef Protectors, for activities across the seascape and nurturing environmental ambassadors in the community		NRM Manager	Link to BAS Reef Protectors, participate in education and outreach activities as well as research / monitoring
C11	Develop interpretive materials for dissemination of information through structured frameworks (e.g. Sustainable Fishery Plan, Student Engagement and Awareness Strategy etc.)	Some interpretive materials, but not long term, standardized or linked to strategic activities Manual being developed for tour guides for best practices.	SACD has interpretive materials, that are long term, standardized and linked to strategic activities, and support outreach needs of all programme areas		Community Outreach Programme Manager / Education Officer	SACD outreach materials include best practices for tourism, fishing, coastal development and climate change resilience Interpretive for Resource Information Centre Interpretive activities
C12	Engage land owners/developers, residents and users of private lands / cayes adjacent to or in CBWS to improve best management practices	Limited outreach to private landowners / resorts – primarily through CBAC representation	Land owners/developers, residents and users of private lands / cayes		Executive Director/ Community Outreach Programme Manager	Protection and restoration of mangroves; compliance with legislation for water and chemical management NBCC 4.4

Community Development and Outreach

Objective: Improving communication, collaboration, capacity and engagement within communities, and ensuring accurate information and perceptions for decision making

Management Actions	Present Status (2018-2019)	Desired Status	Year	Responsible Party	Notes	
Public Outreach and Information						
C13	Collaborate with partners to sensitize politicians to the need for improved management of the coastal zone	There is a level of national awareness of the need for improved management of the coastal zone, but less so at local level	There is national and local political support improved management of the coastal zone		Executive Director	
C14	Implement strategy to increase awareness of climate change impacts	Climate change awareness is included in the Community Engagement and Investment Plan	SACD is implementing climate change strategies in the northern communities in collaboration with partners		Community Outreach Manager /Education Officer	
Income Diversification						
C15	Implement the investment component of the Community Engagement and Investment Strategy	SACD has a Community Investment Strategy. 3 projects are being invested in in 2019, targeted at fishers	Income diversification projects are implemented successfully, contributing to annual incomes / reducing pressure on CBWS resources		Community Outreach Programme Manager	
C16	Ensure SACD has the skilled human resources to successfully implement the investment projects	SACD has some capacity for project implementation but not the required human resources	SACD has the skilled human resources to successfully implement investment projects in its investment portfolio		Executive Director	Need to employ Development Officer, Business / Marketing Officer, Community Liaison Officer,
C17	Develop joint entrepreneurial combined grant / microloan system with BAS	No current grant / microloan system in place under SACD. BAS has an ongoing system	There is a joint entrepreneurial combined grant / microloan system with BAS		Executive Director	

Community Development and Outreach

Objective: Improving communication, collaboration, capacity and engagement within communities, and ensuring accurate information and perceptions for decision making

Management Actions	Present Status (2018-2019)	Desired Status	Year	Responsible Party	Notes	
Income Diversification						
C18	Identify and investigate options for mission-related business impact investment opportunities for SACD for adding value to agricultural products and profit sharing	It is identified in the Community Investment Strategy	SACD has implemented a successful business impact investment project in one of the communities, in partnership with the community business		Executive Director	Could be in partnership with BAS or other relevant NGOs
Community Capacity Building						
C19	Strengthen capacity of and communication with CBAC	Active CBAC, meeting every quarter – limited follow up communication	Effective two-way, consistent communication with CBAC, with timely follow up on recommendations		NRM Manager / Community Liaison Officer	Need to prioritise hiring of Community Liaison Officer to take on this responsibility
C20	Strengthen capacity of Conservation Researchers	6 active CRs, 4 are well engaged and good stewards of CBWS. Strategy going forward is to be synergized with BAS reef Protectors	Continue strengthening the CR programme, and define synergies with BAS Reef Protectors, for activities across the seascape		NRM Manager	Link to BAS Reef Protectors, Build capacity for participation in activities NBCC 1.8
C21	Build capacity of tour guides and tourism resorts in best tourism practices for CBWS	A best practices document was developed several years ago, but without the engagement and input of the tour guides – no tour guides at the time. Manual is being developed for tour guides for best practices.	Engaged tour guides / tourism sector that follow best practices, with improved stewardship of the resources of natural of CBWS		Executive Director / Community Outreach Programme Manager	Rules and regulations. Increase awareness of tour guides, boat captains and visitors of the Wildlife Protection Act and its protection of CBWS biodiversity NBCC 7.5; NBCC 7.6 NBCC 8.1; NBCC 8.2

Community Development and Outreach

Objective: Improving communication, collaboration, capacity and engagement within communities, and ensuring accurate information and perceptions for decision making

Management Actions		Present Status (2018-2019)	Desired Status	Year				Responsible Party	Notes
Community Capacity Building									
C22	Build capacity of fishers in best fishing practices for CBWS	Developing best practices for the beach traps, with integration into the sustainable fishery plan.	All CBWS fishers engaged and demonstrating best practices, with improved stewardship of the resources of natural of CBWS					Executive Director / Community Outreach Programme Manager	
C23	Work with communities to implement strategies to build climate change resilience	Strategies are identified within the Community Engagement and investment Strategy	Climate change resilience / adaptation strategies identified in the Community Engagement and investment Strategy have been implemented, with increased awareness of climate change issues and increased resilience in communities					Education Officer	

3.4.4 TOURISM AND RECREATION

Programme Objective: To ensure tourism use of Corozal Bay Wildlife Sanctuary is planned, developed and conducted following environmental and safety best practices

Whilst tourism development and management is not currently a key focus of SADC, the organization is planning for tourism in 2019 / 2020, linked to its financial sustainability activities.

Tourism visitation to Corozal Bay Wildlife Sanctuary is currently low volume, and not regulated. The size of the protected area and the multiple departure points for visitors (Consejo, Corozal, Sarteneja, San Pedro and coastal resorts such as Orchid Bay and Cerros Sands) are challenging for tourism management, with responsibility for tourism conduct and safety currently lying with the tour guides using the area. National tourism planning initiatives have recently targeted the Corozal area, with the aim of improving tourism resources and marketing, with the potential to increase visitation to the area. Under its business arm, SADC will also be developing its own ecotourism packages, providing a model for best practices in the protected area, marketing of Sarteneja as a tourism destination and increasing employment opportunities in the CBWS communities.

SADC recognizes the importance of developing a framework of tourism regulations and best practices guidelines, establishing these before the volume of tourism traffic increases in the protected area. This includes providing site level training for tour guides in collaboration with the Belize Tourism Board, to ensure they meet the target standards to be established for the Wildlife Sanctuary. This training for CBWS tour guides will also extend to provision of accurate information on the wildlife and ecosystems of the estuary, to build capacity for high-class tours.

This will be supported by the establishment of an Interpretive Centre, providing visitor information and displays on Corozal Bay Wildlife Sanctuary, and linking visitors with tour guides and tourism activities.

Tourism and Recreation

- *Visitor Safety and Protection*
 - *Visitor Education and Interpretation*
-

D. Tourism and Recreation

Programme Objective: To ensure tourism use of Corozal Bay Wildlife Sanctuary is planned, developed and conducted following environmental and safety best practices

Management Actions	Present Status (2018-2019)	Desired Status	Year	Responsible Party	Notes
D1 Develop a Tourism Use Plan / Strategy for CBWS	There is currently no Tourism Use Plan or Strategy for CBWS	SACD is guided by a Tourism Use Plan / Strategy for CBWS	1	NRM Manager Development Officer	
Visitor Safety and Protection					
D2 Develop an Emergency Response Plan for dealing with potential emergency situations in CBWS	The SACD Emergency Response Plan does not include tourism-related accidents	SACD has an Emergency Response Plan that includes response to tourism emergencies (accidents etc.)	1	NRM Manager Development Officer	First Aid training for all SACD staff
D3 Develop tourism best practices manual (covering safety and environmental sustainability) and training for tour guides / boat captains using CBWS	Draft tourism best practices were developed by STGA. These now need to be revised to be useful to SACD	SACD has a tourism best practices manual (covering safety and environmental sustainability). It has been disseminated to tour guides, with engagement and training in best practices for using CBWS	1 - 2	NRM Manager Development Officer	
D4 Provide information for visitors on best practices for CBWS	Draft tourism best practices were developed by STGA. These now need to be revised to be useful to SACD	Signage, displays and leaflets provide adequate, accessible information for visitors to be aware of tourism best practices	1 - 2	NRM Manager Development Officer	Best practices around manatees, dolphins, nesting birds, stromatolites, fish traps, and sport fishing regulations
D5 Provide coastal hotels / resorts with best practices information for visitors using CBWS	Draft tourism best practices were developed by STGA. These now need to be revised to be useful to SACD	All coastal hotels / resorts have information for display to visitors on best practices	1 - 2	NRM Manager Development Officer	

D. Tourism and Recreation

Programme Objective: To ensure tourism use of Corozal Bay Wildlife Sanctuary is planned, developed and conducted following environmental and safety best practices

Management Actions	Present Status (2018-2019)	Desired Status	Year	Responsible Party	Notes	
Visitor Safety and Protection						
D6	Liaise with BTB to ensure that all tour operators / tour guides meet BTB standards	A first meeting has been held with BTB representatives on how to improve with this situation	SACD collaborates with BTB to ensure that all tour guides using CBWS meet BTB standards		NRM Manager	
D7	Ensure that all rangers have First Aid certification	SACD has scheduled First Aid training for staff	All SACD rangers and other staff have First Aid certification, renewed annually		NRM Manager	
Visitor Education and Interpretation						
D8	Establish an Interpretive Centre, presenting information on CBWS, conservation targets and visitor best practices	A proposal has been submitted to the Ministry of tourism under the STP II to establish this. A filed visit is schedule to seek the possibility to be funded.	SACD has a functional Interpretive Centre providing adequate information to tourists, tour guides and community members on CBWS		Executive Director	
D9	Establish signage in key areas, providing information on zones / regulations, guidelines for wildlife watching	Initial public use zoning has been developed through public consultation, but is still to be finalized, and is not defined by signage	Zones are finalized, with adequate signage		NRM Manager	Manatees, dolphins, nesting birds, stromatolites, fish traps, sport fishing regulations NBCC 7.4
D10	Develop site-level manual and training for tour guides, providing accurate information on CBWs	The manual is being developed for use in future training programmes	CBWS tour guides have benefitted from information transfer from SACD, improving tour interpretation quality		NRM Manager	Integrates best practices manual NBCC 7.6

3.4.5 GOVERNANCE AND ADMINISTRATION PROGRAMME

Programme Objective: To provide SACD with effective governance and administration systems and structures, with mechanisms to promote financial sustainability.

SACD has developed a strong administrative programme to ensure transparency and accountability. Capacity building of both staff and Board members is considered a key strategy, to ensure improvement in developing management strategies as well as implementing those strategies on the ground. By strengthening the management authority of the protected area, SACD can more effectively implement its programs in CBWS for successful conservation outcomes.

SACD has a revised Strategic Plan (2019 – 2023) that clearly defines the organization’s Vision, Mission and Goal, and identifies four Key Strategic Targets:

- Financial Sustainability
- Institutional Strengthening
- Natural Resource Management
- Communication and Engagement

Management and Administration

- *Planning*
 - *General Management and Administration*
 - *Financial Management*
 - *Concessions / Commercial Uses*
 - *Partnership Relations*
 - *Information Technology*
-

FINANCIAL SUSTAINABILITY

Within the next five years, SACD will have improved its financial sustainability

TARGETS

- SACD will meet 100% of its critical annual operational costs each year based on its annual work plan and budget.
- SACD will invest in at least two income generating ventures that provide 10% of the organization’s annual operational budget by the fifth year.
- SACD will reduce its dependency on grant funding by at least 10% per year.
- SACD will have strengthened its technical capacity to develop financial sustainability mechanisms based on Blue Carbon and other income options.

INSTITUTIONAL STRENGTHENING

SACD's Board of Directors and Executive Director have the capacity to guide and strengthen the organization's growth over the next five years. By the end of the fifth year:

TARGETS

- SACD will exceed critical human resources, technical capacity, operational funding, infrastructure and equipment for protected area management.
- SACD will have at least 50% staff required for optimal management.
- CBWS management effectiveness has improved from the 2019 score of 83.3% to at least 90%.
- SACD has met at least 5% of its optimal staffing requirement through effective partnership, internship and volunteers.
- SACD policies and procedures meet the expanding needs of the organization

NATURAL RESOURCE MANAGEMENT

In the next five years, SACD will have improved ecosystem functions and services, and increased representation of important mangrove ecosystems within its management scope.

TARGETS

- In the next five years, CBWS management effectiveness has improved from the 2019 score of 83.3% to at least 90%.
- Over the next five years, SACD will effectively implement the Management Plan for CBWS
- Within five years, SACD will have increased representation of important mangrove ecosystem within its management scope by 10%.

COMMUNICATION AND ENGAGEMENT

Within the next five years, stakeholder understanding, appreciation and support of SACD's work and purpose will have increased.

TARGETS

- SACD has updated and is executing its Communication Plan
- At least 50% of stakeholders identified in the Communication Plan know and understand SACD's role and functions.
- Improved stakeholder community awareness of the values of ecosystem services provided by the Northern Belize river-to-reef seascape, and their importance in supporting local livelihoods.

- 100% of students in the northern fisher communities have a good understanding of key conservation concepts defined in the Community Engagement and Investment Strategy.

E. Management and Administration Programme

Objective: To provide SACD with effective governance and administration systems and structures, with mechanisms to promote financial sustainability

Management Actions		Present Status (2018-2019)	Desired Status	Year				Responsible Party	Notes
Planning									
E1	Ensure SACD has a current Strategic Plan with an integrated M&E framework that is up to date and being implemented.	SACD's Strategic Plan is up to date (2019-2023), but needs to be integrated into an organization M&E framework	SACD's Strategic Plan is fully updated, approved and being implemented in line with the CBWS Management Plan, with biennial M&E					Executive Director	2019 – 2023
E2	Ensure that CBWS management plan is up to date, integrates re-designation as Wildlife Sanctuary (2), realignment of boundaries, establishment of zones, integration of NBCC objectives and activities, and is being implemented with an M&E framework	Management Plan expired in 2018, though the plan has been under revision for updating during 2019. The plan is completed and includes an M&E framework.	Management Plan (2020 - 2024) is fully updated and approved, with an integrated M&E framework					Executive Director, Board of Directors	Re-designation as a Wildlife Sanctuary (2), realignment of boundaries and establishment of zones are scheduled for 2019
E3	Develop, review, evaluate and revise annual work plans and annual budgets based on the Management Plan, Strategic Plan and strategies	Preliminary organizational annual work plans and budget exist primarily based on projects and project implementation plans. Efforts were done to incorporate the ABC accounting system, but still needs to be aligned with QuickBooks and the updated Management Plan	An Annual Work plan (and budget) is developed and implemented each year based on a rapid evaluation of implementation of the previous annual work plan, projects, the Management Plan and assessment of gaps and priorities					Executive Director	Annual work plan and budgets due on November of each year for implementation the following year

E. Management and Administration Programme

Objective: To provide SACD with effective governance and administration systems and structures, with mechanisms to promote financial sustainability

Management Actions	Present Status (2018-2019)	Desired Status	Year	Responsible Party	Notes	
Planning						
E4	Develop and implement integrated M&E framework for SACD, covering the Management plan, Strategic Plan, conservation / management strategies, annual work plan and management effectiveness	No integrated M&E frameworks exist to assess implementation and success of the different plans Management effectiveness assessment has been conducted in 2016, 2017 and 2019 using the national tool. Management plan implementation has not been fully evaluated.	Effective M&E Framework developed and under implementation Annual management effectiveness assessment conducted and used for strengthening management effectiveness		Executive Director	M&E framework needs to provide timeframes: annual rapid evaluation of MP implementation and annual work plan to inform next annual work plan. At least biennial organizational ME.
E5	Develop a Sustainable Fishery Plan (SFP) for CBWS, with endorsement by the relevant authority – adopted and implemented for the protected area	Planning for sustainable fishery document has existed since 2012. Complete SFP – due in January 2019	A completed Sustainable Fishery Plan is endorsed by the relevant authorities, is being implementation, and evaluated on an annual basis		Executive Director, NRM	Plan implementation to start in 2019 NBCC 2.2
E6	Ensure SACD implements climate change adaptation planning for CBWS and stakeholder communities	Several plans have been created that support adaptation towards climate change for stakeholder communities. Partner with the WWF project to achieve this through their climate smarting project	A fully developed climate change adaptation plan is being implemented for CBWS and stakeholder communities		Executive Director, NRM	1. Socio-economic Needs Assessment for Northern Communities (2018) 2. Local Early Action Plan for Sarteneja, Chunox, Copper Bank (2017)

E. Management and Administration Programme

Objective: To provide SACD with effective governance and administration systems and structures, with mechanisms to promote financial sustainability

Management Actions	Present Status (2018-2019)	Desired Status	Year	Responsible Party	Notes	
Planning						
E7	Review and revise the NBCC plan in 2020,	The NBCC Plan was developed in 2015 but has not been fully adopted over the system. The revision could be used to strengthening collaboration with other PAs in the NBCC	A revised NBCC plan with commitment from all Pas in the system towards effective collaboration		Executive Director	
General Management and Administration						
E8	Ensure the Board of Directors continues to effectively participate in and guide organizational decisions as recommended by the SACD Strategic Plan	SACD's Board of Directors has undergone a full restructuring, with adopted policies and procedures, updated AoA, signed commitment letters and is implementing quarterly meetings	Strong Board of Directors with an understanding of their roles and responsibilities and the management of CBWS, committed and actively participating in management decisions for SACD and CBWS		Executive Director, BoD	Need to increase the number of directors to strengthen capacity Recommendations for strengthening in the Strategic Plan
E9	Strengthen the Advisory Committee (CBAC), to increase community participation in the decision making process and management of CBWS	CBAC is established, meets quarterly and has been undergoing a series of capacity building sessions for effective participation in the management of CBWS	Strong CBAC with committed members actively participating in management decisions of CBWS and demonstrating an increased understanding of their roles and responsibility and the management of CBWS		Communication and Outreach Manager, NRM Manager	

E. Management and Administration Programme

Objective: To provide SACD with effective governance and administration systems and structures, with mechanisms to promote financial sustainability

Management Actions	Present Status (2018-2019)	Desired Status	Year	Responsible Party	Notes	
General Management and Administration						
E10	Ensure the number and availability of operational staff is sufficient across all management programmes of CBWS	SACD has sufficient staff for critical management across all programmes, but staff have an excessive workload. More personnel will lead to more effective programme delivery	At least 90% of SACD's required personnel are available and effectively delivering the outputs expected across all management programmes of CBWS		Executive Director, BoD	Needs assessment is required to identify the most critical and increase gradually per year
E11	Develop a Human Resource Strategy that identifies training needs based on annual human resource assessments and staff evaluations	Staff evaluation format developed and used to evaluate staff. No formal human resources assessment conducted and training needs	A Human Resource Strategy exists and is being implemented, identifying and providing training opportunities for staff members across all programs		Executive Director, BoD	
E12	Invest in capacity building opportunities for staff members across all programs, linked to relevance and outputs of annual staff evaluations	Capacity building opportunities are dealt with on a case by case based on outputs from the staff evaluations and training needs, but not based on a formal strategy	Staff members are participating in relevant capacity building opportunities based on the Human Resource Strategy and annual staff evaluations		Executive Director	Staff evaluation should be scheduled for September / October to ensure capacity building is integrated into annual workplan in November

E. Management and Administration Programme

Objective: To provide SACD with effective governance and administration systems and structures, with mechanisms to promote financial sustainability

Management Actions		Present Status (2018-2019)	Desired Status	Year				Responsible Party	Notes
General Management and Administration									
E13	Strengthen capacity of SACD to engage and manage its international volunteer / intern programme, addressing skills gaps	SACD has no structured international volunteer programme - past volunteers have been engaged based on ToRs, but without a formal structure.	SACD has a formal structure for integrating international volunteers as part of SACD's operations, effectively addressing skills gaps within the organization					Executive Director	
E14	Maintain and strengthen community volunteer programme to support monitoring and research activities in CBWS and NBCC	SACD has a strong community volunteer programme to support monitoring and research activities	SACD continues to strengthen its community volunteer programme to support monitoring and research activities					NRM Manager	NBCC 1.8
Financial Management									
E15	Ensure that financial systems are established and properly managed – inclusive of external financial audits	SACD is effective in its use of QuickBooks, with relevant processes in place, and produces financial audits on an annual basis	SACD continues to have a fully effective financial systems, properly managed and implemented					Executive Director, Financial Officer, and BoD	Yearly Financial Audit due every march of the following year
E16	Explore opportunities for diversification of funding (biodiversity offsets, blue carbon, conservation easements etc.) within the context of the Financial Mobilization Plan	A Financial Mobilization Plan exists with some funding available for income diversification specifically in tourism ventures	Opportunities for income diversification are identified and are being implemented as per the Financial Mobilization Plan					Executive Director, Development Officer	NBCC 1.7

E. Management and Administration Programme

Objective: To provide SACD with effective governance and administration systems and structures, with mechanisms to promote financial sustainability

Management Actions		Present Status (2018-2019)	Desired Status	Year	Responsible Party	Notes
Financial Management						
E17	Increase financial sustainability mechanisms at system level for cost effective, system level plan implementation	The NBCC provides framework for system level collaboration but actual collaboration is limited. Opportunities for exploring Blue Carbon	SACD and other NBCC partners are collaborating for identification of system level financial sustainability mechanisms		Executive Director	NBCC 1.6 NBCC 1.7
Concession / Commercial Use						
E18	Explore financial systems and agreements for user fees associated with sport fishing and tourism activities	No financial systems or agreement exist for sport fishing and tourism activities	A user fee system is in place for sport fishing and tourism activities and a method of fee collection has been established		Executive Director	Investigate Turneffe Flats user fees system NBCC 1.7
Partnership Relations						
E19	Establish the Northern Belize Coastal Complex working group for implementation of the NBCC management plan	A task force was established but was only active up to the beginning of 2018 A formal agreement was never institutionalized	An NBCC working group has been established, with increased communication and collaboration, and the NBCC management plan is being implemented		Executive Director	NBCC 1.1
E20	Identify effective mechanisms for communication, collaboration, and information sharing with organizations working in the NBCC	Efforts have been ongoing since 2016 but collaboration has only been maintained with Bacalar Chico MR/NP and with Transboundary Partners	Mechanisms for effective communication and collaboration have been established, with increased communication, collaboration and information in the NBCC		Executive Director, NRM Manager	Integrated into the SACD Communication Plan. Integrates transboundary partners NBCC 1.2

E. Management and Administration Programme

Objective: To provide SACD with effective governance and administration systems and structures, with mechanisms to promote financial sustainability

Management Actions		Present Status (2018-2019)	Desired Status	Year				Responsible Party	Notes
Partnership Relations									
E21	Formation of a Transboundary working Partnership between Belize and Mexico and continued partnership	Activities have been ongoing in partnership with SEMA and ECOSUR. A draft MOA exists but has not been signed by the relevant partners	MOA is signed and transboundary working partnership between Belize and Mexico is strengthened					Executive Director	ECOSUR, SEMA etc.
E22	Develop collaborative partnerships with DoE, Forest Department, Pesticide Control Board for enforcement of legislation and guidelines relevant to mangrove regulations and pollution in the watershed	No collaborative Partnership exists with DOE, Forest Department and PCB regarding agriculture issues in watershed Some collaboration exists with Forest Department in addressing mangrove related issues around CBWS	SACD is collaborating with the DoE, Forest Department, PCB and is effectively enforcing the legislation and guidelines relevant to mangrove regulations, and lobbying for reduced pollution in the watershed					Executive Director, NRM Manager	NBCC 3.6; NBCC 3.7; NBCC 3.8
E23	Develop and implement strategy to maintain partnerships with donors – keeping them informed and aware for progress of work in area	No strategy exist to maintain donors informed about the work in CBWS outside specific projects	SACD maintains partnerships with all of its donors and a strategy is in place to inform donors about progress of work on a regular basis					Executive Director, Development Officer	Integrated into Communication Plan
Information Technology									
E24	Ensure relevant technology is available across all CBWS management programmes (e.g. GIS, SMART)	Management does include GIS and SMART	SACD has 100% of the technological capability to support programming across all management programs					Executive Director, Natural Resource Manager	

E. Management and Administration Programme

Objective: To provide SACD with effective governance and administration systems and structures, with mechanisms to promote financial sustainability

Management Actions	Present Status (2018-2019)	Desired Status	Year	Responsible Party	Notes	
Information Technology						
E25	Ensure that data protection and back-up systems are in place	Some data back-up systems are in place but need to be updated to include an institutionalized formal back-up process that all staff follow. Computers are protected by anti-virus programmes, but could be strengthened	SACD has a strong data protection and data-back up system in place and data is secured for future reference		Executive Director	

3.4.6 INFRASTRUCTURE, OPERATIONS AND MAINTENANCE

Programme Objective: SACD has the infrastructure and equipment for effective management of its operations

During the 5-year management planning period, priorities include:

- Ensure the annual workplan budget includes acquisition and maintenance of the boats, engines, vehicle and monitoring equipment necessary for the effective management of the protected area.
- Address identified signage requirements for the protected area.
- Construction and equipping of visitor interpretation facilities as an additional resource for tour guides, and for improved transfer of information
- Construction of the tourism infrastructure and equipment required for the effective implementation of its financial sustainability strategy.
- Ensure the SACD Headquarters building continues to meet the needs of the organization, and expand if and when necessary
- Ensure SACD has the funding to maintain fleet operations for meeting critical management needs or above.
- Construction of docking facility and ramp facility for the effective operations of surveillance and enforcement
- Upgrade of the solar system to support the power demands required for the SACD office operations

Infrastructure, Operations and Maintenance

- *Docking Facilities*
 - *Administration and Operational Infrastructure*
 - *Tourism Infrastructure*
 - *Fleet Operations and Management*
-

F. Infrastructure, Operations and Maintenance

Objective: SACD has the infrastructure and equipment for effective management of its operations

Management Actions	Present Status (2018-2019)	Desired Status	Year	Responsible Party	Notes	
Docking Facilities						
F1	Ensure SACD has the infrastructure to safely launch and access the SACD vessels	SACD has no dedicated launch / docking infrastructure	SACD has a dedicated launch / docking infrastructure that enables it to launch and access the SACD vessels effectively and safely		Executive Director, NRM Programme Manager	
Administration and Operational Infrastructure						
F2	Ensure the SACD Headquarters is fully operational and sufficient for SACD needs for effective management of CBWS	SACD Headquarters is completed, but the staff is expanding and the organization is developing a tourism initiative that will need more space	The SACD Headquarters is fully operational and sufficient for SACD needs for effective management of CBWS		Executive Director	
F3	Ensure SACD has the equipment for effective management of CBWS	SACD has most required equipment for effective management of CBWS.	SACD has the equipment for effective management of CBWS. AC units are fully operational. Desk tops for key positions are replaced when required		Executive Director, Programme Managers	Most desktops need to be replaced. The solar power needs to be upgraded to meet the needs for fully operational AC units operational for optimal environment for equipment and staff.
F4	Ensure equipment is well maintained	SACD requires staff to ensure equipment is well looked after but has no formal maintenance schedules or budgets	SACD equipment is well maintained		Programme Managers	

F. Infrastructure, Operations and Maintenance

Objective: SACD has the infrastructure and equipment for effective management of its operations

Management Actions	Present Status (2018-2019)	Desired Status	Year	Responsible Party	Notes	
Tourism Infrastructure						
F5	Ensure SACD has the tourism infrastructure and equipment to support the organization's tourism initiative	SACD has some funding for construction for housing visiting groups and equipment to support SACD's tourism initiative	SACD has the infrastructure for effective management of its tourism initiative		Executive Director, Development Officer	
Fleet Operations and Management						
F6	Ensure SACD has the vehicle(s) required for effective management of CBWS	SACD has a vehicle that provides the necessary support for the organization. An additional vehicle is needed to ensure support of all programmes	SACD has the vehicle(s) required for effective management of CBWS		Executive Director	Vehicle required for Community outreach activities and administrative programmes
F7	Ensure SACD has the boats(s) required for effective management of CBWS	SACD has two vessels that support the implementation of the management activities for CBWS. An additional shallow draft vessel is required, with the reallocation of the largest vessel (Chelonia) to support the financial sustainability mechanism of the organization	SACD has the vessels required for effective management of CBWS and		Executive Director	Chelonia is not adequate for patrols (too big for shallow waters of CBWS) – a shallow draft patrol vessel is needed. However, a vessel is required for expeditions, modification of Chelonia would suit this need.

3.5 Timeline, Evaluation and Review

The five-year timeline provides guidance for implementation of the management plan, but should be considered adaptable, as the management context changes over the years. The timeline also provides a framework against which implementation effectiveness can be measured, to ensure orderly and planned implementation of activities throughout the management plan period (Table 57: Example). This should be developed at the start of management plan implementation, to inform management activities.

The annual work plan and budget is developed from the timeline at the end of each year, a collaborative process that should involve all the program managers and staff, to ensure that cross-cutting strategies such as Environmental Education and Sustainable Development are aligned with and support the site-specific management activities for CBWS.

TABLE 57 EXAMPLE: NATURAL RESOURCE MANAGEMENT PROGRAMME TIMELINE

Management Activity	Responsible Party	Year				
		1st	2nd	3rd	4th	5th
Surveillance and Enforcement						
Ensure CBWS has the skilled human resources and equipment for effective surveillance and enforcement	Executive Director					
Update CBWS Surveillance and Enforcement plan	NRM Manager					
Implement regular surveillance and enforcement patrols based on updated Surveillance and Enforcement Plan	NRM Manager					
Collaborative enforcement within the NBCC and transboundary, with effective communication, standard operating procedures and sharing of information.	NRM Manager					
Ensure CBWS has effective data management for evaluation of surveillance and enforcement outputs to answer key management questions and inform adaptive management	NRM Manager					
Ensure enforcement personnel have the knowledge required for effective enforcement procedures and maintaining the required chain of custody to enable a case to be prosecuted successfully if required.	NRM Manager					
Increase the technical capacity of SACD staff to be able to address illegal activities in the coastal ecosystems	NRM Manager					
Build ranger capacity for surveillance and enforcement through ranger exchanges	NRM Manager					
Improve ranger safety in conflict situations, and build capacity to respond to protect / save lives	NRM Manager					
Build ranger capacity as first responders to protect / save lives	NRM Manager					

Monitoring and review of the management plan and the Annual Work Plans is essential in order to ensure that management is effective in achieving its objectives. This can be achieved through use of a 'measures of success' framework. An annual rapid assessment of management effectiveness should be conducted, with a baseline established ideally just before the first year of management plan implementation, using the national indicators for management effectiveness (Young et al., 2005; revised Walker and Walker, 2009).

An example of the Monitoring and Evaluation Framework has been developed for the management plan, composed of four tracking matrices, to be used for tracking implementation, outputs outcomes and national impacts of the management programme activities. These matrices have been developed to facilitate the annual review process. Time should be taken to complete each one fully and as accurately as possible at the end of each year, and gaps / further actions identified to improve success. If this is maintained on an annual basis, it will feed directly into the development of Operational Plans and greatly facilitate any management staff transition handover.

Included is an example of the suggested structure for the four Measures of Success matrices (Tables 58, 59, 60 and 61).

Table 58: Natural Resource Management Program - IMPLEMENTATION

Measure of Success of Implementation								
N.B. It is important to note that the numerical values ascribed to the measures of success are not scores, but indicators of the stage of implementation	1 No improvement on present status							
	2 Planning has started, but no implementation							
	3 Planning is completed, but no implementation							
	4 Implementation is started, but not yet completed							
	5 Implementation is completed or ongoing (continuous activities), activity has succeeded							
Management Activities	Measure of Success					Desired Status (Outcome and Impact)	Comments: Justification for Measure of Success score. Problems, concerns. Notes for inclusion in updated Management Plan	
	Year							
Activity	1	2	3	4	5			
Surveillance and Enforcement								
A1	Ensure CBWS has the skilled human resources and equipment for effective surveillance and enforcement						1 head ranger, 4 fully trained rangers, second fully equipped surveillance vessel, second SMART system, boat-based radios.	Special Constable, Fisheries Officer training, navigation / GPS, SMART, basic /advanced engine maintenance, oxygen kit, first aid, bullet proof vests, weapon handling(?)
A2	Update CBWS Surveillance and Enforcement plan						Updated plan integrating / transboundary collaboration	Already have the funding for this activity. Integrate collaboration in the seascape, with multi-enforcement patrols
A3	Implement regular surveillance and enforcement patrols based on updated Surveillance and Enforcement Plan						Coordinated patrols following the surveillance and enforcement plan, with informed decision making based on the data available	SMART data collection –on resource use in the area – commercial boat traffic, commercial / sport fishing, and tourism, biodiversity monitoring, enforcement hotspots and database of community users

Table 59: Natural Resource Management Program - OUTPUT

Measure of Success of Output								
		1 0 – 25% achieved						
		2 26 – 50% achieved						
		3 51 – 75% achieved						
		4 76 – 99% achieved						
		5 100% achieved – completed or ongoing satisfactorily						
Management Activities		Measure of Success					Comments: Justification for Measure of Success score. Problems, concerns. Notes for inclusion in updated Management Plan	
		<i>Year</i>						
Activity	2020	2021	2022	2023	2024	Desired Status (Output)		
Surveillance and Enforcement								
A1	Ensure CBWS has the skilled human resources and equipment for effective surveillance and enforcement	2					All rangers are trained for effective surveillance and enforcement activities	50% of the rangers are fully trained for effective surveillance and enforcement. Funding has been located to train the remaining 50% (including newly recruited rangers)
A2	Update CBWS Surveillance and Enforcement plan	2					CBWS Surveillance and Enforcement plan	Funding is available to update the CBWS Surveillance and enforcement Plan. The Plan is 50% through the revision process. Still needs input from S+E partners and CBAC
A3	Implement regular surveillance and enforcement patrols based on updated Surveillance and Enforcement Plan	3					Reduced illegal activity in CBWS	Regular patrols are being implemented (Average 3.5 per week), but not based on an updated S+E Plan, and not sufficient for management. Patrols are targeted at hotspots, but some areas are under-patrolled

Table 60: Natural Resource Management Program - OUTCOME

Measure of Success of Output								
		1 0 – 25% achieved						
		2 26 – 50% achieved						
		3 51 – 75% achieved						
		4 76 – 99% achieved						
		5 100% achieved –or ongoing satisfactorily						
Management Activities		Measure of Success					Comments: Justification for Measure of Success score. Problems, concerns. Notes for inclusion in updated Management Plan	
		Year						
Activity	Desired Outcome	2020	2021	2022	2023	2024		
Surveillance and Enforcement								
A1	Ensure CBWS has the skilled human resources and equipment for effective surveillance and enforcement	Increased viability of conservation targets	2					No change in commercial fish species annual average size and weight of catch per fisher (but not a decrease, either). Need to improve ability to impact illegal coastal development impacts. Need to reduced mortality of manatees in CBWS. Water quality has not improved.
A2	Update CBWS Surveillance and Enforcement plan							
A3	Implement regular surveillance and enforcement patrols based on updated Surveillance and Enforcement Plan							
A4	Collaborative enforcement within the NBCC and transboundary, with effective communication, standard operating procedures and sharing of information.							

Table 61: Natural Resource Management Program - IMPACT

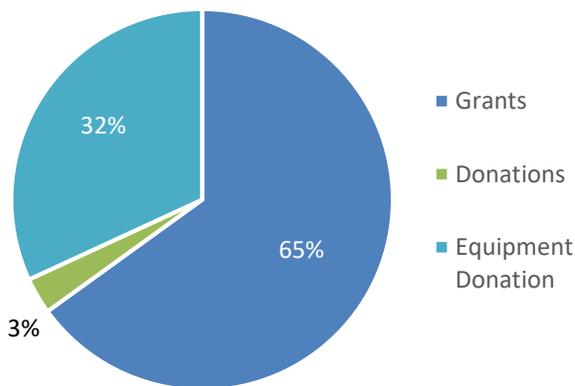
Measure of IMPACT							
	1 No contribution to national NBSAP Targets						
	2 A small contribution to national NBSAP Targets						
	3 A medium-level contribution to national NBSAP Targets						
	4 A significant contribution to national NBSAP Targets						
Management Activities		Measure of Impact					Comments: Justification for Measure of Success score. Problems, concerns.
		Year					
Activity	NBSAP TARGET	2020	2021	2022	2023	2024	
Surveillance and Enforcement							
Ensure CBWS has the skilled human resources and equipment for effective surveillance and enforcement	TARGET B1. By 2020 primary extractive natural resource use in terrestrial, freshwater and marine environments is guided by sustainable management plans, with improved biodiversity sustainability	3					CBWS is one of the largest MPAs. Surveillance and enforcement efforts are targeted and somewhat effective in managing the fishery – still need zones for more effective enforcement. RELEVANT ACTIONS <i>B1.1 Strengthen effective management and monitoring of natural resource extraction in the terrestrial, freshwater and marine environments by the regulatory agencies</i> <i>B1.2 Strengthen enforcement of natural resource extraction legislation and regulation</i> <i>B1.3 Develop /strengthen and implement sustainable natural resource use management plans and permitting systems</i>
Update CBWS Surveillance and Enforcement plan							
Implement regular surveillance and enforcement patrols based on updated Surveillance and Enforcement Plan							
Collaborative enforcement within the NBCC and transboundary, with effective communication, standard operating procedures and sharing of information.							

3.6 Financing

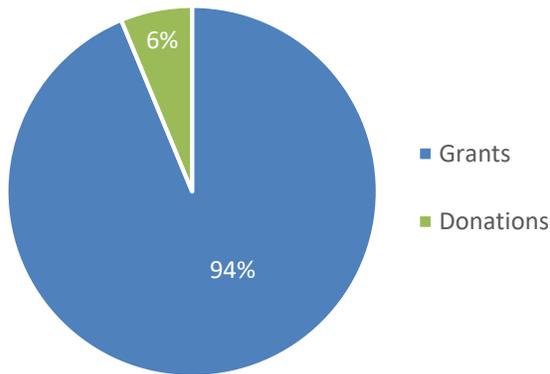
An annual budget is prepared based on the Annual Workplan. The SACD Executive Director and Programme Managers are responsible for preparing the annual budget, based on the annual workplan, which is then submitted to the Board of Directors for approval. SACD is responsible for sourcing funds for implementation, largely through grant funding from a variety of donor agencies.

INCOME AND EXPENDITURE

SACD income for 2017 and 2018 shows a heavy dependence on non-discretionary grant funding. In 2017, 97% of the income can be considered grant funding, with 32% of this in the form of



2017 INCOME BY TYPE



2018 INCOME BY TYPE

FIGURE 61: INCOME BY TYPE (GRANTS VS. DONATIONS)

equipment donation a patrol boat under the MCCAP project. 3% of income in 2017 was from donations – though a large percentage of this income was for specific activities, even though the funding wasn't tied into a grant agreement.

In 2018, the grant to donation ratio is similar, with 94% of income being grant-based and on-discretionary (Figure 61). The Financial Mobilization Plan has been developed to identify mechanisms to diversify funding sources through internal financial sustainability mechanisms

SACD has, however been able to put together and maintain a diverse portfolio of seven key, engaged, multi-year funders. These range from PACT (the key mechanism for national investment into protected areas), to small, targeted foundation funding from the New England Biolabs Foundation (Figure 62). There has also been significant investment by both OAK and Summit Foundations in ensuring SACD

has the funds to be able to operate effectively, with allocated grants for human resources and patrols. This support continued into 2018 (Figure 62).

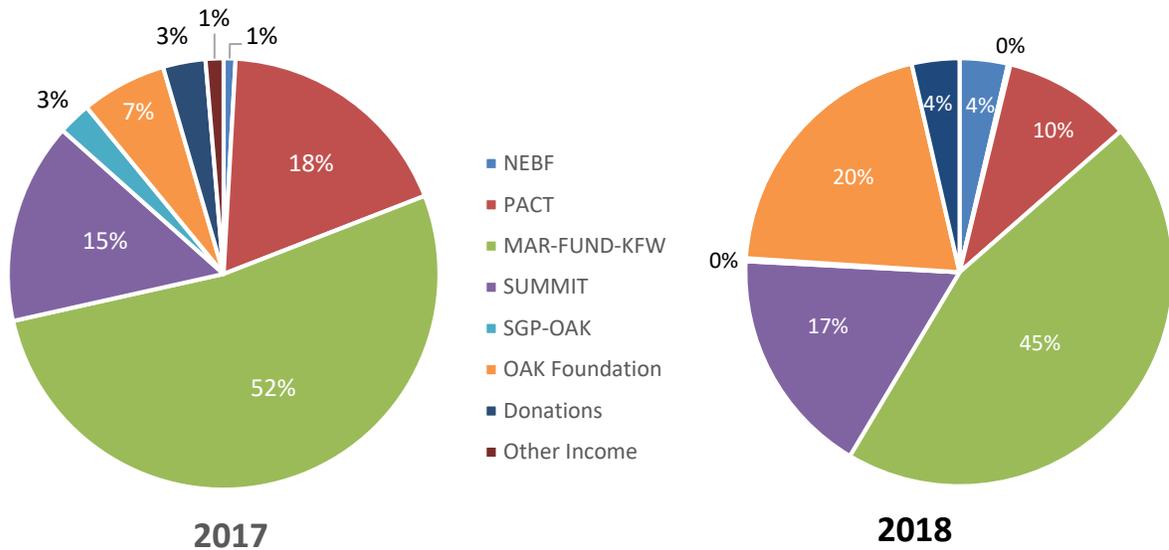


FIGURE 62: INCOME BY SOURCE

The financial breakdown of expenditures for the organization in 2017 and 2018 was relatively even across each programme area, ranging from 16% of budget investment for community outreach, to 37% for Natural Resource Management activities. (Figure 63). It should be noted that the Research and Monitoring Programme is currently managed under the Natural Resource Management Programme.

Community Outreach activities have been more project-orientated, with funding for specific activities such as climate change awareness and support of student education activities. There has also been a focus on engagement of fishers and other stakeholders through the establishment and capacity building of the Corozal Bay Advisory Committee, and through awareness activities. This continued and strengthened in 2018, supporting the development of the CBWS Sustainable Fishery Plan.

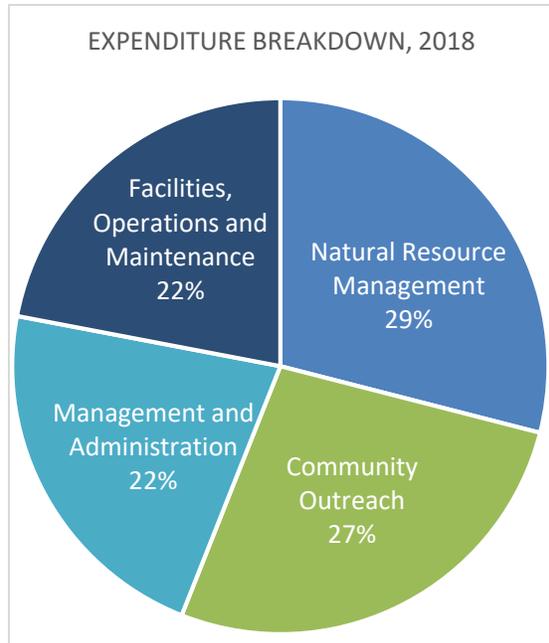
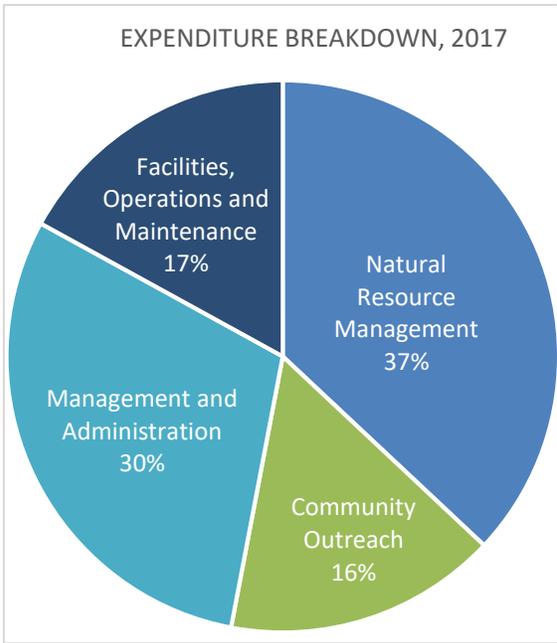


FIGURE 63: EXPENDITURE BREAKDOWN FOR 2017 AND 2018, (SACD DATA, 2019)

FINANCIAL SUSTAINABILITY

Financial sustainability is a key focus of the SACD Strategic Plan (2019 to 2023), with the following targets identified:

- SACD will meet 100% of its critical annual operational costs each year based on its annual work plan and budget.
- SACD will invest in at least two income generating ventures that provide 10% of the organization's annual operational budget by the fifth year.
- SACD will reduce its dependency on grant funding by at least 10% per year.
- SACD will have strengthened its technical capacity to develop financial sustainability mechanisms based on Blue Carbon and other income options.

SACD has been managing CBWS with limited financial resources secured primarily from grant funding, with an operating budget of \$410,440 in 2017 to cover the projected operational costs (staff and non-staff resources). One of the major challenges is the high reliance on project grants. This project-driven approach has not allowed the organization to fully develop its financial viability. The organization has therefore been looking at mechanisms for financial sustainability beyond grants, and in 2018, developed a Financial Mobilization Plan to look at the options available for diversifying its income sources.

SACD operated at or near critical level in 2017, with the Financial Mobilization report identifying the financial gap between critical and optimal management as approximately \$433,750 - double the 2017 budget availability (Praxi5, 2017). Three options were considered as potential financial sustainability mechanisms, with development of a tourism operation focused on hosting expedition groups selected for investment (Praxi5, 2017).

4. Implementing the Plan

The following outline presents the first steps towards implementing the management plan.

At the Start of the Management Plan Period

1. Develop the timeline for all programme areas and activities (Table 58)
2. Develop the four Measures of Success tables for all program areas and activities, identifying relevant indicators, to provide a baseline (Tables 59; 60; and 61)
3. Identify those activities scheduled for implementation in the first year and develop the first annual workplan
4. Implement the Annual Workplan

At the End of the First Year...

1. Update the M+E Framework tables for all program areas and activities, and develop a summary report of results and recommendations for integration into the next Annual Workplan and / or adaptation of the management plan
2. Review the workplan, and identify challenges and adaptive strategies, for inclusion in the next workplan (this should be a participatory exercise)
4. Update the status of the indicators and develop a report on the outputs, to be integrated into the Annual Report
3. Identify those activities scheduled for implementation in the second year and develop the second annual workplan, also incorporating adaptive strategies from the workplan review
5. Implement the second Annual Workplan

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