Crooked Tree Wildlife Sanctuary Management Plan

2019 - 2023

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This management plan has been made possible through the GIZ supported tri-national Programme for the Protection and Sustainable Use of the Selva Maya Region

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CROOKED TREE WILDLIFE SANCTUARY

GOAL

"Crooked Tree is a community-driven Wildlife Sanctuary that balances responsible stewardship of the wetland and other natural resources with sustainable use, based on traditional practices, securing benefits for current and future generations"

OBJECTIVES

Objective 1: Community-driven conservation and stewardship of Crooked Tree Wildlife Sanctuary and the Crooked Tree landscape

Objective 2: Continued maintenance of environmental services - particularly support of a traditional sustainable fishery and flood control functions

Objective 3: Sound research informing management decisions and integrating community participation

Objective 4: Provision of a world-renowned tourism resource that is valued by visitors and provides socio-economic opportunities for the community

Plan Facilitated By:

Wildtracks, Belize

Acronyms

ALIDES	Alliance for the Sustainable Development of Central America
BAS	Belize Audubon Socicety
BFD	Belize Fisheries Department
BTB	Belize Tourism Board
BTFS	Belize Tropical Forest Studies
CBD	Convention on Biological Diversity
CCAD	Central American Commission for Environment and Development
CTVC	Crooked Tree Village Council
CTWS	Crooked Tree Wildlife Sanctuary
FAO	Food and Agriculture Organization
FD	Forest Department
GDP	Gross Domestic Product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GoB	Government of Belize
GSDS	Growth and Sustainable Development Strategy
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
KfW	Kreditanstalt für Wiederaufbau
MAFFSDI	Minisrty of Agriculture, Fisheries, Forestry, Sustainable Development and Immigration
NBSAP	National Biodiversity Strategy and Action Plan
NCSP	National Climate Startegy and Plan
NMWG	National Manatee Working Group
NPAPSP	National Protected Areas Policy and System Plan
NPAS	National Protected Areas System
NSTMP	National Sustainable Tourism MasterPlan
PACT	Protected Areas Conservation Trust
SIB	Statistial Institute of Belize
TNC	The Nature Conservancy
UNDP	United Nations Development Programme
WTTC	World Travel and Tourism Council
WWF	World Wide Fund for Nature

Introduction

Background and Context

Crooked Tree Wildlife Sanctuary (CTWS), with an estimated area of 37,985 acres (15,372 ha), was established by the Government of Belize as a national protected area in 1984 (SI 95 of 1984) in recognition of its national and regional importance for waterbirds. This subtropical freshwater matrix is a complex network of shallow lagoons, streams, creeks, and marshes set within a patchwork landscape of pine / short grass savannah and tropical forest. In 1998, Crooked Tree Wildlife Sanctuary was declared as Belize's first Ramsar site (Ramsar Site 946) based on Ramsar Criteria 2: "*A wetland considered internationally important for supporting vulnerable, endangered, or critically endangered species or threatened ecological communities*". It's importance, however, extends far beyond this – to its role as a wetland sink, draining excess flood waters from the Belize River watershed during storm events, before they pose a risk to life and property in Belize City and other communities downstream.

Situated in the Belize River watershed, Crooked Tree Lagoon system is the largest wetland in Belize. The system is always in flux, with water flowing in during the wet season, and out during the dry season, altering the level of the lagoon water throughout the year. In the dry season, as the water starts to drain out of the system, fish and invertebrates become concentrated in receding, shallow waters, providing a plentiful and accessible food supply for thousands of resident and migratory wading birds, resulting in the Crooked Tree Lagoon system being considered as one of the best birding destinations in Belize. The area protects at least eleven threatened species (Critically Endangerd, Endangered or

THREATENED SPECIES	
Critically Endangered	
Central American river turtle	*Dermatemys mawii*
Central American Black-handed (Geoffroy's) Spider Monkey	*Ateles geoffroyi*[*]
Endangered	
Yucatan Black Howler Monkey	*Alouatta pigra*
Baird's Tapir	*Tapirus bairdii*
Vulnerable	
Agami Heron	*Agamia agami*
Spanish Cedar	*Cedrela odorata*
Great Curassow	*Crax rubra*
Cerulean Warbler	*Dendroica cerulea*
Big-leaf Mahogany	*Swietenia macrophylla*
White-lipped Peccary	*Tayassu pecari*
Antillean manatee	*Trichechus manatus*

***Note: T**he subspecies in Belize is now considered genetically identical to A. g. vellerosus, a Critically Endangered sub-species (Moralez-Jiminez et al., 2015).*

TABLE 1: THREATENED SPECIES OF CTWS (IUCN, 2018)

Vulnerable (IUCN, 2018); BAS Staff consultations, 2018; Wildltracks, 2004, Commmunity consultatioons, 2018; Table 1). Critically endangered Central American river turtles, endangered Yucatan black howler monkeys and yellow headed parrots all reproduce within the protected area and migratory birds inhabit the pine savanna, logwood swamps and forest during winter. The riparian forest lining the creeks and broadleaf forest of Blackburn Ridge provides important connectivity for wide ranging species and for maintained forest health and ecosystem services as climate change impacts increase.

Crooked Tree Village itself was founded in 1750, and lies on an island surrounded by the Wildlife Sanctuary. The current population is estimated at 806 (SIB, 2010), supported by subsistence farming, livestock raising, fishing, logging and increasingly, tourism. It is accessed by a causeway that links to the Northern Highway.

Crooked Tree Wildlife Sanctuary falls under the authority of the Forest Department, with on-site management by Belize Audubon Society, a leading Belize-based non-governmental organization. The boundaries of the Wildlife Sanctuary are defined by Statutory Instrument 95 of 1984, but are based on the high water mark, which fluctuates annually depending on the season, leading to challenges in identifying the boundaries on the ground. The original Wildlife Sanctuary status was equivalent to IUCN Category IV, designated for management mainly for conservation through management intervention. This is now being amended to integrate sustainable fishing activities for traditional fishers within the protected area – with the revision to Wildlife Sanctuary (2) / IUCN Category VI, following the revision of the legal protected areas framework

The overall management vision, developed in 2018 through a full community / stakeholder consultation process, is that:

> *Crooked Tree is a community-driven Wildlife Sanctuary that balances responsible stewardship of the wetland and other natural resources with sustainable use, based on traditional practices, securing benefits for current and future generations*

The goal of the protected area is *"to maintain biological integrity and traditional cultural resources within a functional conservation area, as an as an effective RAMSAR site".*

Management of the Wildlife Sanctuary has been led by Belize Audubon Society in the past (which holds the co-management agreement for the protected area), but is now moving towards the establishment and integration of a management committee comprised of the key stakeholders - Forest and Fisheries Departments, Belize Audubon Society, the Crooked Tree Village Council and representatives from the traditional natural resource users.

Summary of Key Characteristics:

- Large wetland area of national importance for resident and migratory birds
- Support of subsistence and commercial fishermen of Crooked Tree communities
- Critical wetland sink protecting downstream populations during storm events
- Ecosystem representation
- Forest connectivity
- Protection of riparian, wetland and savanna vegetation

Summary of Resilience Features

- Wetland system is adapted to fluctuate between flood and drought conditions
- Natural aquatic life is already compromised by the presence of invasive Tilapia (*Oreochromis niloticus*). However, this species may be more adaptable to predicted changes, and provide local community members with continued access to fish as an important protein source

National Protected Areas System Rationalization Report (Walker et al., 2012)

Purpose and Scope of Management Plan

The management of Crooked Tree is guided by its categorization as a Wildlife Sanctuary, designated under the National Park Systems Act of 1981 (Chapter 215, Laws of Belize, Revised Edition 2000), and revised as the National Protected Areas System:

> *"for the protection of nationally significant species, biotic communities or physical features."*

This Management Plan has been developed in collaboration with the Crooked Tree Village Council, the Crooked Tree community, the Forest and Fisheries Departments and Belize Audubon Society, and provides the contextual background for informed management decision making and a structured framework of activities to assist the collaborating management partners to ensure the Wildlife Sanctuary continues to support biodiversity, wetland functionality, flood sink values and other environmental services, and livelihoods.

This Management Plan is designed to guide the management of the protected area through the next five years (2019 – 2023). In line with the National Protected Areas Policy and System Plan, it reflects the participatory approach to management being adopted in Belize today, with the input of key stakeholders of CTWS through a series of community workshops. It includes information on the physical, socio-economic, biological and ecosystem service attributes of the protected area and documents the legislative framework under which the protected area is designated and managed. It summarizes current uses and management challenges, and integrates support for a transition to designation as a Wildlife Sanctuary (2), allowing for traditional natural resource extraction through establishment of Managed Access as a framework for continued use, supported by a Sustainable Resource Use Plan.

The Management Plan summarizes the outputs of the conservation planning processes - for the Wildlife Sanctuary itself, and for the larger landscape, and integrates climate change assessment outputs. It identifies the management challenges, and defines the goals and objectives of management for the five-year period.

The Plan provides a framework for both broad management strategies as well as more specific activities to achieve the goals of maintaining ecosystem functions and natural resource values, based on the best available data and scientific knowledge. It outlines specific management programmes, integrating conservation planning strategies, as well as relevant strategies of national and regional plans. It also sets in place the means for measuring management effectiveness, and recommends an implementation schedule. 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.

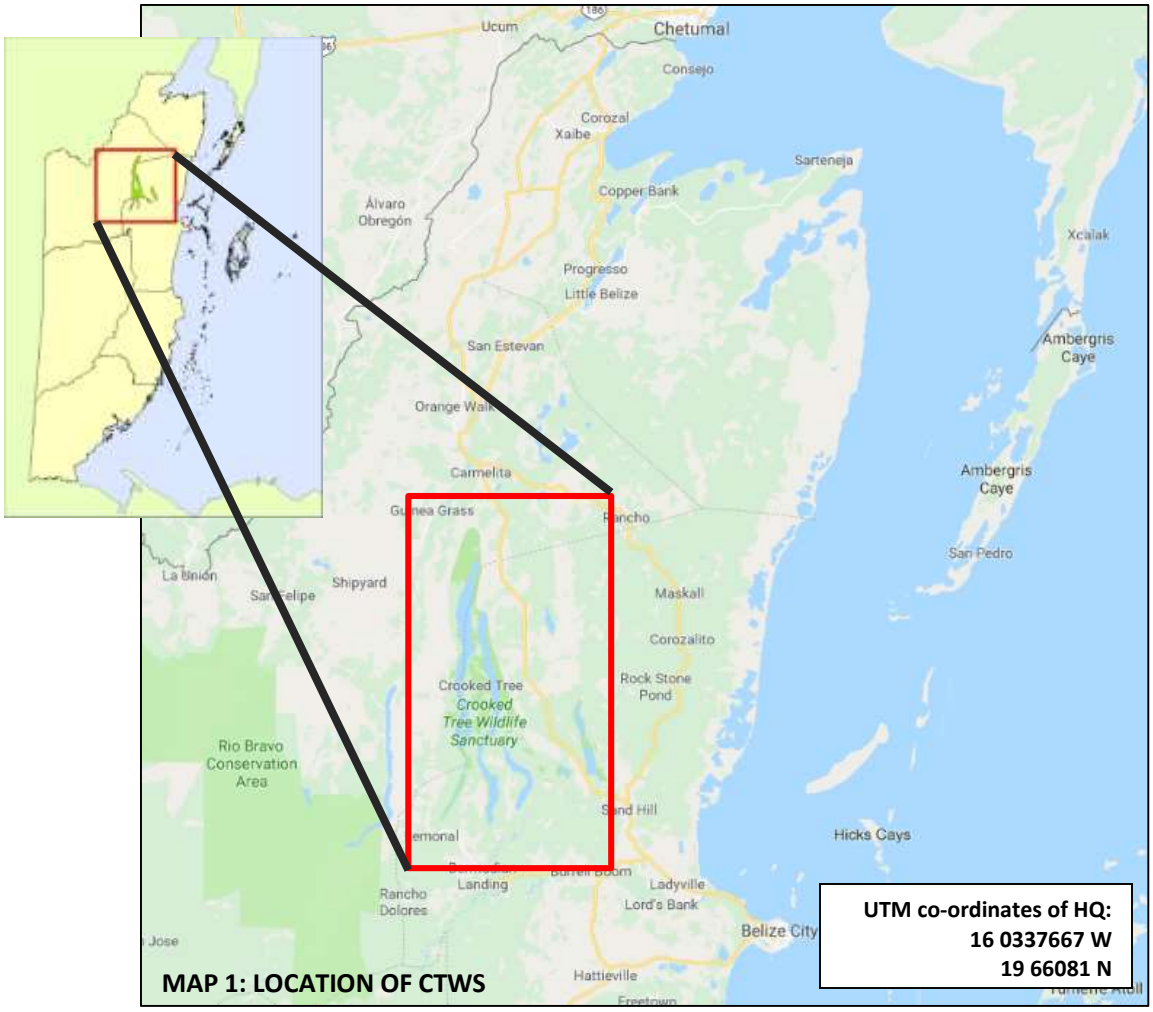
Section One

Current Status

1. CURRENT STATUS

1.1 LOCATION

The approximately 37,985 acres (15,372 ha) of the Crooked Tree Wildlife Sanctuary lies on the flat northern plain (part of the limestone Yucatan platform), 33 miles north of Belize City / 27 miles south of Orange Walk, and straddles the boundary between the districts of Orange Walk and Belize (Map 1). It is divided into two sections - the Crooked Tree Lagoon system is located 3.4 miles to the west of the Northern Highway, and is comprised of Calabash Pond, Revenge, Western, Crooked Tree (Northern) and Southern Lagoons, all of which drain south into the Belize River via a series of creeks. This section has the village of Crooked Tree at its center. The secondary group of lagoons lies to the east of the Northern Highway, with an area of 1,400 acres, being comprised of Jones and Mexico Lagoons, which also drain into the Belize River.



MAP 1: LOCATION OF CTWS

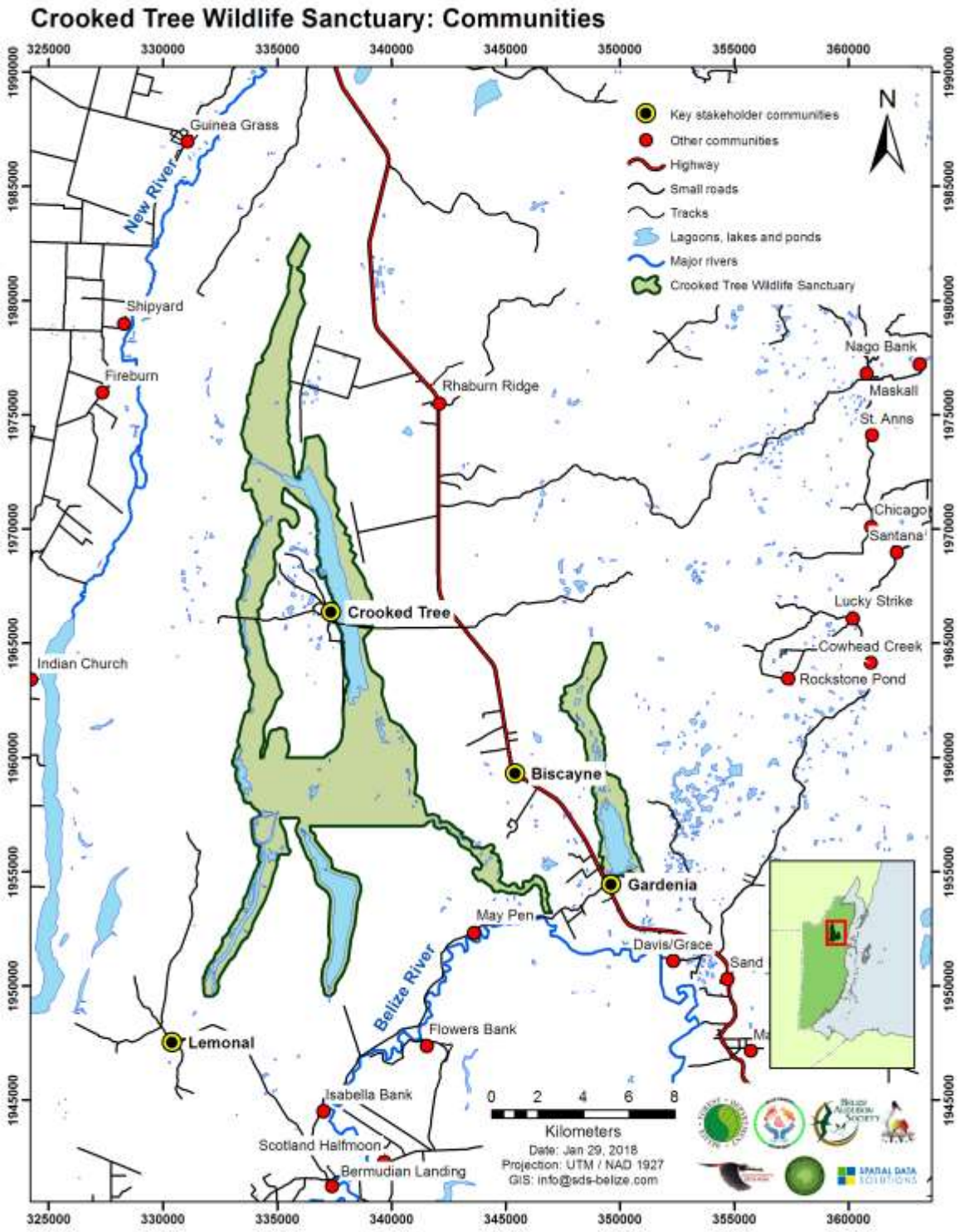
ACCESS

Access to Crooked Tree Village and the Wildlife Sanctuary was traditionally by boat from the Belize River through Black Creek, though this route is now overgrown and needs re-clearance in order to be easily trafficable. Both the village and the Wildlife Sanctuary can now be accessed by road from the Northern Highway (Philip Goldson Highway), following the construction of a causeway across the lagoon, linking the community with Belize's national road network. The causeway road leaves the Highway at Mile 33, and travels west for 3.4 miles (5.7 km), entering the Wildlife Sanctuary and crossing the Causeway, to end in Crooked Tree Village.

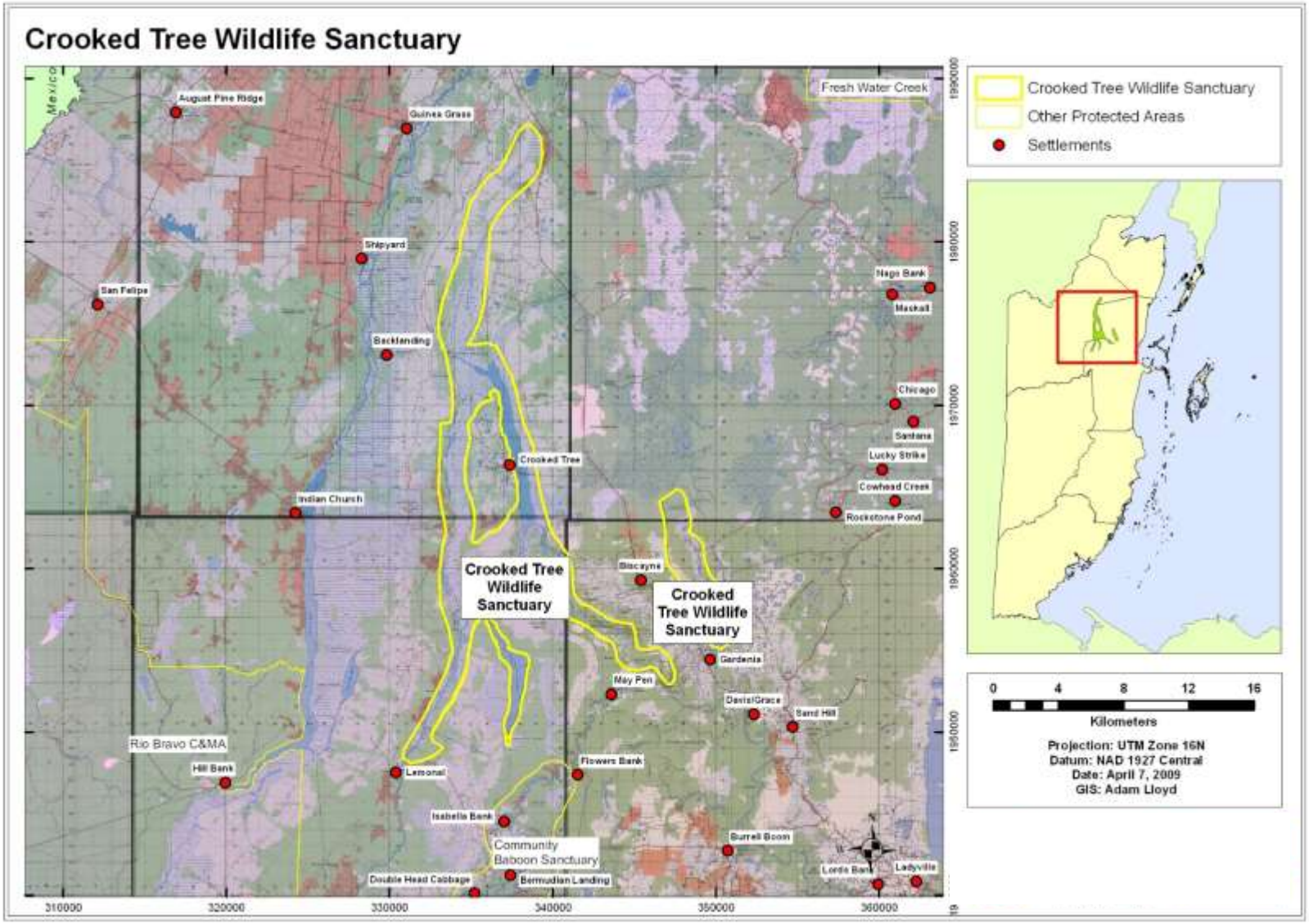
A road from Bermudian Landing to Lemonal crosses Spanish Creek just south of the southwestern tip of the protected area, providing access for fishers of Lemonal. Fishers from Biscayne and Gardenia access the Black Creek area by foot or horseback, across the savanna.

COMMUNITIES ADJACENT TO CROOKED TREE WILDLIFE SANCTUARY

Five key buffering communities are located within the immediate Crooked Tree landscape, with Crooked Tree Village most closely linked to the protected area. This community is located on the central island surrounded by the lagoons and wetlands of the Wildlife Sanctuary. Lemonal Biscayne and Gardenia are also considered as key communities, with natural resource users that use the protected area. Secondary communities include May Pen, which is diminishing in size following significant flooding, and Rockstone Pond (Maps 2 and 3).



MAP 2: CROOKED TREE WILDLIFE SANCTUARY: COMMUNITIES



MAP 3: THE LOCATION OF CROOKED TREE WILDLIFE SANCTUARY AND COMMUNITIES IN THE LANDSCAPE

1.2 REGIONAL AND INTERNATIONAL CONTEXT

Belize, recognized as part of the Mesoamerican biodiversity hotspot, was founded on its biodiversity wealth, and it is this natural capital that continues to support today's economy. Crooked Tree Wildlife Sanctuary is Belize's largest freshwater wetland area, and one of the most important. The protected area is one of two sites in Belize listed as Wetlands of International Importance under Ramsar, the Convention on Wetlands, based on the importance of healthy, functioning wetlands. These are recognized as being essential for their contribution towards a range of global targets, including the United Nations Sustainable Development Goals, the Aichi biodiversity targets, the Paris Agreement on Climate Change and Land Degradation Neutrality. This convention, ratified by Belize and all other Central American countries in the region, provides the framework for international cooperation in the wise and sustainable use of wetland habitats, through intergovernmental treaties. It places general obligations on member countries relating to the conservation of wetlands throughout their territory, and for Belize, special obligations pertaining to Crooked Tree Wildlife Sanctuary and Sarstoon Temash National Park (the second RAMSAR site in Belize). The Convention sets out a number of criteria for recognition of a wetland as of 'International Importance' (Table 2), with Crooked Tree Wildlife Sanctuary qualifying under Criteria 2, as "supporting vulnerable, endangered, or critically endangered species or threatened ecological communities" (Ramsar, 1996).

Up to 87% of the global wetland resource has been lost since 1700. We lose wetlands three times faster than natural forests.

Ramsar, 2018

Unlike many of its larger Central American neighbors, the natural wetlands of Belize still retain the majority of their wetland functions, without the need for major restoration activities. However, as development continues, the pressures on the wetlands are increasing, with the need to ensure that protection of these critical areas is integrated into national land use planning. In 2018, the Ramsar Secretariat identified a series of urgent actions required at the international and national level to raise awareness of the benefits of wetlands, put in place greater safeguards for their survival and ensure their inclusion in national development plans.

RAMSAR RECOMMENDATIONS:

Enhance the network of Ramsar Sites and other wetland protected areas: designation of over 2,300 internationally important wetlands as Ramsar Sites is encouraging. However, designation is not enough. Management plans must be developed and implemented to ensure their effectiveness. Fewer than half Ramsar Sites have done this as yet.

Integrate wetlands into planning and the implementation of the post-2015 development agenda: include wetlands in wider scale development planning and action including the Sustainable Development Goals, the Paris Agreement on Climate Change and the Sendai Framework on Disaster Risk Reduction.

Strengthen legal and policy arrangements to protect all wetlands: wetland laws and policies should apply cross-sectorally at every level. National Wetland Policies are needed in all countries. An important tool here is the 'avoid–mitigate–compensate' sequence recommended by Ramsar - it is easier to avoid wetland impacts than to restore wetlands.

Implement Ramsar guidance to achieve wise use: Ramsar has a wide range of relevant guidance. Ramsar mechanisms – such as reports on changes in ecological character, the Montreux Record of Ramsar Sites at risk and Ramsar Advisory Missions – that help to identify and address challenges to the conservation and management of Ramsar Sites.

Apply economic and financial incentives for communities and businesses: Funding for wetland conservation is available through multiple mechanisms, including climate change response strategies and payment for ecosystem services schemes. Eliminating perverse incentives has positive benefits. Businesses can be helped to conserve wetlands through tax, certification and corporate social responsibility programmes. Government investment is also critically important.

Integrate diverse perspectives into wetland management: Multiple wetland values must be taken into account. To ensure sound decision-making, stakeholders need an understanding of wetland ecosystem services and their importance for livelihoods and human well-being.

Improve national wetland inventories and track wetland extent: knowledge supports innovative approaches to wetland conservation and wise use. Examples include remote sensing and field assessments, citizen science and incorporating indigenous and local knowledge. Identification and measurement of indicators of wetland benefits and drivers of change are key to supporting wise use policy and adaptive management.

Ramsar Convention Secretariat, 2018

In addition to Ramsar, Belize is party to a number of global Multilateral Environmental Agreements (MEAs) that focus on biodiversity issues (Table 2). Many of these are legally binding, and are required to be integrated within the national legislative framework.

Key International and Regional Conventions and Agreements of Relevance to Crooked Tree Wildlife Sanctuary	
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** *CTWS is an important and integral part of Belize's national protected areas system, protecting biodiversity and threatened species, as per Belize's commitment under the CBD.*
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.** *With its importance in flow regulation within the Central Belize Watershed, the protected area plays a key role in maintaining water flow of the rivers that flow into the coastal waters of Belize, and from there on the reef – including the seven sites that form Belize's World Heritage Site*
Alliance for the Sustainable Development of Central America (ALIDES) (1994)	**Regional alliance supporting sustainable development initiatives.** *As a national protected area, CTWS provides sustainable benefits to local communities through ecosystem services (including water security) and tourism, whilst also protecting biodiversity and threatened species, as per Belize's commitment under ALIDES.*
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 Programmes.** *Belize has worked with other ALIDES members towards the regional protection and wise use of wetlands, and the maintenance of forest connectivity through biological corridors, towards long term biodiversity viability. CTWS lies within the Northern Biological Corridor, with a role in maintenance of forest connectivity*
Convention on the Conservation of Biodiversity and the Protection of Priority Wilderness Areas in Central America (Managua, 1992)	**To conserve biological diversity and the biological resources of the Central American region by means of sustainable development** *CTWS is recognized as a priority wetland under Ramsar, which promotes sustainable development and wise use of wetland resources.*

TABLE 2: KEY INTERNATIONAL CONVENTIONS AND AGREEMENTS OF RELEVANCE TO CROOKED TREE WILDLIFE SANCTUARY

As a signatory of the **Convention on Biological Diversity (CBD),** Belize is committed to ensuring it has measures in place to protect biodiversity, with promotion of sustainable use, contributing to the 2010 CBD strategic goals and targets (CBD, 2018).

More specific targets of the CDB relevant to Crooked Tree Wildlife Sanctuary include:

- promoting the conservation of the biological diversity of ecosystems, habitats and biomes;
- promoting sustainable use and consumption, by encouraging use of products derived from sources that are sustainably managed;
- addressing threats to biodiversity related to the pressures of habitat loss, land use change and degradation, and unsustainable water use;
- addressing challenges to biodiversity from climate change, and pollution;
- maintaining the capacity of ecosystems to deliver goods and services that support sustainable livelihoods, local food security and health care, especially of poor people

As a requirement of the CBD (Article VI (a)), the CBD focal point in Belize, the Forest Department, has revised and is implementing the National Biodiversity Strategy and Action Plan (NBSAP, 2016) to regulate and manage activities that have or are likely to have significant adverse impacts on the conservation, sustainable use and the sharing of the benefits of Belize's biological diversity. The NBSAP is focused on achieving set targets, linked to the global Aichi Targets and Sustainable Development Goals. The goal and objectives for the Wildlife Sanctuary, and the wider goal, mission and activities of the Belize Forest Department and Belize Audubon Society, contribute towards relevant NBSAP targets. Belize has largely met global protection targets for almost all terrestrial ecosystems within the National Protected Areas System, with identification of required actions for those that are under-represented. Crooked Tree Wildlife Sanctuary provides important representation of wetland ecosystems within the National Protected Areas System.

Belize is a party to the **United Nations Framework Convention on Climate Change (UNFCCC)** which, whilst not a Multilateral Environmental Agreement, is closely associated to the environment, and sets an overall framework for intergovernmental efforts to tackle the challenges posed by climate change. Belize is considered a Small Island Developing State under this convention, with the impacts of climate change far outweighing the contribution to emissions, and at high risk of negative impacts from climate change.

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. These seven sites are seen as representative of the Belize Barrier Reef and are impacted by land-based pollution and watershed impacts. CTWS is important in maintaining the watershed functionality of the Central Belize Watershed, though the watershed has significant agricultural development that does impact the water quality of the rivers and therefore the reef. As a signatory to the regional **Cartagena Convention**, Belize has also ratified the **Land-Based Sources of Pollution Protocol** as part of a concerted global effort to

address the potential impacts of land-based sources of pollution on the marine environment. Under this Convention, Belize is required to address the issues of agrochemical pollution, nutrient runoff, deforestation and land use change. These are all issues identified as threats to the Crooked Tree wetlands.

Belize has not yet signed on to the **Convention on Conservation of Migratory Species of Wild Animals (Bonn Convention, 1979)**, though this is a target of the current five-year National Biodiversity Strategy and Action Plan. The CMS is an environmental treaty under the aegis of the United Nations Environmental Programme, and provides a global platform for the conservation and sustainable use of terrestrial, aquatic and avian migratory species throughout their range. Ratification of this Convention is an action under Belize's NBSAP, and would be of benefit to CTWS, supporting its role in protecting migratory bird species.

At the regional level, Belize is included in both Central American and Wider Caribbean agreements. The **Sistema de la Integración Centroamericana (SICA)** provides a regional coordination and collaboration framework for Central America. Under this is the **Central American Commission for Environment and Development (CCAD)**, the regional organization of Heads of State formed under SICA, responsible for the environment of Central America. The Central American Policy on the Conservation and Wise Use of Wetlands was developed under CCAD, and accepted in 2002, based on the RAMSAR guidelines for policy development. It was developed to "strengthen the conservation and wise use of wetlands of the region through action and cooperation among the countries for the well-being of the present and future generations of Central Americans.". Belize has also participated in the Regional Initiative for the Conservation and Wise Use of Caribbean Wetlands (CariWet).

The **Alliance for the Sustainable Development of Central America (ALIDES)** calls for sustainable development with strategies for improved management of more sustainable resource extraction, with a programme for wetlands

1.3 NATIONAL CONTEXT

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 importance of protected areas such as CTWS, and the need to mainstream biodiversity across all sectors in Belize, improve integration of

biodiversity and protected areas 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 most relevant to CTWS is **Goal C: PROTECTION.** This is supported by the **National Protected Areas Policy and System Plan (NPAPSP**) (GoB, 2005; revised: 2015). This guides system-level and individual protected area management efforts to support the national objectives of ecological and economic sustainability over the long term, with the development of human and institutional capacity to effectively manage biodiversity resources within the NPAS. The NPAPSP centres on the following policy statement, which has been 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.*

GOAL C: PROTECTION

TARGET C4. By 2025, average management effectiveness of the National Protected Areas System has improved to 80%

C4.1 Implement the revised National Protected Area System Plan (NPASP) and supporting NPAS Rationalization Report

C4.2 Improve financial sustainability mechanisms for the NPAS

C4.3 Conduct 2016 and 2020 Assessments of management effectiveness of protected areas and implement recommendations

C4.4 10% of PAs have demonstrated economic value and direct livelihood support through PA /ecosystem services

C4.5 Engage buffer communities for collaborative stewardship of the NPAS

KEY STRATEGIES OF GOAL C: PROTECTION OF THE NATIONAL BIODIVERSITY STRATEGY AND ACTION PLAN

The Wildlife Sanctuary is important in protection of the critically endangered Central American river turtle (hicatee), a species that has declined significantly across Belize, and is considered one of the top 25 most endangered turtle in the world. This species is still being hunted in Crooked Tree Wildlife Sanctuary despite its global and national status.

The endangered yellow headed parrot has also declined significantly over the last 30 years. This species flocks to Crooked Tree village when the cashew trees are fruiting, and nests in old pine trees on the pine savanna.

RELEVANT NBSAP TARGETS

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.

TARGET B4. BY 2020, Belize is restoring 30% of degraded ecosystems to maintain and improve the status of ecosystems and ecosystem services essential for increasing Belize's resilience to climate change impacts.

TARGET C1. By 2030, Belize's natural landscapes and seascapes are all functional and build biodiversity resilience to climate change.

TARGET C2. By 2020, three key corridors identified under the National Protected Areas Policy and System Plan are physically and legally established, and effectively managed.

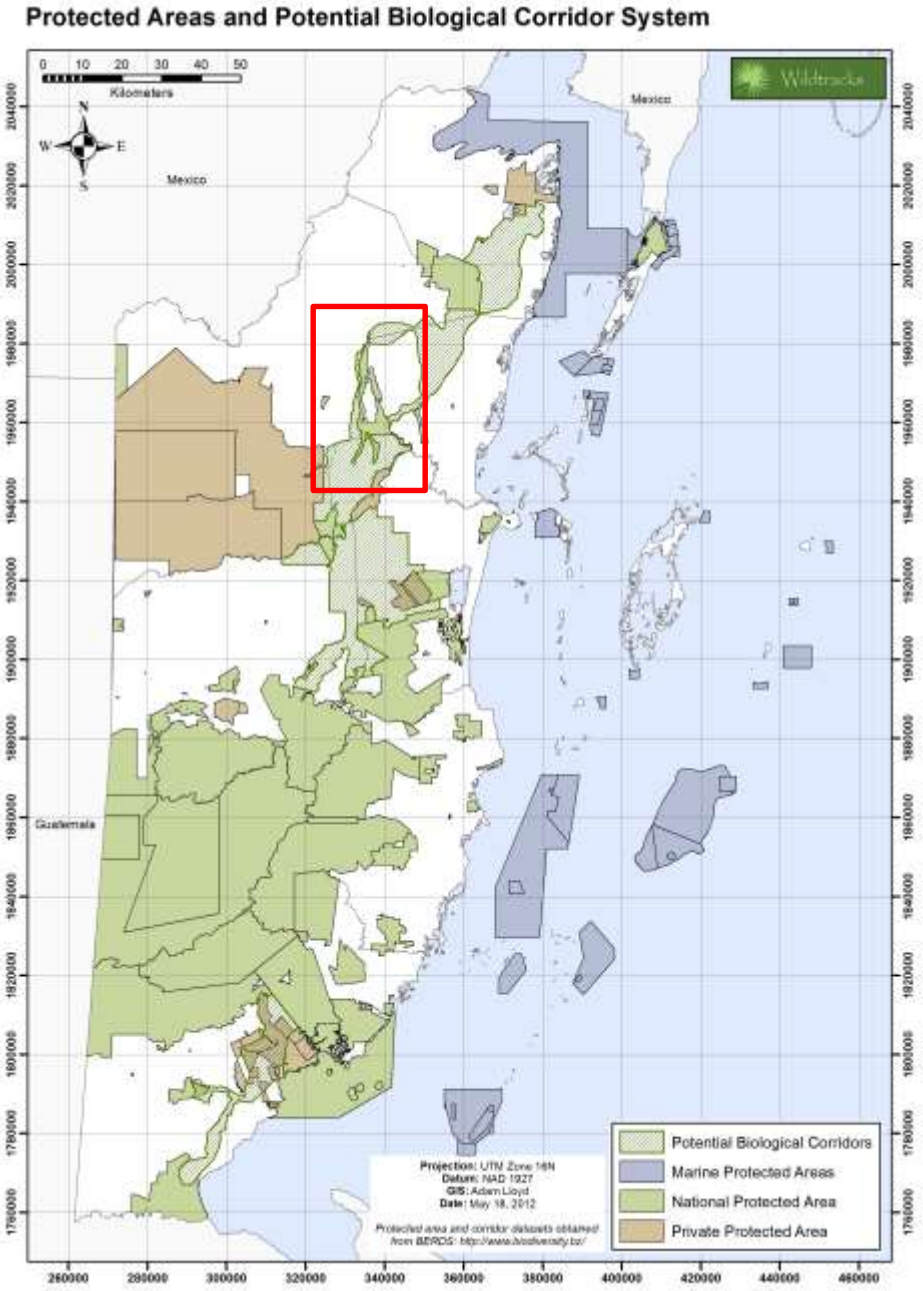
TARGET C3. Between 2016 and 2030, no species will become functionally extinct in Belize.

TARGET C4. By 2020, average management effectiveness of the National Protected Areas System has increased to 80%.

TARGET D1. By 2025, key ecosystem services are sustainably managed and resilient to threats.

TARGET E1. By 2020, all relevant government Ministries, 75% of relevant civil society, and 25% of the private sector and general public are effectively involved in the implementation of the NBSAP.

Crooked Tree's location is important nationally in terms of maintaining forest connectivity in the landscape, falling within the corridor linking Freshwater Creek Forest Reserve to the northeast, and Rio Bravo Conservation and Management Area to the south west (Map 4). There are however problems of lack of direct connectivity – in general, conceptual connectivities have not been implemented on the ground in northern Belize, with the exception of the North East Biological Corridor, targeting the corridor between Shipstern Conservation and Management Area and Freshwater Creek Forest Reserve.



MAP 4: CTWS LOCATION IN RELATION TO PROPOSED NATIONAL BIOLOGICAL CORRIDORS

Under a National Protected Areas System rationalization exercise, a number of recommendations were made for CTWS to improve representation or protection of specific national targets:

Priority Ecosystem / Species Protection

- Area is important for traditional community resource extraction – re-designate as Wildlife Sanctuary (2).
- Should be re-aligned with IUCN Category VI.
- Needs an approved sustainable fishery plan, with use agreements.
- All other activities should be non-extractive as per the Wildlife Sanctuary designation.

National Protected Areas System Rationalization Recommendations (Walker et al., 2012)

Both the NBSAP and the NPAPSP 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.

The national objective of the **National Sustainable Tourism Master Plan** is to *"more than double overnight tourist arrivals while enhancing average length of stay and daily expenditure"***.** The qualities of the environment and the need to conserve these qualities are recognised in the MasterPlan, with the sustainable development program providing the framework that will *"ensure the NSTMP maintains a balance of the three pillars of sustainable development: social accountability, environmental conservation and economic prosperity."* Whilst the NSTMP is primarily focused on destination development, financing and marketing, it does recognize the importance of conservation and environmental management in supporting Belize's tourism industry. The Belize Audubon Society, in its focus on promoting bird tourism, has been actively promoting Crooked Tree Wildlife Sanctuary, and Belize, as a birding destination, and building the capacity of bird guides to professionalize the experience for visitors.

1.3.2 LEGAL FRAMEWORK

Several key laws have been enacted to protect ecosystems, ecosystem services and biodiversity, contributing to the conservation framework of Belize. The Ministry of Agriculture, Fisheries, Forestry, Environment and Sustainable Development is the administrative agency for the **National Protected Areas System Act (revised, 2015),** the **Forest Act (1927), Fisheries Act (1948),** and the **Wildlife Protection Act (1981).**

KEY NATIONAL LEGISLATION PROTECTING FAUNA, FLORA, AND NATIONAL HERITAGE

The National Protected Areas System Act (2015)
Provides a framework for establishment and maintenance of the national protected areas system.

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.

The Fisheries Act (1980)
Principal governing legislation regulating the fishing industry, and is directly concerned with maintaining sustainable fish stocks and protecting the marine and freshwater environments.

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.

The **National Protected Areas System Act** provides the framework for management of the national protected areas in Belize, and is the primary tool for biodiversity planning and management, implemented through the Ministry of Agriculture, Forestry, Fisheries and Sustainable Development. It defines the various categories of protected area, including Wildlife Sanctuary, and the activities that can be conducted in the area. It provides the framework for on-going effective management of Belize's natural resources within protected areas.

As a non-extractive protected area, hunting is not currently permitted within the boundaries of CTWS under the NPAS Act, and wildlife is also managed outside the protected areas through the **Wildlife Protection Act (1982),** which regulates hunting, as well as providing protection for many terrestrial species in Belize. Regulated and protected species are listed in the Schedule. This Act is scheduled for revision and significant strengthening in 2019.

The **Fisheries Act** (being revised as the Fisheries Resource Bill), is administered under the Fisheries Department and is the principal governing legislation regulating the fishing industry. It is directly concerned with

maintaining sustainable fish stocks and protecting the marine and freshwater environments. This includes the inland fisheries, with regulations that provide for sustainability of freshwater fish resources - though these are seldom implemented outside the National Protected Areas System.

The **National Integrated Water Resources Act (2011)** recognizes that:

"Belizeans have a fundamental right to water ", safeguarded through the "planned development, coordinated management, sustainable use and protection of Belize's water resources consistent with the social, economic and environmental needs of present and future generations, and to ensure that all Belizeans have access to affordable, safe, adequate and reliable water."

It also integrates climate change as a key theme. There is recognition of the role of protected areas in the maintenance of water security in the Integrated Water Resource Management Policy and the Act.

In the area of "Gathering Grounds", the Act strengthens the protection provided to the forests managed under the Forestry Department:

50. (1) The Authority shall ensure that all gathering grounds shall …

> *(a) be retained as forest reserves or national parks, as the case may be, in accordance with the provisions of the Forests Act and the National Parks System Act;*

The **Pesticides Control Act (1990)** provides a mechanism for the registration and regulation of pesticide importation and use through the Pesticide Control Board, important for improving pesticide management, and reducing contamination of the rivers.

Tourism legislation in Belize falls under the mandate of the Ministry of Tourism through the **Belize Tourism Board (BTB).** This regulates tourism activities such as guide: visitor ratios, guide training and certification, and licensing of tour operators and accommodation and is focused on maintaining standards for tourism in Belize.

The **Protected Areas Conservation Trust** (PACT) is the primary national financial sustainability mechanism for support of the National Protected Areas System. The Protected Areas Conservation Trust Act was passed in 1995 (Act 15 of 1995), and PACT was established as a statutory body in 1996. Since its establishment, PACT has assisted local conservation organizations, including BAS, with

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)

funding for projects assisting in the maintenance of effective protected areas and providing leverage for funding from external sources. PACT's investments are aligned with the operational framework of the National Protected Areas Policy and System Plan (NPAPSP), focused on building management effectiveness of the NPAS, and strengthening biodiversity conservation in Belize.

1.3.3 LAND TENURE

SITE LEVEL LEGISLATION

Crooked Tree Wildlife Sanctuary is national land, designated by Statutory Instrument (SI 95 of 1984, under the National Protected Areas System Act. The core area has had protected status since it declaration. As such, there are currently restrictions on activities that can take place within the area. Research, educational and recreational activities are permitted, but theoretically, no extractive use (sustainable or otherwise) is currently allowed. As the Crooked Tree Lagoon system has been traditionally of great importance to the local communities, continued extraction of natural resources has been allowed, though this contradicts the legislation and has caused conflict in the past between Belize Audubon Society, thecurrent co-management body, and the local community members.

WILDLIFE SANCTUARY DECLARATION (CROOKED TREE) ORDER 1984

Firstly: Crooked Tree Lagoon Area: All that land in the Belize District comprising strips 300 feet wide measured inland from both shores or banks of Calabash Pond, Revenge Lagoon, the creek which connects Revenge Lagoon to Crooked Tree (Northern) Lagoon, Western Lagoon, Poor Hall Creek, Spanish Creek Lagoon, Southern Lagoon, and Black Creek. Also a strip 300 feet wide measured inland from the eastern shore of Crooked Tree (Northern) Lagoon; and also all the submerged lands beneath each of the said waterways: and including firstly, approximately 600 acres of land situate between Western Lagoon on the west, Crooked Tree (Northern) Lagoon on the east, an east-west line on the north, and the creek connecting Poor Hill Creek to Crooked Tree (Northern) Lagoon on the south and, secondly approximately 2,300 acres of land situate between Crooked Tree (Northern) Lagoon and Black Creek and on the south side of the junction of these two waterways, but excluding any lands leased or grants which lie within the area…

Secondly: Mexico and Jones Lagoon Area: All those lands situate in the Belize District comprising strips 300 feet wide measured inland from the high water mark of both eastern and western shores of Mexico and Jones Lagoons and also the submerged lands beneath these waterways.

In recognition of this conflict between protection and traditional use, the revision of the national protected areas legislation divides Wildlife Sanctuaries into two categories. Wildlife Sanctuary (1) still retains the non-extractive conditions, but Wildlife Sanctuary (2) allows for traditional use of some resources based on an approved sustainable use plan. This management plan includes actions for moving the Wildlife Sanctuary to a Wildlife Sanctuary (2) management category.

The management regime is currently aligned with IUCN designation **Category IV: Protected areas managed primarily for ecosystem protection and recreation.** This is defined as:

> "*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*."

Wildlife Sanctuary (2): allows for continued traditional community use, but presence and active adoption and implementation of a sustainable use plan, based on adequate baseline knowledge and total allowable annual harvest, should be a pre-requisite as should a use agreement with the communities and permitting of users.

Under the protected areas system rationalization process, it is recommended that the protected area should be re-aligned as **Category VI: Protected areas managed for conservation of ecosystems and habitats.** This is defined as:

> *"Conserves 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."*

…with the primary objective of protecting natural ecosystems and use natural resources sustainably, when conservation and sustainable use can be mutually beneficial.

CTWS BOUNDARY DESCRIPTION

...to a point 300 feet west of the high water mark of the western shore of Southern Lagoon, the approximate coordinates of which point are 3 35 915 meters east and 19 57 559 meters north; thence southerly along a meandering line 300 feet inland from the high water mark of the western shore of Southern Lagoon for a distance which would form a a base in a straight line of approximately 4.91 miles to a point 300 feet south of the high water mark at the southern tip of Southern lagoon, the approximate coordinates of which point are 3 37 275 meters east and 19 49 560 meters north; thence northerly and northwesterly along a meandering line 300 feet inland from the high water mark of the eastern shore of Southern Lagoon...

SI 95 of 1984

BOUNDARIES

The boundaries of the Wildlife Sanctuary have not been clearly demarcated and agreed upon on the ground, with the boundary itself being defined by the high water mark "*…southerly along a meandering line 300 feet inland from the high water mark of the western shore of Southern Lagoon".* This has had significant implications on the ability of Belize Audubon Society to effectively manage the protected area, and been an area of past conflict.

There is some disagreement among older and more recent maps of the area as to the exact boundaries within the protected area. The most recent country GIS shapefile (LIC) doesn't include Southern Lagoon within the protected area – however there has been no change in the Statutory Instrument to support this, and it is considered a mapping error (Forest Department, pers. com.). The issues associated with lack of clear definition of the boundary, on paper or on the ground, contradictory shapefiles and the presence of survey lines has lead to potential for concerns over land tenure within the protected area.

1.3.4 EVALUATION OF NATIONAL AND INTERNATIONAL IMPORTANCE

Crooked Tree Wildlife Sanctuary contributes to Belize's commitments under the Convention on Biological Diversity - towards the maintenance of viable populations of at least eleven threatened species of international concern, recognized under the IUCN Redlist as Critically Endangered, Endangered or Vulnerable (Table 3; IUCN, 2018). This includes the critically endangered Central American river turtle and black handed spider monkey, as well as the endangered Yucatan black howler monkey, a Yucatan endemic, yellow-headed parrot and Baird's tapir. To date, at least 28 species of mammal have been recorded, with a further 25 bat species recorded at the adjacent Hill Bank site (Miller et al., 2010), and potentially occuring within the Wildlife Sanctuary. 356 species of birds have been recorded in the area over the years – over 60% of the total species recorded in Belize. 39 of Belize's amphibians and reptiles have been recorded within the Sanctuary to date, with a further 48 potentially present in the area based on range maps and habitat types.

THREATENED SPECIES	
Critically Endangered	
Central American river turtle	*Dermatemys mawii*
Central American Black-handed (Geoffroy's) Spider Monkey	*Ateles geoffroyi*[*]
Endangered	
Yucatan Black Howler Monkey	*Alouatta pigra*
Baird's Tapir	*Tapirus bairdii*
Vulnerable	
Agami Heron	*Agamia agami*
Spanish Cedar	*Cedrela odorata*
Great Curassow	*Crax rubra*
Cerulean Warbler	*Dendroica cerulea*
Big-leaf Mahogany	*Swietenia macrophylla*
White-lipped Peccary	*Tayassu pecari*
Antillean manatee	*Trichechus manatus*

Note: *The subspecies in Belize is now considered genetically identical to A. g. vellerosus, a Critically Endangered sub-species (Moralez-Jiminez et al., 2015).*

TABLE 3: THREATENED SPECIES OF CTWS (IUCN, 2018)

Crooked Tree's large expanse of wetland has been highlighted as an area of international concern, providing feeding grounds for thousands of waterbirds, including the regionally endangered jabiru and wood storks, providing an important tourist destination, with the associated economic benefits to the Crooked Tree community and Belize as a whole. In the national context, it is crucial in terms of ecosystem services (Table 4) – especially for flood control, with floodwaters from the Belize River draining

ECOSYSTEM SERVICES OF CROOKED TREE WILDLIFE SANCTUARY	
Provisioning	▪ Provision of Freshwater: Freshwater availability for storage and retention of water for domestic, industrial, and agricultural use ▪ Provision of Materials: Support of logwood for construction, ▪ Provision of Food: Production of fish and game species and the elements that make Crooked Tree an important stop-over habitat for migratory bird species
Regulation	▪ Water Regulation: Groundwater recharge and discharge ▪ Flood Control and Storm Protection: The wetland is important for absorbing excess waters during storm events, reducing the volume of water in the Belize River and reducing the risk of flooding downstream in river-side communities and Belize City ▪ Erosion Regulation: Retention of riparian forest cover on the creek banks prevents excessive soil erosion and sedimentation of creeks and the lagoon, assisting in prevention of sedimentation impacts downstream that may reduce full flood sink functions and impact water clarity once the water leaves the Belize River and reaches the reef. ▪ Climate Regulation: Wetlands are a source of and sink for greenhouse gases; influence local and regional temperature, precipitation, and other climatic processes ▪ Pollination: Habitat for pollinators
Recruitment	▪ Traditionally Harvested Fish: The lagoon system, when fully inundated acts as a nursery area for traditionally harvested fish species, supporting the local communities and re-populating the Belize River ▪ Game Species Reservoir: The forest acts as a reservoir for game species such as great curassow, white-tailed deer and peccary, re-stocking the adjacent landscape and providing game, an important protein source, for the Crooked Tree community
Cultural and Socio-Economic	▪ Spiritual and Inspirational: Providing peace, tranquility and inspiration ▪ Recreation and Tourism: The scenic beauty of the lagoon system, the thousands of wetland birds and wildlife are important as recreational and tourism resources. ▪ Socio-economic benefit: Tourism-based income associated with CTWS has the potential to be increasingly important in the adjacent communities – particularly for Crooked Tree, and for local / professional bird-focused tour guides ▪ Education: Crooked Tree Wildlife Sanctuary is an important educational resource for Belize schools, providing opportunities for formal and informal education and training
Support	▪ Tropical wetlands are very productive, playing an important role in the cycling of nutrients and providing ecosystems necessary for different life stages of commercial and non-commercial species ▪ Soil formation: Sediment retention and accumulation of organic matter for improving soils

TABLE 4: ECOSYSTEM SERVICES OF CROOKED TREE WILDLIFE SANCTUARY (ADAPTED FROM MILLENNIUM ECOSYSTEM ASSESSMENT, 2005)

into the extensive wetlands, reducing the potential for major flooding in residential areas further down river – especially Ladyville and Belize City. In the local context, the area has been important as a source of traditional natural resources for the Crooked Tree community since long before its protection as a Wildlife Sanctuary.

1.3.5 SOCIO-ECONOMIC CONTEXT

NATIONAL CONTEXT

Belize has a population currently estimated at approximately 380,030 (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, Belize and Stann Creek valleys. 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 (2016 est.)	380,030
Population density (2015)	14.6/sq. km.
Urban Population (2015)	43.1%
Annual growth rate (2015 est.)	2.1%
Life expectancy (2015 est.)	70.1
Below Poverty Level	33.5% (2002) 43% (2010)
Literacy rate (2015)	82.3%
Unemployment rate (2016)	10.1%
GDP (per capita, 2015)	Bz$9,813.88 per capita
Annual GDP Growth (2015)	1.9%

TABLE 5: BELIZE DEMOGRAPHIC STATISTICS, (SIB, 2016)

It is a country of many cultures, with Mestizo, Creole, Maya and Garifuna forming the major population groups. Over the last 30 years, there has been a shift in the cultural demographic of the country, 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, often then sending funds back to support extended families in the communities. Belize is also attracting immigration of retirees from countries such as the USA, Canada and Europe, either as seasonal residents or as retirees - a trend being reflected in Crooked Tree as well.

The economy of Belize has historically been based largely on logging, which has more recently been superseded in importance by agriculture, with fisheries, banana, sugar and citrus forming some of the key traditional exports that have contributed significantly towards the gross domestic product (GDP). A shift into oil extraction was briefly significant in supporting the economy, but was short lived, and has now declined. The economy is currently being supported by an expanding tourism industry, a major contributor to the tertiary sector (64.2% of GDP). Agriculture, aquaculture and fishing are the major primary sector industries contributing 14.3% of GDP. Both tourism and the primary sector industries are heavily reliant on ecosystem services.

Belize's tourism industry, one of the fastest growing sectors in Belize, is rapidly becoming the major foreign exchange earner, with over 1,441,306 tourists arriving in Belize in 2017. 427,075 of these were overnight visitors, the remaining approximately 1 million are day visitors through the cruise industry (Figure 1; BTB, 2018). 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.

FIGURE 1: BELIZE OVERNIGHT TOURISM ARRIVALS 2000 – 2017, BTB, 2018

Overnight tourism in Belize shows a distinct seasonality, with the majority of visitors arriving in the first quarter of the year (BTB, 2018). The lowest months are September and October, the main tropical storm season (Figure 2).

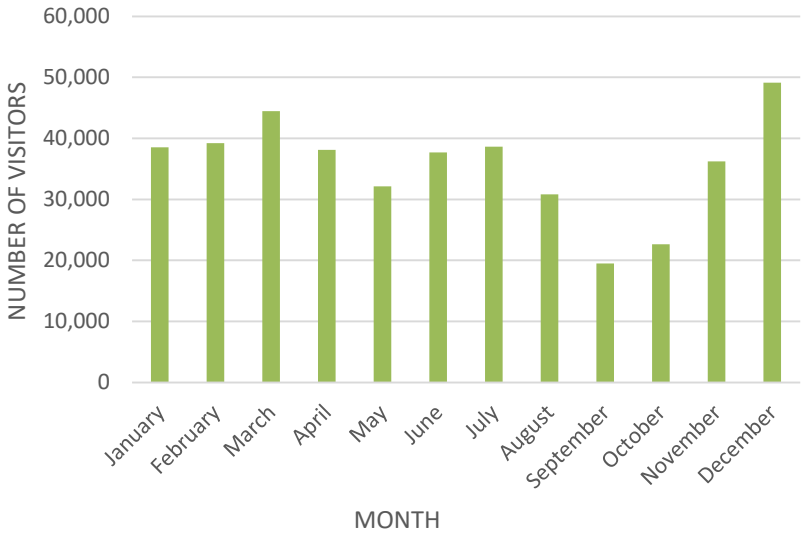


FIGURE 2: BELIZE OVERNIGHT TOURISM ARRIVALS PER MONTH (AVERAGE: 2000 – 2017) (BTB, 2018)

Direct tourism expenditure in Belize exceeded Bz$555.3 million in 2017 – 15% of the total GDP (WTTC, 2018). When indirect contributions are taken into account from related support industries, this rises to 41.3% of the GDP. In 2017, the tourism industry supported over 21,000 direct jobs – 13.4% of total employment, expanding to 37.3% of total employment when related support industries are taken into account (WTTC, 2018).

The northern coastal plain has undergone extensive land use change, with large areas of sugar cane supporting many of the rural communities, and, along with cattle farming, driving much of the forest clearance and land use change. Both are increasing in the local landscape, with the

expansion of Mennonite farmland to the west of Crooked Tree, and large-scale privately owned cattle and sugar cane farms to the north / north east of the area.

Whilst Crooked Tree Village is the oldest stakeholder community, other communities also need to be considered, with natural resource users that have established traditional use extraction within the area (Table 6). Communities are predominantly Creole, though there is an increasing Mestizo and Mennonite presence in the landscape.

KEY STAKEHOLDER COMMUNITIES OF CTWS

Community	Distance from CTWS (km)	Population (SIB, 2010)	Number of Households	Date Established
Crooked Tree	0 km	806	224	1750's
Biscayne	4 km	518	129	1976
Gardenia	2 km	303	78	1985
Lemonal	1 km	169*	41	1926

**This is now estimated to have decreased to 110, following the closure of the school in the community*

TABLE 6: KEY STAKEHOLDER COMMUNITIES OF CROOKED TREE WILDLIFE SANCTUARY (Castillo, 2014)

A recent socio-economic assessment of the key communities provided information on the primary sources of employment of those surveyed within each community, with Crooked Tree demonstrating the greatest reliance on the natural resources through fishing and farming (Figure 3; Castillo, 2014)…and therefore amongst the most vulnerable to natural disasters.

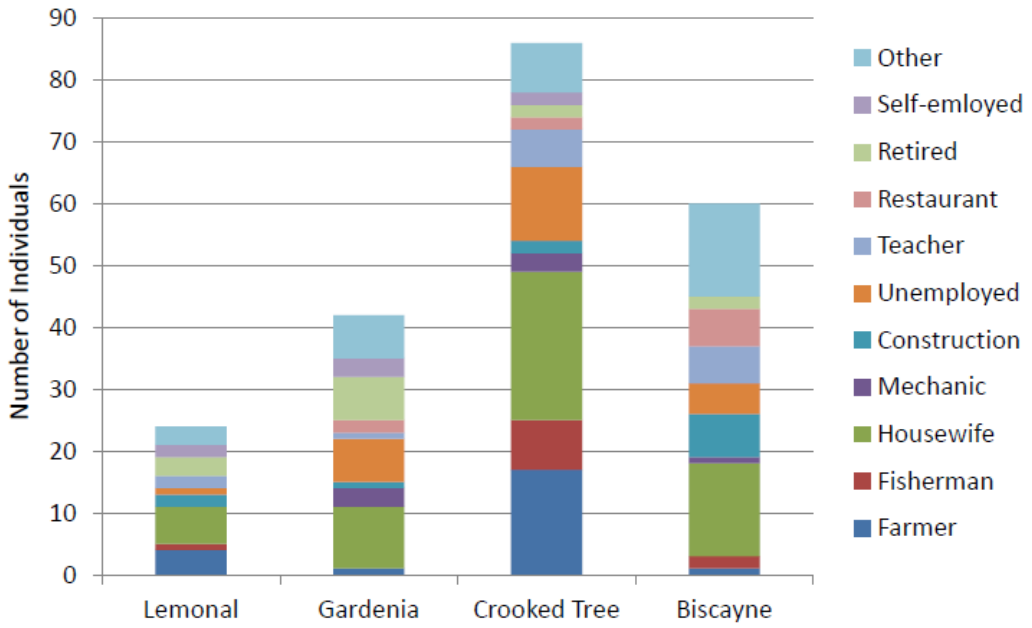


FIGURE 3: SOURCES OF EMPLOYMENT (Castillo, 2014)
Survey sample size (Number of households): Crooked Tree: 61 (27%); Biscayne: 39 (30%); Gardenia: 25 (32%); Lemonal: 11 (27%)

Survey respondents indicated different levels of reliance on the natural resources – 75% of households in Lemonal, 57.7% in Crooked Tree, 53.5% in Biscayne, and 44% in Gardenia considered themselves to be reliant on natural resources for their household income, through farming, fishing or tourism (Figure 4; Castillo 2014).

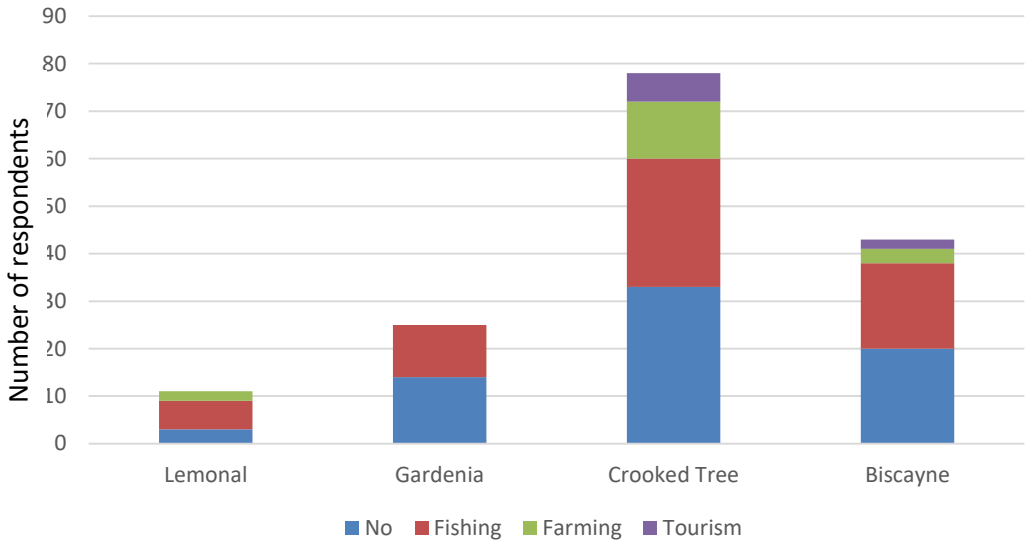


FIGURE 4: RELIANCE ON NATURAL RESOURCES (Castillo, 2014)

All four communities have households that use the Wildlife Sanctuary for fishing, with Lemonal, Crooked Tree and Biscayne all having households reliant on farming. Only Crooked Tree and Biscayne have households that benefit directly from nature-based tourism.

1.4 PHYSICAL CHARACTERISTICS

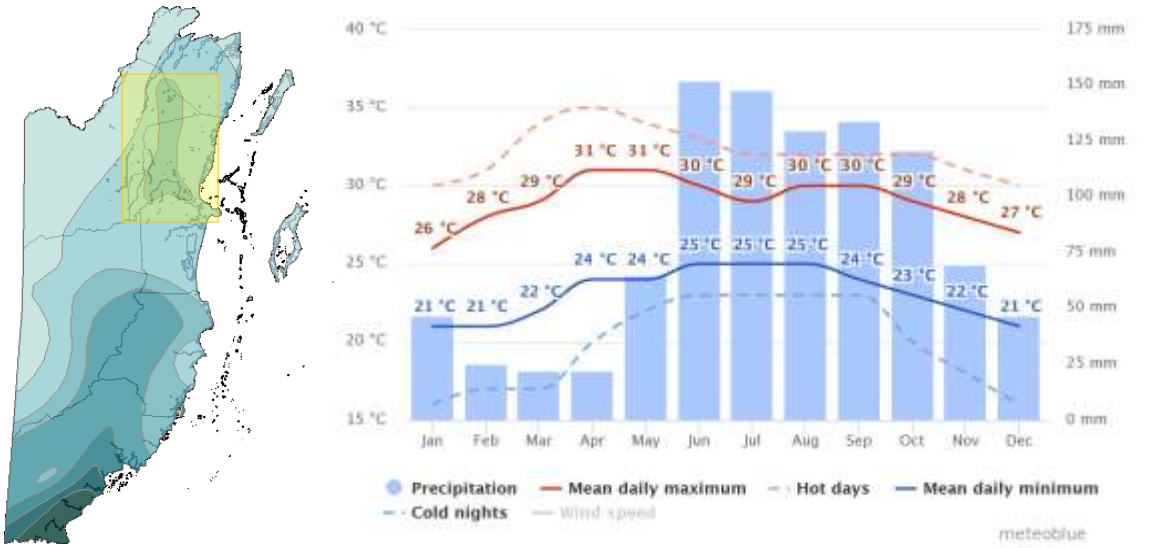
1.4.1 CLIMATE

WIND SYSTEMS

Belize is affected by three very distinct seasonal weather systems: trade winds, northers and tropical storms. All three have an influence on the rainfall and temperature patterns. The predominant winds are the ***Trade Winds***, blowing from the east and south-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.

RAINFALL

Crooked Tree Wildlife Sanctuary receives between approximately 2,032 to 2,540 mm of rain per year (Figure 5). There is a pronounced dry season stretching from January through to May, with an average of only 22 mm recorded in April, the driest month. This is followed by a wetter season (June to October) with total rainfalls in the region of 134 to 153 mm, often associated with passing tropical storms. The wetland ecosystem appears to be impacting the rainfall for the area, creating a microclimate with higher annual rainfall than the surrounding landscape.



Rainfall Isohyets

- 40 - 60" (1016 - 1524mm)
- 60 - 80" (1524 - 2032mm)
- 80 - 100" (2032 - 2540mm)
- 100 - 120" (2540 - 3048mm)
- 120 - 140" (3048 - 3556mm)
- 140 - 160" (3556 - 4064mm)
- 160 - 180" (4064 - 4572mm)

FIGURE 5: CLIMATE IN BELIZE

TEMPERATURE

The annual mean temperature in the CTWS area is 24.8°C, fluctuating throughout the year from a minimum monthly average of 21°C in January (with minimum night temperatures of 16°C in December and January), during the cold fronts. A maximum average in April and May of 31.0°C corresponds with the peak dry season, when water levels are at their lowest (Figure 5). Highest daily temperatures of 35°C are recorded in April (www.meteoblue.com).

TROPICAL STORMS

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 circulations, and ranging in scale from tropical depressions and tropical storms (with sustained wind speeds < 39 and 74 mph respectively) to hurricanes (with sustained wind speed ≥ 74 mph). These storms move westward towards the Caribbean and Central American coastline, often gathering strength until they hit land. They generally bring extreme weather conditions – heavy rains, and destructive winds.

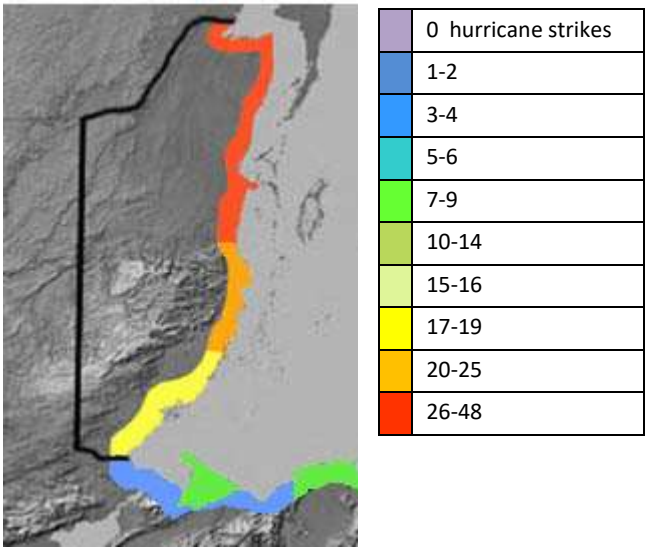


FIGURE 6: HURRICANE STRIKES IN BELIZE, 1851 – 2009
After Anderson, 2016

Whilst many hurricanes have very focused paths of destruction, their effects are wide ranging. Northern Belize has been hit by hurricanes between 26 and 48 times between 1851 and 2009 (Figure 6; Anderson, 2016), though hurricanes are not evenly distributed over time, and the last 25 years have seen an increase in storm activity. Despite the distance from the coastline, Crooked Tree Wildlife Sanctuary has been affected on an almost annual basis by tropical storms, some of these reaching hurricane strength. The strong winds associated with hurricanes cause structural damage to the forest, affecting habitat quality for wildlife for months and sometimes years afterwards. Tropical storms and hurricanes, even tropical depressions, can bring significant increases in rainfall, causing extensive flooding and increased water flow in the rivers, impacting aquatic organisms, riparian vegetation and causing erosion of river banks. Crooked Tree plays an important role as a flood sink for the largest watershed in Belize, with storm event flood waters flowing into the system from the Belize River, leading to extensive flooding of the wetlands, flooding the lower lying areas of the community

itself and recently even topping the causeway and cutting off the community from the Northern Highway.

1.4.2 GEOLOGY

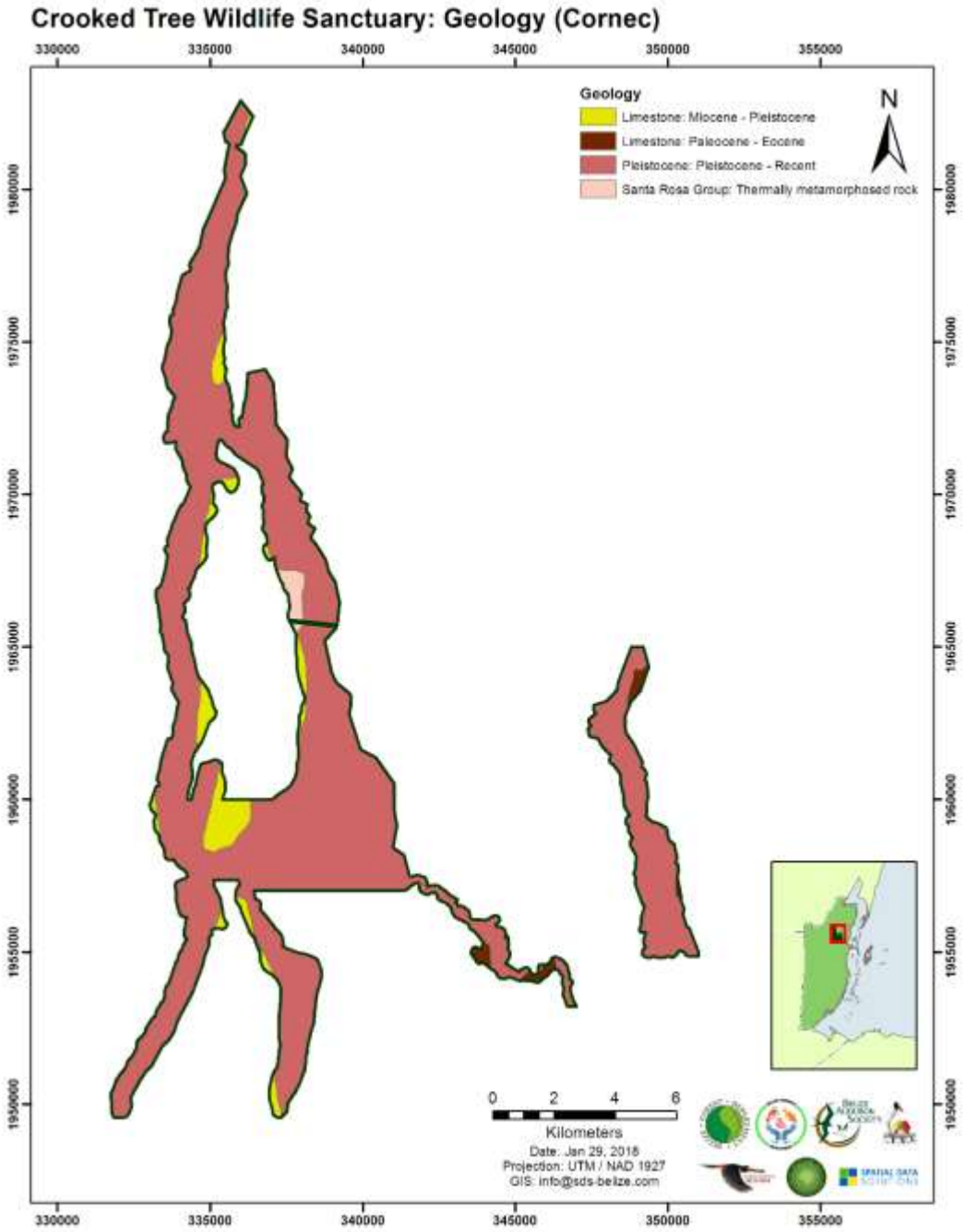
Crooked Tree Wildlife Sanctuary lies on the Northern Coastal Plain, and is part of the flat, low elevation Yucatan limestone platform that stretches northwards into the Yucatan Peninsula of Mexico. The first rock was laid down in the Palaeozoic Era during a period of marine deposition (Map 5). Following this, tectonic activity in the Triassic Period of the early Mesozoic Era caused an uplifting of the land above sea level, with little deposition until the late Mesozoic Era, during the Cretaceous Period (65 – 136 million years ago – some 200 million years following the initial uplifting).

TIME SCALE OF FORMATION OF CTWS GEOLOGY

Era	Period	Time Span (million years ago)	Geological Activity
Cenozoic Era	Quaternary Period	0 – 2 million	Sea level fell and the northern coastal plain emerged from the sea. Continued alluvial deposition from the Belize River system.
	Tertiary Period	2 – 65	The northern coastal plain was covered by shallow seas, with continued deposition of limestones, conglomerates and marls
Mesozoic Era	Cretaceous Period	65 – 136	Marine inundation by oceanic water covered virtually the whole of Belize with limestone, followed by a series of rises and falls in sea level, causing a switching back and forth from marine to alluvial deposition, forming alternating layers.
	Jurassic Period	136 – 190	Coastal plain remained primarily above sea level, with alluvial deposition of red shales and sandstones, but no marine deposits
	Triassic Period	225 – 190	Tectonic activity causes some folding and uplifting, with northern plain emerging above sea level. Erosion from newly formed Maya Mountains created alluvial deposition areas on coastal plain and far out to sea.
Palaeozoic Era	Carboniferous Permian	225 – 570	Belize covered by a shallow ocean, with deposition of marine sediments forming a base of sedimentary rocks throughout the country (in Crooked Tree, these are now overlain by younger rocks)

TABLE 7: TIME SCALE OF FORMATION OF CTWS GEOLOGY

During this Cretaceous Period, a series of inundation phases and associated marine deposition alternated with exposure of the land through decreasing sea levels, and deposition from alluvial river deposits originating in the northern Maya Mountains. On entering the early Cenozoic Era, during the Tertiary Period (2 to 65 million years ago), the Plain was inundated once again by coastal waters, forming a shallow tropical sea, associated with the deposition of the limestones, conglomerates and marls that is so distinctive of the northern half of Belize (Map 5; Table 7).



MAP 5: GEOLOGY OF CROOKED TREE WILDLIFE SANCTUARY (CORNEC, 2002, REVISED 2004)

The Northern Coastal Plain finally emerged from the sea in the Quaternary Period, during the last 2 million years, with continued alluvial deposition from the Belize River in the Crooked Tree area.

Whilst the Yucatan platform has appeared to have remained relatively stable tectonically, the opening of the Yucatan trough caused slumping along north-northeast trending faults, resulting in low lying wetlands and lagoon systems such as that of Crooked Tree and New River, following the direction of the fault lines.

1.4.3 SOILS

Two major soil and land use studies have taken place in Belize – the first a comprehensive study of the whole country by Wright et al. (1959), looking at soils and associated vegetation assemblages in great detail. The second is a more recent study by King et al. (1989), based on Wright but using techniques such as satellite imagery to update the original report. King et al. demarcated a number of land regions and systems throughout Belize to classify different soil characteristics.

Land Regions are broad-scale divisions of the landscape into different units based primarily on topography. Crooked Tree lies within a single region - the Northern Coastal Plain – a region that encompasses the flat and undulating land of Northern Belize and the Belize River Valley, with underlying limestone bedrock.

Land Regions are broadscale divisions of the landscape into different units based primarily on topography.

Land Systems classify soil typess within Land Regions, and are more heavily influenced by the geology and topography of the area, with the parent bedrock and steepness of the terrain playing an important part in soil characteristics.

King et al., 1989

Within the Land Region, classification of Land Systems and soil types are more heavily influenced by the geology and topography of the area, with the parent bedrock and gradient of the terrain playing an important part in soil characteristics. Fifteen Land Systems have been identified for the Crooked Tree area (Map 6; Table 8).

At the local scale, savanna environments are very patchy and heterogeneous, resulting in a wide variation of soil characteristics within a small area (Bridgewater, et al., 2012). At a broadscale level, savanna soils of Northern Belize are typically palaeo-alluvial, coarse sediments from the erosion of mountains and from littoral sediments from ancient shorelines (Wright, et al., 1959), with areas of elevated calcareous formations that support forest biomes (Goodwin, et al., 2013). The low nutrient acidic savanna soils overlying the limestone bedrock have pH values from about 5.3 to 5.7, with higher levels where there are ground water or perched water table influences (BTFS, 2012). Cation exchange capacity was low overall, adding to the characterization of savanna

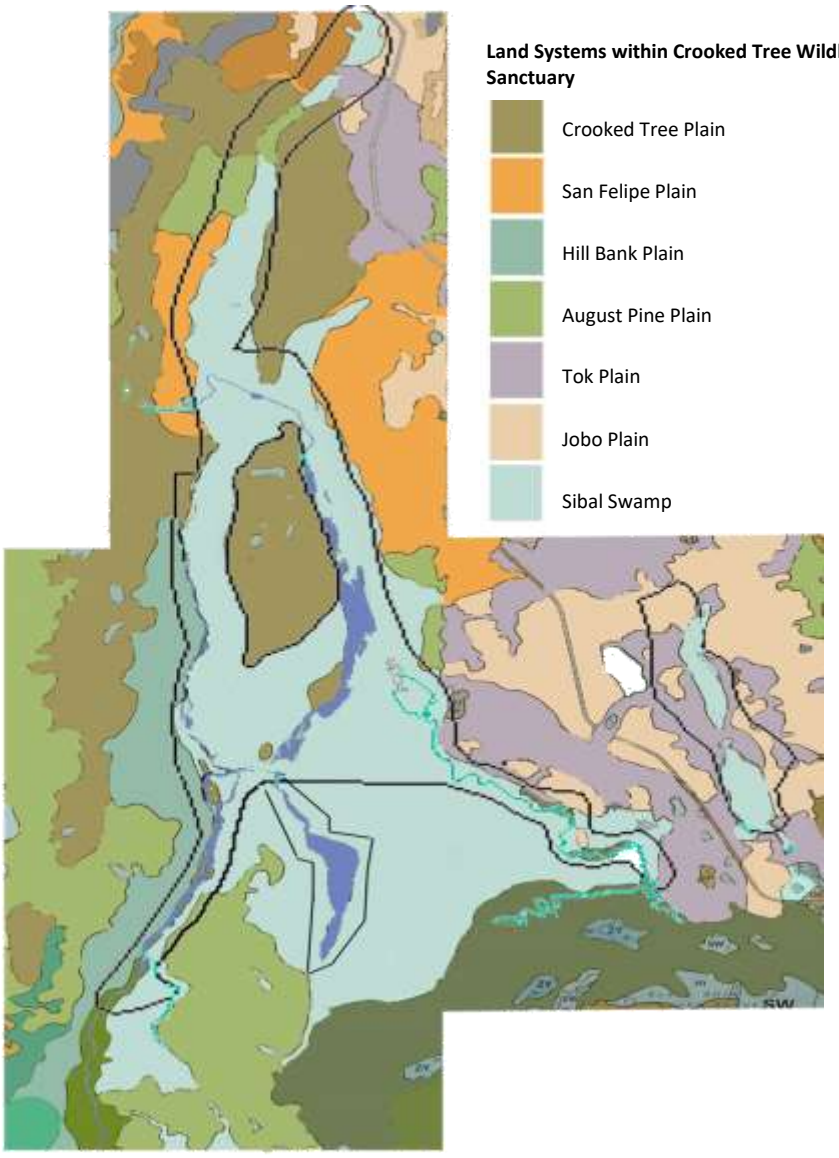
soils being nutrient poor. Clay deposits tend to dominate savannas of low relief (Map 7; Bridgewater, et al., 2012).

LAND SYSTEMS AND SUB-UNITS OF CROOKED TREE WILDLIFE SANCTUARY

Land System	Sub-unit	Main Soil Type	Limiting Factor For Cultivation
Crooked Tree Plain	Redeposited old alluvial wash	Shipstern + Ycacos	Root room, nutrients, salinity, wetness
	Undulating Plain	Ycacos	Wetness, salinity
Hill Bank Plain	Flat Plain	Puluacax < (Xaibe, Remate + Ycacos)	Nutrients, drainage
	Spanish Creek Floodplains	Ycacos > (Puluacax + Xaibe + Remate)	Wetness, salinity nutrients
San Felipe Plain	Redeposited old alluvial wash	Xaibe, Puluacax + Remate	Moisture, nutrients
	Undulating Plain	Puluacax > (Remate + Xaibe)	Nutrients
August Pine Plain	Redeposited old alluvial wash	Xaibe+ Puluacax > Ycacos	Nutrients, drainage
	Undulating Plain	Boom > (Tok + Backlanding + Crooked Tree)	Moisture, wetness, nutrients
Lower Belize Floodplain	Low floodplain bench backland	BV: Bermudian Landing	Wetness, flooding
	Low floodplain bench	BV: Lemonal > Freetown	Flooding
Sibal Swamp Jobo Plain	Herbaceous Swamp	Sibal	Wetness
	Flat Plain	Altun Ha > Puluacax	Workability, moisture, nutrients, wetness
Tok Plain	Flat Plain	Tok > (Boom + Buttonwood)	Wetness, nutrients
	Redeposited old alluvial wash	Haciapina	Nutrients, drainage

TABLE 8: LAND SYSTEMS AND SUB-UNITS OF CROOKED TREE WILDLIFE SANCTUARY (After King et al., 1989)

Where annual inundation occurs, long-term buildup of organic-rich alluvium within Crooked Tree wetlands from Belize River floods has resulted in areas of very fertile soils. Savanna wetland soils often contain higher levels of organic material that not only reduces sediment/soil porosity, (resulting in poor drainage), but also contributes to the buildup of anaerobic environments that break down detritus much slower, contributing to the buildup of sequestered organic carbon.



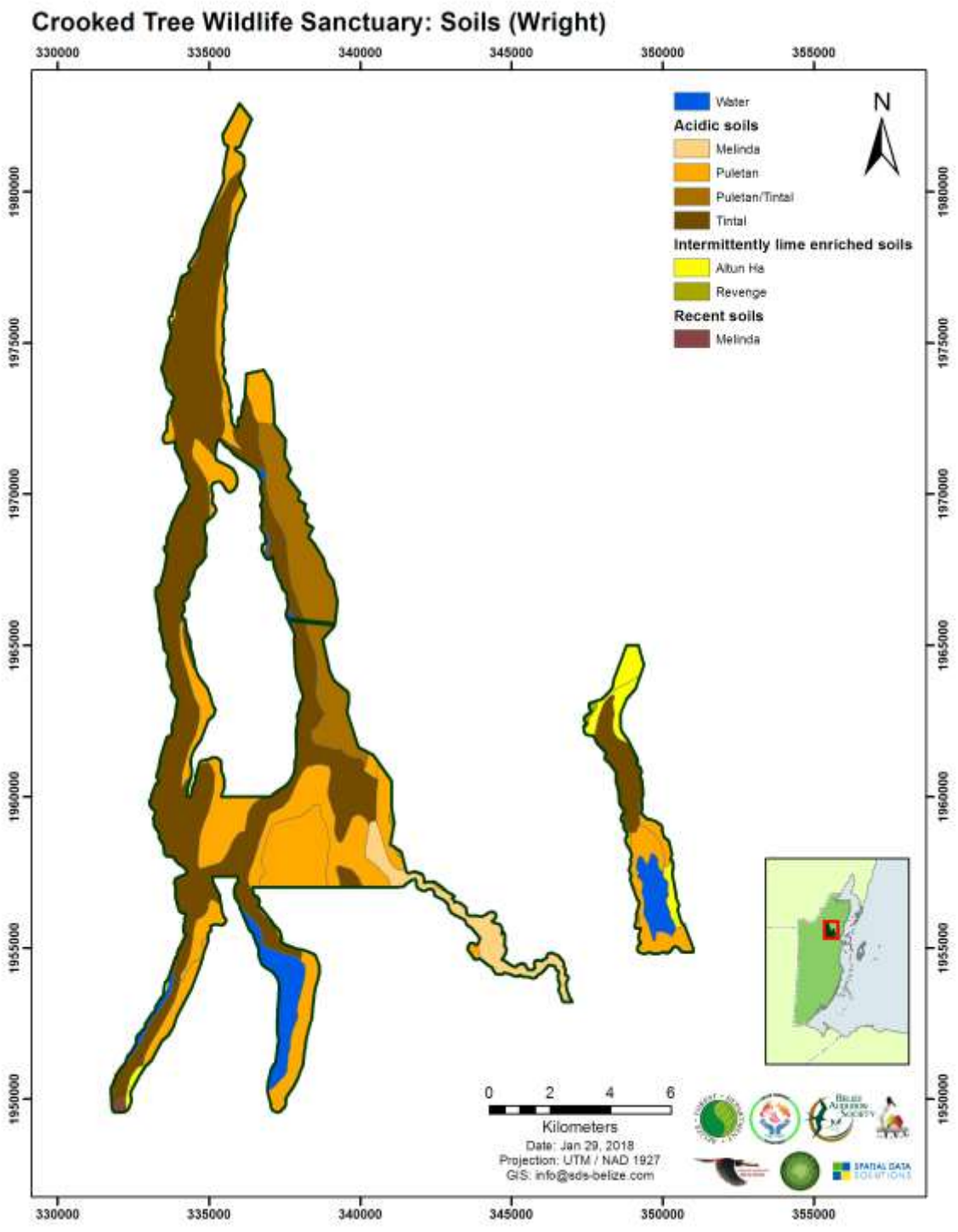
MAP 6: LAND SYSTEMS AND SUB-UNITS OF CROOKED TREE WILDLIFE SANCTUARY (AFTER KING ET AL., 1989)

CHARACTERISTICS OF THE LAND SYSTEMS OF CROOKED TREE WILDLIFE SANCTUARY

Land System	Characteristics	Location within Crooked Tree
Crooked Tree Plain	***Undulating Plain:*** Land with less than a 25° angle, overlying old silicaceous alluvium on the northern plain, derived from the metasedimentary rocks of the Maya Mountains. Characteristic vegetation is lowland pine savanna, often with a dense covering of tall pines (*Pinus caribaea*), large oaks, sandpaper tree, craboo and calabash trees.	Found between Western - Revenge Lagoon and the Northern Lagoon drainage system, on Crooked Tree island, and in the Revenge Works area
	Redeposited old alluvial wash: Overlies a combination of old river and coastal alluvium	Located primarily on the shoreline of Western Lagoon, on the western bank of Crooked Tree island, and the eastern shoreline of Blackburn
Hill Bank Plain	***Flat Plain***: On hard limestone bedrock with Chacluum and ramgoat soil subsuites, though it also includes soil of the Yalbac subsuite. Characteristic vegetation is high broadleaf semi-deciduous soil with sapote and santa maria	Forms the east-facing areas of Blackburn ridge, along the western bank of Spanish Creek and mid-Western Lagoon
San Felipe Plain	***Undulating Plain:*** Undulating plain on old alluvium overlying sascab (soft limestone), producing soils ranging from Boom Subsuite to Pixoy Subsuite. Vegetation is transitional from Broken Pine Ridge through pine and oak savanna to open savanna with palmetto. Characteristic soils belong to the Felipe subsuite. ***Redeposited old alluvial wash***	Primarily on the east shoreline of Northern Lagoon and west shoreline of Revenge Lagoon
August Pine Plain	Boom subsuite of Puletan, sandy topsoil over a finer textured compact subsoil, with pine savanna. Characteristic vegetation is pine savanna. Undulating plain dissected by parallel drainage lines containing either calcareous alluvium of Sennis subsuite or redeposited old alluvial wash of the Haciapina subsuite ***Redeposited old alluvial wash***	Found on the interfluve between New River and Western – Revenge Lagoon drainage system
Lower Belize Floodplain	On alluvium. Flat often swampy areas between water channel and floodplain edge. Melinda soil type. Characteristic vegetation is high broadleaf forest ***Alluvial wash*** ***High floodplain bench***	Soils deposited by the Belize River, this system runs on either side of the river, at the southernmost part of the protected area, south of Southern Lagoon and up the first portion of Black Creek
Sibal Swamp	***Herbaceous swamp:*** On alluvium, Sibal soil, herbaceous swamp, savanna plain. Veg: Herbaceous – mostly rushes, sedges and marsh forest. Herbaceous swamp – permanently flooded or waterlogged; marsh forest plain – seasonally waterlogged; savanna plain – an intergrade between herbaceous swamp and marsh forest plain ***Savanna Plain***	Recently deposited soils within the lowest lying marsh and lagoon system areas.

Characteristics of the Land Systems of Crooked Tree Wildlife Sanctuary / 2		
Jobo Plain	***Flat Plain:*** Formed on flinty crystalline siliceous early-tertiary limestones, producing a landscape with many sinkhole ponds. Veg: Semi-deciduous broadleaf forest of moderate height.	Found adjacent to the Mexico and Jones lagoon area, and east to the north eastern boundary of the main Crooked Tree Wildlife Sanctuary.
Tok Plain	***Flat Plain:*** Developed on old strand deposits overlying hard limestone – a flat plain with many depressions and small lakes. Characteristic vegetation is open savanna with few pines and oaks	Characteristic of the soils adjacent to Mexico and Jones lagoons, as pockets within the Jobo Plain soils.

TABLE 9: CHARACTERISTICS OF THE LAND SYSTEMS OF CROOKED TREE WILDLIFE SANCTUARY (After King et al, 1989)



MAP 7: SOILS OF CROOKED TREE WILDLIFE SANCTUARY (WRIGHT, 1959)

1.4.4 HYDROLOGY

The hydrology of the Crooked Tree landscape is dominated by two large lagoon systems - the Crooked Tree lagoons, and to the west of these, the New River Lagoon. Both lie within a landscape of inundated pools linked by small creeks and wetlands (Map 9). Crooked Tree Wildlife Sanctuary lies within the Lower Belize River floodplain of the Belize River Watershed, the largest of twenty-nine watersheds identified in Belize (Belize Environmental Profile, unpublished). It originates in the western slopes of the Maya Mountain, draining the Chiquibul and Vaca Plateau areas, and in eastern Guatemala (Map 8). A complex drainage area of an estimated 6,356.7km², the Belize River Watershed can be divided into four major sub-basins:

MAP 8: BELIZE RIVER WATERSHED

Mopan and Chiquibul – The fast flowing Mopan River originates in the Chiquibul area as the Chiquibul River, almost 1,000 m above sea level. It drains westwards into Guatemala before flowing east back into Belize. By the time it joins the Macal River, it has dropped to an altitude of just 48 m above sea level, with a drainage area estimated at 1,020 km².

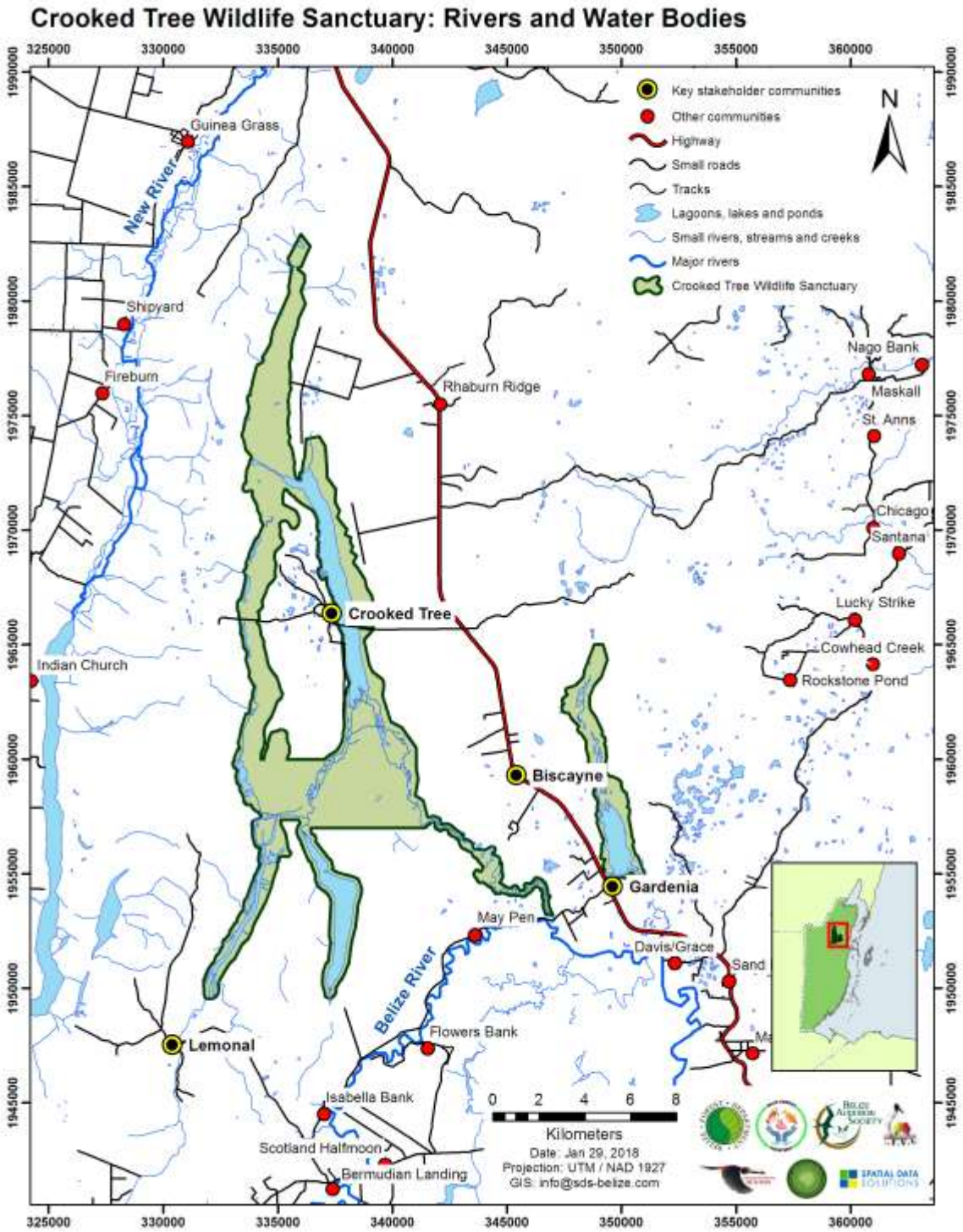
Macal River – Starting at a much lower altitude, the Macal's course remains within Belize, and receives water from an area of about 2,355 km², through many tributaries before joining the Mopan River, just north of San Ignacio.

Upper Belize River – From the confluence of the Mopan and Macal Rivers (joining to form the Belize River), the Belize River flows eastwards through a well-developed valley, falling only 28 m over this approximately 55 km stretch, and being joined by the major tributaries of Iguana Creek, Roaring Creek and Labouring Creek. The drainage area for this sub-watershed is estimated to be approximately 1536 km².

Lower Belize River – Once past Labouring Creek, the river slows down, entering the floodplain, and meandering through this final stretch, draining an estimated 1,445 km² before reaching the sea.

Crooked Tree lies within this last sub-basin, acting as part of a huge water storage area for the Belize River when it is in flood. When extensive rainfall causes high-stage floods, water is forced backwards up Black Creek and into the Crooked Tree wetland complex of Northern, Western and Revenge Lagoons, filling the inundation area, then flooding the adjacent pine savanna, and

backing up Spanish Creek and Southern Lagoon. Once the river flow is back to normal, the stored water then drains back into the river through Black Creek (Figure 7).



MAP 9: HYDROLOGY OF THE CROOKED TREE WILDLIFE SANCTUARY LANDSCAPE

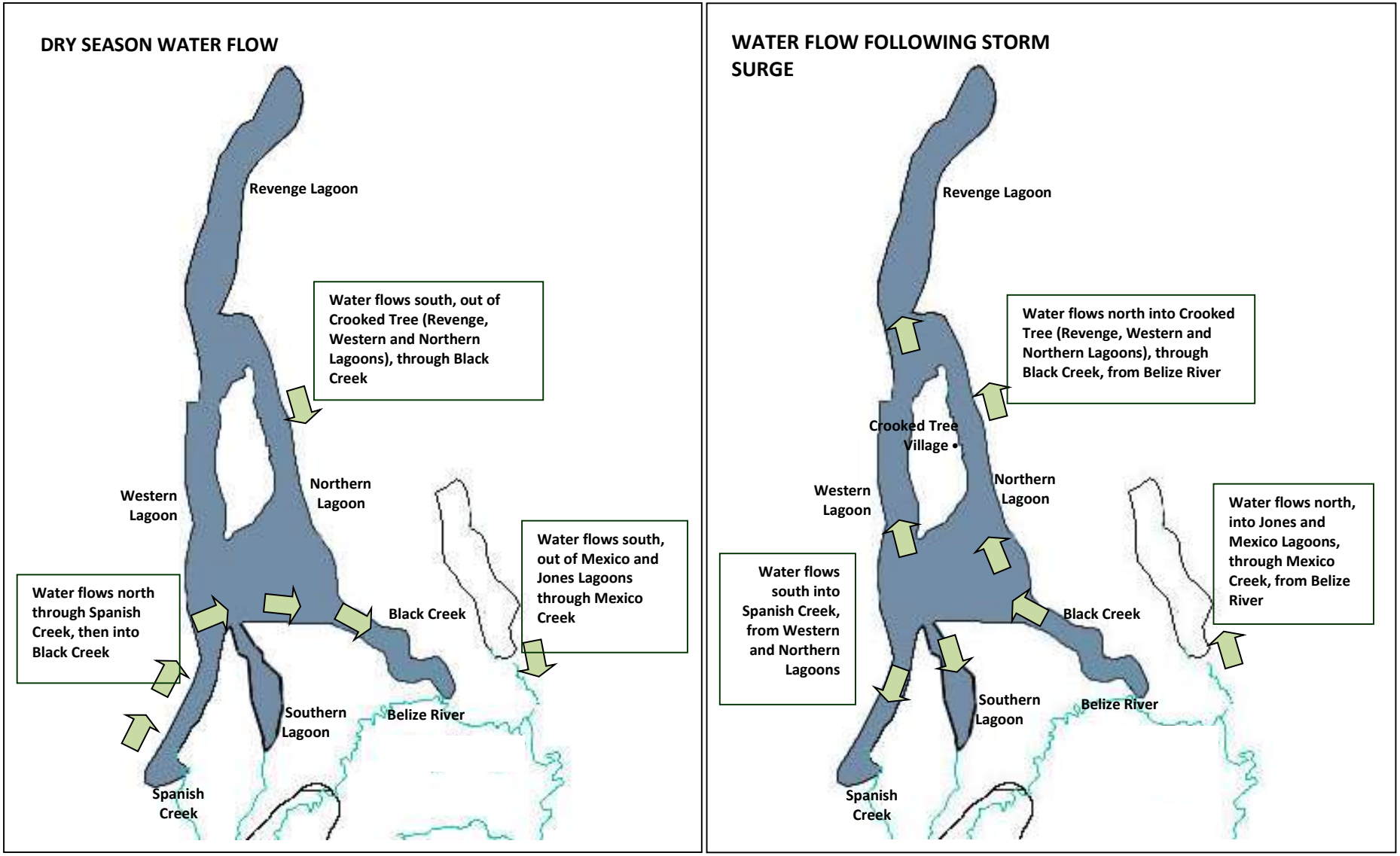


FIGURE 7: DRY AND WET SEASON WATER FLOW - CTWS

Western Lagoon is separated from the New River watershed to the west by a low ridge, running north - south – however there is some discussion locally as to whether the two systems link up in time of highest flood water levels through Dawson Creek, particularly after tropical storm events. Similar speculation exists about Crabcatcher Lagoon to the south-west, again part of the New River watershed. If this does occur, the flow would be expected to be to the west, with the Crooked Tree system flowing into the New River watershed.

The Crooked Tree system is also supplied by Spanish Creek, which is fed by a number of small springs and by its own, small drainage basin during the rainy season. Water flow for much of the year through this tributary is slow, and sometimes even stagnant, but during storm events, the creek is thought to link with Labouring Creek, through both a small creek that passes through the Rio Bravo lands at times of high flood, and through sheet flow through the forest (Meerman et. al., 2004).

Mexican and Jones Lagoons – the eastern section of Crooked Tree Wildlife Sanctuary - act as a flood storage area in a similar way as the main lagoon system, with water backing up Mexico Creek during storm events to flood the two water pans and surrounding savannas. Once the Belize River falls, the stored water is released more slowly through Mexico Creek. There is concern about possible impairment to draining of this system with the failure to remove construction materials from the Mexico Creek Bridge on the Northern (Philip Goldson) Highway.

Water Level

Monitoring of water levels in Crooked Tree Wildlife Sanctuary has been conducted over the last five years, with a gauge located in the deepest section of the Crooked Tree Lagoon near the bridge. The outputs demonstrate that the average annual water level recorded in 2017 were the lowest during that period. 2014 was the highest, attributed to intense rains and extensive flooding in late 2013, which impacted the water level in the lagoon for about 6 months (Figure 8).

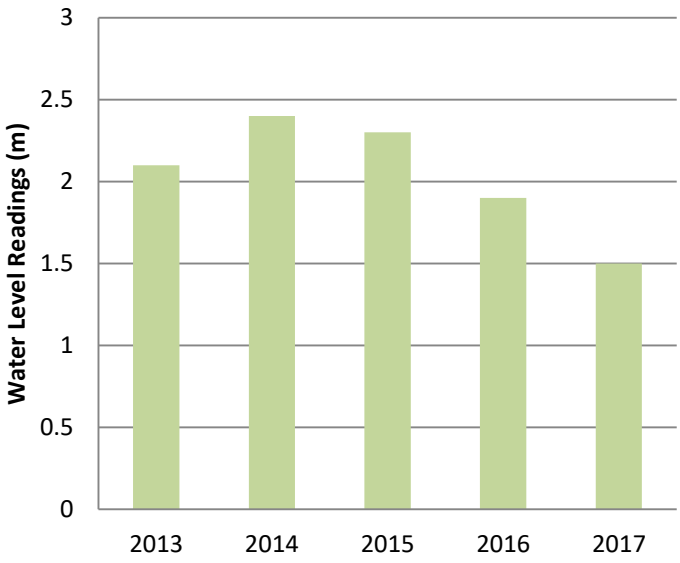


FIGURE 8: ANNUAL AVERAGE WATER LEVEL OF CROOKED TREE LAGOON (BAS DATA, 2013 – 2017)

1.5 BIODIVERSITY OF MANAGEMENT AREA

1.5.1 ECOREGIONS

Ecoregions can be defined as:

> *Relatively large units of land containing a distinct assemblage of natural communities sharing a large majority of species, dynamics, and environmental conditions…with boundaries that approximate the original extent of natural communities prior to land use."*
>
> **WWF Conservation Science Programme, 2001**

The WWF initiative divides the terrestrial world into eight biogeographic areas and fourteen biomes (major global plant communities, determined by rainfall and climate). These fourteen biomes have been further divided into 867 ecoregions, thought to be the minimum level of resolution required for effective regional conservation planning. Biogeographically, Belize lies within the Neotropics, and encompasses three of the fourteen terrestrial biomes (Figure 9):

FIGURE 9: ECOREGIONS OF BELIZE (WWF, 2001)

- Tropical and subtropical moist forest
- Tropical and sub-tropical coniferous forest
- Mangroves

Crooked Tree itself falls within two of these biomes – Tropical and sub-tropical moist broadleaf forest, and Tropical and sub-tropical coniferous forest. Both of these are further subdivided into ecoregions under the WWF Terrestrial Ecosystem initiative.

Tropical and subtropical moist forest biome: This biome of the Neotropical biogeographic region is further subdivided into eighty Ecoregions, of which only one is represented in small areas within Crooked Tree– the Petén-Veracruz Moist Forest (Box 12). Overall, this large block of tropical forest stretches through Belize, Guatemala and southern Mexico, the northern limit being approximately 22°N, towards the northern extent of Veracruz State in Mexico, with the southern extent reaching approximately 15°N, just north of the southern border of Guatemala.

Throughout their range, these forests tend to be a matrix of moist tropical forest, bajo, wetlands and riparian habitats. Species-richness is high (though the number of endemic species is low) with a high proportion of tightly linked ecological interactions such as symbiosis. Many tree, vertebrate and invertebrate species occur at relatively low densities, resulting in large areas being needed for the support of viable populations, particularly of the larger predators. There is much disturbance of this biome throughout Central America (and the world as a whole), resulting in not only the loss of key predators, but also secondary local extinctions and changes in species composition when these key species are removed. These tropical and sub-tropical forests are very susceptible to change, with understory species being sensitive to even small disturbances in the microclimate, and unwilling to move through more open habitats, making them particularly vulnerable to habitat fragmentation. For all these reasons, tropical moist forests such as those found in small patches particularly on the western edge of Crooked Tree typically require large protected areas to maintain viable populations and sustain ecological processes, with buffering from edge effects, and provision for linkage through natural habitat corridors. Crooked Tree, whilst playing a role in protection through connectivity, does not contain large enough areas of this ecoregion to support viable populations, particularly of the larger mammal species.

Belizean Pine Forest: This represent one of the few examples of lowland and premontane pine forests in the Neotropics, and is of very limited distribution, the estimated 2,800 square kilometers mapped under the ecoregions programme being found predominantly in Belize (two other small, unmapped patches are also known to occur, the first in southern Quintana Roo, Mexico, the second in northeast Guatemala). This lowland pine forest, characterized by a grassy open pine savanna, is found in the Crooked Tree area, in the central northern plain, and along the southern coastal plain (the premontane pine forests are limited to the Mountain Pine Ridge area, and have a much more closed canopy). This limited range has led to the conservation status of this ecoregion being classified as critical/endangered, and its conservation is considered to be a high priority at the regional level.

Species characteristic of this ecoregion include Caribbean Pine (*Pinus caribaea* var. *hondurensis*), oaks (*Quercus* sp.) and the palmetto palm (*Acoelorraphe wrightii*). The predominant tree species, the Caribbean pine, requires periodic low intensity burns for its regeneration. However, increasing burn frequency to promote grass growth for cattle and attracting white tailed deer has led to a decrease in the density of pine – frequent fires preventing the growth of young pine. The increasing numbers, severity and range of fires is considered the major threat to this ecoregion, as soils tend to be too poor for extensive agricultural use, and inundation in wet season tends to dissuade development.

When viewing mapping at ecoregion level, it should be borne in mind that ecoregions reflect a 'best compromise' – their boundaries are rarely abrupt, and can be subject to some disagreement. There will often be a mosaic of smaller ecosystems within the general area that will differ from the defined biome (such as small swamps within tropical forest), and whilst the majority of an area may be of mangrove, as is the case for much of the north east corner of Belize, the remaining

area of forest may be more important for species diversity and conservation within that area, whilst not being reflected within the biome classification. Species will also not necessarily be restricted to one biome or another, but may transcend ecoregion and biome boundaries. Taking into account these considerations, ecoregions still offer the best opportunity for evaluation of landscape conservation at the regional level, transcending political boundaries.

1.5.2 ECOSYSTEMS

A total of 10 terrestrial and 2 aquatic ecosystems have been mapped in CTWS, and 1 more aquatic ecosystem (water body) described (Table 10; Figure 9). The most current ecosystem classification and mapping (Maps 10 and 11; Meerman, 2017) is based on soils, rainfall, seasonality, elevation and gradient and integrates the savanna ecosystem mapping conducted in 2013 (Goodwin et al., 2013).

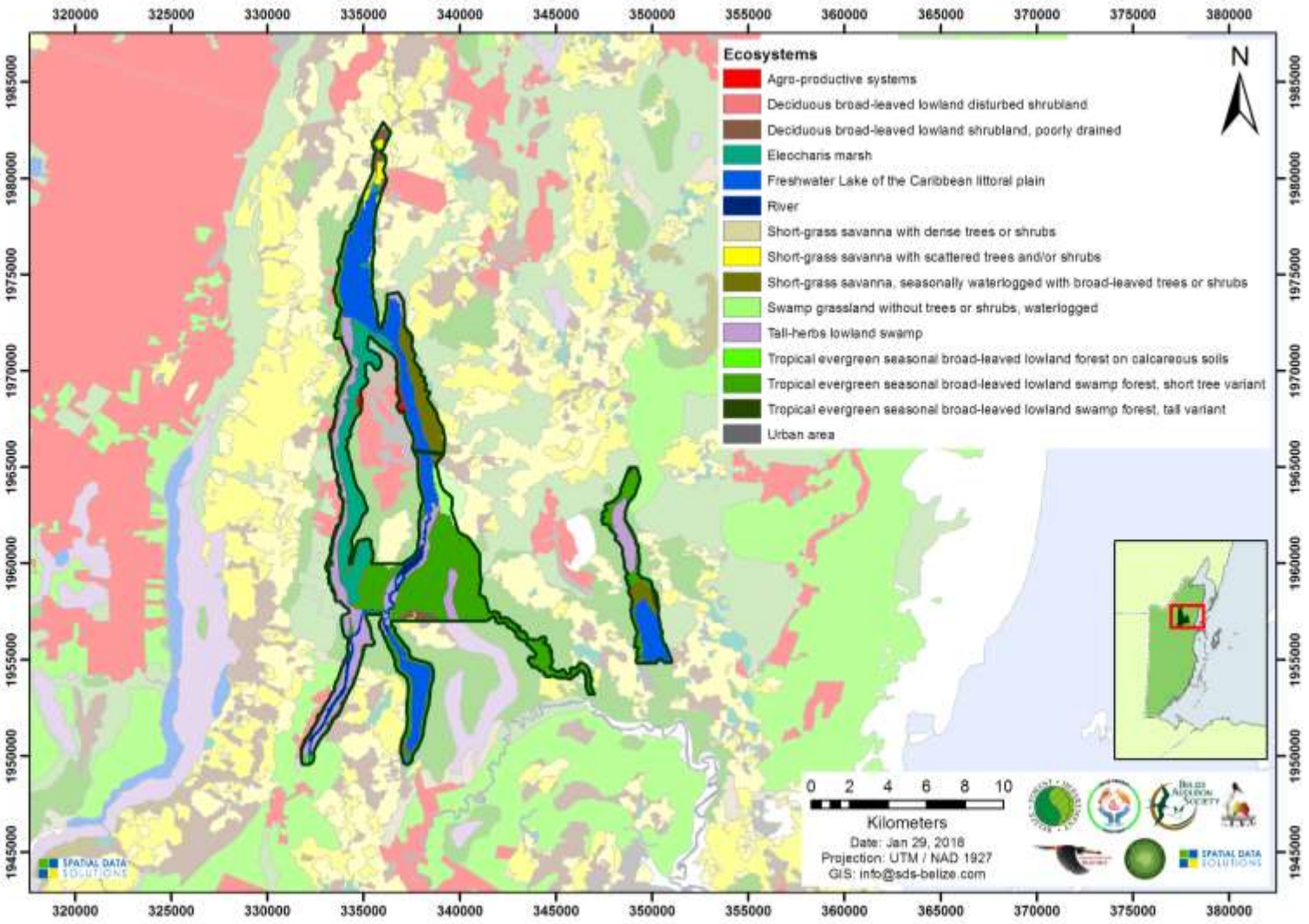
ECOSYSTEMS

- Tropical evergreen seasonal broad-leaved lowland swamp forest, short tree variant
- Tropical evergreen seasonal broad-leaved lowland swamp forest, tall variant
- Tropical evergreen seasonal broad-leaved lowland forest on calcareous soils
- Deciduous broad-leaved lowland shrubland, poorly drained
- Short-grass savanna with dense trees or shrubs
- Short-grass savanna with scattered trees and/or shrubs
- Short-grass savanna, seasonally waterlogged with broad-leaved trees or shrubs
- Swamp grassland without trees or shrubs, waterlogged
- Tall-herbs lowland swamp
- Eleocharis marsh
- Freshwater Lake of the Caribbean littoral plain
- River

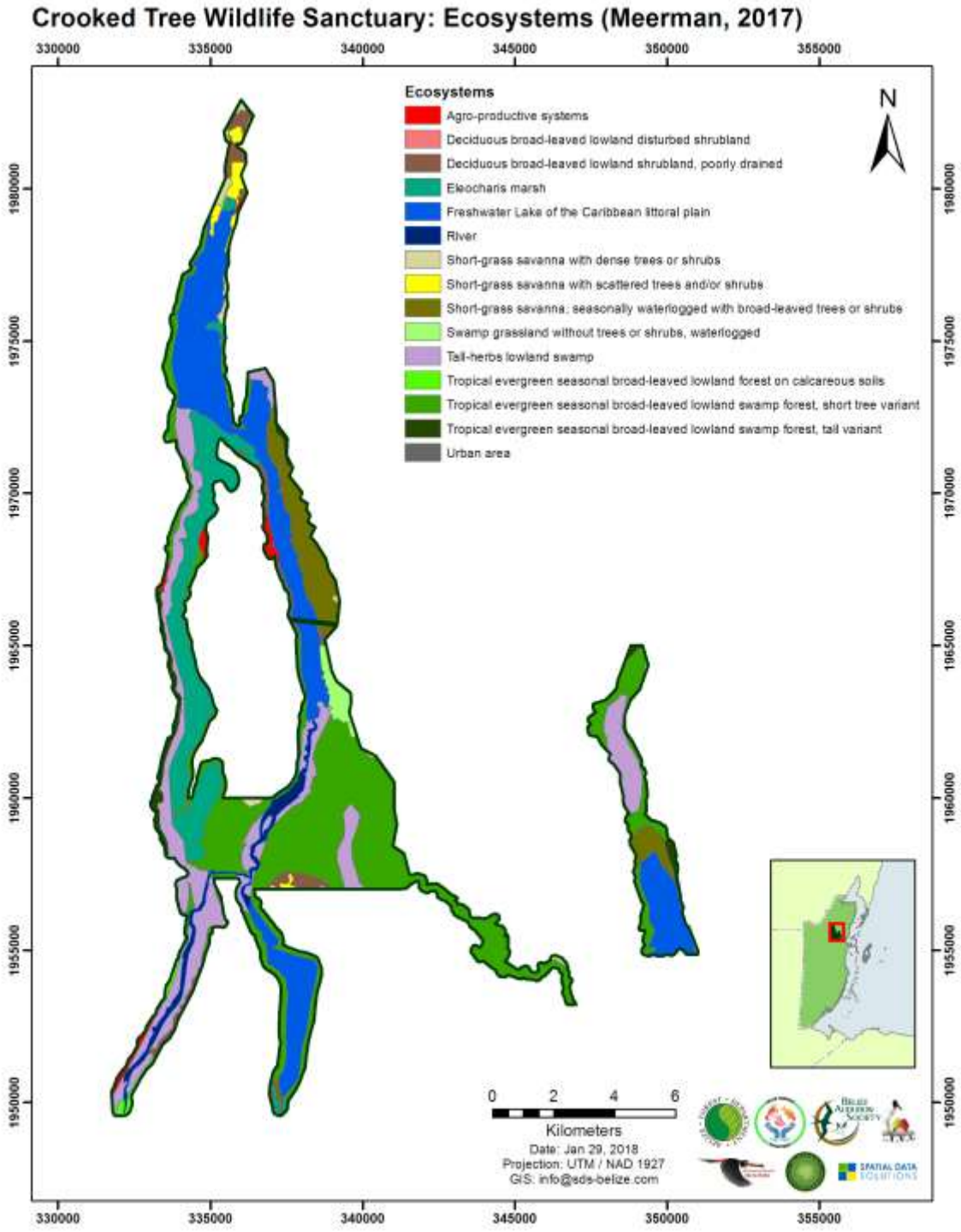
Two further non-natural ecosystems are also found within the immediate landscape, with some incursion into the protected area – Urban areas and Agro-productive systems.

ECOSYSTEM	UNESCO_CLA	PA_HA	National HA	% of national ecosystem coverage
Lowland broad-leaved moist forest	Tropical evergreen seasonal broad-leaved lowland forest on calcareous soils	59.65	290,578.97	0.02
Lowland broad-leaved moist forest	Tropical evergreen seasonal broad-leaved lowland swamp forest, tall variant	192.99	118,200.72	0.16
Lowland broad-leaved moist scrub forest	Tropical evergreen seasonal broad-leaved lowland swamp forest, short tree variant	3,390.96	36,248.97	9.35
	Deciduous broad-leaved lowland shrubland, poorly drained	264.21	70,973.77	0.37
Shrubland	Deciduous broad-leaved lowland disturbed shrubland	1.43	26,630.56	0.01
	River	261.31	3,945.07	6.62
Water	Freshwater Lake of the Caribbean littoral plain	2,315.00	9,028.16	25.64
	Short-grass savanna with scattered trees and/or shrubs	133.07	98,333.07	0.14
	Short-grass savanna, seasonally waterlogged with broad-leaved trees or shrubs	486.38	5,068.77	11.87
Lowland savanna	Short-grass savanna with dense trees or shrubs	601.77	66,521.01	0.15
Wetland	Swamp grassland without trees or shrubs, waterlogged	99.59	369.09	34.76
	Eleocharis marsh	128.29	8,044.26	14.80
	Tall-herbs lowland swamp	1,190.39	37,053.28	4.26
Agricultural uses	Agro-productive systems	119.00	465,172.15	0.03
Urban	Urban area	30.25	26,485.39	0.11

TABLE 10: ECOSYSTEMS OF CTWS (Meerman, 2017)



MAP 10: ECOSYSTEMS OF CROOKED TREE WILDLIFE SANCTUARY IN THE LANDSCAPE (MEERMAN, 2017)



MAP 11: ECOSYSTEMS OF CROOKED TREE WILDLIFE SANCTUARY (MEERMAN, 2017)

The following is adapted from Goodwin et al., 2013 and Boles, 2018.

Wetlands: The majority of the ecosystems of Crooked Tree Wildlife Sanctuary are part of a mosaic of wetland, lagoon and creeks, with some savanna wetland defined by the annual cycle of inundation and drought. The wetlands of Northern Lagoon are often dominated by the emergent jointed spikerush (*Eleocharis interstincta*), growing in thin to thick broken patches and bands between the open water and the tree line of the swamps, extending into the canopied swamp area. Growing between *Eleocharis* stands and at times integrated with the emerged stalks include water snowflakes (*Nymphoides indica*), white water Lily (*Nymphaea ampla*), lanceleaf arrowhead (*Sagittaria lancifolia*), shrub to small tree size bullet tree (*Bucida buceras*), and bastard logwood (*Mimosa bahamensis*) growing around the edges of the shoreline. Large patches of dotleaf waterlily (*Nymphaea ampla*) and water snowflake (*Nymphoides indica*) are also found in the small open backwaters within the fringing swamps of Northern.

The Western Lagoon is largely covered from shore to shore by thick stands of spikerush, particularly the northern end. Comparatively less emergent vegetation is found in the Southern Lagoon. Jones Lagoon on the eastern side of the Northern Highway is very different from those lagoons on the western side of the highway. There is very little emergent and even submerged vegetation along the shoreline. Instead, much of the sediment of this lagoon is covered by a loose bed of crumbly to thin layer of algae, cyanobacteria, small submerged sedges and other associated organisms.

Savannas: The Crooked Tree savannas exist as a gradation from the higher, drier, and often sandy soils, with more closed- canopied broadleaf and pine forests (woodlands) and a broken, patchy herbaceous layer, through intermediate, more open savannas with open canopies ranging from many to very few trees and shrubs, and with well-developed herbaceous layers dominated by native grasses in drier, better drained areas, and by sedges in wetter areas, interspersed with other plants. These areas may experience short periods of flooding - but not as extensively as savanna wetlands that are inundated for sometimes months each year - such as *Eleocharis* marsh and cutting grass marsh (Cameron, et al., 2011). Savanna woodlands contain semi-open to dense canopied area, ranging from 10 to 50% canopy coverage, made up of oak, Caribbean Pine, Craboo, and Palmetto Palm. A recent assessment of savannas across Belize has distinguished five sub-categories of savanna and associated plant species (Table 11; Boles, 2018 / Goodwin, et al. 2013).

On the drier Belizean savannas, Caribbean pine (*Pinus caribaea*) is the dominant tree, with the transition areas between savanna and forest and drier, sandy soils supporting dense growth of oak (*Quercus oleoides*) (Bridgewater, 2012). Two smaller tree species, craboo (*Byrsonima crassifolia*) and sandpaper tree (*Curatella americana*), are able to tolerate waterlogged soils and are common in savannas with regular inundation.

Thick patches of palmetto palm (*Acoelorraphe wrightii*) occur around water courses, growing in clumps - the roots develop just above the water table, and can grow in wet or dry environments,

and the heavy fibrous stems are fire resistant, ensuring this species is able to withstand the annual cycle of waterlogging and fires. These species are indicative of the harsh savanna environment, which also leads to a high degree of specialization and endemics - out of the 41 endemic plant species recorded for Belize, 17 are specialists found only in savannas (Bridgewater, et al., 2012). White Poisonwood (*Cameraria latifolia*), calabash (*Crescentia cujete*), and bullet tree (*Bucida buceras*) are found in wetter savannas and buttonwood (*Conocarpus erectus*) and red mangrove (*Rhizophora mangle*) are also present within these areas. Epiphytes such as the cow horn orchid (*Myrmecophila tibicinis*), devils gut cactus (*Selenicereus testudo*) and bromeliads (such as the bromeliad *Aechmaea magdalenae*) are common in savannas.

FOREST TYPE	DESCRIPTION
Oak Woodland	Well-drained area with dense oak canopy (*Quercus oleoides*) generally having developed understory of shrubs (*Calliandra houstoniana, Russelia sarmentosa, Miconia albicans*), with some forest species (*Tabernaemontana alba, Hampea trilobata*); herbaceous layer sparse, few grasses, heavy litter layer, termites common
Pine Woodland	Well-drained sandy soils, dense pine (*Pinus caribaea*), many times with dense understory of oak and shrubs, herbaceous layer of grasses and rich species list (*Hypericum terrae-firmae, Turnera spp, Oxalis frutescens, Clitoria guianensis, Sauvagesia erecta*)
Palmetto Thickets	Poorly drained soils containing flooded hogwallow relief, thick patches of palmetto (*Acoelorraphe wrightii*), associated shrubs (*Parathesis cubana, Acmella filipes, Hibiscus costatus, Mimosa spp.*)
Open Savanna	Poorly drained grassland (many sedges as well), herbaceous layer dominated by sedges and grasses, seasonal herbs (*Polygala spp., Xyris spp., Utricularia spp.,* and *Drosera capillaris*, with *Pinus caribaea, Quercus oleoides, Acoelorraphe wrightii* and *Byrsonima crassifolia* growing in shrub islands.
Seasonally Waterlogged Savanna (with shrubs and trees)	Areas flooded many weeks during the wet season, includes shrubs (*Crescentia cujete, Cameraria latifolia, Dalbergia glabra, Haematoxylon campechianum*), this habitat typically lies between savanna and wetlands.
Wetlands	Fully flooded marshes and lagoons that include *Eleocharis spp., Cladium sp., Sagittaria lancifolia, Nymphaea ampla*).

TABLE 11: SAVANNA SUB-CATEGORIES (Boles, 2018, Goodwin et al., 2013)

At the other end of the gradient are waterlogged savannas or savanna wetlands that give way to large, open lagoons in the wet season. The wet savanna orchard, essentially a swamp forest with a relatively open canopy where tree species are spaced somewhat evenly apart and reflecting a planted “orchard,” and contains a larger density of small trees and woody shrubs while lacking both pine and oak (Cameron, et al., 2011). Sedges dominate, but the herbaceous layer is not as species rich as in the drier open savannas.

Savannas in the CTWS and CTWS landscape are defined not only by the acidic soil characteristics and inundation, but also by fire, with many of the plant species being either fire-resilient of fire-dependent. Fires can start naturally as a result of lightening strikes and, unless preceded by a significant forest impact (e.g. fire following large scale damage caused by hurricanes, resulting in increased fuel load), they are likely to be relatively fast moving flash fires of low intensity. Fires such as these might shift the balance of competitive ability, enabling a pine and oak association to become established in an area previously classified as broadleaf forest. Without any further disturbance, this would eventually be re-invaded by the broadleaf community that originally occurred there. However, if further fires occur within a relatively short time-frame (perhaps a decade), the developing broadleaf forest is further suppressed and the soils degraded by the leaching associated with the removal of the shrub and leaf litter layers and the burning of any organic content. Exposed to such periodic fires, the pine/oak vegetation assemblages may become more stable and persistent, with relatively few broadleaf species being able to survive on such degraded soils.

With increased frequency of fires, the balance of the pine/oak woodland association is shifted towards pine savanna – an open pine woodland with a relatively species poor herb/shrub layer (Myers et al, 2002). Each additional fire episode greatly impacts the remaining soil fertility and structure, further reducing the ability of most broadleaf species to become established. Annual or biennial fires tend to suppress tree regeneration and result in a low degraded shrub or grassland. The CTWS savannas are impacted on an annual basis by escaped agricultural fires and firest set by local hunters to attract game species to the new post-fire shoots.

1.5.3 FAUNA

INTRODUCTION

Crooked Tree Wildlife Sanctuary is known for its wetland wildlife, particularly for the thousands of waterbirds that gather to feed there as the water starts to dry up. It is an important for many wetland species, including the critically endangered Central American river turtle (hicatee) and endangered Antillean manatee (Table 12).

The native fish species of the lagoons and creeks reproduce in the inundated savanna during the wet season. The wetland ecosystem has been impacted by the relatively recent arrival of invasive *Tilapia* in 1985 - community consultations in 2004 suggested that native species had been significantly impacted by the invasive *Tilapia,* but the system now appears to have reached a balance, with initial sharp declines having stabilized (Crooked Tree community consultation, 2004, 2018; Esselman, pers. com. 2004).

VERTEBRATE SPECIES BREAKDOWN FOR CROOKED TREE WILDLIFE SANCTUARY

Vertebrate Group	No. Species (CTWS)	No. Species (Belize)
Mammals	30*	163
Birds	349	587
Amphibians and Reptiles	39**	161
Freshwater Fish	28	119

***59** if presence of bat species recorded at Hill Bank are confirmed (Miller et al., 2010)

** With the potential for a further 58 species based on national ranges (Lee, 2000).

Baseline References:

Mammals - Jacobs and Castaneda, 1998; Miller et al., 2010

Birds - Jones and Vallely, 2001; R. Martinez, 2017

Reptiles and Amphibians – Paul Walker, 2004; Lee, 2000

Fish – Greenfield and Thomerson, 1997

TABLE 12: VERTEBRATE SPECIES BREAKDOWN FOR CROOKED TREE

MAMMALS OF CROOKED TREE WILDLIFE SANCTUARY

Thirty species of mammal have been recorded within Crooked Tree Wildlife Sanctuary – 18.4% of the total number of mammal species known to be present in Belize. Of these thirty, five are species of international concern, (Table 13; IUCN Red List, 2018). One species, the Central American spider monkey is considered critically endangered (Schwitzer et al., 2017), and three species – Baird's tapir, Yucatan black howler monkey and the Antillean manatee – are 'endangered'. One species, the white-lipped peccary, is classified as 'vulnerable' (IUCN, 2018), though it is expected that, with the rapid declines across the region, this will be reclassified as either endangered or critically endangered in the next revision. A further 30 species have been recorded from adjacent areas (Hillbank / Whitewater Lagoon but still require verification. This includes several bat species (Miller et al., 2010). Other species of conservation concern (near threatened) include two of Belize's five wild cats (the jaguar and margay), as well as the Neotropical river otter (IUCN, 2018). Crooked Tree also protects a number of species endemic to the Mesoamerican or Yucatan region – including the Yucatan black howler and Yucatan squirrel.

THREATENED SPECIES	
Critically Endangered	
Central American Spider Monkey	*Ateles geoffroyi*[*]
Endangered	
Yucatan Black Howler Monkey	*Alouatta pigra*
Baird's Tapir	*Tapirus bairdii*
Antillean Manatee	*Trichechus manatus*
Vulnerable	
White-lipped Peccary	*Tayassu pecari*

Note: *The subspecies in Belize A. g. vellerosus (Moralez-Jiminez et al., 2015), is assessed as Critically Endangered (Schwitzer et al., 2017).*

TABLE 13: THREATENED MAMMALS OF CTWS (IUCN, 2018)

The majority of Crooked Tree is wetland, terrestrial habitat within the protected area being largely restricted to the 300-foot-wide strip of land extending back from the high water mark. This narrow belt of pine savanna and riparian forest surrounding the freshwater system forest species with safe access to the water and connectivity across the forested portions of the landscape, though has been breached along much of the western bank of Western Lagoon by clearance for farmlands.

Riparian species, closely associated with the wetlands, are present, with Neotropical river otter and raccoon being recorded. Paca and Yucatan black howler monkeys are known to frequent the forests that line the creek systems (Spanish Creek and Black Creek), but habitat degradation in this riparian belt has resulted in them moving away from the river (community consultations, 2018), and more recently howler monkeys have started being heard calling around the Crooked Tree community itself, with several troops heard calling in the early mornings. This species is an important tourism resource for the area. Central American spider monkeys are restricted to the higher forests of the Blackburn Ridge, largely outside the protected area itself, and now form only a remnant population of a few individuals (community consultations, 2018). The larger population reported from a forest block south-west of Lemonal has reportedly been extirpated by recent land clearance – potentially severing all habitat connectivity between the spider monkeys in Crooked

Tree and elsewhere (Spanish Creek Wildlife Sanctuary and Rio Brave Conservation and Management Area.

The patches of tropical forest within the protected area are, however, small and lack sufficient connectivity to maintain viable populations of the larger mammal species, with a number of the key species such as white-lipped peccary in decline. Wide ranging species such as white-lipped peccary, and Baird's tapir, are highlighted as of concern because of their dwindling populations in Central America, as hunting pressure increases and the necessary forested habitat decreases outside (and in this case inside) of the protected areas. Baird's Tapir (IUCN Red List: Endangered) is becoming increasingly rare throughout its range, with primary threats being deforestation and hunting. Within Belize, it is protected under the Wildlife Protection Act (1981), and is not known to be hunted within the Crooked Tree area. Crooked Tree plays an important role in the maintenance of crucial tapir habitat. Tracks and faeces were seen at various points throughout Crooked Tree during the dry season - particularly at the water's edge by Black Creek and Spanish Creek.

The five cat species present in Belize have all been recorded within Crooked Tree – jaguars have been an increasing issue for cattle farmers in the area, with forest clearance reducing prey availability and suitable habitat for this species – displacing individuals and, increasing the potential for focus on domestic species such as cows and sheep. The Forest Department and BAS have been working with the cattle farmers in the area to reduce wildlife conflict, promoting improved animal husbandry that will reduce attacks on livestock. Wildlife conflicts are also encountered with coati and white-tailed deer, which will raid crops in small farms/milpas, reducing the effectiveness of agriculture in the area.

Savanna species such as white-tailed deer and nine-banded armadillo are present in the extensive pine savanna areas contiguous with the protected area. White-tailed deer are one of the characteristic species of the open pine savanna, and were once widely distributed throughout the area. Hunting pressure used to be seasonal, concentrated on the wet season, when rising water levels led to the animals being concentrated on Indian Hill; and in the dry season, when hunters would set fire to the savanna to attract deer to the ashes and young grass shoots. Recent reports suggest that populations are now hunted throughout the year, and populations are much lower than in previous years.

Antillean manatee access the lagoon system when the waters are at their highest, entering from Black Creek. Current threats within the Crooked Tree system are snagging in fishing nets (particularly in Black Creek, where illegal nets are sometimes stretched across the creek), and the possibility of boat collisions, but despite this, CTWS is a relatively safe environment for them in comparison with the Belize River, where manatee mortality from boat strikes has risen alarmingly in recent years. Belize is considered to be the stronghold for manatees in Mesoamerica, with a population of between 700 – 1000, based on a maximum national population count of 507 manatees in 2012 (NMWG / Auil, 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 Panama) is estimated at only 2,350 (Quintana-Rizzo, et al. 2010).

However, from 2010 to the end of 2018, 277 manatees have been reported as stranded (Figure 10; Galves, 2015; Galves pers. com., 2017, NMWG, 2018; L. Searle pers. com.). There has been a significant increasing trend in mortality, with 18 strandings in 2010, rising to 43 strandings in 2018 (Galves, 2015; Galves pers. com.), more than double the 2010 level. Over the same timeframe (2010 – 2018), there has been a 600% increase in the number of live strandings requiring rehabilitation (Walker pers. com.). Much of this increase is associated with the increasing tourism-related boat traffic in the Belize City / Belize River area. As the manatees using the Crooked Tree Wildlife Sanctuary access it via the Belize River, they are inevitable exposed to this very high risk of boat-strike.

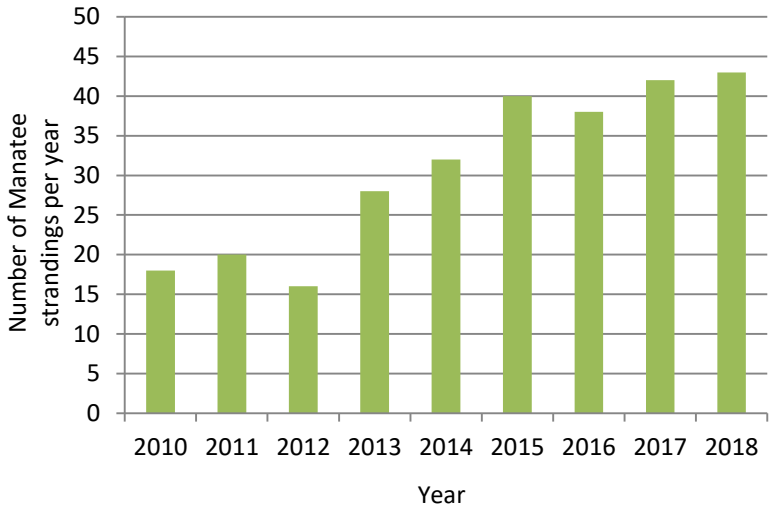


FIGURE 10: ANNUAL MORTALITY OF MANATEES IN BELIZE (Data: National Manatee Working Group)

At the lower Belize population estimate of 700 individuals, the 2018 mortality represents an over 6% mortality of the national population: already higher than the 5% that population modelling indicates to be possibly sustainable (Castelblanco et al., 2012).

No in-depth mammal surveys have been conducted within the protected area, so further species can be expected to be added to the Wildlife Sanctuary species list – opossums, bats and rodents in particular.

MAMMALS OF CROOKED TREE WILDLIFE SANCTUARY

Common Name	Species Name	IUCN Status
Didelphimorphia		
Didelphidae		
Common Opossum	*Didelphis marsupialis*	
Virginia Opossum	*Didelphis virginiana***	
Grey Four-eyed Opossum	*Philander opossum***	
Water Opossum	*Chironectes minimus***	
Mexican Mouse Opossum	*Marmosa mexicana***	
Edentata		
Myrmecophagidae		
Northern Tamandua	*Tamandua mexicana*	
Dasypodidae		
Nine-banded Armadillo	*Dasypus novemcinctus*	
Chiroptera		
Emballonuridae		
Proboscis Bat	*Rhynchonycteris naso*	
Greater White-lined Bat	*Saccopteryx bilineata**	
Lesser Dog-like Bat	*Peropteryx macrotis**	
Greater Dog-like Bat	*Peropteryx kappleri**	
Northern Ghost Bat	*Diclidurus albus**	
Thomas' Bat	*Centronycteris centralis**	
Noctilionidae		
Greater Fishing Bat	*Noctilio leporinus**	
Mormoopidae		
Ghost-faced Bat	*Mormoops megalophylla**	
Common Mustached Bat	*Pteronotus parnellii**	
Lesser (Wagner's) Mustached Bat	*Pteronotus personatus**	
Davy's Naked-backed Bat	*Pteronotus davyi**	
Phyllostomidae		
Little Yellow-shouldered Bat	*Sturnira lilium**	
Sowell's Short-tailed Bat	*Carollia sowelli**	
Short-tailed Bat	*Carollia perspicillata**	
Brown Long-tongued Bat	*Glossophaga commissarisi**	
Seba's Short-tailed Bat	*Glossophaga soricina**	
Common Vampire Bat	*Desmodus rotundus*	
Vespertilionidae		
Argentine Brown Bat	*Eptesicus furinalis**	
Western Red Bat	*Lasiurus blossevillii**	
Southern Yellow Bat	*Lasiurus ega**	
Northern Yellow Bat	*Lasiurus intermedius**	
Elegant Myotis	*Myotis elegans**	
Yucatan Yellow Bat	*Rhogeessa aeneus**	

MAMMALS OF CROOKED TREE WILDLIFE SANCTUARY

Common Name	Species Name	Status
Chiroptera		
Molossidae		
Black Mastiff Bat	*Molossus rufus**	
Broad-eared Bat	*Nyctinomops laticaudatus**	
Mexican Dog-faced Bat	*Cynomops mexicanus**	
Primates		
Cebidae		
Yucatan Black Howler	*Alouatta pigra*	Endangered
Central American Black-handed Spider Monkey	*Ateles geoffroyi*	Endangered (sub-species is Critically Endangered)
Rodentia		
Sciuridae		
Yucatan Squirrel	*Sciurus yucatanenis*	
Deppe's Squirrel	*Sciurus deppei**	
Erethizontidae		
Mexican Porcupine	*Coendou mexicanus**	
Dasyproctidae		
Central American Agouti	*Dasyprocta punctata*	
Agoutidae		
Paca	*Agouti paca*	
Carnivora		
Canidae		
Grey Fox	*Urocyon cinereoargenteus*	
Procyonidae		
Northern Raccoon	*Procyon lotor*	
White-nosed Coati	*Nasua narica*	
Kinkajou	*Potos flavus*	
Mustelidae		
Grison	*Galictis vittata*	
Tayra	*Eira barbara*	
Neotropical River Otter	*Lutra longicaudis*	Near Threatened
Felidae		
Ocelot	*Leopardus pardalis*	
Margay	*Leopardus wiedii*	Near Threatened
Jaguarundi	*Herpailurus yagouaroundi*	
Puma	*Puma concolor*	
Jaguar	*Panthera onca*	Near Threatened

MAMMALS OF CROOKED TREE WILDLIFE SANCTUARY

Common Name	Species Name	Status
Perissodactyla		
Tapiridae		
Baird's tapir	*Tapirus bairdii*	Endangered
Artiodactyla		
Tayassuidae		
Collard Peccary	*Tayassu tajacu*	
White-lipped Peccary	*Dicotyles pecari*	Vulnerable
Cervidae		
White-tailed Deer	*Odocoileus virginianus*	
Red brocket Deer	*Mazama americana*	Data Deficient
Trichechidae		
Antillean manatee	*Trichechus manatus*	Endangered

References: Emmons et. al. (1996), Miller B. and Miller C. (2010), Crooked Tree Wildlife Sanctuary Staff Consultations, 2018, Community Consultations, 2018, Crooked Tree Wildlife Sanctuary Management Plan (draft – 2004)

*Bat species recorded at Hill Bank (Miller et al., 2010), but not yet verified for Crooked Tree Wildlife Sanctuary
**Oppossum species that still need to be verified

TABLE 14: MAMMALS OF CROOKED TREE WILDLIFE SANCTUARY

BIRDS OF CROOKED TREE WILDLIFE SANCTUARY

Crooked Tree was established as a Wildlife Sanctuary in recognition of its importance for its rich wetland birdlife, particularly in the dry season, when the water levels fall low, concentrating birds within the shallow, open lagoon areas. The mosaic of shaded creeks, open, inundated wetland, lagoon, and shallow pools provide a rich variety of habitats that support many wetland species. The forest areas are also important, providing resources for permanent residents, and connectivity for migrant forest species. A total of 348 species have been recorded in the area (BAS, 2007 (draft); BAS checklist, E-bird - L. Jones, R. Martinez, P. Balderamas (2019) of which four are considered to be globally threatened (Table 15). A further 18 species are considered in need of further verification before being added to the list.

THREATENED SPECIES	
Endangered	
Yellow-headed Parrot	*Amazona oratrix*
Vulnerable	
Agami Heron	*Agamia agami*
Great Curassow	*Crax rubra*
Cerulean Warbler	*Setophaga cerulea*

TABLE 15: THREATENED BIRDS OF CTWS (IUCN, 2018)

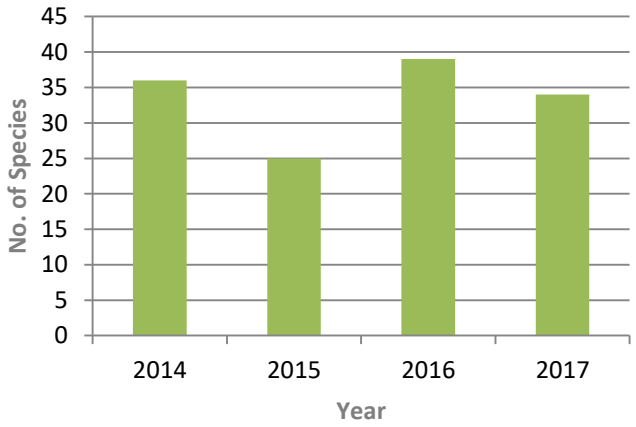


FIGURE 11: NUMBER OF SPECIES RECORDED PER YEAR AT CTWS (BAS / CAWS DATA)

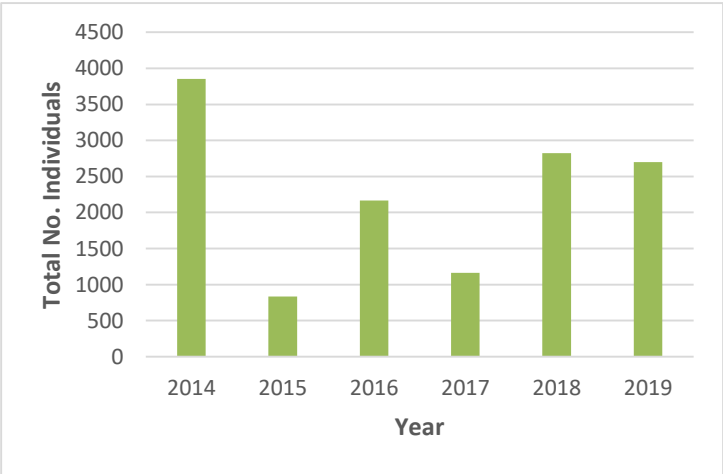


FIGURE 12: TOTAL NUMBER OF INDIVIDUALS OF KEY WATERBIRD SPECIES RECORDED PER YEAR AT CTWS (BAS /CAWS DATA, 2014 - 2019)

The annual changes in water level have a significant impact on the number of birds using the wetland – as the waters recede, the availability of food increases as small fish, amphibians and aquatic invertebrates become concentrated in the remaining shallow water. This draws in many thousands of herons, egrets, ducks, storks and other wetland birds. BAS has been collecting consistent data since 2011 as part of the Central American Waterbird Census (CAWC), in collaboration with the Waterbird Conservation Council, in coordination with Wetlands International and BirdLife International. Surveys using the point count methodology record both resident and migratory

species at designated locations covering different ecosystems within Crooked Tree Wildlife Sanctuary.

Waterbird diversity has been shown to fulctuate from year to year, with 2016 having the highest number of waterbird species recorded (39 species; Figure 11). Bewteen 2014 and 2019, 2014 was the year with the maximum number of individual birds recorded (3,852 individuals – Figure 12; Table 16; BAS / CAWS data). Birds with consistently low counts included muscovy duck and jabiruand the data shows declines in other species – blue winged teal, American coot, snowy egrets and roseate spoonbills among them, though these may be attributable to the timing of the surveys and water levels. Fluctuations between years may be due to a number of reasons - impacts on the bird populations (e.g. destruction of nesting colonies / sites, pest control on rice fields, changes in farming practices, increased hunting pressure, fire in the nesting areas), shifts in distribution (increasing bird populations at shrimp farms and rice fields, diverting birds away from traditional feeding areas), and changes in rainfall patterns that prevent the lagoon from drying out as reliably as previously.

SPECIES	2014	2015	2016	2017	2018	2019
Neotropic Cormorant	1169	348	671	375	813	706
Wood Stork	687	2	744	32	34	850
Great Egret	757		76	214	180	534
Northen Jacana	160	34	93	42	538	48
Black-bellied Whistling Duck	205		86	85	272	70
Limpkin	88	37	10	60	321	111
White Ibis	138	17		148	209	73
American Coot		285	10	40	131	29
Snowy Egret	91	11	151	73	24	60
Roseate Spoonbill	280					2
Blue-winged Teal		17	172	33	9	7
Green heron	26		33	15	58	41
Anhinga	6	48	38		62	17
Black-necked Stilt	153		14			
Great Blue Heron		16	45	29	8	69
Cattle Egret	38				94	
Jabiru	35				21	17
Little Blue Heron		14	20		34	
Boat-billed Heron						42
Muscovy Duck	6	1	1	3	8	7

TABLE 16: WATERBIRD SPECIES THAT CONGREGATE AT CROOKED TREE WILDLIFE SANCTUARY (BAS / CAWS data, 2014 - 2019)

The general perception in the Crooked Tree community, however, is that the waterbird populations have declined over recent years – something that may have significant impacts on tourism visitation.

Endangered Yellow headed parrots (*Amazona oratrix* ssp. *belizensis*) have been flagged as a critical species, as increasing frequency of fires, competition for fruit with citrus farmers, and poaching of nestlings for the illegal pet trade have reduced the national population significantly with estimates of fewer than 1,500 individuals remaining in the wild (BBR, 2014). This species flies into Crooked Tree in large numbers during the fruiting season, attracted to the cashew trees that dominate the village landscape. Their large size and ability to learn words makes this species particularly attractive for the illegal pet trade. A significant push to enforce legislation addressing the issue of the illegal pet trade in parrots was started in 2012, and strengthened in 2014, with a permit system being introduced for birds in long term captivity, and a no-tolerance stance for new birds entering the trade through poaching. There are initiatives in place to increase nesting sites artificially, in safe areas within the Crooked Tree farmlands, but the natural nest sites are in the pine savanna, with a critical need to manage fires, and increase enforcement against poaching of the nestlings.

BIRD SPECIES REQUIRING VERIFICATION	
Cinnamon Teal	*Spatula cyanoptera*
Plumbeous Kite	*Ictinia plumbea*
Crested Caracara	*Caracara cheriway*
Hudsonian Godwit	*Limosa haemastica*
Short-billed Dowitcher	*Limnodromus griseus*
Bonaparte's Gull	*Chroicocephalus philadelphia*
Ring-billed Gull	*Larus delawarensis*
Common Tern	*Sterna hirundo*
White-crowned Pigeon	*Patagioenas leucocephala*
Ruddy Quail Dove	*Geotrygon montana*

TABLE 17: BIRD SPECIES REQUIRING VERIFICATION

A number of bird species that are expected to occur at CTWS have not yet been verified to date (Table 17), but are exected to be recorded in the future.

BIRDS OF CROOKED TREE WILDLIFE SANCTUARY

Species		Status	Hammond	Glenn	Jones	E-bird
Little Tinamou	*Crypturellus soui*	uP		x		x
Thicket Tinamou	*Crypturellus cinnamomeus*					x
Least Grebe	*Tachybaptus dominicus*	cP	x	x	x	x
Pied-billed Grebe	*Podilymbus podiceps*	cW, uS	x	x	x	x
American White Pelican	*Pelecanus erythrorhynchos*	cW		x	x	x
Brown Pelican	*Pelecanus occidentalis*	oV			x	x
Neotropic Cormorant	*Phalacrocorax brasilianus*	vW	x	x	x	x
Double-crested Cormorant	*Phalacrocorax auritus*	oV			x	x
Anhinga	*Anhinga anhinga*	fP	x	x	x	x
Magnificent Frigatebird	*Fregata magnificens*	X		x		x
American Bittern	*Botaurus lentiginosus*	x				
Least Bittern	*Ixobrychus exilis*	uP		x	x	x
Pinnated Bittern	*Botaurus pinnatus*					
Bare-throated Tiger-Heron	*Tigrisoma mexicanum*	uP		x	x	x
Great Blue Heron	*Ardea herodias*	vW, uS	x	x	x	x
Great Egret	*Ardea alba*	vW, uS	x	x	x	x
Snowy Egret	*Egretta thula*	vW, uS	x	x	x	x
Little Blue Heron	*Egretta caerulea*	vW, uS	x	x	x	x
Tricolored Heron	*Egretta tricolor*	cW	x	x	x	x
Reddish Egret	*Egretta rufescens*	X		x		x
Cattle Egret	*Bubulcus ibis*	cW, uS	x	x	x	x
Green Heron	*Butorides virescens*	cP	x	x	x	x
Agami Heron	*Agamia agami*	uW		x	x	x
Black-crowned Night-Heron	*Nycticorax nycticorax*	fW, uS	x	x	x	x
Yellow-crowned Night-Heron	*Nyctanassa violacea*	fP	x	x	x	x
Boat-billed Heron	*Cochlearius cochlearius*	fP	x	x	x	x
White Ibis	*Eudocimus albus*	vW, uS	x	x	x	x
Glossy Ibis	*Plegadis falcinellus*	fW	x	x	x	x
White-faced Ibis		x				
Roseate Spoonbill	*Platalea ajaja*	fP		x	x	x
Jabiru	*Jabiru mycteria*	fP	x	x	x	x
Wood Stork	*Mycteria americana*	vP	x	x	x	x
Black Vulture	*Coragyps atratus*	vP	x	x	x	x
Turkey Vulture	*Cathartes aura*	vP	x	x	x	x
Lesser Yellow-headed Vulture	*Cathartes burrovianus*	cP	x	x	x	x
King Vulture	*Sarcoramphus papa*	oV		x		x
Black-bellied Whistling-Duck	*Dendrocygna autumnalis*	vW, uS	x	x	x	x
Fulvous Whistling-Duck	*Dendrocygna bicolor*	fW	x	x	x	x
Canada Goose	*Branta canadensis*					x
Muscovy Duck	*Cairina moschata*	cP	x	x	x	x
American Wigeon	*Anas americana*	rW			x	x
Blue-winged Teal	*Anas discors*	vW	x	x	x	x
Green-winged Teal	*Anas crecca*	X		x		?
Northern Shoveler	*Anas clypeata*	rW		x	x	x
Northern Pintail	*Anas acuta*					x

BIRDS OF CROOKED TREE WILDLIFE SANCTUARY

Species		Status	Hammond	Glenn	Jones	E-bird
Ring-necked Duck	*Aythya collaris*	fW		x	x	x
Lesser Scaup	*Aythya affinis*	cW		x	x	x
Hooded Merganser	*Lophodytes cucullatus*	x				
Masked Duck	*Nomonyx dominicus*	x			x	x
Ruddy Duck	*Oxyura jamaicensis*	x				
Osprey	*Pandion haliaetus*	cW	x	x	x	x
Gray-headed Kite	*Leptodon cayanensis*	rP		x		x
Snail Kite	*Rostrhamus sociabilis*	vP	x	x	x	x
White tailed Kite	*Elanus leucurus*					x
Swallow-tailed Kite	*Elanoides forficatus*					x
Hook-billed Kite	*Chondrohierax uncinatus*					x
Double-toothed Kite	*Harpagus bidentatus*					x
Black-collared Hawk	*Busarellus nigricollis*	fP	x	x	x	x
Crane Hawk	*Geranospiza caerulescens*	uP		x		x
Gray Hawk	*Buteo nitidus*	fP		x	x	x
Common Black-Hawk	*Buteogallus anthracinus*	fP		x		x
Great Black-Hawk	*Buteogallus urubitinga*	uP		x	x	x
Roadside Hawk	*Buteo magnirostris*	fP	x	x	x	x
Short-tailed Hawk	*Buteo brachyurus*	fP		x	x	x
White-tailed Hawk	*Geranoaetus albicaudatus*					x
Swainson's Hawk	*Buteo swainsoni*					x
Black Hawk-Eagle	*Spizaetus tyrannus*	uP		x		x
Zone-tailed Hawk	*Buteo albonotatus*					x
Northern Harrier	*Circus hudsonius*					x
Collared Forest-Falcon	*Micrastur semitorquatus*	uP		x	x	x
Laughing Falcon	*Herpetotheres cachinnans*	fP	x	x	x	x
American Kestrel	*Falco sparverius*					x
Merlin	*Falco columbarius*	oW	x	x	**x**	x
Aplomado Falcon	*Falco femoralis*	uP	x	x	**x**	x
Bat Falcon	*Falco rufigularis*	fP			**x**	x
Peregrine Falcon	*Falco peregrinus*	uW		x	x	x
Plain Chachalaca	*Ortalis vetula*	cP	x	x	x	x
Great Curassow	*Crax rubra*	rP		x		x
Black-throated Bobwhite	*Colinus nigrogularis*	fP		x		x
Ruddy Crake	*Laterallus ruber*	cP		x	x	x
Yellow-breasted Crake	*Hapalocrex flaviventer*					x
Russet-naped Wood-Rail	*Aramides cajaneus*	cP	x	x	x	x
Sora	*Porzana carolina*	cW			x	x
Purple Gallinule	*Porphyrio martinica*	uP	x	x		x
Common Gallinule	*Gallinula chloropus*	cW, uS		x	x	x
American Coot	*Fulica americana*	vW, uS	x	x	x	x
Sungrebe	*Heliornis fulica*	uP	x	x	x	x
Limpkin	*Aramus guarauna*	vP	x	x	x	x
Semipalmated Plover	*Charadrius semipalmatus*	uT			x	x
Black-bellied Plover	*Pluvialis squatarola*					x
American Golden Plover	*Pluvialis dominica*					x

BIRDS OF CROOKED TREE WILDLIFE SANCTUARY

Species		Status	Hammond	Glenn	Jones	E-bird
Southern Lapwing	*Vanellus chilensis*					x
Collared Plover	*Charadrius collaris*					x
Killdeer	*Charadrius vociferus*	uW		x	x	x
Black-necked Stilt	*Himantopus mexicanus*	vW, uS		x	x	x
American Avocet	*Recurvirostra americana*	rW			x	x
Northern Jacana	*Jacana spinosa*	vP	x	x	x	x
Greater Yellowlegs	*Tringa melanoleuca*	cW		x	x	x
Lesser Yellowlegs	*Tringa flavipes*	cW		x	x	x
Solitary Sandpiper	*Tringa solitaria*	uW	x	x	x	x
Stilt Sandpiper	*Calidris himantopus*					x
Spotted Sandpiper	*Actitis macularia*	cW	x	x	x	x
Willet	*Tringa semipalmata*					
Ruddy Turnstone	*Arenaria interpres*	uT			x	x
Semipalmated Sandpiper	*Calidris pusilla*	uT		x	x	x
Western Sandpiper	*Calidris mauri*	vW		x	x	x
Least Sandpiper	*Calidris minutilla*	vW		x	x	x
White-rumped Sandpiper	*Calidris fuscicollis*	cT			x	x
Pectoral Sandpiper	*Calidris melanotos*	uT		x	x	x
Long-billed Dowitcher	*Limnodromus scolopaceus*	uW		x		x
Wilson's Snipe	*Gallinago delicata*	uW		x		x
Wilson's Phalarope	*Phalaropus tricolor*	X			x	x
Laughing Gull	*Leucophaeus atricilla*	uT			x	x
Gull-billed Tern	*Sterna nilotica*	fW		x	x	x
Caspian Tern	*Sterna caspia*	cW	x	x	x	x
Sandwich Tern	*Sterna sandvicensis*	X		x		x
Forster's Tern	*Sterna forsteri*	X		x	x	x
Black Tern	*Chlidonias niger*	cT		x	x	x
Rock Pigeon (Feral)	*Columba livia*	cP			x	x
Pale-vented Pigeon	*Patagioenas cayennensis*	cP	x	x	x	x
Scaled Pigeon	*Patagioenas speciosa*					x
Red-billed Pigeon	*Patagioenas flavirostris*	uP	x	x		x
Short-billed Pigeon	*Patagioenas nigirostris*					x
White-winged Dove	*Zenaida asiatica*	uP		x	x	x
Eurasian Collared Dove	*Streptopelia decaocto*					x
Common Ground-Dove	*Columbina passerina*	uP		x	x	x
Plain-breasted Ground-Dove	*Columbina minuta*	fP		x	x	x
Ruddy Ground-Dove	*Columbina talpacoti*	cP	x	x	x	x
Blue Ground Dove	*Claravis pretiosa*					x
White-tipped Dove	*Leptotila verreauxi*	cP	x	x	x	x
Gray-headed Dove	*Leptotila plumbeiceps*					x
Mourning Dove	*Zenaida macroura*					x
Olive-throated Parakeet	*Eupsittula nana*	cP		x	x	x
White-crowned Parrot	*Pionus senilis*	cP		x		x
White-fronted Parrot	*Amazona albifrons*	cP	x	x	x	x
Brown-hooded Parrot	*Pyrilia haematotis*					x
Yellow-lored Parrot	*Amazona xantholora*	fP		x	x	x

BIRDS OF CROOKED TREE WILDLIFE SANCTUARY

Species		Status	Hammond	Glenn	Jones	E-bird
Red-lored Parrot	*Amazona autumnalis*	cP		x	x	x
Yellow-headed Parrot	*Amazona oratrix*	fP	x	x	x	x
Yellow-billed Cuckoo	*Coccyzus americanus*	uT		x	x	x
Mangrove Cuckoo	*Coccyzus minor*	oT		x		x
Squirrel Cuckoo	*Piaya cayana*	fP		x	x	x
Striped Cuckoo	*Tapera naevia*	fP			x	x
Groove-billed Ani	*Crotophaga sulcirostris*	cP	x	x	x	x
Barn Owl	*Tyto alba*	uP		x		x
Ferruginous Pygmy-Owl	*Glaucidium brasilianum*	uP		x		x
Mottled Owl	*Ciccaba virgata*	uP		x		x
Vermiculated Screech Owl	*Megascops guatemalae*					x
Lesser Nighthawk	*Chordeiles acutipennis*	fW	x	x	x	x
Common Nighthawk	Chordeiles minor					x
Common Pauraque	*Nyctidromus albicollis*	cP	x	x	x	x
Yucatan Nightjar	*Antrostomus badius*					x
Yucatan Poorwill	*Nyctiphrynus yucatanicus*					x
Northern Potoo	*Nyctibius jamaicensis*					x
Vaux's Swift	*Chaetura vauxi*	fP		x		x
Lesser Swallow-tailed swift	*Panyptila cayennensis*					x
Long-billed Hermit	*Phaethornis longirostris*	fP		x		x
Green-breasted Mango	*Anthracothorax prevostii*	fP		x	x	x
Canivet's Emerald	*Chlorostilcon canivetii*	uP	x	x	x	x
White-bellied Emerald	*Amazilia candida*	uP		x		x
Azure-crowned Hummingbird	*Amazilia cyanocephala*					x
Rufous-tailed Hummingbird	*Amazilia tzacatl*	cP	x	x	x	x
Buff-bellied Hummingbird	*Amazilia yucatanensis*	uP	x	x	x	x
Cinnamon Hummingbird	*Amazilia rutila*					x
Ruby-throated Hummingbird	*Archilochus colubris*	uT	x	x	x	x
Black-headed Trogon	*Trogon melanocephalus*	cP		x	x	x
Gartered Trogon	*Trogon violaceus*	cP		x		x
Lesson's Motmot	*Momotus momota*	fP		x		x
Ringed Kingfisher	*Ceryle torquata*	cP	x	x	x	x
Belted Kingfisher	*Ceryle alcyon*	cW	x	x	x	x
Amazon Kingfisher	*Chloroceryle amazona*	uP		x		x
Green Kingfisher	*Chloroceryle americana*	cP	x	x	x	x
American Pygmy Kingfisher	*Chloroceryle aenea*	cP	x	x	x	x
White-necked Puffbird	*Notharchus macrorhynchos*	rP		x		x
Collared Aracari	*Pteroglossus torquatus*	cP	x	x	x	x
Keel-billed Toucan	*Ramphastos sulfuratus*	cP		x		x
Acorn Woodpecker	*Melanerpes formicivorus*	cP	x	x	x	x
Yucatan Woodpecker	*Melanerpes pygmaeus*			x	x	x
Golden-fronted Woodpecker	*Melanerpes aurifrons*	cP		x	x	x
Yellow-bellied Sapsucker	*Sphyrapicus varius*	uW	x	x		x
Ladder-backed Woodpecker	*Picoides scalaris*	uP		x	x	x
Smoky-brown Woodpecker	*Veniliornis fumigatus*	uP		x		x
Golden-olive Woodpecker	*Piculus rubiginosus*	uP		x		x

BIRDS OF CROOKED TREE WILDLIFE SANCTUARY

Species		Status	Hammond	Glenn	Jones	E-bird
Lineated Woodpecker	*Dryocopus lineatus*	fP	x	x	x	x
Pale-billed Woodpecker	*Campephilus guatemalensis*	uP		x		x
Rufous-breasted Spinetail	*Synallaxis erythrothorax*	cP		x	x	x
Plain Xenops	*Xenops minutus*	uP		x		x
Buff-throated Foliage-gleaner	*Automolus ochrolaemus*					
Tawny-winged Woodcreeper	*Dendrocincla anabatina*	uP		x		x
Ruddy Woodcreeper	*Dendrocincla homochroa*	uP		x		x
Olivaceous Woodcreeper	*Sittasomus griseicapillus*	cP		x	x	x
Northern Barred-Woodcreeper	*Dendrocolaptes sanctihomae*	lP		x		x
Ivory-billed Woodcreeper	*Xiphorhynchus flavigaster*	cP	x	x	x	x
Streak-headed Woodcreeper	*Lepidocolaptes souleyetii*	fP		x	x	x
Barred Antshrike	*Thamnophilus doliatus*	cP		x	x	x
Dusky Antbird	*Cercomacra tyrannina*	cP		x		x
Black-faced Antthursh	*Formicarius analis*	uP		x		x
Northern Beardless-Tyrannulet	*Camptostoma imberbe*	fP		x	x	x
Greenish Elaenia	*Myiopagis viridicata*	fP	x	x	x	x
Yellow-bellied Elaenia	*Elaenia flavogaster*	cP	x	x	x	x
Ochre-bellied Flycatcher	*Mionectes oleagineus*	fP	x	x		x
Northern Bentbill	*Oncostoma cinereigulare*	fP		x	x	x
Slate-headed Tody-Flycatcher	*Poecilotriccus sylvia*	uP		x	x	x
Common Tody-Flycatcher	*Todirostrum cinereum*	cP		x	x	x
Yellow-olive Flycatcher	*Tolmomyias sulphurescens*	cP		x	x	x
Stub-tailed Spadebill	*Platyrinchus cancrominus*	uP		x		x
Royal Flycatcher	*Onychorhynchus coronatus*	uP		x		x
Eastern Wood-Pewee	*Contopus virens*	cT			x	x
Tropical Pewee	*Contopus cinereus*	fP		x	x	x
Yellow-bellied Flycatcher	*Empidonax flaviventris*	uW		x	x	x
Acadian Flycatcher	*Empidonax virescens*					x
Least Flycatcher	*Empidonax minimus*	fW		x	x	x
Vermilion Flycatcher	*Pyrocephalus rubinus*	cP	x	x	x	x
Bright-rumped Attila	*Attila spadiceus*	fP		x	x	x
Yucatan Flycatcher	*Myiarchus yucatanensis*	uP		x	x	x
Dusky-capped Flycatcher	*Myiarchus tuberculifer*	cP	x	x	x	x
Great Crested Flycatcher	*Myiarchus crinitus*	uW	x	x	x	x
Brown-crested Flycatcher	*Myiarchus tyrannulus*	cS		x	x	x
Great Kiskadee	*Pitangus sulphuratus*	vS	x	x	x	x
Boat-billed Flycatcher	*Megarynchus pitangua*	uP	x	x	x	x
Social Flycatcher	*Myiozetetes similis*	vP	x	x	x	x
Sulphur-bellied Flycatcher	*Myiodynastes luteiventris*	cS		x		x
Piratic Flycatcher	*Legatus leucophaius*	uS		x		x
Tropical Kingbird	*Tyrannus melancholicus*	vP	x	x	x	x
Couch's Kingbird	*Tyrannus couchii*	cP	x	x	x	x
Eastern Kingbird	*Tyrannus tyrannus*	cT			x	x
Scissor-tailed Flycatcher	*Tyrannus forficatus*					x

BIRDS OF CROOKED TREE WILDLIFE SANCTUARY

Species		Status	Hammond	Glenn	Jones	E-bird
Fork-tailed Flycatcher	*Tyrannus savana*	cP	x	x	x	x
Gray-collared Becard	*Pachyramphus major*	rP		x		x
Rose-throated Becard	*Pachyramphus aglaiae*	uP	x	x	x	x
Masked Tityra	*Tityra semifasciata*	cP		x	x	x
Black-crowned Tityra	*Tityra inquisitor*	uP		x	x	x
White-collared Manakin	*Manacus candei*	fP		x	x	x
Red-capped Manakin	*Pipra mentalis*	fP		x	x	x
White-eyed Vireo	*Vireo griseus*	cW		x	x	x
Mangrove Vireo	*Vireo pallens*	cP	x	x	x	x
Yellow-throated Vireo	*Vireo flavifrons*	uW		x	x	x
Red-eyed Vireo	*Vireo olivaceus*	cT		x	x	x
Yellow-green Vireo	*Vireo flavoviridis*	cS		x	x	x
Philadelphia Vireo	*Vireo philadelphicus*					x
Lesser Greenlet	*Hylophilus decurtatus*	cP	x	x	x	x
Rufous-browed Peppershrike	*Cyclarhis gujanensis*	fP	x	x	x	x
Tawny-crowned Greenlet	*Tunchornis ochraceiceps*					x
Green Jay	*Cyanocorax yncas*	fP	x	x	x	x
Brown Jay	*Cyanocorax morio*	vP	x	x	x	x
Yucatan Jay	*Cyanocorax yucatanicus*	fP	x	x	x	x
Purple Martin	*Progne subis*	vT	x	x	x	x
Gray-breasted Martin	*Progne chalybea*	vS	x	x	x	x
Tree Swallow	*Tachycineta bicolor*	vW		x	x	x
Mangrove Swallow	*Tachycineta albilinea*	cP	x	x	x	x
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	cW	x	x	x	x
Cliff Swallow	*Petrochelidon pyrrhonota*	uT			x	x
Barn Swallow	*Hirundo rustica*	cT			x	x
Bank Swallow	*Riparia riparia*					x
Spot-breasted Wren	*Thryothorus maculipectus*	cP	x	x	x	x
House Wren	*Troglodytes aedon*	cP	x	x	x	x
White-bellied Wren	*Uropsila leucogastra*	fP		x	x	x
White-breasted Wood-Wren	*Henicorhina leucosticta*	fP		x		x
Long-billed Gnatwren	*Ramphocaenus melanurus*	cP		x		x
Blue-gray Gnatcatcher	*Polioptila caerulea*	cP	x	x	x	x
Wood Thrush	*Hylocichla mustelina*	cW	x	x	x	x
Swainson's Thrush	*Catharus ustulatus*					x
Clay-colored Thrush	*Turdus grayi*	cP	x	x	x	x
Gray Catbird	*Dumetella carolinensis*	cW	x	x	x	x
Black Catbird	*Melanoptila glabrirostris*	lP		x	x	x
Tropical Mockingbird	*Mimus gilvus*	cP	x	x	x	x
Cedar Waxwing	*Bombycilla cedrorum*	oW		x		x
Ovenbird	*Seiurus aurocapillus*	fW		x	x	x
Blue-winged Warbler	*Vermivora pinus*	uW	x	x	x	x
Golden-winged Warbler	*Vermivora chrysoptera*	uT		x		x
Tennessee Warbler	*Vermivora peregrina*	cT		x	x	x
Northern Parula	*Parula americana*	uW	x	x	x	x

BIRDS OF CROOKED TREE WILDLIFE SANCTUARY

Species		Status	Hammond	Glenn	Jones	E-bird
Tennessee Warbler	*Vermivora peregrina*	cT		x	x	x
Northern Parula	*Parula americana*	uW	x	x	x	x
Yellow Warbler	*Dendroica petechia*	cW	x	x	x	x
Palm Warbler	*Setophaga palmarum*					x
Prairie Warbler	*Setophaga discolor*					x
Chestnut-sided Warbler	*Dendroica pensylvanica*	cW			x	x
Magnolia Warbler	*Dendroica magnolia*	cW	x	x	x	x
Cape May Warbler	*Dendroica tigrina*	rT		x		x
Cerulean Warbler	*Setophaga cerulea*					x
Yellow-rumped Warbler	*Dendroica coronata*	fW	x	x	x	x
Black-throated Green Warbler	*Dendroica virens*	fW	x	x	x	x
Wilson's Warbler	*Cardellina pusilla*					x
Blackburnian Warbler	*Dendroica fusca*	uT			x	x
Yellow-throated Warbler	*Dendroica dominica*	fW	x	x	x	x
Grace's Warbler	*Dendroica graciae*	cP		x	x	x
Bay-breasted Warbler	*Dendroica castanea*	uT		x		x
Black-and-white Warbler	*Mniotilta varia*	cW	x	x	x	x
American Redstart	*Setophaga ruticilla*	cW	x	x	x	x
Prothonotary Warbler	*Protonotaria citrea*	fT		x	x	x
Worm-eating Warbler	*Helmitheros vermivorus*	fW		x	x	x
Swainson's Warbler	*Limnothlypis swainsonii*	X		x		x
Hooded Warbler	*Wilsonia citrina*	cW		x	x	x
Northern Waterthrush	*Seiurus noveboracensis*	cW	x	x	x	x
Louisiana Waterthrush	*Seirus motacilla*	uT	x	x		x
Kentucky Warbler	*Oporornis formosus*	fW		x	x	x
Common Yellowthroat	*Geothlypis trichas*	vW	x	x	x	x
Gray-crowned Yellowthroat	*Geothlypis poliocephala*	uP		x		x
Yellow-breasted Chat	*Icteria virens*	fW	x	x	x	x
Gray-throated Chat	*Granatellus sallaei*	lP		x		x
Bananaquit	*Coereba flaveola*	uP		x		x
Gray-headed Tanager	*Eucometis penicillata*	lP		x		x
Red-throated Ant-Tanager	*Habia fuscicauda*	cP		x	x	x
Rose-throated Tanager	*Piranga roseogularis*					x
Summer Tanager	*Piranga rubra*	cW	x	x	x	x
Scarlet Tanager	*Piranga olivacea*	fT		x		x
Blue-gray Tanager	*Thraupis episcopus*	cP	x	x	x	x
Yellow-winged Tanager	*Thraupis abbas*	rP			x	x
Scrub Euphonia	*Euphonia affinis*	fP		x	x	x
Yellow-throated Euphonia	*Euphonia hirundinacea*	cP		x	x	x
Olive-backed Euphonia	*Euphonia gouldi*	uP		x		x
Red-legged Honeycreeper	*Cyanerpes cyaneus*	uP			x	x
Blue-black Grassquit	*Volatinia jacarina*	cP		x	x	x
Yellow-faced Grassquit	*Tiaris olivaceus*					x
Variable Seedeater	*Sporophila americana*	uP		x	x	x
White-collared Seedeater	*Sporophila torqueola*	vP	x	x	x	x
Thick-billed Seed-Finch	*Oryzoborus funereus*	fP		x	x	x

BIRDS OF CROOKED TREE WILDLIFE SANCTUARY

Species		Status	Hammond	Glenn	Jones	E-bird
Olive Sparrow	*Arremonops rufivirgatus*	uP		x		x
Green-backed Sparrow	*Arremonops chloronotus*	cP	x	x	x	x
Chipping Sparrow	*Spizella passerina*	fP		x	x	x
Botteri's Sparrow	*Peucaea botterii*					x
Savannah Sparrow	*Passerculus sandwichensis*					x
Grayish Saltator	*Saltator coerulescens*	cP	x	x	x	x
Black-headed Saltator	*Saltator atriceps*	cP		x	x	x
Buff-throated Saltator	*Saltator maximus*					x
Northern Cardinal	*Cardinalis cardinalis*	fP	x	x	x	x
Black-faced Grosbeak	*Caryothraustes poliogaster*					
Rose-breasted Grosbeak	*Pheuticus ludovicianus*	fT		x		x
Blue-black Grosbeak	*Cyanocompsa cyanoides*	uP		x		x
Blue Bunting	*Cyanocompsa parellina*	lP		x		x
Blue Grosbeak	*Passerina caerulea*	fT		x	x	x
Indigo Bunting	*Passerina cyanea*	cT		x	x	x
Painted Bunting	*Passerina ciris*	uT		x		x
Dickcissel	*Spiza americana*					x
Red-winged Blackbird	*Agelaius phoeniceus*	vP	x	x	x	x
Eastern Meadowlark	*Sturnella magna*	cP		x		x
Melodious Blackbird	*Dives dives*	vP	x	x	x	x
Great-tailed Grackle	*Quiscalus mexicanus*	vP	x	x	x	x
Bronzed Cowbird	*Molothrus aeneus*	fP		x	x	x
Giant Cowbird	*Molothrus oryzivorus*					x
Black-cowled Oriole	*Icterus prosthemelas*	fP	x	x	x	x
Orchard Oriole	*Icterus spurius*	cW	x	x	x	x
Hooded Oriole	*Icterus cucullatus*	cP	x	x	x	x
Yellow-backed Oriole	*Icterus chrysater*	uP		x	x	x
Yellow-tailed Oriole	*Icterus mesomelas*	uP		x	x	x
Altamira Oriole	*Icterus gularis*	uP		x	x	x
Baltimore Oriole	*Icterus galbula*	cW	x	x	x	x
Yellow-billed Cacique	*Amblycercus holosericeus*	cP		x	x	x
Montezuma Oropendola	*Psarocolius montezuma*	uP	x	x		x

Legend (from Jones and Vallely, 2001)

v = very common	P = permanent resident
c = common	S = seasonal resident
f = fairly common	V = visitor
u = uncommon	T = transient (migrant)
o = occasional	W = winter resident
l = local	X = one or two records only

Reports

Hammond
Glenn pers. com., 2004
Lee Jones,
E-bird reports from Roni Martinez, Lee Jones, Philip Balderamas (http://www.ebird.org)

HERPETOFAUNA OF CROOKED TREE WILDLIFE SANCTUARY

The amphibians and reptiles (herpetofauna) of Crooked Tree is poorly known, with only 39 (40%) of the species expected to occur there having being recorded from sightings or local reports. The overall herpetofauna of the area is likely to include approximately 97 species – based on known species occurrences, known ranges and habitat preferences. Of these, only 8 out of the likely 17 amphibian species and 39 of the 80 reptile species likely to occur there are reported locally.

THREATENED SPECIES	
Critically Endangered	
Central American river turtle	*Dermatemys mawii*

TABLE 18: THREATENED HERPETOFAUNA OF CTWS (IUCN, 2018)

By far the most conservationally important herpetofaunal species occurring in the Wildlife Sanctuary is the critically endangered Central American river turtle (*Dermatemys mawii*) – the hicatee – considered one of the is one of the 25 most endangered species of turtles in the world (Table 18; Rhodin et al., 2011). Community surveys suggest that *D. mawii* has declined in the Crooked Tree lagon system (Castillo, 2014, community consultations, 2018) Spanish Creek and Black Creek have been highlighted as classic *Dermatemys* habitat (Vogt et al., 2011). This species has a restricted range in southern Mexico, Guatemala and Belize, and has been intensely harvested for its meat and, to a lesser extent, for its eggs and shell (Moll, 1986; Polisar, 1994, 1995). Research in northern / central Belize between 1989 and 1991 indicated that the level of harvesting was not sustainable, resulting in species-specific legislation in 1993 to regulate its extraction (Rainwater et al., 2012). Research in 2010 led to the conclusion that the current level of harvesting of *D. mawii* at the national level was unsustainable and consider it a serious threat to the continued viability of the species in Belize (Rainwater et al., 2012). Although legally fully protected within the Wildlife Sanctuary it has been heavily hunted as a popular, traditional dish, especially in the Easter period of Lent. It can still be legally hunted outside protected areas (though with a short closed season and with size and bag limits), and enforcement against hunting within protected areas such as Crooked Tree has historically been very weak. In the early 2000's, reports of pickups from Lemonal driving through Crooked Tree hicatee piled high in the back of the truck bed were not uncommon (despite there being a limit of 5 specimens per vehicle).

The deeper, dark waters of Black Creek provide some respite from turtle divers (a popular hunting method in clearer waters), but the use of turtle nets, despite being banned, continues to challenge hopes of this critically endangered species being able to climb back from the precipice of local and national extinction. Whilst near extinction of the species has occurred in most of its former range in southern Mexico and eastern Guatemala, viable populations have persisted longer in Belize – but the population decline in Crooked Tree clearly demonstrates that the current level of legal protection alone will not save the species. It does however provide an opportunity for the Crooked Tree Wildlife Sanctuary Management Committee to establish strong community support for focussed conservation efforts to save this culturally important species: a rebounded hicatee population in the Crooked Tree wetlands would be an endorsement of success and show that community collaboration really can deliver genuine conservation outputs.

Another prominent reptile present in the wetlands is the Morelet's crocodile (*Crocodylus moreletii)*, Crooked Tree providing prime habitats for this species. Genetic studies in New River Lagoon demonstrate that crocodiles disperse widely, suggesting that the Crooked Tree and New River Lagoon crocodiles are part of a single population (Denver et al., 2002). Crocodiles have made a successful come-back in Crooked Tree and elsewhere in Belize after a moratorium on hunting this species was established in response to heavy hunting pressure between the 1940's and 1970's, which decimated the population. They were first protected in Belize under the Wildlife Protection Act of 1981, and a ban on the international shipping of skins put into place that same year (Boles, 2016). Their rebound in Crooked Tree is however a cause for concern amongst Crooked Tree fishers, who frequently encounter crocodiles in the wetlands. Although legally protected, large crocodiles are frequently killed by fishers fearful of attack (Community consultations, 2018). Analysis of eggs in the adjacent New River Lagoon system has shown that there is significant DDE contamination (a derivative of DDT) (Wu et al., 2000; Wu et al., 2006), a concern for crocodiles in Crooked Tree as well, as they lie within the same landscape. Crocodiles are also a bycatch of the net fishing practices, causing damage to nets when they are accidently captured. Conversely the tourism sector values crocodiles, especially prominent large individuals, for their contribution to the visitor appeal of the wetlands wilderness. An education / awareness / training programme is recommended, to address these areas of conflict and inform fishers and other community members of best practices to reduce risk, perceived or real, to establish a monitored crocodile population that can be more comprehensively incorporated into nature-based tourism across the wetlands.

Several other reptile species, primarily freshwater turtles, are becoming of increasing conservation concern, in particular the freshwater loggerhead (*Staurotypus triporcatus*) and the elusive narrow-bridged musk turtle (*Claudius angustatus*). The diverse aquatic habitats within Crooked Tree Wildlife Sanctuary provide the opportunity, with the engagement of broad stakeholder support and participation, for the wetlands to be returned to their prior nationally apical position in the conservation of these and other species.

Lying within the northern coastal plain, most of the other herpetofaunal species of Crooked Tree are lowland generalists – ubiquitous species that are often able to tolerate significant levels of habitat degradation. For these too, Crooked Tree is becoming increasingly important for the continued health of their populations: even these generalists are unable to persist in the face of the rapidly advancing land-use change, driven largely by Mennonite farming to the west and south, and new sugar cane plantations and cattle to the north. Whilst not fitting the profile of wide-ranging species that require large tracts of forest, many of Crooked Trees herpetofaunal species will disappear in the medium- to long-term unless the rapidly diminishing connectivity with the other protected areas (Freshwater Creek Forest Reserve, Rio Bravo Conservation and Management Area, the Community Baboon Sanctuary and Spanish Creek Wildlife Sanctuary) can be maintained. Several of these species offer opportunities to extend tourism use of the wetland beyond its peak in the dry season – when the waterbirds concentrate around the feeding grounds

of receding waters – into the wet season when charismatic species such as the red-eyed tree-frog, amongst others, can be observed in massive breeding aggregations at night.

Frequent anthropogenic fires can have devastating impacts on the herpetofauna of savanna habitats. Whilst a few species may be able to retreat into subterranean refuges, the majority of amphibians and reptiles are likely to be killed by the fire itself – with the speed of fire spread being too fast to allow escape. Natural lowland savanna fires are generally several / many years apart, allowing repopulation of the herpetofaunal species from nearby unaffected areas. However, annual anthropogenic fires do not. The resulting decline in species richness is therefore potentially significant. As recently as the late 1980's, one could walk savannas after fires and find the burnt remains of numerous *Rhinoclemmys* and *Kinosternon* turtles, now it is rare to find any: they have largely been extirpated from these habitats by the increased frequency of anthropogenic fires (P. Walker, pers. obs.). Compounding the direct killing of herpetofauna by the fire itself, degraded structural complexity and reduced plant diversity is likely to also negatively impact savanna habitat quality for remaining herpetofauna.

HERPETOFAUNA OF CROOKED TREE WILDLIFE SANCTUARY

Family	Species	Red List	Recorded/ Reported	Potential
AMPHIBIA				
Bufonidae	*Rhinella marina*	LC	1	
	Incilius valliceps	LC	1	
Hylidae	*Dendropsophus microcephalus*	LC	1	
	Scinax staufferi	LC	1	
	Smilisca baudinii	LC	1	
	Tlalohyla loquax	LC		1
	Tlalocohyla picta	LC		1
	Trachycephalus typhonius	LC		1
	Triprion petasatus			1
Leptodactylidae	*Leptodactylus fragilis*	LC		1
	Leptodactylus melanonotus	LC	1	
Microhylidae	*Gastrophryne elegans*	LC		1
	Hypopachus variolosus	LC		1
Phyllomedusidae	*Agalychnis callidryas*	LC		1
Ranidae	*Lithobates berlandieri*	LC	1	
	Lithobates vaillanti	LC		1
Rhinophrynidae	*Rhinophrynus dorsalis*	LC	1	
REPTILIA				
Crocodylidae	*Crocodylus moreletii*	LC	1	
Dermatemydidae	*Dermatemys mawii*	CR	1	
Emydidae	*Trachemys venusta*	LR	1	
Geomydidae	*Rhinoclemmys areolata*	NT	1	

HERPETOFAUNA OF CROOKED TREE WILDLIFE SANCTUARY

Family	Species	Red List	Recorded/ Reported	Potential
Kinosternidae	*Claudius angustatus*	LR-NT	1	
	Staurotypus triporcatus	LR-NT	1	
	Kinosternon acutum	LR-NT		1
	Kinosternon leucostomum			1
	Kinosternon scorpiodes	NT	1	
Corytophanidae	*Basilicsus vittatus*	LC	1	
	Corytophanes cristatus	LC		1
	Laemanctus longipes	LC		1
Eublepharidae	*Coleonyx elegans*	LC		1
Gekkonidae	*Hemidactylus frenatus***		1	
Gymnophthalmidae	*Gymnophthalmus speciosus*			1
Phyllodactylidae	*Phyllodactylidus tuberculosus*			1
	Thecadactylus rapicauda		1	
Sphaerodactylidae	*Sphaerodactylus glaucus*	LC	1	
	Sphaerodactylus millepunctatus	LC		1
Iguanidae	*Ctenosaura similis*	LC	1	
	Iguana iguana		1	
Phrynosomatidae	*Sceploporus chrysostictus*	LC		1
	Sceloporus lundelli	LC		1
	Sceloporus variablis	LC		1
Polychrotidae	*Anolis lemurinus*			1
	Anolis rodriguezii			1
	Anolis sagrei			1
	Anolis sericeus			1
	Anolis tropidonotus			1
Scincidae	*Marisora brachypoda*	LC		1
	Mesoscincus schwartzei	LC		1
	Sphenomorphus cherriei	LC		1
Teiidae	*Aspidoscelis angusticeps*		1	
	Aspidoscelis maslini			1
	Holcosus undulata	LC	1	
Xantusiidae	*Lepidophyma flavimaculatum*	LC		1
Boidae	*Boa constrictor*		1	
Colubridae	*Adelphicus quadrivirgatus*	LC		1
	Coniophanes bipunctatus	LC		1
	Coniophanes fissidens			1
	Coniophanes imperialis	LC		1
	Coniophanes schmidti	LC		1
	Conophis lineatus	LC		1
	Dipsas brevifacies			1
	Drymarchon melanurus	LC	1	1
	Drymobius margaritiferus		1	
	Ficimia publia			1

HERPETOFAUNA OF CROOKED TREE WILDLIFE SANCTUARY

Family	Species	Red List	Recorded/ Reported	Potential
Colubridae (cont.)	*Imantodes cenchoa*		1	
	Lampropeltis triangulum		1	
	Leptodeira frenata	LC		1
	Leptodeira septentrionalis		1	
	Leptophis ahaetulla		1	
	Leptophis mexicanus	LC	1	
	Masticophis mentovarius	LC		1
	Mastiogdryas melanolomus	LC		1
	Ninia sebae	LC	1	
	Oxybelis aeneus			1
	Oxybelis fulgidus		1	
	Oxyrhopus petola			1
	Pseudoelaphe flavirufa	LC		1
	Pseustes poecilonotus			1
	Scaphiodontophis annulatus	LC		1
	Senticolis triaspis	LC		1
	Sibon nebulatus			1
	Sibon sanniolus	LC		1
	Spilotes pullatus		1	
	Symphimus mayae			1
	Tantilla schistosa	LC		1
	Tantillita canula	LC		1
	Thamnophis marcianus	LC	1	
	Thamnophis proximus		1	
	Tretanorhinus nigroluteus		1	
	Tropidodipsas sartorii.	LC		1
	Xenodon rhabdocephalus			1
Typhlopidae	*Typhlops microstomas*			1
Elapidae	*Micrurus diastema*	LC		1
	Micrurus nigrocinctus	LC		1
Viperidae	*Bothrops asper*		1	
	Crotalus tzabcan	LC	1	
Total Species			**39**	**58**

References: Wildtracks survey (Paul Walker), 2004; Lee, 2000

** Invasive gecko species from South East Asia

FISH OF CROOKED TREE WILDLIFE SANCTUARY

Twenty-eight species of fish have been recorded to date at Crooked Tree Wildlife Sanctuary Walker et al., 2004). The fish biodiversity of Crooked Tree Wildlife Sanctuary is maintained largely by the seasonal variations in water flow, which help support a large and healthy, species-diverse population of freshwater species that inhabit the main lagoon systems and creeks, retreating to creeks (Black Creek and Spanish Creek) and smaller, deeper pools as water drains out of the main system during the dry season. As water depth increases and the system floods, following the onset of wet season, these fish then restock the wetland area, breeding activity in many being triggered by the water changes following the first heavy rains and inundation of the adjacent logwood and savanna areas.

With increasing water depth, later in the wet season, other species start entering the lagoons from the Belize River - tarpon (*Megalops atlanticus*), vaca (*Ictalurus furcatus*) and snook (*Centropomus undecimalis*) among them - species that are normally more closely associated with estuarine conditions. These species gradually disperse from the system when the water flow starts to reverse and the system starts to dry up once again.

This cycle of waterflow has maintained the wetland fish fauna of the area in the past. More recently, however, this balance has been altered by a number of major impacts - the construction of a causeway in 1983, linking Crooked Tree and the mainland and blocking water flow, followed by the opening of culverts to return water flow to its original level in 1992. Once culverts were put in, in 1992, it was estimated that it took two years for the fish populations to recover (Community consultations, 2004). A second dam-like causeway was then constructed, across Western Lagoon in 2009, again without culverts. Efforts are currently underway to install culverts to restore the natural water flow (Community consultations, 2018).

The arrival of invasive Tilapia (*Oreochromis niloticus*), first noted in small numbers in the lagoon system in 1985, led to an assessment of the situation in 1997 through the World Conservation Union (Salas, 1997). Consultations in the Crooked Tree community in 2007 “Crooked Tree fishers reported catching only a few Tilapia in 1990, half a sack full in 1991, and many sacks in 1994” demonstrated the rapid increase of this invasive species in the wetland (Esselman, 2009) This species has spread throughout Mesoamerica following its introduction for aquaculture, and subsequent accidental release (in Belize, primarily due to hurricane flooding). Invasive Tilapia are considered a threat to native aquatic biodiversity, causing local extinctions around the world, contributing to eutrophication and fish kills (Starling et al., 2002), and altering food webs (Canonico et al., 2005). It was determined that for the Crooked Tree lagoon system, eradication of this invasive alien species would be impossible, and fisheries targeted at preferentially catching tilapia through an annual series of ’haul days’ as the lagoon waters dropped was put forward as a management option, to reduce tilapia levels within the system, and to fish the remaining waters before the water and oxygen levels fell too low, and fish started to die.

A stock assessment of the Crooked Tree fisheries was carried out in 1985, giving a broad baseline assessment of the three major fisheries species of the lagoon system (Meekin, 1985). At that point

in time, studies of net and line catches showed that the bay snook *Petenia splendida,* Mayan cichlid (*Cichlasoma urophthalmus*) and mosmos (*Cichlasoma friedrichsthalii)* were the three most commonly caught species.

By 2004, preliminary survey results show a major shift in species composition in the cichlid species assemblage within the Crooked Tree wetland system, with net hauls resulting in a catch of 150 to 200 lb of tilapia, composing 80% or more of the catch, with only 20% composed of the preferred native species (community consultations, 2004). Local reports were of significant decreases in the *Petenia* population, and a virtual crash in that of *C. friedrichsthali*. Decreasing length of *C. uropthalmus* was also commented on by 100% of the fishermen surveyed, as was a general perception that the native cichlid species appeared 'thin'. Similar experiences were documented in Nicaragua, where the biomass of native cichlids has been reduced by 80% as a result of the establishment of tilapia (McCrary, 2001, 2007). It has been recorded as eradicating underwater vegetation, destroying feeding and breeding niches, and promoting outbreaks of parasites among native fish species (Canonico et al., 2005).

A series of 'haul days' are authorised by the Forest and Fisheries Department each year during the dry season, when the water levels recede. If the drought period lasts for a few months, the lagoon waters drop, and if fish are not harvested, the shallow, low oxygen, hot waters result in massive fish kills. The balance of Tilapia vs. local traditionally harvested fish species has shifted again over more recent years, with annual monitoring of catch from haul days between 2013 and 2017 demonstrating that average haul day hauls have ranged from 814 lbs total catch in 2016 to 1,784 lbs in 2017, with a maximum catch for the 2017 hauls of 5,064 lbs (Figure 13; BAS data, 2018). The catch data also demonstrated that in the most recent years, the % catch of bay snook and Tilapia during hauls is very similar, each contributing approximately 40 – 45% of the total catch, with Mayan cichlids and red-headed cichlids forming the final 10%

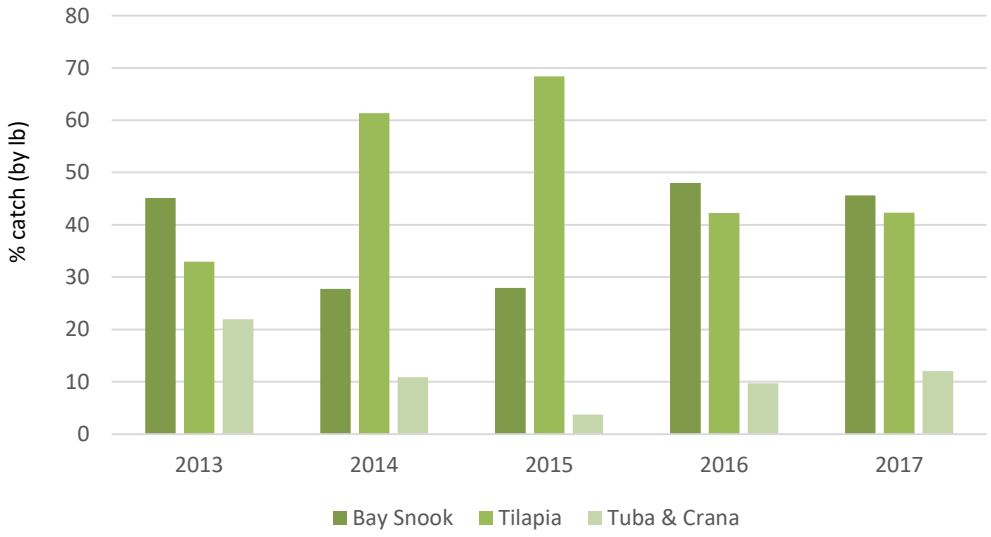


FIGURE 13: % CATCH BY WEIGHT (LBS) PER SPECIES RECORDED ON CTWS HAUL, 2013 - 2017 (BAS DATA)

The eight to ten local commercial fishermen who used nets in 2004 estimated that they each caught 50,000 lbs or more of fish annually on average, depending on net length (community feedback, 2004)….with a catch that was almost entirely tilapia. They struggled with this change in species composition – in 2004, the preferential market was for the native species, selling locally or in Carmelita at Bz$3.00 to Bz$3.50 per pound wholesale for fillet of *Petenia splendida* and *Cichlasoma uropthalmus*, whilst tilapia, the majority of the catch, was only selling for Bz$1.00 a pound (K. Bruce, pers. com., 2004). The local consumption of tilapia was very low, as traditionally the Crooked Tree community have a strong preference for the local species. There has been a shift since then, however, with local consumption of tilapia increasing – a necessity when much of the protein source of the community comes from fish. Prices have now improved, with Tilapia selling at $2 a pound for whole fish, and $5.00 a pound for fillet. Native fish now sell for $3.00 a pound for whole fish. To increase market potential, the village now runs an annual 'Tilapia Fest', where much of the surplus fish catch is sold, and Tilapia prices can reach $9.00 a pound.

Whilst only a few families fish as their primary income source, more than half the village is estimated to go fishing at some point or other for home supply, fish being a major source of protein. This is a particularly important dietary component for larger families.

Crooked Tree villagers are the main fisheries stakeholders of the main lagoon systems of Crooked Tree, but the other communities also make use of the fisheries resource. Lemonal and Isabella Bank fish in Southern Lagoon, whilst surveys in Gardenia and Biscayne show that the majority of people who fish there do so in Black Creek or Mexico and Jones lagoons. It is important that traditional fishers from these communities are included in in the development of the sustainable fishery plan for the area.

FISH SPECIES OF CROOKED TREE

Order	Family	Species	
Clupeiformes	Clupeidae	Threadfin shad	*Dorosoma petenense*
		Longfin gizzard shad	*Dorosoma anale*
Elopiformes	Megalopidae	Tarpon	*Megalops atlanticus*
Characiformes	Characidae	Central tetra, billum	*Astyanax aeneus*
		Mayan tetra, billum	*Hyphessobrycon compressus*
Siluriformes	Ictaluridae	Blue catfish, bakra	*Ictalurus furcatus*
	Ariidae	Mayan catfish	*Ariopsis assimilis*
	Pimelodidae	Guatemalan chulin, buttersea	*Rhamdia guatemalensis?*
		Filespine chulin, buttersea	*Rhamdia laticauda*
Atheriniformes	Rivulidae	Dogtooth rivulus	*Rivulus tenuis*
	Poeciliidae	Pike Killifish	*Belonesox belizanus*
		Poopsie	*Gambusia sexradiata*
		Southern yucatan mosquito fish	*Gambusia yucatana*
		Twospot livebearer	*Heterandria bimaculata*
		Picotee livebearer	*Phallichthys fairweatheri*
		Shortfin molly	*Poecilia mexicana*
	Atherinidae	Belize silverside	*Atherinella sp. 1*
Perciformes	Cichlidae	Yellowjacket cichlid, mosmos	*Cichlasoma friedrichsthali*
		Firemouth cichlid	*Cichlasoma meeki*
		Jack Dempsey	*Cichlasoma octofasciatum?*
		False firemouth cichlid	*Cichlasoma robertsoni*
		Yellowbelly cichlid	*Cichlasoma salvini*
		Blue-eye cichlid	*Cichlasoma spilurum*
		Redhead cichlid, tuba	*Cichlasoma synspilum*
		Mayan cichlid, crana	*Cichlasoma uropthalmus*
		Bay Snook, bocona	*Petenia splendida*
		Tilapia	*Oreochromis niloticus*
	Centropomidae	Snook	*Centropomus undecimalis*

Sources: Greenfield and Thomerson, 1997
Meekin, 1985

1.5.5 ARCHAEOLOGICAL INTEREST

The Crooked Tree landscape is thought to have been modified in the past by the Maya, with evidence of dams and canals indicating that there was once an extensive irrigation system for agricultural activities. Signs of past Maya agricultural activity and settlement are concentrated primarily around the Western Lagoon area, where the Chau Hiix Maya site is located. Chau Hiix, Maya for 'jaguarundi' is a pre-Hispanic Maya community situated 2 miles west of Crooked Tree Village, and lying between the larger Maya centres of Lamanai and Altun Ha. Chau Hiix is thought to have been inhabited from approximately 1200 B.C. to 1600 A.D. The site has a central pyramid that rises almost 75 feet above the flat lagoon landscape. The site has been the focus of a long term study by the University of Indiana, USA, but has more recently been impacted by land clearance as agricultural lands extend into the area.

1.6 CULTURAL AND STAKEHOLDER USE OF CROOKED TREE WILDLIFE SANCTUARY

1.6.1 TOURISM USE

Tourism use of the Wildlife Sanctuary is relatively low, averaging 1,658 per year over the last seven years (Figure 14). The majority of visitors are drawn by the rich bird life and culture of the village, but limited investment in CTWS tourism facilities and the continued conflicts between the CTWS management and community has been a challenge to the area developing as a valued tourism resource for the country.

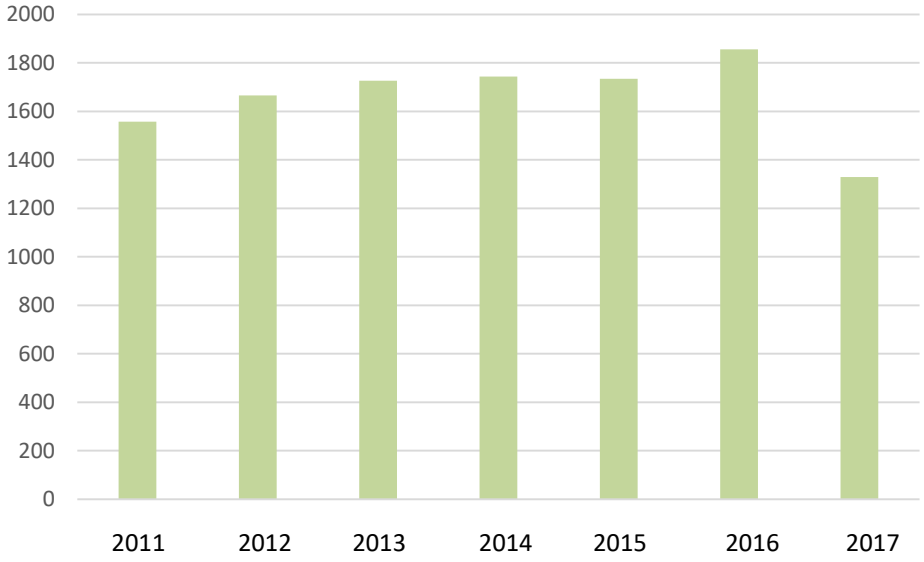


FIGURE 14: VISTATION TO CROOKED TREE WILDLIFE SANTUARY, 2011 – 2017 (BAS, 2018)

Whilst visitation is not currently reaching its potential, it has supported the development of a number of hotels and restaurants in the community, and the training of a number of well-established bird guides, providing the infrastructure for future tourism expansion.

1.6.2 EDUCATIONAL USE

The Belize Audubon Society has engaged the children of Crooked Tree Village in several environmental education outreach activities over the last eight and half years. These include:

World Wetlands Day: The BAS has celebrated World Wetland Day annually on Feb 2nd since 1998, with activities involving both the community and Crooked Tree Government School. These activities and field trips are focused at engaging stakehlolders and encouraging learning of the importance of the CTWS. During the last 9 years, World Wetland Day activities have expanded to other buffer community schools such as Biscayne, Rahburn Ridge and Carmelita in the month of February each year. Most recently in Feb 2013, the BAS organized a trip for some children from Crooked Tree to visit Belize's second Ramsar Site in Toledo.

Junior Bird Club: The Junior Bird club was formed in 2008 with school children from the Crooked Tree Government School, to enagage children in conservation and to create awareness. The members of the founding club were given the necessary birding equipment to explore the birds in their environment, with National Audubon Society then taking on support of the initiative, donating better binoculars and scopes to BAS for the children and staff to use to enhance their birding experience. Over the years as the children graduated from primary school, new members joined the club and continued their monthly birding activities with staff from the Crooked Tree Wildlife Sanctuary (CTWS). Although some members graduated, the passion and interest built over the years remained and they still participate in activities when possible. The Junior Bird Club activities have continued through to 2013, and a new bird club was established in Biscayne Government School in 2017.

School Outreach Programme: The School Outreach Programme is focused on helping to promote nature friendly schools (Biscayne and Crooked Tree Government Schools) through beautification projects, signage, bird gardens, rest benches, murals etc. The programme is guided by the BAS conservation calendar, which includes World Wetlands day, Earth Day, Village and school clean-up, World Wildlife Day and various bird counts (such as the Global Big Day). These days are used to create awareness on a variety of environmental topics in the schools.

Nature School for Belizean Children: Crooked Tree Wildlife Sanctuary is one of the sites selected by Belize Audubons Society as a Nature School, for use as a learning experience for wetland education by primary school shildren from across Belize, and as a tertiary education field site.

Summer Camp: The summer camp programme at BAS has been consistent since 2004. Each summer the staff of BAS organize activities at the various protected areas, including Crooked Tree. While the other participants from all over Belize pays a fee to attend the Crooked Tree Camp, a selection of children from Crooked Tree have always been invited free of cost and enjoy the full benefits of the Summer Camp activities.

Children were also invited to visit another protected area (St. Herman's Blue Hole National Park) in 2012. In 2017, a new Summer Camp was established at Biscayne, targeting the Biscayne Govnernment School students, spreading engagement activities to other CTWS stakeholder communities.

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 (TNC, 2007). Over the years, it has evolved into the Open Standards approach integrated into the Protected Areas Management Planning Framework in Belize today (Walker et. al., 2005).

Conservation Targets for Crooked Tree Wildlife Sanctuary

- Wetland
- Pine Savannah
- Riparian Forest
- Traditionally Harvested Fish Species
- Hunted Species
- Logwood
- Waterbirds

This section summarizes the outputs of five multi-sectoral workshops held in the Crooked Tree community between October and December, 2018, to plan for future management of the Crooked Tree Wildlife Sanctuary. Participants included the relevant authorities (the Forest and Fisheries Departments), Belize Audubon Society, as the co-management partner, representatives of the Corooked Tree Village Council, and natural resource users of the Crooked Tree community.

Workshop 1: Defining the Vision, Selecting Targets and Assessing Viability
Workshop 2: Identifying Threats, Conducting a Situation Analysis and Defining Goals
Workshop 3: Sustainable Use Planning for the Crooked Tree Fishery
Workshop 4: Developing Objectives and Identifying Strategies
Workshop 5: Reviewing the Outputs, Identifying Indicators to Measure Success

A final workshop on the 15th December, 2018, presented the outputs to the participants to ensure they reflected the outputs from the workshops.

2.1 MANAGEMENT TARGETS

Management 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. For the purposes of the Management Action

Planning process, the selected biodiversity targets were required to meet the following criteria, where possible:

- **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 landscape level, the planning for the National Protected Areas System Plan, the NPAPSP Rationalization recommendations, the National Biodiversity Strategy and Action Plan, for building climate change resilience, and for maintaining national biological corridors. Focal targets should be grounded in the reasons for the Wildlife Sanctuary's current status of protection, and of its importance in flood control.

- **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.

2.1.1 IDENTIFICATION OF MANAGEMENT TARGETS

Seven Management Targets were chosen to represent and encompass the biodiversity values of Crooked Tree Wildlife Sanctuary, and to provide a basis for setting goals, developing strategies and actions, and monitoring success.

Ecosystem Level Targets: Ecological communities that occur together, share common ecological processes, and have similar characteristics:

- ***Wetland***
- ***Pine Savannah***
- ***Riparian Forest***

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

- ***Traditionally Harvested Fish***
- ***Game Species***
- ***Waterbirds***

Species: Individual species that require specific management strategies:

- ***Logwood***

The first CTWS workshop idetified seven targets, each with a series of associated nested targets – species or species assemblages considered of particular conservation importance that are represented by the target (Table 19).

Management Targets and Nested Targets for Crooked Tree Wildlife Sanctuary	
Management Target	**Nested Target**
Wetland	Freshwater turtles (including the Central American river turtle) Non-commercial fish species Morelet's crocodile Water quality
Pine Savannah	Caribbean pine Yellow headed parrots Nesting birds (including whistling ducks, muscovy ducks, jabiru, quail, Yucatan bobwhite, common pauraque)
Riparian Forest	Bri-bri / fig Yucatan black howler monkey Jaguar / Puma
Traditionally Harvested Fish Species	Bay snook Mayan cichlid (crana) Quetzal cichlid (tuba) Blue catfish (vaca / baca) Bigmouth sleeper (dormilon)
Game Species	Paca / gibnut White-lipped peccary Collared peccary Great curassow White-tailed deer / Red brocket deer Nine-banded armadillo Agouti
Waterbirds	White ibis Roseate spoonbills Jabiru Wood storks Whistling ducks Agami heron Snail kite Osprey Black-collared hawk Other waterbirds
Logwood	Logwood Palmetto

TABLE 19: CONSERVATION TARGETS AND KEY NESTED TARGETS (CTWS Workshops, 2018)

2.1.2 ASSESSING BIODIVERSITY VIABILITY

The Viability Assessment 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

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

The overall viability rating for the conservation area is **FAIR**, with the majority (six targets) rating as **FAIR** and one target rating as **GOOD**. No target rates as **POOR** or **VERY GOOD** (Table 20).

MANAGEMENT TARGET	LANDSCAPE CONTEXT	CONDITION	SIZE	VIABILITY RANK
Wetland	Fair	Fair	Fair	**FAIR**
Pine Savannah	Fair	Fair	Good	**FAIR**
Riparian Forest	Fair	Fair	Fair	**FAIR**
Traditionally Harvested Fish Species	Fair	Fair	Fair	**FAIR**
Game Species	Fair	Fair	Fair	**FAIR**
Logwood	Fair	Fair	Fair	**FAIR**
Waterbirds	Good	Good	Good	**GOOD**
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 20: MANAGEMENT TARGET VIABILITY (CTWS Workshops, 2018)

ECOSYSTEMS: WETLAND		
Current Status	**Goal**	***Objectives:*** ▪ *To restore the wetland biodiversity, ecosystem services and functions*
FAIR	**GOOD**	

Justification	**Species / ecosystems nested in this target**
Crooked Tree Wildlife Sanctuary was designated for its national and regional importance as a wetland, and recognised as a Ramsar Site for its global importance, based on the high biodiversity of the area – particularly for its bird species. It is also considered critically important in its role in flood control, draining excess water from the Belize River during extreme storm events, reducing the threat of flooding of downstream communities – including Belize City. The wetland, a complex maze of creeks and lagoons, fills in the wet season, with water draining into the system from the surrounding savannahs, from Spanish Creek, and from the Belize River (through Black Creek), then emptying through Black Creek in the dry season, often until the lagoon basins are dry. As the water drops, aquatic invertebrates and fish become more accessible for waterbirds, bringing many hundreds to the area to feed and providing an important destination for birding tours. The system relies on the un-obstructed flow of water, currently impeded by causeways with limited / no culverts, and blockages in the creeks. This reduces the flow of fish into the system, and impacts the success of subsistence and commercial fishermen. It also impacts the turtle nesting sites which can become inundated as a result of restricted water flow.	Wetland ecosystems: ▪ Tropical freshwater lagoons and creeks ▪ Rooted underwater communities of freshwater lakes / water bodies ▪ Tropical lowland tall herbaceous swamp ▪ Tropical evergreen seasonal broadleaf lowland swamp forest: low variant ▪ Broad-leaved lowland shrubland: leguminous variant Wetland species: ▪ Central American river turtle (hicatee) (*Dermatemys mawii*) **CR** ▪ Baird's Tapir (*Tapirus bairdi*) **EN** ▪ Antillean manatee (*Trichechus manatus manatus*) EN ▪ Agami heron (*Agamia agami*) **VU** ▪ Neotropical river otter (*Lontra longicaudis*) ▪ Jabiru (*Jabiru mycteria*) ▪ Wood stork (*Mycteria Americana*) ▪ Black-collared hawk (*Busarellus nigricollis*) ▪ Osprey (*Pandion haliaetus*)

ECOSYSTEMS: PINE SAVANNA

Current Status	Goal
FAIR	GOOD

Objective:

- *To improve the condition and long term viability of the pine savanna and yellow headed parrots*

Justification

The pine savanna of the Crooked Tree Wildlife Sanctuary is one of the few examples of lowland / premontane pine forests in the Neotropics, with very limited distribution, and found predominantly in Belize. This has led to it being considered critical/endangered (WWF, 2000), and its conservation is a high priority at the regional level. It has also been flagged as under-represented within the National Protected Areas System.

26% of Crooked Tree Wildlife Sanctuary is considered savanna (Bridgewater et al., 2012), ranging from a spectrum of habitats from dense tree savanna to open and seasonally inundated savannah types, with patches of dense trees and open wetland (Bridgewater et al., 2012). Several endemic plant species have been identified in the area, including *Ageratum radicans, Hypericum aphyllum, Melastelma stenomeres, Passiflora urbaniana*, as well as characteristic species such as the sandpaper tree (*Curatella americana*), cycad (*Zamia prasina*) and *Turnera aromatica* (Bridgewater et al., 2012). The old growth pine trees are important nesting sites for the yellow headed parrot, an endangered species that is targeted for the illegal pet trade. The savanna also provides habitat for a number of specialized bird species, such as the black-throated bobwhite, acorn woodpecker and blue-grey gnatcatcher.

Inundation in the wet season tends to deter development, but the increasing number, severity and range of fires is considered the major threat to this ecosystem. Increasing burn frequency by farmers to promote grass growth for cattle and hunters to attract white tailed deer has led to a decrease in the density of pine, reduces overall species diversity and affects nesting birds.

Species / ecosystems nested in this target

Pine savannah ecosystems

- Tropical evergreen seasonal needle-leaf lowland dense forest
- Short-grass savanna with needle-leaved trees
- Short-grass savanna with shrubs

Pine savannah species

- Caribbean pine (*Pinus caribaea*)
- White oak (*Quercus oleoides*)
- Palmetto palm (*Acoelorraphe wrightii*)

Endemic plants (no common names)

- *Ageratum radicans*
- *Hypericum aphyllum*
- *Melastelma stenomeres*
- *Passiflora urbaniana*

Vertebrate species

- Yellow headed parrot (*Amazona oratrix*) **EN**
- Acorn woodpecker (*Melanerpes formicivorus*)
- Tree nesting ducks (whistling ducks)
- Black-throated bobwhite quail (*Colinus nigrogularis*)
- Plumbeous vireo (*Patagioenas plumbea*)
- Blue-gray gnatcatcher (*Polioptila caerulea*)
- Grace's warbler (*Setophaga graciae*)
- Gray-crowned yellowthroat (*Geothlypis poliocephala*)
- Yellow-backed oriole (*Icterus chrysater*)
- Tropical rattlesnake (*Crotalus durissus*)
- White tailed deer (*Odocoileus virginianus*), collared peccary (*Pecari tajacu*), nine-banded armadillo (*Dasypus novemcinctus*)

ECOSYSTEMS: RIPARIAN FOREST / VEGETATION		
Current Status	**Goal**	***Objectives:*** ▪ *To return the Riparian Forest to its natural state, with reduced erosion, maintaining forest connectivity along the river bank*
FAIR	**GOOD**	

Justification	**Species / ecosystems nested in this target**
Riparian forest and vegetation along the creeks and lagoon margins are considered critical as corridors within the landscape, facilitating movement of wide-ranging mammals and birds – particularly game species, tapir, jaguar and the endangered Yucatan black howler monkeys. They can also be potential climate corridors as they have physical characteristics that make them cooler than the surrounding landscape, with higher tree cover (Seavy et al., 2009). Riparian vegetation provides habitat for species such as paca, green iguanas and protected nesting sites for agami and boat-billed herons. This riverside ecosystem plays an important role in maintaining the river banks, and preventing erosion, as well as filtering any agro-pollution that may otherwise enter the water from adjacent farmlands.	Tree species characteristic of riparian vegetation: ▪ Bri-bri (I*nga spp.)* ▪ Fig species (*Ficus spp.*) Vertebrate species characteristic of riparian vegetation: ▪ Paca / gibnut (*Cuniculus paca*) ▪ Neotropical river otter (*Lontra longicaudis*) ▪ Northern Raccoon (*Procyon lotor*) ▪ Agami heron (*Agamia agami*) **VU** ▪ Kingfisher species ▪ Nesting waterbirds – boat-billed heron (*Cochlearius cochlearius*), night herons

ECOSYSTEMS: TRADITIONALLY HARVESTED FISH SPECIES		
Current Status	**Goal**	***Objectives:*** ▪ *To improve sustainability and long term viability of traditionally harvested fish species*
FAIR	**GOOD**	

Justification	**Species / ecosystems nested in this target**
The Crooked Tree community has a long tradition of fishing in the lagoons and creeks in the Wildlife Sanctuary traditionally focused on the larger native cichlids. Fish populations are impacted by seasonal variations in water flow - as water depth increases and the system floods, following the onset of wet season, fish restock the wetland area from the Belize River, through Black Creek. Water continues to enter the system, inundating not only the lagoon itself, but spreading out into the logwood and savannah areas, triggering breeding activity in many species. As the water depth continues to increase, other species start entering the system from the Belize River (tarpon (*Megalops atlanticus*), baca (*Ictalurus furcatus*) and snook (*Centropomus undecimalis*) among them. These species gradually die off in the system when the water flow starts to reverse, and the system starts to dry up once again. However, over the last thirty-five years, there has been a radical shift in species composition of the catch following the invasion by *Tilapia,* first noted in the lagoon in 1983, with competition between this and local species resulting in 80% of the catch being this single invasive species by 2004. Local reports suggested significant decreases in the *Petenia* population, and a virtual crash in that of *Parachromis friedrichsthali*. Decreasing length of *C. uropthalmus* was also commented on at that time by 100% of the fishermen surveyed (community consultations, 2004). Since then, the system has stabilized, with the relative contribution of species to the haul catch being 42.3% Tilapia to 57.7% local species (45.6% Bay snook, 12.1% tuba and crana) (BAS / CTWS haul data, 2017).	Native commercial / subsistence fish species ▪ Bay snook (*Petenia splendida*) ▪ Crana / Mayan Cichlid (*Cichlasoma urophthalmus*) ▪ Tuba / Quetzal cichlid (*Vieja synspilum*) ▪ Yellow jacket /Mosmos (*Parachromis friedrichsthalii*) ▪ Tarpon (*Megalops atlanticus*) ▪ Vaca / Baca (*Ictalurus furcatus*) ▪ Snook (*Centropomus undecimalis*) ▪ Dormilon (*Gobiomorus dormitor*) Estuarine fish ▪ Jacks ▪ Stone bass Invasive Species ▪ Tilapia (*Oreochromis niloticus*)

SPECIES ASSEMBLAGES: GAME (HUNTED) SPECIES		
Current Status	**Goal**	***Objectives:*** ▪ *To sustain all hunted species for the enjoyment of all generations*
FAIR	**GOOD**	

Justification	**Species / ecosystems nested in this target**
Game species are defined as those animals (mammals, birds and reptiles) that can be hunted legally for meat in Belize with the required permits, in specified areas and according to the legislated seasons. Crooked Tree, as a community, has a strong hunting tradition, and a traditional culture that favours game meat, whether hunted or bought. Some families are reliant on subsistence hunting to provide an important protein supplement to their diets. The majority of the hunting occurs outside the protected area, in the Blackburn area and in the riparian belt. Game species are reported to be decreasing in the area as a result of increasing land clearance, reduced connectivity, and unsustainable hunting practices (Community consultations 2018).	Game species: ▪ Paca (*Cuniculus paca*) ▪ Agouti (*Dasyprocta punctata*) ▪ White-lipped peccary (*Tayassu pecari*) **VU** ▪ Collared peccary (*Pecari tajacu*) ▪ Great curassow (*Crax rubra*) **VU** ▪ Crested guan (*Penelope purpurascens*) ▪ Plain chachalaca (*Ortalis vetula*) ▪ Muscovy duck (*Cairina moschata*) ▪ Red brocket deerm (*Mazama americana*) ▪ Nine-banded armadillo (*Dasypus novemcinctus*)

SPECIES ASSEMBLAGES: WATERBIRDS		
Current Status	**Goal**	***Objectives:*** ▪ *To return the number a diversity of waterbirds of Crooked Tree Wildlife Sanctuary tp 2016 levels*
FAIR	**GOOD**	

Justification	**Species / ecosystems nested in this target**
Waterbirds are at the heart of Crooked Tree's tourism and have the potential to support a thriving bird-based tourism industry, particularly with Belize's strong entry into the bird tourism market. Whilst there are waterbirds in the area throughout the year, the key congregation time is when the waters are receding, leaving shallow pools that concentrate fish and invertebrates, increasing accessibility to these food resources, and attracting thousands of resident and migratory waterbirds. The primary threats to the birds are in their nesting sites – several of these species, including the jabiru, nest in the pine savanna, which faces increasing impacts from fire (CTWS Community consultations, 2018). Others use the riparian vegetation – again impacted by fire, and degrading from a tree / shrub belt supporting nests to a bamboo thicket.	Waterbirds ▪ Jabiru (*Jabiru mycteria*) ▪ Wood stork (*Mycteria americana*) ▪ Agami heron (*Agamia agami*) ▪ Roseate spoonbill (*Platalea ajaja*) ▪ Anhinga (*Anhinga anhinga*) ▪ Neotropical cormorant (*Phalacrocorax brasilianus*) ▪ Least grebe (*Tachybaptus dominicus*) ▪ Sungrebe (*Heliornis fulica*) ▪ Yellow-crowned night-heron (*Nyctanassa violacea*) ▪ Boat-billed heron (*Cochlearius cochlearius*) ▪ Muscovy duck (*Cairina moschata*) ▪ Whistling ducks ▪ Amazon kingfisher (*Chloroceryle amazona*) ▪ Pigmy American kingfisher (*Chloroceryle aenea*)

<table>
<tr><th colspan="3">SPECIES TARET: LOGWOOD</th></tr>
<tr><th>Current Status</th><th>Goal</th><td rowspan="2">Objectives:
▪ To maintain</td></tr>
<tr><td>FAIR</td><td>GOOD</td></tr>
<tr><th colspan="2">Justification</th><th>Species / ecosystems nested in this target</th></tr>
<tr><td colspan="2">Logwood, a short tree that grows in swampy areas, has traditionally been important to the economy and lives of people in Belize. The first settlers were drawn to the area for its logwood stocks, shipped to Europe to extract a high-value dye for textiles. Mahogany started to take over export trade importance in the mid 1930’s, and the logwood industry declined from then onwards. The last shipment was in 1932. Crooked Tree Village was established around 1750, based on the logwood industry.

Logwood trees, while no longer being extracted for their dye, are now increasingly impacted by fire and poor harvesting practices. Trees become harder (denser wood) with age, increasing their value as fence posts for cattle pasture. However, people have shifted to cutting young, growing trees rather than older dead wood. There is also concern that the largescale Mennonite development to the west will increase the demand for posts</td><td>Logwood (Haematoxylon campechianum)
Palmetto (Acoelorrhaphe wrightii)</td></tr>
</table>

2.2 ASSESSMENT OF CRITICAL THREATS

2.2.1 ASSESSMENT OF CRITICAL THREATS

Threats were assessed using the Open Standards methodology, during the second of a series of workshops, with representation from the fishing and tourism sectors, property owners, Fisheries and Forest Departments, and Belize Audubon Society.

A series of workshops was conducted in late 2018, with input from a broad range of stakeholders. They focused on the assessment of stresses and threats affecting the management targets, and providing each target with a threat status rating. Outputs from the workshop facilitated 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 (Tables 21 and 22). The summary results from the planning process provide each focal target with a threat status rating (Table 23).

IDENTIFIED THREATS TO CROOKED TREE WILDLIFE SANCTUARY TARGETS

VERY HIGH
- Fire
- Altered water flow
- Unsustainable hunting
- Unsustainable fishing

HIGH
- Forest clearance
- Poaching of parrots

MEDIUM
- Unsustainable logwood extraction
- Pollution

Crooked Tree Wildlife Sanctuary has an overall threat rating of **VERY HIGH.** Five targets, **Wetland, Pine Savanna, Riparian (River-side) Forest, Traditionally Harvested Fish Species and Game Species (Hunted Species)** have a threat rating of **VERY HIGH**. One target, Logwood, has a threat rating of **HIGH**, and one, Waterbirds, has a threat rating of **MEDIUM**. Climate change was assessed separately. Threats to the external landscape rate as **VERY HIGH**, with rapid land-use change, converting tropical forest to cattle pasture, and impacting forest connectivity in the landscape (Table 24).

Rating Critical Threats – definitions (TNC, 2007)

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) (Table 21).

STRESS (TNC, 2007)		
Criteria	**Score**	
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	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.
Criteria	**Score**	
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

TABLE 21: CRITERIA FOR ASSESSING STRESS (OPEN STANDARDS / TNC, 2007)

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).

SOURCE OF STRESS (TNC, 2007)		
Criteria	**Score**	
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.
Criteria	**Score**	
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 center).
	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).

TABLE 22: CRITERIA FOR ASSESSING SOURCE OF STRESS (OPEN STANDARDS / TNC, 2007)

Threats Across Targets within CTWS	Wetland	Pine Savanna	Riparian (River-side) Forest	Traditionally Harvested Fish Species	Game Species (Hunted Species)	Logwood	Waterbirds	Overall Threat Rank
Fire	MEDIUM	VERY HIGH	VERY HIGH		VERY HIGH	HIGH	MEDIUM	**VERY HIGH**
Unsustainable Hunting		VERY HIGH	VERY HIGH		VERY HIGH		LOW	**VERY HIGH**
Unsustainable Fishing	VERY HIGH			VERY HIGH			LOW	**VERY HIGH**
Altered Water flow	VERY HIGH			VERY HIGH		HIGH	HIGH	**VERY HIGH**
Forest Clearance	HIGH	HIGH	HIGH		VERY HIGH	MEDIUM		**HIGH**
Illegal Wildlife Trade – Poaching of Parrots		VERY HIGH						**HIGH**
Unsustainable Logwood Extraction						HIGH		**MEDIUM**
Water Pollution	HIGH							**MEDIUM**
Overall Threat Status for Targets	**VERY HIGH**	**VERY HIGH**	**VERY HIGH**	**VERY HIGH**	**VERY HIGH**	**HIGH**	**MEDIUM**	**VERY HIGH**

TABLE 23: THREATS ACROSS CTWS TARGETS (CTWS Workshops, 2018)

IDENTIFIED ANTHROPOGENIC THREATS TO CROOKED TREE WILDLIFE SANCTUARY		
THREATS TO BIODIVERSITY IN CTWS		
Threat	**Impact on Biodiversity**	**Cause**
Fire	▪ Reduced condition / degradation of pine savanna ▪ Reduced species populations in pine ecosystems ▪ Reduced old growth oak trees for parrot and duck nesting ▪ Degraded riparian vegetation ▪ Reduced habitat connectivity for game species ▪ Impacts on logwood	▪ Escaped agricultural fires in the landscape ▪ Savanna fires set illegally by hunters to promote new shoots ▪ Savanna fires set illegally by cattle farmers to promote new shoots ▪ Camp fires set by recreational hunters and fishers
Unsustainable Hunting	▪ Reduced game species populations within CTWS along the rivers (paca, curassow, tinamou, peccary, armadillo etc.) and in the forest areas	▪ Important traditional protein source to supplement diet ▪ Poverty in local communities ▪ Meat considered important culturally ▪ Increased accessibility as Blackburn causeway increases access to Blackburn Ridge ▪ Deforestation in the landscape, reducing available habitat for game species – concentrating populations in remaining areas ▪ High market demand for game meat
Unsustainable Fishing	▪ Reduced fish populations of those species targeted (larger cichlids) ▪ Potential impact on birds	▪ Important traditional protein source to supplement diet in lower income households ▪ Poverty in local communities ▪ Fish considered important culturally ▪ Increased impacts of fishing by non-traditional fishers from other communities ▪ Increased pressure of fishing on the source population in the Belize River ▪ Illegal fishing practices – nets across creeks / damming of creeks / lagoon ▪ Altered water flow into and out of the wetland system
Altered water flow	▪ Changes in distribution and seasonality of aquatic species and wetland birds ▪ Poor water quality, degradation of flooded vegetation and potential for high mercury levels in fish north of Blackburn Causeway ▪ Changes in water level in turtle nesting sites, reducing nest success	▪ Poorly planned access to farmlands – Blackburn Causeway with no culverts, cohunes felled across creeks etc., resulting in dammed waterways ▪ Debris left in creeks after bridge construction ▪ Increased sedimentation in some areas reducing water depth, following clearance and erosion of riverbank

IDENTIFIED ANTHROPOGENIC THREATS TO CROOKED TREE WILDLIFE SANCTUARY		
THREATS TO BIODIVERSITY IN CTWS		
Threat	**Impact on Biodiversity**	**Cause**
Deforestation	▪ Reduced extent of forest in CTWS landscape ▪ Reduced populations of game and charismatic species and / or threatened species – jaguar, tapir, peccary, howler and spider monkeys ▪ Reduced resilience to climate change impacts	▪ Cattle farming ▪ Expanding Mennonite footprint ▪ Expanding agricultural areas in the CTWS landscape
Wildlife Crime – Illegal Poaching of Parrots	▪ Reduced populations of Amazon parrots – especially endangered yellow headed parrot ▪ Reduced old-growth oaks on savanna as nesting trees are cut to poach parrot nestlings	▪ Long history of parrot keeping in community ▪ Opportunistic take of nestling \s when encountered ▪ Targeted poaching of Amazon parrots ▪ Demand created by cross boundary market in Mexico and onwards ▪ The majority of illegal capture for the wildlife trade is thought to occur outside the boundaries of the protected area, and includes targeted nest theft of yellow headed parrots for commercial gain.
External Threats that will impact biodiversity of CTWS		
Threat	**Impact on Biodiversity**	**Cause**
Expanding Human Footprint	▪ Removal of forest and associated biodiversity ▪ Agricultural and urban contamination of water systems ▪ Reduced forest cover, altering local rainfall patterns	▪ Expanding human footprint (agriculture and human settlements) is removing forest cover adjacent to Crooked Tree Wildlife Sanctuary. ▪ Increased accessibility for pole / post cutting, hunting and fishing in the buffer areas.

TABLE 24: ANTHROPOGENIC THREATS TO CTWS AND THE CTWS LANDSCAPE (CTWS Workshops, 2018)

Threats to biodiversity of Crooked Tree Wildlife Sanctuary: Fire

Fire	***Status:***	***Historical***	***Active***	***Potential***
	Conservation Target(s): Pine Savanna, Riparian vegetation			
	Stresses (*Direct*)*:* ▪ Degradation of pine savanna ▪ Reduced density of pine trees ▪ Reduced populations of species associated with the pine savanna ecosystem ▪ Reduced populations of birds that use the savanna for nesting – yellow headed parrots, whistling ducks ▪ Degradation of riparian forest / vegetation ▪ Reduced populations of species associated with riparian forest – e.g. howler monkeys ▪ Reduced riparian forest connectivity			
	Sources of Stress (Indirect)***:*** ▪ Poor fire management in agricultural buffer ▪ Savanna fires set by hunters to attract deer to new shoots ▪ Savanna fires set by cattle farmers to improve grazing for cattle ▪ Fires set by recreational hunters / fishers at camp sites			
Scope	***Very High***	All pine savanna and the majority of the riparian forest in the Crooked Tree landscape have been impacted by fire		
Severity	***Very High***	The pine savanna and riparian vegetation have both been significantly degraded by the increasing frequency of fires		
Contribution	***Very High***	Fire is the primary cause of pine savanna and riparian forest degradation, exacerbated by hurricanes		
Irreversibility	***High***	It would be feasible to restore the pine savanna and riparian forest through replanting and active fire management, but this would be expensive on both human and financial resources, and would require behavioural change and enforcement.		

Management Strategies:

Strategy 1: Improve awareness of the legislation relevant to fires (regulations for agricultural fires and legislation banning hunting fires)

Strategy 2: Run community fire awareness and capacity building campaign before dry seasons, including signage, targeting particularly hunters and farmers (Protect pine, protect cashew, no fire)

Strategy 3: Promote climate-smart agriculture, with training for improved fire management in the CTWS landscape

Strategy 4: Identify and engage community leaders (tour guides, women, church leaders) to advocate for good fire management in the community

Strategy 5: Integrate education and awareness activities in school to strengthen knowledge of the need for good fire management

Strategy 6: Enforcement of fire regulations – surveillance of fire hotspots and critical times

Threats to biodiversity of Crooked Tree Wildlife Sanctuary: Unsustainable Fishing

Illegal Fishing	***Status:***	***Historical***	***Active***	***Potential***
	Conservation Target(s): Traditionally harvested fish, Waterbirds			
	Stresses (*Direct*)*:* ▪ Reduced fish populations (particularly large cichlids) ▪ Trophic shifts in freshwater communities			
	Sources of Stress (Indirect)***:*** ▪ Low income in local communities ▪ Traditional / cultural occupation ▪ Market demand from local communities and towns			
Scope	***Very High***	Fishing occurs throughout the CT lagoons and creeks		
Severity	***Very High***	Illegal setting of nets across Black Creek reduces inflow of fish to the CT system		
Contribution	***Very High***	Unsustainable fishing is the primary threat to fish species in the CTWS system		
Irreversibility	***Medium***	Reversing this trend and reducing the fishing pressure on native fish species would require stopping non-traditional fishing, and a cultural shift to reduce traditional commercial activity, combined with income diversification options and adequate enforcement – but would be feasible		

Management Strategies:

Strategy 1: Develop and implement a Managed Access system that protects the traditional rights of Crooked Tree commercial and non-commercial (subsistence, recreational and sport) fishers, based on a Sustainable Fishery Plan

Strategy 2: Socialize the Managed Access system to ensure that the key stakeholder communities (and all fishers) are aware of fishing regulations

Strategy 3: Investigate mechanisms for clearly identifying recognized traditional fishers (both commercial and non-commercial) during surveillance activities

Strategy 4: Use boat-to-boat process to build communication between enforcement personnel and CT fishers

Strategy 4: Enforce national fishing legislation and identified community sustainable fishery regulations, in a transparent manner, with the backing of the Village Council

Strategy 5: Provide skills training opportunities for fishers to assist them in diversifying their income and reduce pressure (agriculture, aquaponics)

Strategy 6: Build community pride of responsible stewardship of the fish resources

Strategy 7: Provide education in schools on the value of wildlife

Threats to biodiversity of Crooked Tree Wildlife Sanctuary: Unsustainable Hunting

Unsustainable Hunting	***Status:***	***Historical***	***Active***	***Potential***
	Conservation Target(s): Game Species			
	Stresses (*Direct*)*:* ▪ Reduced game species populations			
	Sources of Stress (Indirect)***:*** ▪ Low income in local communities ▪ Traditional / cultural occupation ▪ Market demand from local communities and towns			
Scope	***Very High***	Hunting occurs throughout the forested areas of the Crooked Tree landscape		
Severity	***Very High***	Game species populations have declined significantly		
Contribution	***High***	Hunting is considered the second highest threat to game species, after forest clearance		
Irreversibility	***High***	Reversing this trend and reducing hunting pressure would require a cultural shift away from a traditional activity, combined with income diversification options and adequate enforcement – but would be feasible		

Management Strategies:

Strategy 1: Develop and implement a Managed Access system that protects the traditional rights of Crooked Tree hunters

Strategy 2: Ensure all commercial hunters are aware of hunting regulations, and have the relevant licenses

Strategy 3: Enforce hunting legislation in a transparent manner, with the backing of the Village Council

Strategy 4: Provide skills training opportunities for hunters to assist them in diversifying their income and reduce pressure (agriculture, aquaponics, farming of game species)

Strategy 5: Improve knowledge of presence, distribution and ternds in populations of key hunted species, and community engagement and ownership / improved stewardship through community monitoring using camera traps

Strategy 6: Build community pride of responsible stewardship of the natural resources

Strategy 7: Provide education in schools on the value of wildlife

Threats to biodiversity of Crooked Tree Wildlife Sanctuary: Altered Water Flow

Altered Water Flow	***Status:***	***Historical***	***Active***	***Potential***
	Conservation Target(s): Wetland, Traditionally harvested fish, Waterbirds, Riparian Forest			
	Stresses (*Direct*)*:* ▪ Shift in ecological niches in wetland, impacting density, distribution and viability of all wetland species ▪ Reduced connectivity with Belize River, impacting flow of fish into and out of system ▪ Reduced wetland functionality, including flood control ▪ Reduced viability of freshwater life in inundated areas resulting from damming of the system ▪ Inundation of turtle nesting sites, with reduced nesting success			
	Sources of Stress (Indirect)***:*** ▪ Damming of Western Lagoon by Blackburn Causeway to provide access to Blackburn Ridge farming area ▪ Partial blocking of water flow by Crooked Tree Causeway and May Pen Bridge ▪ Bulldozing trees into creeks during agricultural clearance ▪ Felling of trees to provide cheap natural bridges to access farmlands across Black Creek in dry season ▪ Sediment build up at creek entrances as a result of increased erosion of creek banks ▪ Halting of annual clearance of Black Creek as a result of improving access with construction of Crooked Tree Causeway			
Scope	***Very High***	Any significant blockage affects the entire system		
Severity	***Very High***	Changes to the water flow patterns has significant impacts on the biodiversity and ecosystem services of the system		
Contribution	***Very High***	Impeded water flow is the primary contributing factor to changes in the water flow patterns		
Irreversibility	***High***	Would require installation of culverts and removal of blockages from existing culverts and bridges, clearing of Black Creek vegetation overgrowth and annual maintenance. It would also require behavior change by farmers currently felling trees to cross creeks.		

Management Strategies:

Strategy 1: Improve the waterlow in the lagoon system by increasing the the number of culverts in the Crooked Tree Causeway and installing culverts in the Blackburn Causeway

Strategy 2: Restore and maintain flow in Black Creek, including clearing blockage by May Pen Bridge and trees that have been pushed into / fallen into creek

Strategy 3: Engage farmers in restoration / maintenance of creeks draining Blackburn Ridge farms

Strategy 4: Restore / maintain flow in Spanish Creek

Threats to biodiversity of Crooked Tree Wildlife Sanctuary: Forest Clearance				
Forest Clearance	***Status:***	***Historical***	***Active***	***Potential***
	Conservation Target(s): Game Species, Riparian Forest, Pine Savanna			
	Stresses (*Direct*)*:* ▪ Reduced extent of forest in the Crooked Tree landscape ▪ Reduced populations of forest-dwelling species, including Game Species ▪ Reduced connectivity – increasing forest fragmentation ▪ Potential local impacts on rainfall and water availability			
	Sources of Stress (Indirect)***:*** ▪ Low income in local communities ▪ Cattle farming in the Blackburn Ridge area ▪ Potential for large scale Mennonite land clearance in Blackburn area			
Scope	***Very High***	Forest removal in the Crooked Tree landscape is increasing		
Severity	***Very High***	Where forests have been removed, there are no forest species remaining.		
Contribution	***Very High***	Agriculture, particularly cattle, is the key factor driving forest clearance. Sugar cane is also expanding in the landscape		
Irreversibility	***High***	It would be difficult to restore the forest, but maintaining forest corridors in the landscape would be feasible, ensuring that some landscape functionality is retained		

Management Strategies:

Strategy 1: Encourage farmers to leave forest buffer corridors around their farms

Strategy 2: Clarify the 66' legislation and definition of high water level, demarcate on the ground, and develop village regulations for management of the 66' buffer

Strategy 3: Community awareness campaign for 66', including national and village regulations covering tree clearance, camping, garbage, right of way

Strategy 4: Develop a Land Use Plan for Blackburn Ridge with input from the Lands Departmet, and socialize with the community and relevant agencies / Government departments

Strategy 5: Targeted surveillance and enforcement against tree clearance and /or installation of fence posts in the 66' buffer

Strategy 6: Ensure any contracted surveyor is informed of the need to adhere to the Lands Subsidiary Act with respect to the 66'

Strategy 7: Reforestation of critical areas of the 66' buffer

Strategy 8: Build community pride of responsible stewardship of the natural resources

Strategy 9: Provide education in schools on the value of wildlife

Threats to biodiversity of Crooked Tree Wildlife Sanctuary: Poaching of Parrots

Poaching of Parrots	***Status:***	***Historical***	***Active***	***Potential***
	Conservation Target(s): Pine Savanna (Yellow-headed and other parrots)			
	Stresses (*Direct*)*:* ▪ Reduced viability of nesting parrots (including the endangered Yellow-headed parrot)			
	Sources of Stress (Indirect)***:*** ▪ Low income ▪ Market demand in Belize and Mexico ▪ Organized wildlife crime			
Scope	***Very High***	Any areas with parrot nests are targeted in nesting season		
Severity	***Very High***	Any active nest discovered will have all nestlings removed		
Contribution	***Very High***	Poaching is the primary threat to nesting parrots		
Irreversibility	***High***	Improved, targeted surveillance and enforcement of nesting areas during nesting season		

Management Strategies:

Strategy 1: Develop community patrol team to monitor nesting sites from late April / early May to June in target areas and in collaboration with the Forest Department

Strategy 2: Improve enforcement of the Wildlife Act re. poaching of parrot nests in the Crooked Tree area

Strategy 3: Improve awareness in schools of wildlife legislation and pride in the Crooked Tree parrots

Strategy 4: Continue to pilot artificial nest sites in safe locations

Strategy 5: Develop and implement a community population monitoring plan for yellow headed parrots

Threats to biodiversity of Crooked Tree Wildlife Sanctuary: Pollution

Pollution	***Status:***	***Historical***	***Active***	***Potential***
	Conservation Target(s): Wetland, Traditionally harvested fish, Waterbirds			
	Stresses (*Direct*)*:* ▪ Reduced health of wetland system ▪ Reduced viability of aquatic biodiversity			
	Sources of Stress (Indirect)***:*** ▪ Agricultural runoff ▪ Potential pollution from sugar cane farm canal draining into CTWS ▪ Poor plastic / solid waste management ▪ Septic tanks and open latrines ▪ Fire runoff ▪ Damming by Blackburn Causeway, resulting in mercury contamination with potential build up in fish tissues			
Scope	***High***	Contamination enters the lagoon from multiple points, including from the Belize River, and therefore affects much of the lagoon system		
Severity	***Medium***	The level of contamination is unknown, but is not considered to be significant. However there are concerns of mercury build-up in fish		
Contribution	***Very High***	Pollution is thought to be one of the highest contributors to reduced water quality		
Irreversibility	***High***	It would be feasible to reduce the level of contamination entering the lagoon system from all sources except the Belize River		

Management Strategies:

Strategy 1: Investigate the potential and cumulative impacts of land use change in the CTWS landscape (e.g. the new, 17,000 acre Mennonite farmland planned for Blackburn Ridge and potential pollution issues from Green Lands Farm (sugar cane)), and address where necessary

Strategy 2: Promote climate-smart agriculture and technology aimed at imptoving best farming practices, with reduced agrochemical use and use of alternative farming techniques in the Crooked Tree landscape

Strategy 3: Facilitate improved septic systems for the remaining 20% pit latrines in Crooked Tree Village

Strategy 4: Improve community knowledge of the wetland dynamics and water quality, with a community-based water quality monitoring programme, building on the CT Wetlands Campaign

Strategy 5: Build awareness and action for improved garbage / plastics management within the school and community

Threats to biodiversity of Crooked Tree Wildlife Sanctuary: Unsustainable Logwood Extraction

Unsustainable Logwood Extraction	***Status:***	***Historical***	***Active***	***Potential***
	Conservation Target(s): Logwood			
	Stresses (*Direct*)*:* ▪ Reduced long term viability of logwood in the Crooked Tree landscape ▪ Reduced extent of logwood in the Crooked Tree landscape			
	Sources of Stress (Indirect)***:*** ▪ Traditional harvested resource of Crooked Tree ▪ Unsustainable cutting of logwood (e.g. harvesting of growing, green posts, not just dry deadwood) for use in Crooked Tree ▪ Unsustainable cutting of logwood for use external to Cooked Tree ▪ Demand for logwood for fencing posts			
Scope	***High***	Logwood is targeted in all locations in the Crooked Tree landscape		
Severity	***Medium***	Increased cutting of green (living) logwood reduces viability of this species. People cutting posts from outside extract the resource less sustainably, targeting larger posts		
Contribution	***Very High***	Considered the primary cause of reduced viability, though logwood is also impacted by fire and land clearance		
Irreversibility	***High***	There would need to be on-site regulation of the logwood extraction to improve long term viability for this species, and to provide some protection to traditional logwood cutters of Crooked Tree		

Management Strategies:

Strategy 1: Develop and implement a Managed Access framework for logwood extraction in the Crooked Tree area in partnership with Forest Department and with participation of logwood cutters, based on community need, community-defined regulations and good science

Strategy 2: Build community pride in the tradition of logwood extraction

Strategy 3: Improve community fire management in key logwood areas

2.3 MONITORING OF SUCCESS OF CONSERVATION STRATEGIES

The series of indicators allocated to each conservation target during the planning process provides a measures of success framework for site level monitoring. Monitoring the success of conservation strategies is an integrated component of the Conservation Action Planning process (Table 25).

Key Cross-Cutting Conservation Strategies	**Wetland**	**Pine Savanna**	**Riparian Forest**	**Traditionally Harvested Fish**	**Game Species**	**Logwood**	**Waterbirds**	**Indicators for Measuring Success of Outputs and Outcomes**
Finalize and demarcate CTWS boundaries on the ground and clarify 66' regulations with Lands Department								▪ *Revised map of CTWS* ▪ *CTWS demarcated on the ground* ▪ *% of fishers / hunters / logwood extractors and tour guides who know locations of CTWS boundaries*
Develop and implement Managed Access systems that for fishing, hunting and logwood extraction protect the traditional rights of Crooked Tree natural resource users, and based on good science informing Sustainable Use Plans								▪ *Established, implemeneted system of permits and regulations for natural resource use* ▪ *Target game/ fish species abundance* ▪ *Logwood extent / density* ▪ *Quantity of logwood extracted per year* ▪ *% of fishers / hunters / logwood extractors actively supportive of and participating in Managed Access*
Ensure all commercial fishers / hunters / logwood cutters are aware of national and site-level fishing / hunting regulations, and have the required licenses								▪ *% of fishers / hunters / logwood extractors operating with relevant licenses / permits*
Enforce national fishing / hunting legislation and identified community sustainable fishery / hunting regulations, in a transparent manner, with the backing of the Village Council								▪ *# incidences of illegal fishing / hunting/ logwood extraction per year* ▪ *# patrols per year in the Crooked Tree area*
Identify and engage advocates (tour guides, women, church leaders) to advocate for good environmental stewardship in the community								▪ *Number of advocates engaged and actively leading community environmental stewardship activities* ▪ *Number of activities / participants per activity per year*
Integrate education and awareness activities in school to raise knowledge of the biodiversity and ecosystem services of CTWS and need for good environmental stewardship								▪ *Number of school activities / participants per activity per year* ▪ *% of participants who demonstrate an increase in knowledge and action as a result of school activities*

Key Cross-Cutting Conservation Strategies	**Wetland**	**Pine Savanna**	**Riparian Forest**	**Traditionally Harvested Fish**	**Game Species**	**Logwood**	**Waterbirds**	**Indicators for Measuring Success of Outputs and Outcomes**
Build community pride in responsible stewardship of CTWS natural resources								▪ *% interviewees in Crooked Tree who express pride in Crooked Tree's natural resources* ▪ *% interviewees in Crooked Tree who demonstrate a change in attitude / behaviour*
Provide skills training / microloan opportunities for fishers / hunters / logwood cutters and their families to assist them in diversifying their income and reduce pressure on the natural resources								▪ *% of fishers / hunters / logwood extractors participating in income diversification activities / opportunities* ▪ *% of fishers / hunters / logwood extractors that have reduced their income dependency on natural resources*
Build resilience of farming practices to climate change and reduce environmental impact through teaching best practices, improved fire management and adoption of agroecology / agroforestry principles								▪ *% of farmers implementing \climate-smart technologies and best practices* ▪ *% of farms include with buffer forest corridors* ▪ *Extent of intact buffer zones in the CT area*
Investigate mechanisms for recognition of traditional non-commercial fishers / hunters (e.g. local subsistence / recreational fisher permit system)								▪ *Abundance of wildlife in buffer areas (camera traps)* ▪ *Annual rainfall patterns* ▪ *% of boundary adjacent to CTWS that is managed for maintenance of forest cover* ▪ *% of boundary adjacent to CTWS that is managed with collaborative surveillance and enforcement* ▪ *Number of hunting / fishing incidences reported*
Use boat-to-boat process to build communication between enforcement personnel and Crooked Tree fishers								▪ *Number of boat-to-boat conversations per month / year* ▪ *% of fishers demonstrating improved engagement in Managed Access and meeting Managed Access requirements*

Key Cross-Cutting Conservation Strategies	**Wetland**	**Pine Savanna**	**Riparian Forest**	**Traditionally Harvested Fish**	**Game Species**	**Logwood**	**Waterbirds**	**Indicators for Measuring Success of Outputs and Outcomes**
Conduct feasibility study to provide support for improving water flow by causeways								▪ *Feasibility study*
Engage the Department of Environment + Ministry of Works towards Increasing the number of culverts in the Crooked Tree Causeway								▪ *% identified required culverts are in place / modified in causeways*
Restore flow of Black Creek								▪ *% of identified key blockages in Black Creek removed* ▪ *Annual clearance of Black Creek achieved* ▪ *% of natural resource users (fishers / tour guides / post cutters) surveyed with the perception that that water flow has improved*
Engage farmers in leaving / re-establishing forest corridors in the Blackburn area								▪ *% of farmers understand the reasoning for and supportive of maintaining forest corridors* ▪ *% of targeted farmers integrating forest corridors into farms / replanting forest species* ▪ *Extent of intact natural vegetation buffer zones in the CT area*
Reforestation of critical areas of the 66' buffer to restore connectivity								▪ *% of riparian belt with replanted riparian trees* ▪ *% of riparian belt with connectivity* ▪ *Number of howler monkey troops using the riparian vegetation and their population size*
Encourage maintenance / restoration of creeks in Blackburn Ridge area by farmers								▪ *% of farmers who understand the need to maintain water flow* ▪ *% of farmers who keep creeks clear of obstruction*
Improve knowledge of wetland dynamics and water quality and communicate outputs to Crooked Tree villagers								▪ *Report on water dynamics* ▪ *Annual report on water quality* ▪ *% of Crooked Tree interviewees who have seen / read information on water quality outputs*

TABLE 25: KEY CROSS CUTTING CONSERVATION STRATEGIES

2.4 PLANNING FOR CLIMATE CHANGE

2.4.1 SITE RESILIENCE ASSESSMENT

Planning for climate change is based on determining the protected area resilience and vulnerability, and identifying adaptive strategies that can assist in maintaining the viability of biodiversity and increase social resilience at both site and stakeholder community level. This assessment of the predicted implications of climate change has been conducted for Crooked Tree Wildlife Sanctuary, based on the ***conservation targets*** identified during conservation planning, and on the ***environmental services*** provided by the protected area, identified in the management plan context.

The following assessment has been based on Belize's "***Guidelines for Integrating Climate Change Adaptation Strategies into Protected Areas Management Plans"*** management planning framework (Walker et al., 2005), and provides a mechanism for assessing the implications of climate change through a series of steps:

1. Understanding climate change projections for the Wildlife Sanctuary
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

IDENTIFICATION OF THE PRIMARY CLIMATE CHANGE ELEMENTS

The primary climate change elements associated with Crooked Tree Wildlife Sanctuary and the associated landscape over the next twenty-five years are identified as:

- Increased intensity of storms
- Increased flood / drought events
- Increased air temperature
- Increased water temperature

In the long term, however, there will also be an increasing threat of salt intrusion into the system, with increasing sea-level rise.

IDENTIFIED RESOURCES OF CROOKED TREE WILDLIFE SANCTUARY

An initial assessment was conducted of the primary resources important to Crooked Tree Wildlife Sanctuary (Table 26). Also reviewed were the conservation targets identified during the conservation planning workshop.

IDENTIFIED RESOURCES OF CROOKED TREE WILDLIFE SANCTUARY	
Wetland functionality as a flood control mechanism, in supporting a traditional freshwater fishery providing both subsistence and commercial fish, and as an important bird-based tourism destination, supporting socio-economic development in the community.	
Black Creek and the Crooked Tree Lagoon System	Black Creek is the critical link between the Crooked Tree Lagoon System and the Belize River, allowing water to flow into the system and back out, depending on the season. It is this connectivity that provides flood control, draining excess water from the Belize River during storm events, reducing the risk of flooding in downstream population centres, including Belize City.
Traditional Harvested Fish	Crooked Tree has a high dependency on fish from the lagoon system for subsistence, commercial and recreational use.
Connected Forest	As a traditional hunting community, there is a cultural demand for game meat, generally hunted from the forests of the Blackburn Ridge and creek sides. The game species rely on forest connectivity in a landscape of increasing deforestation.
Waterbirds	The Wildlife Sanctuary is recognized as a Ramsar site based originally on its importance for waterbirds. This also supports the growing tourism to the area

TABLE 26: IDENTIFIED KEY RESOURCES OF CROOKED TREE WILDLIFE SANCTUARY

For each target, the impacts of the identified primary climate change elements (increased intensity of storms, decreased precipitation, increased air temperature and increased water temperature), were rated on a scale of 1 to 4 (Table 27). Ratings took into account factors such as the severity, scope, contribution and irreversibility of each climate change element.

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

TABLE 27: CLIMATE CHANGE IMPACT RATINGS

Historical climate data from the Caribbean demonstrates the impacts of an approximate 1°C of global warming since pre-industrial times in the region. One degree has contributed to:

- a warming of both air and ocean surface temperatures
- an increase in the number of very hot days and nights
- longer and more frequent periods of droughts
- an increase in very heavy rainfall events
- higher sea levels
- more intense hurricanes with stronger winds and significantly increased rainfall.

The climate change predictions for the Crooked Tree Wildlife Sanctuary landscape were identified from recent literature and climate change models, and an assessment was conducted on the expected impacts on the selected conservation targets (Tables 28, 29 and 30). Four conservation targets were identified as at highest risk from climate change impacts, and were selected for the climate change assessment:

- Wetland
- Pine Savanna
- Riparian Forest
- Traditionally Harvested Fish

Waterbirds were not selected, as their climate change resilience is tied to the resilience of the four selected targets.

CLIMATE CHANGE PREDICTIONS FOR CROOKED TREE WILDLIFE SANCTUARY AND ADJACENT LANDSCAPE			
	Current Status	**25 – 50 yrs**	**100 yrs**
Increased frequency of storms	Increased storm activity from 1999 onwards, with annual fluctuations. More storms during El Nina, fewer El Nino. Stronger storms (more Cat 4 / 5).	Increased storm activity from 1999 onwards, with annual fluctuations. More storms during El Nina, fewer El Nino. Stronger storms (more Cat 4 / 5).	Increased storm activity from 1999 onwards, with annual fluctuations. More storms during El Nina, fewer El Nino. Stronger storms (more Cat 4 / 5).
Decreased reliability of precipitation / Increased flood and droughts	Mean annual rainfall over Belize has decreased at an average rate of 3.1 mm per month per decade since 1960 (UNDP). Reliability of rainfall is decreasing, resulting in increased droughts and floods.	Predicted annual rainfall decrease of approximately 10% by 2079, with increasing unpredictability. Significant changes in rainfall patterns are predicted.	Predicted decrease in precipitation of up to between 24% and 48%; (IPCC, 2007), with significant fluctuations attributed to El Niño
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).	Temperatures are projected to increase by between approximately 0.6°C and 2°C for the RCP2.6 climate prediction scenario, and by 3.6°C and 5.2°C for the RCP8.5 scenario, in relation to the baseline period 1986–2005, for Central America and northern South America–Amazonia (IPCC, 2014).	Mean warming for Latin America at the end of 21st century could reach 1˚C to 4˚C (SRES B2) or 2˚C to 6˚C (SRES A2) (IPCC, 2014).

TABLE 28: CLIMATE CHANGE PREDICTIONS FOR CTWS AND ADJACENT LANDSCAPE

Predicted climate change element	CONSERVATION TARGETS						
	Wetland	***Pine Savanna***	***Riparian Forest***	***Traditionally Harvested Fish***	***Game Species***	***Logwood***	***Waterbirds***
Increased Intensity of Storms	Low (1)	High (3)	High (3)	Low (1)	Medium (2)	Medium (2)	High (3)
Increased Floods / Droughts	High (3)	High (3)	High (3)	Medium (2)	High (3)	Medium (2)	High (3)
Increased Air / Water Temperature	High (3)	Medium (2)	Low (1)	Very High (4)	Medium (1)	Low (1)	Medium (2)
Averaged Rating	2.33 Selected	2.67 Selected	2.33 Selected	2.33 Selected	2.00	1.67	2.67

TABLE 29: ASSESSMENT OF PREDICTED IMPACTS OF CLIMATE CHANGE ON CONSERVATION TARGETS

Climate Change Impacts	Management Features		
	Wetland	Pine Savanna	Riparian Forest
Increased frequency of storms	Crooked Tree is a resilient wetland system that experiences annual flooding during the rainy season. Increasing storms will exacerbate the flooding, impacting the community, and will increase the water level above current flood waters, resulting in water contamination as a result of flooding of latrines, water flow from cattle pastures and adjacent agricultural lands.	Hurricane impacts on the pine savanna ecosystem include damage ranging from loss of tree limbs to removal of all standing trees. Post-hurricane fires, fueled by the increased fuel load, then exacerbate the impacts and can cause the transition to degrade to short-grass savanna, The loss of old oaks required by the yellow-headed parrots, wood ducks and other birds for nesting will reduce viability of these species in the landscape.	Whilst riparian forests in Belize are adapted to be relatively resilient to disturbance, the increased hurricane intensity will cause increased damage, impacting the stature and structure of the river-side vegetation, and may remove some tree species less tolerant of more frequent disturbance. This will lead to increased fuel load and fire risk, degradation to a bamboo-dominated riparian shrubland and loss of the forest connectivity that is so important for game species and arboreal species such as endangered howler monkeys.
Decreased Reliability of Precipitation – Increased drought and floods	Crooked Tree is a resilient wetland system that experiences annual drought and flooding. Changes in the timing and amount of rainfall will impact aquatic life, with potential to alter spawning times of fish and amphibians. Vegetation composition and distribution will also be impacted, with less resilient species disappearing as conditions become more extreme. Flooding of turtle nesting sites may impact nest viability.	Increasing drought in pine savanna areas will increase fire risk and the associated degradation of the ecosystem to short grass savanna, with the decline in species diversity. Fruiting seasonality and supply would also be impacted, affecting those species reliant on these resources and those species higher up the food chain.	Whilst riparian forests in Belize are adapted to be relatively resilient to flooding, they are less resilient to drought, favouring waterside locations. Increased droughts could therefore result in species loss. Extended drought conditions will also exacerbate fire risk, leading to degradation of the ecosystem.

TABLE 30: CLIMATE CHANGE IMPACTS ON MANAGEMENT FEATURES

Climate Change Impacts	Management Features		
	Wetland	Pine Savanna	Riparian Forest
Air /Water Temperature	The shallow nature of the lagoon system results in it being highly susceptible to Increasing water temperatures. This will reduce the oxygen content of the water, decreasing the carrying capacity of the ecosystem, and leading to more frequent fish kills, and impacts up the food chain. Increased air and water temperatures will also affect species that demonstrate environmental sex-determination, such as the critically endangered Central American river turtle.	Increasing air temperatures will impact pine savanna species – *Pinus caribaea* has an average upper tolerance level of 34°C. If high temperatures exceed this for lengthy periods, pines will be outside their tolerance zone, with general ecosystem shifts towards more drought tolerant species.	Increased air temperatures will increase the anthropogenic risk of fires, promoting the shift to bamboo-dominated shrubland, and reducing the potential for regeneration to a riparian forest structure
Sea level rise / salt intrusion	Salt water intrusion into the Belize River system has been recorded as far upriver as the Black Creek mouth. In the long term, predicted increases in sea level will result in the seasonal inflow of saline water. This will then result in buildup of salts in the system as the lagoon dries up in the dry season, leading to a shift towards more salt tolerant species	In the long term, predicted increases in sea level will result in the seasonal inflow of saline water during high tides, and eventually inundation of the area (very long term) – the pine savanna vegetation will change towards more salt-tolerant species, with greater similarity to the current pine savannas of the southern coastal plain.	Salt water intrusion into the Belize River system has been recorded as far upriver as the Black Creek mouth. In the long term, predicted increases in sea level will result in the seasonal inflow of saline water. This may result in a shift towards estuarine species in the Riparian Forest – such as red mangroves, and the disappearance of less salt-tolerant species.

TABLE 30 CLIMATE CHANGE IMPACTS ON MANAGEMENT FEATURES

Climate Change Impacts	Management Features Traditionally Harvested Fish
Increased frequency of storms	The increased frequency and strength of tropical storms may have no, or even a beneficial impact on the traditionally harvested cichlid and other fish species of the lagoon system, with the potential to increase the flow of fish into the system through Black Creek, and the length of time that the system is inundated. The deeper water following storm events will also extend the foraging and nesting areas available for local fish species, reducing competition with *Tilapia*.
Decreased Reliability of Precipitation – Increased drought and floods	Increasing drought and a longer dry season may have significant implications on the local fish species, with lagoons and pools drying out more frequently. This would result in reduced diversity of species, as only the more resilient would be able to withstand the increasingly harsh conditions of extreme flooding / extreme drought. The system would also become increasingly at risk from fires, with the potential to alter the physio-chemical attributes of both the lagoon soils and water.
Air /Water Temperature	The shallow nature of the lagoon system increases its susceptibility to Increasing water temperatures. This will reduce the oxygen content of the water, decreasing the carrying capacity of the ecosystem, and leading to more frequent fish kills, with impacts up the food chain.
Sea level rise / salt intrusion	Salt water intrusion into the Belize River system has been recorded as far upriver as the Black Creek mouth. In the long term, predicted increases in sea level will result in the seasonal inflow of saline water. This will then result in buildup of salts in the system as the lagoon dries up in the dry season, leading to a shift towards more salt tolerant fish species

TABLE 30: CLIMATE CHANGE IMPACTS ON MANAGEMENT FEATURES

2.4.2 CLIMATE CHANGE-RELATED THREAT ASSESSMENT

A threat assessment was conducted highlighting the highest current anthropogenic threats to each of the key conservation targets. Potential threats that may evolve as a result of climate change were also identified (Table 31). The threats were then assessed using a series of ratings (Table 32).

Key Conservation Target	Current Anthropogenic Threats	Potential Key Climate Change-Related Anthropogenic Threats
Wetland	▪ Altered water flow ▪ Unsustainable fishing ▪ Agrochemical Pollution ▪ Unsustainable Harvesting of Logwood	▪ Increased pressure for access to fish stock by non-traditional fishers as farming becomes less sustainable ▪ Removal of water for irrigation of agricultural areas as rainfall becomes less reliable ▪ Altering natural water flow through damming of lagoon or creeks ▪ Changes in wetland characteristics as a result of changes in ground water quality and increased extraction to supply growing urban populations and agricultural lands adjacent to the Crooked Tree Lagoon system
Pine Savanna	▪ Poorly Managed Agricultural Fires ▪ Hunter-Set Fires ▪ Illegal Logging ▪ Poaching of Parrots	▪ Increased fire risk from agricultural fires following tropical storms and associated increased fuel load ▪ Clearances of savannah for agriculture and urban settlements as population migrates away from coastal areas as a result of sea level rise
Riparian Forest	▪ Riparian Clearance ▪ Riparian Forest Fragmentation ▪ Poorly Managed Fire	▪ Increased storms result in increased fuel load, increasing the fire risk ▪ Clearance of riparian forests for agriculture and urban settlements as population migrates away from coastal areas as a result of sea level rise
Traditionally Harvested Fish	▪ Unsustainable fishing ▪ Altered water flow	▪ Increased pressure for access to fish stock by non-traditional fishers as farming becomes less sustainable

TABLE 31: CURRENT AND POTENTIAL KEY 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 32: RATING CRITERIA FOR ASSESSING CLIMATE CHANGE ADAPTATION THREATS PER TARGET (AFTER TNC, 2007/ OPEN STANDARDS)

TABLE 33: ASSESSMENT OF CLIMATE CHANGE ADAPTATION THREATS					
	Certainty	***Severity***	***Scope***	***Irreversibility***	***Averaged Score***
Wetland					
Increased pressure for access to fish stock by non-traditional fishers as farming becomes less sustainable	***Very High (4):*** The area is already accessed by non-traditional fishers – this will increase in the future unless effective enforcement is in place.	***Medium (2):*** Increased fishing pressure by non-traditional fishers may shift the balance of fish species in the lagoons and creeks, but the wetland functionality itself will remain intact. Illegal nets across Black Creek will impact the number of fish able to enter the lagoon system to repopulate after droughts.	***High (3):*** Fishing incursions occur through more than 50% of the area – in both the lagoons and creeks.	***Medium (2):*** Significant investment in engagement of traditional fishers and enforcement activities would be needed to ensure the area is respected as a traditional use area. If this is in place, then reversal would be possible.	***2.75***
Removal of water for irrigation of agricultural areas as rainfall becomes less reliable	***Medium (2):*** Agriculture is increasing in the areas adjacent to the lagoon system – with a predicted increase in droughts, the probability of drawdown of water from the lagoons / creeks for irrigation will increase.	***Low (1):*** The predictions are for annual droughts, which will dry out the lagoons more frequently, and negatively impact agriculture in the adjacent areas. Pumping water from the creeks and lagoons for irrigation may result in the water drying up faster, but is unlikely to be significant.	***Very High (4):*** Drawing water from the lagoon will affect the water level of the whole system, but is unlikely to be at a significant amount (maybe only mm) in the near future (next five years).	***High (3):*** Reversible, but would require alternative water sources, perhaps from a deep water well.	***2.50***

TABLE 33: ASSESSMENT OF CLIMATE CHANGE ADAPTATION THREATS					
	Certainty	***Severity***	***Scope***	***Irreversibility***	***Averaged Score***
Wetland					
Altered natural water flow through damming of lagoon or creeks to improve access to farmlands	***Very High (4):*** Causeways are already reducing /obstructing water flow – increased flooding will encourage continued road development to maintain access to farm areas, acting as dams in inundated areas	***Very High (4):*** Causeways are reducing wetland functionality as a flood sink, with vegetation die-off in areas that remain inundated. Drainage will be impacted by any road development that raises the road above the natural soil level,	***Very High (4):*** Changes in water flow will affect the entire system	***Medium (2):*** Once the blockage is removed or culverts added, the lagoon drainage system will revert back to normal state.	***3.50***
Changes in ground water quality and increased extraction to supply growing urban populations and agricultural lands adjacent to the Crooked Tree Lagoon system	***High (3):*** The populations of Crooked Tree and other adjacent communities are growing with increasing water demands. New agricultural areas are also being established in the area that will require irrigation if rainfall decreases.	***Medium (2):*** Depending on the scale of draw from the groundwater, the severity may be sufficient to exacerbate the predicted droughts, with disappearance of more vulnerable plant and animal species.	***Very High (4):*** Any changes in groundwater will have the potential to impact the entire system.	***High (3):*** Whilst theoretically reversible, the practicalities are that reducing use of the groundwater is unlikely to happen, as access to water is considered a right, and the population is predicted to increase.	***3.00***

TABLE 33: ASSESSMENT OF CLIMATE CHANGE ADAPTATION THREATS					
	Certainty	***Severity***	***Scope***	***Irreversibility***	***Averaged Score***
Pine Savanna					
Increased fire risk from agricultural and hunter fires	***Very High (4):*** The savanna is already being impacted by increasing fire frequency. More intense dry seasons and increased fuel load after tropical storms will increase fire risk	***High (3):*** The pine savanna is being and will increasingly be degraded by the increased frequency of fire	***Very High (3):*** If fire occurs, it will cover more than 75% of the pine savanna	***High (3):*** Recovery will take many tens of years, and full recovery may not be achieved within 100 years. Improving fire management and preventing hunting fires requires a behavioural shift.	***3.25***
Riparian Forest					
Increased fire risk associated with increased fuel load from tropical storms	***Very High (4):*** The riparian vegetation is already being impacted by increasing fire frequency. More intense dry seasons and increased fuel load after tropical storms will increase fire risk	***High (3):*** The Riparian Forest is being and will increasingly be degraded by the increased frequency of fire	***High (3):*** Fire will impact between 50% and 75% of the Riparian forest in any one year	***High (3):*** Recovery will take many tens of years, and full recovery may not be achieved within 100 years. Improving fire management and preventing hunting fires requires a behavioural shift.	***3.25***

TABLE 33: ASSESSMENT OF CLIMATE CHANGE ADAPTATION THREATS					
	Certainty	***Severity***	***Scope***	***Irreversibility***	***Averaged Score***
Traditionally Harvested Fish Species					
Increased pressure for access to fish stock by non-traditional fishers as farming becomes less sustainable	***Very High (4):*** The area is already accessed by non-traditional fishers – this will increase in the future unless effective enforcement is in place.	***High (3):*** Increased fishing pressure by non-traditional fishers may shift the balance of fish species in the lagoons and creeks. Illegal nets across Black Creek will impact the number of fish able to enter the lagoon system to repopulate after droughts.	***High (3):*** Fishing incursions occur through more than 50% of the area – in both the lagoons and creeks.	***Medium (2):*** Significant investment in engagement of traditional fishers and enforcement activities would be needed to ensure the area is respected as a traditional use area. If this is in place, then reversal would be possible	***3.00***
Altered natural water flow through damming of lagoon or creeks to improve access to farmlands	***Very High (4):*** Causeways and blockages in creeks are already reducing /obstructing fish movement through the system	***Very High (4):*** If Black Creek and Spanish Creek become blocked, there will be no / limited replenishment of fish stocks to the lagoon system	***Very High (4):*** Changes in water flow will affect the fish stocks in the entire system	***Medium (2):*** Once blockages are removed, the fish stocks revert back to normal state.	***3.50***

RANKED OUTPUTS

The assessment provides a prioritization 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 (Tables 33 and 34). The highest ranked threat is the predicted (and already occurring) alteration of water flow through damming of parts of the Crooked Tree system – partial obstruction of the Black Creek and complete obstruction by the Blackburn Causeway. This is already significantly impacting the wetland trapped behind the dam, with the loss of wetland plant species (including logwood) and inundated savanna species.

CLIMATE CHANGE RELATED THREAT	RELEVANT TARGET(S)	AVERAGED SCORE
Altered natural water flow through damming of lagoon or creeks to improve access to farmlands	Wetland (3.50) Traditionally Harvested Fish (3.50)	3.50
Increased fire risk from agricultural and hunter fires	Pine Savanna (3.25) Riparian Forest (3.25)	3.25
Changes in ground water quality and increased extraction to supply growing urban populations and agricultural lands adjacent to the Crooked Tree Lagoon system	Wetland (3.00)	3.00
Increased pressure for access to fish stock by non-traditional fishers as farming becomes less sustainable	Wetland (2.75) Traditionally Harvested Fish forest (3.00)	2.88

TABLE 34: SUMMARY OF CLIMATE CHANGE-RELATED THREAT ASSESSMENT OUTPUTS

2.4.3 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 (Table 35).

TABLE 35: CLIMATE CHANGE ADAPTATION STRATEGIES				*Indicators*
Goal	***To restore the health and ecosystem services of the wetlands of Crooked Tree Wildlife Sanctuary through improved water flow***			▪ *% of natural resource users (fishers / tour guides / post cutters) surveyed who think that water flow has improved*
Objective	Engage all stakeholders (Government, communities and landowners) in ensuring that the water flow into and out of the Crooked Tree Lagoon system is not obstructed, with maintenance of natural wetland characteristics and flood sink functionality.			▪ *% of CT surveyed who understand the need to maintain water flow*
Strategy	***Strategic Actions***	***Complimentary Activities***	***Timeline***	
Restoration of Black Creek	Engage national and local stakeholders in the maintenance of natural water flow and wetland characteristics ▪ Partner with the National Climate Change Office to identify funding for restoration of Black Creek ▪ Community action to restore Black Creek and maintain it on an annual basis	Climate change planning for Belize / Belize City	Ongoing (5 years +)	▪ *% of identified key blockages in Black Creek removed* ▪ *Annual clearance of Black Creek*
Improvement of water flow through causeways	Engage the national and local stakeholders towards: ▪ increasing the number of culverts in the Crooked Tree Causeway ▪ installing culverts in the Blackburn Causeway ▪ Restore / maintain flow in Spanish Creek	Climate change planning for Belize / Belize City	Ongoing (5 years +)	▪ *% required culverts are in place and fully functional in causeways*
Goal	Reduce incidence of fires in the CTWS landscape			▪ *Number of fires that impact CTWS per year* ▪ *Number of acres impacted by fire*
Objective	Engage stakeholders in active, improved fire monitoring and management in the landscape			
Reduce fire risk from agricultural and hunter activities	▪ Improve awareness of the legislation relevant to fires (agricultural fires and hunting fires) ▪ Ensure CTWS has fire-fighting equipment on site and accessible	National Fire Management Initiative / Programme for Belize BAS	3 years	▪ *Pre and post community survey to measure knowledge of legislation / regulations relevant to fire* ▪ *Availability of firefighting equipment*

TABLE 35: CLIMATE CHANGE ADAPTATION STRATEGIES				***Indicators***
Goal	***Reduce incidence of fires in the CTWS landscape***			▪ *Number of fires that impact CTWS per year* ▪ *Number of acres impacted by fire*
Objective	Engage stakeholders in active, improved fire monitoring and management in the landscape			
Strategy	***Strategic Actions***	***Complimentary Activities***	***Timeline***	
Reduce fire risk from agricultural and hunter activities	▪ Run fire community awareness campaign before dry season, including signage, to improve fire awareness (Protect pine, protect cashew, no fire) ▪ Provide training for community members, local farmers and BAS staff in effective fire management ▪ Identify and engage advocates (tour guides, women, church leaders) for good fire management in the community ▪ Conduct education and awareness activities in school to raise knowledge of the need for good fire management ▪ Enforcement of fire regulations – targeted surveillance of identified fire hotspots and at critical times ▪ Develop fire management protocols, including prescribed burns	National Fire Management Initiative / Programme for Belize / BAS Fire Management Training and Activities	5 years	▪ *Pre and post community survey to measure knowledge* ▪ *Awareness campaign implementation report* ▪ *Number of persons engaged as advocates for good fire management* ▪ *% of total students in school participating in activities focused on fire awareness per year* ▪ *Pre and post surveys in schools to measure fire awareness* ▪ *Number of patrols that include a focus on enforcement of fire regulations* ▪ *Number of prescribed burns* ▪ *Percentage of target areas for prescribed burns recommended by protocol that are implemented*

TABLE 35: CLIMATE CHANGE ADAPTATION STRATEGIES				*Indicators*
Goal	***Mitigation of increased anthropogenic impacts (settlements and agriculture) in the landscape***			▪ *Population of stakeholder communities within the Crooked Tree drainage area* ▪ *Number of acres impacted by anthropogenic impacts within the Crooked Tree drainage area*
Objective	Improve proactive mitigation of increased agricultural and settlement impacts on the Crooked Tree Wildlife Sanctuary and drainage area			
Strategy	***Strategic Actions***	***Complimentary Activities***	***Timeline***	
Changes in ground water quality and increased extraction to supply growing urban populations and agricultural lands adjacent to the Crooked Tree Lagoon system	▪ Design and implement a water quality monitoring programme, integrating community researchers ▪ Work with farmers in the landscape to build resilience to climate change, reducing impacts on the CTWS drainage area (organic farming, water conservation, maintenance of forest connectivity and canopy)	Agro-ecology / agroforestry projects under Ya'axché Conservation Trust, FCD (Vaca) SACD mapping of New River water quality National Integrated Water Resource Authority	5 years+	▪ *Population of stakeholder communities within the Crooked Tree drainage area* ▪ *Annual draw from lagoon / ground water for irrigation of agricultural areas* ▪ *% of farmers engaged in farming best practices* ▪ *Annual report on water quality* ▪ *% of septic systems are pit latrines*

TABLE 35: CLIMATE CHANGE ADAPTATION STRATEGIES				*Indicators*
Goal	***Sustainable management of fish stocks in CTWS with protection of traditional users rights***			▪ *Site specific Managed Access licenses for CTWS fishers* ▪ *% of CTWS fishers fully engaged and supportive of Managed Access* ▪ *Improved catch per fisher (size / quantity)*
Objective	Effective introduction and implementation of a Managed Access fishery in CTWS			
Strategy	***Strategic Actions***	***Complimentary Activities***	***Timeline***	
Increased pressure for access to fish stock by non-traditional fishers as farming becomes less sustainable	▪ Work with CTWS fishers to design and implement a Managed Access fishery structure for CTWS ▪ Identify key entry points and use areas for illegal fishing incursions. ▪ Ensure effective, targeted, intelligence-based surveillance and enforcement of CTWS to prevent fishing incursions from non-traditional users of the area ▪ Work with farmers in the landscape to build resilience to climate change, reducing impacts on the CTWS drainage area (organic farming, water conservation, maintenance of forest connectivity and canopy)	Fisheries Department Managed Access framework SACD MA development for Corozal Bay Wildlife Sanctuary	5 years+	▪ *% of CTWS fishers consider that the CTWS MA Committee is active and effective* ▪ *% of CTWS fishers fully engaged and supportive of Managed Access* ▪ *Site specific Managed Access licenses for CTWS fishers* ▪ *Number of fishing incursions per year* ▪ *Number of fishing incursions addressed successfully by surveillance and enforcement activities*

Section Three

Management Planning

3. MANAGEMENT PLANNING

3.1 MANAGEMENT AND ORGANIZATIONAL BACKGROUND

The regulatory authority for Crooked Tree Wildlfe Sanctuary (CTWS) lies with the Forest Department (Ministry of Agriculture, Forestry, Fisheries and Sustainable Development), supported by the National Protected Areas Act (2015). As with many national protected areas in Belize, site manangement presently lies with a co-management agency, Belize Audubon Society, with responsibilities presented in a co-management agreement. In 2018, a Crooked Tree Wildlife Sanctuary Steering Committee was established, composed of the Forest and Fisheries Departments, Belize Audubon Society, and the Crooked Tree Village Council, forming a collaboration towards develoment of the revised CTWS management plan, to overcome site-level conflicts that have created significant barriers to effective protected area management on the ground and its contribution to community development.

Management of the Wildlife Sanctuary is currently in a transition stage (end of 2018), with the Forest Department, Fisheries Department, Crooked Tree Village Council and Belize Audubon Society working together to pave the way for a new future of collaborative management structure – the Crooked Tree Wildlife Sanctuary Management Committee, with the community playing a much larger part in decision-making and implementation of the management plan.

As the management structure evolves, it will keep the integrated approach developed in 2018 for the temporary Crooked Tree Steering Committee, with representation from the four key agencies / organizations and two key sectors of the community – commercial fishers and the tourism sector.

The proposed CTWS Management Committee membership is modelled on the previous CTWS Steering Committtee membership:

- Forest Department
- Fisheries Department
- Crooked Tree Village Council
- Belize Audubon Society
- Representative from the CTWS Fishers Committee
- Representative from the Crooked Tree Tourism sector

There also needs to be representation from the traditional fishers of the other identified stakeholder communities, achieved through the CTWS Fishers Committee, following the Managed Access committee structure used by Fisheries Department. Women and youths play important roles within the community and should also be considered for potential membership

Each member brings different strengths and perspectives to the Management Committee:

REPRESENTATIVE	STRENGTHS/ PERSPECTIVES
Forest Department	The management authority for the Wildlife Sanctuary, and mandated with the role of wildlife protection
Fisheries Department	The management authority for the Crooked Tree fishery, with strengths in management of fisheries and enforcement of fishery legislation
Belize Audubon Society	The co-management agency for the protected area. Strengths are in biodiversity monitoring, project financing and management, education and outreach. Has a budget for management of the protected area, with employment of staff and equipment
Crooked Tree Village Council	The local authority for the community, elected by the village. Brings the perspectives of the community and links the Wildlife Sanctuary with community development. Can generate community support for the protected area and provide feedback to the community
Commercial Fishing Sector	Through inclusion of a representative of the CTWS Fishers Committee. Brings the perspectives of the fishers, and ensures that their input is included in management decisions. Can also provide feedback to the fishers
Tourism Sector	Brings the perspectives of the tourism sector, and ensures that their input is included in management decisions. Can also provide feedback to the tourism sector in Crooked Tree.

TABLE 36: STRENGTHS AND PERSPECTIVES OF THE CTWS MANAGEMENT COMMITTEE

The CTWS Management Committee should be fully participatory in the development and approval of the Annual Workplan each October, based on the Management Plan. It should meet at least once a quarter to agree on activities for the following quarter, based on the Workplan. The Belize Audubon Society, as the co-management signatory, will play a supporting role in the implementation of the approved Annual Workplan, in collaboration with the Crooked Tree Village Council, contributing its expertise in protected area management, in sourcing funds for human resources, staff and project activities, financial management and in protected area reporting requirements.

MANAGEMENT COMMITTEE AGENCIES

FOREST DEPARTMENT

The Forest Department (Government of Belize), within the Ministry of Agriculture, Fisheries, Forestry, Environment, Sustainable Development and Immigration (MAFFESDI) is the regulatory agency for protected areas in Belize. Under its Protected Area Management Programme, the Forest Department has oversight of the protected areas under its mandate and, as part of MAFFESDI, is responsible under the BAS / MAFFSDI co-management agreement for:

"… Providing management oversight with respect to the management of the protected area 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."

BAS / MAFFESD Co-management Agreement, 2013

FISHERIES DEPARTMENT

The Fisheries Department (Government of Belize), within the Ministry of Agriculture, Fisheries, Forestry, Environment, Sustainable Development and Immigration (MAFFESDI) is the regulatory agency for management of both marine and inland fisheries fisheries resources in Belize. Some of the primary programs include: inland fisheries enforcement, the conservation and management of hicatee, and research and management of invasive species. The Fisheries Department is well positioned to assist in the establishment of a Managed Access framework for the traditional fishery of the Crooked Tree lagoon, and in the development of a site specific Surveillance and Enforcement Plan for the successful implementation of the framework

CROOKED TREE VILLAGE COUNCIL

The current Crooked Tree Village Council is an elected body that has the role of encouraging and assist cooperation on economic and social development and general welfare of the community. They run community centres, and assist villagers in making representations to government when there are problems with particular services such as school supplies, primary healthcare, and the provision of agricultural extension services. The CTVC recognizes that the natural resources of the area need to be maintained in a sustainable manner and developed further in order to make life challenges easier for Crooked Tree residents. It seeks to build Crooked Tree as one of Belize's main tourist attractions based on the abundance of natural resources, with tourism as the basis for community development. It provides an imoprtant role in ensuring that the commuity is fully participatory in management decisions for the Wildlife Sanctuary, and in ensuring the community is informed and participatory in the implementation of the Wildlife Sanctuary management plan.

BELIZE AUDUBON SOCIETY

Since its establishment, Crooked Tree Wildlife Sanctuary has been managed by Belize Audubon Society (BAS), a non-governmental organization under a co-management agreement with the Forest Department. Over the years, BAS has grown into a leading conservation organisation in Belize, co-managing seven national protected areas, with a vision and a mission that reflects the need for sustainable management of natural resources and a balance between people and the environment. BAS currently has a five-year co-management agreement with the Forest Department for Crooked Tree Wildlife Sanctuary, signed on December, 2013 and extended in 2018 under a letter of commitment from the MAFFESDI. Under this agreement, BAS is responsible for:

> *"the day-to-day management and administration of the protected area, preparation and implementation of management and operational plans for the protected area, and the management and development of the finances of the protected area, as detailed in the National Protected Areas Co-Management Framework.*
>
> *a) Day-to-day management and administration of the protected area 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.*
>
> ***BAS / MAFFESDI Co-management Agreement, 2013***

Priority steps to be taken include:

- Formal establishment of the CTWS Management Committee, established with the Belize Forest Department
- A Terms of Reference that defines the scope and level of involvement / committment of each Committee member - roles and responsibilities
- Developing and implementing mechanisms to ensure effective communication and information sharing between all members
- Developing clear operational frameworks that address / reduce past conflicts
- Integrate a conflict resolution / grevience process into the collaborative management framework

3.1.1 REVIEW OF PREVIOUS MANAGEMENT PLAN

The previous management plan, drafted in 2004, was never finalized, adopted or formally implemented, with political issues that prevented successful community consultation and validation. However, BAS has continued to implement activities in the protected area under the different programme areas, with varying success.

3.1.2 MANAGEMENT EFFECTIVENESS

The last evaluation of management effectiveness was conducted in 2009 / 2010, and provides a snapshot of the state of management effectiveness in 2010, to identify key strategies for strengthening management.

National Indicators

Management effectiveness is evaluated through the **Monitoring Package for Assessing Management Effectiveness of Protected Areas** (Young et. al. 2005, modified by Walker et al., 2010), based on seven different indicator categories (Table 37).

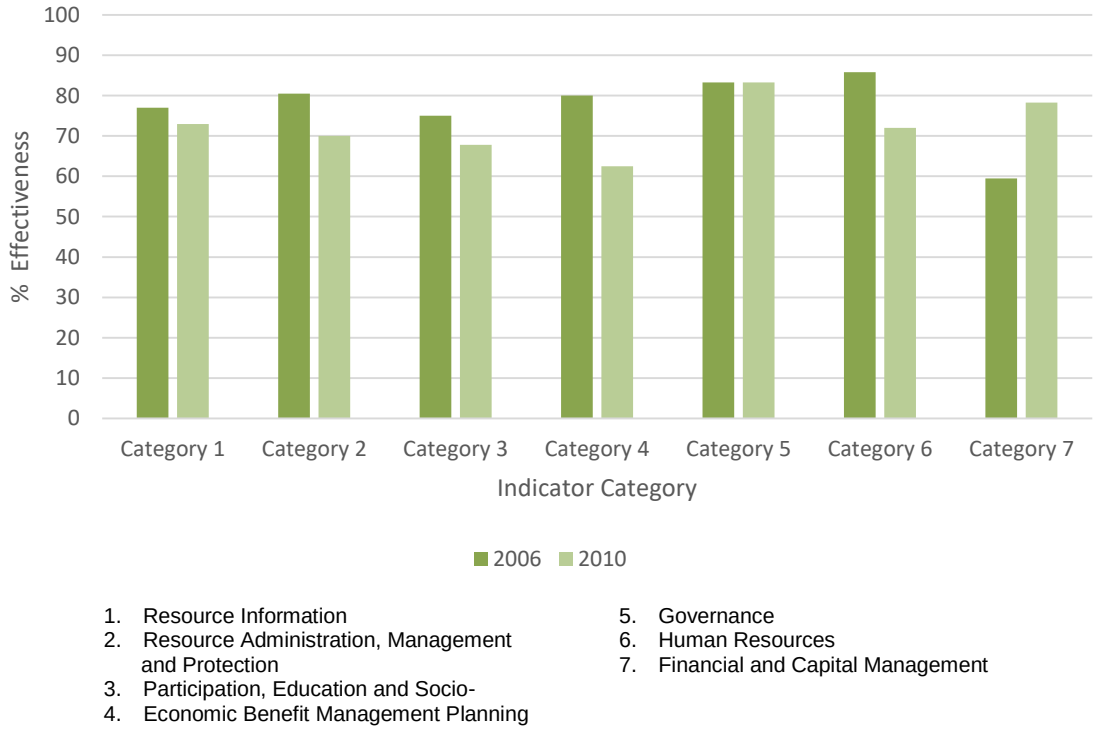
Indicator Categories		
Indicator Category	**Average Score 2006**	**Average Score 2010**
1. Resource Information	77.0	73.0
2. Resource Administration, Management and Protection	80.5	70.0
3. Participation, Education and Socio-Economic Benefit	75.0	67.8
4. Management Planning	80.0	62.5
5. Governance	83.3	83.3
6. Human Resources	85.8	72.0
7. Financial and Capital Management	59.5	78.3
Overall	**77.3%**	**72.4%**

***** Indicators and Indicator categories used are from Walker et al., 2010, (modified from Young et al. (2005)), and scored on a scale of 1 – 4: Poor (1: ≤25%); Fair (2: >25 - 50%); Good (3: >50% - 75%); Very Good (4: >75%)

TABLE 37: RESULTS PER INDICATOR CATEGORY FOR CTWS – 2006 and 2010

The overall management effectiveness of Crooked Tree Wildlife Sanctuary in 2010 was rated as **GOOD,** with a score of **72.4%** (2.90 out of 4.00) – a decrease from **VERY GOOD** (from the 2006 rating of 77.3%) to **GOOD** (Figures 14, 15 and 16). All indicator categories rate as either **GOOD** or **VERY GOOD**, ranging from **62.5%** to **83.3%**. One indicator category (Financial and Capital Management) increased between 2006 and 2010, one (Governance) remained stable, showing no change. These two are mostly tightly linked to the status of the co-management organization rather than the management of the protected area itself, demonstrating the increasing strengths of Belize Audubon Society as a co-management organization. The majority (five) of the indicator categories, however, have decreased from **VERY GOOD** to **GOOD,**

suggesting a significant change in the status of on-site management**.** This is a factor in the identification of the need to greatly increase the engagement and involvement of the Crooked Tree community in implementation of the management plan (Table 38).



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

FIGURE 14: MANAGEMENT EFFECTIVENESS OF MANAGEMENT CATEGORIES

Crooked Tree Wildlife Sanctuary: Strengths and Weaknesses of Indicator Categories and Trend			
Rating	**Range**	**Indicator Category**	**2006 to 2010**
VERY GOOD	>75%	5. Governance	-
		7. Financial and Capital Management	▲
GOOD	>50 – 75%	1. Resource Information	▼
		2. Resource Administration, Management and Protection	▼
		3. Participation, Education and Socio-Economic Benefit	▼
		4. Management Planning	▼
		6. Human Resources	▼
FAIR	>25 – 50%	No indicator Categories rate as Fair	
POOR	≤ 25%	No indicator Categories rate as Critical	
Assessment using modified National Indicators (Young et. al., 2005)			

TABLE 38: STRENGTHS AND WEAKNESSES OF INDICATOR CATEGORIES

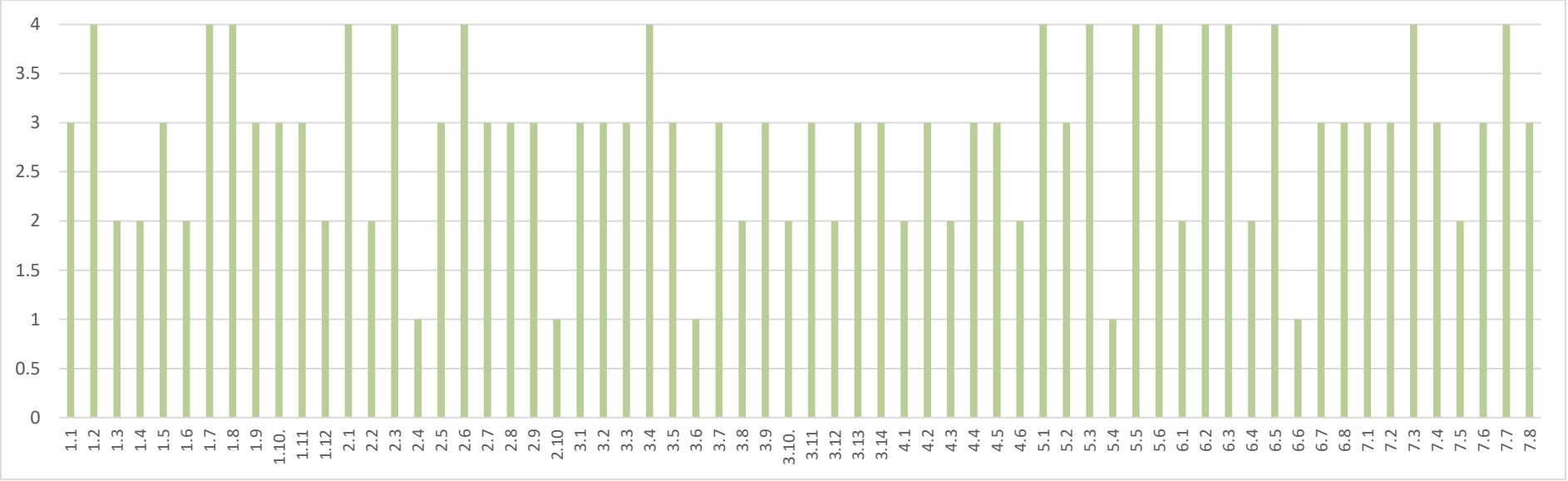


FIGURE 15: MEAN SCORE BY INDICATOR – SORTED BY INDICATOR SECTION

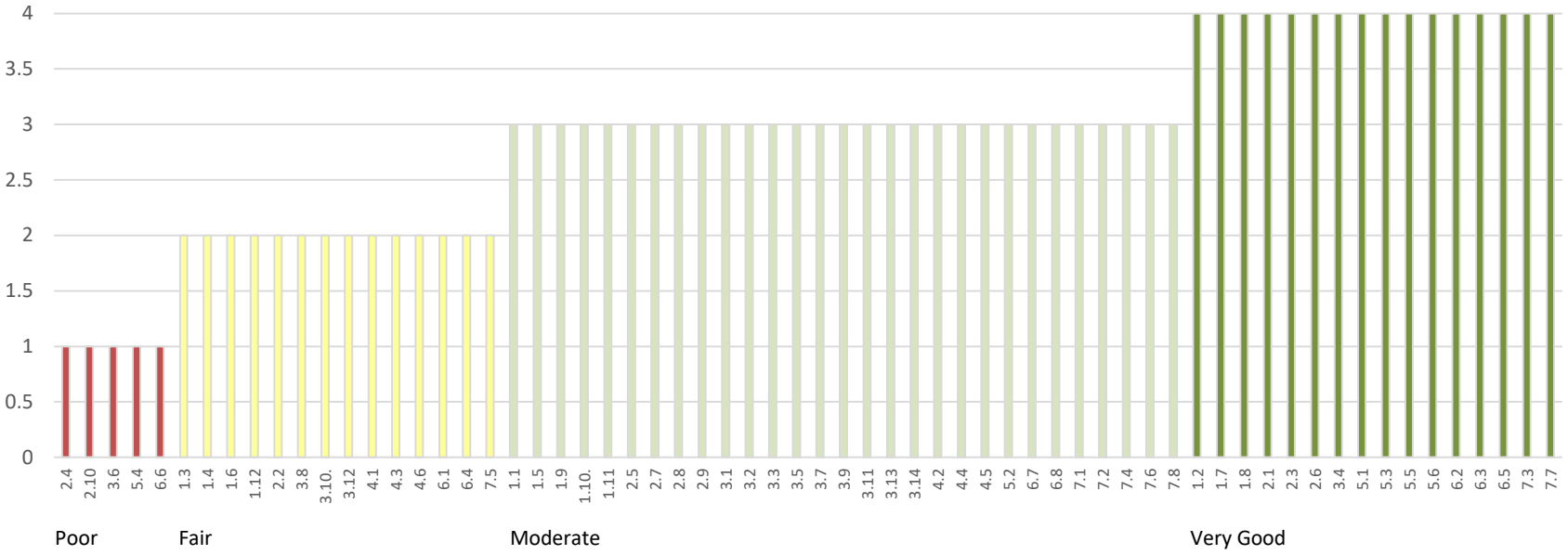


FIGURE 16: MEAN SCORE BY INDICATOR – SORTED BY SCORE

POOR	Five indicators (7.8%) rate as POOR
FAIR	Fourteen indicators (21.9%) rate as FAIR
GOOD	Twenty-nine indicators (45.3%) rate as GOOD
VERY GOOD	Sixteen indicators (25%) rate as VERY GOOD

NON-BIODIVERSITY INDICATORS (YOUNG ET. AL. 2005)		
1. Resource Information	**3. Community Participation and Benefits**	**5. Governance**
1.1 Physical Environment	3.1 Communication Activities	5.1 Protected area objectives
1.2 Biotic Environment	3.2 Stakeholder Engagement	5.2 Co-management agreements
1.3 Cultural and Archaeological Resources	3.3 Educational Activities	5.3 Administrative autonomy
1.4 Social, Cultural, and Economic Context	3.4 Dissemination of Knowledge and Information	5.4 Advisory Committee
1.5 Resource Use and Occupancy	3.5 Level of Stakeholder Participation in Management Benefits	5.5 Board of Directors
1.6 Tenures and Claims	3.6 Local Actors Leading Management	5.6 Inter-organizational mechanisms
1.7 Conservation Target	3.7 Volunteer Activities	**6. Human Resources**
1.8 Systematic Threat Assessment	3.8 Strength of Social Capital	6.1 Qualified Site Manager
1.9 Traditional Knowledge	3.9 Capacity Building Strategies	6.2 Site Manager Availability
1.10 Information Management Systems	3.10 Socio-Economic Benefits Strategy	6.3 Administrative Staff Availability
1.11 Environmental Monitoring Activities	3.11 Extent of Local Economic Benefits	6.4 Technical, Scientific, and Professional Staff Availability
1.12 Functional Scientific Research Activities	3.12 Sustainable Use for Economic	6.5 Operations Staff Availability
2. Resource Management	3.13 Employment in activities related to the protected area	6.6 Human Resource Assessment
2.1 Legal: Legal Status	3.14 Local Recognition of Protected Area Benefits	6.7 Training and Development
2.2 Legal: Boundary Survey and Demarcation	**4. Management Planning**	6.8 Staff Satisfaction
2.3 Legal: Permit, and Approval Processes	4.1 Management Plan Implementation	**7. Financial and Capital Management**
2.4 Tenure Claim Conflict Resolution	4.2 Operational Plan Implementation	7.1 Funding Adequacy
2.5 Guidelines and Best Management Practices	4.3 Regulation and Zoning Implementation	7.2 Revenue Generation
2.6 Natural Resource Management	4.4 Guidelines and Best Management Practices	7.3 Financial Management
2.7 Protection: Surveillance Activities	4.5 Long Term Management Needs Identification	7.4 Infrastructure Adequacy
2.8 Protection: Enforcement Activities	4.6 Program Monitoring and Evaluation	7.5 Equipment Adequacy
2.9 Visitor and Tourism Management Activities		7.6 Internal Access Adequacy
2.10 Visitor and Tourism Monitoring Activities		7.7 Signage Adequacy
		7.8 Maintenance Adequacy

FIGURE 16: NON-BIODIVERSITY INDICATORS (WALKER ET AL., 2010 (MODIFIED FROM YOUNG ET AL. 2005)

INDICATORS REQUIRING SIGNIFICANT STRENGTHENING IN 2010
(Rating as POOR or FAIR)

POOR:

2.4 Tenure Claim Conflict Resolution
2.10 Visitor and Tourism Monitoring Activities
3.6 Local Actors Leading Management
5.4 Advisory Committee
6.6 Human Resource Assessment

FAIR:

1.3 Cultural and Archaeological Resources
1.4 Social, Cultural, and Economic Context
1.6 Tenures and Claims
1.12 Functional Scientific Research Activities
2.2 Legal: Boundary Survey and Demarcation
3.8 Strength of Social Capital
3.10 Socio-Economic Benefits Strategy
3.12 Sustainable Use for Economic
4.1 Management Plan Implementation
4.3 Regulation and Zoning Implementation
4.6 Program Monitoring and Evaluation
6.1 Qualified Site Manager
6.4 Technical, Scientific, and Professional Staff Availability
7.5 Equipment Adequacy

MODERATE / GOOD: Thirty-one indicators rate as MODERATE / GOOD
VERY GOOD: Twenty-four indicators rate as VERY GOOD

3.2 MANAGEMENT STRATEGIES

3.2.1 POLICY AND LEGAL FRAMEWORK

Management strategies are guided by national protected area legislation and objectives, and the goals and objectives of the Forest Department.

Crooked Tree Wildlife Sanctuary is currently designated as a non-extractive protected area under the **National Protected Areas System Act** (2015) (Table 39). Legislative authority is held by the Forest Department (Ministry of Agriculture, Forestry, Fisheries and Sustainable Development), with a co-management agreement with Belize Audubon Society (BAS), the NGO co-management partner responsible for day-to-day management of the protected area.

In the revision of the national protected areas legislation, there was recognition of the need to ensure that traditional use rights of communities are protected where possible. The Wildlife Sanctuary category, for those protected areas designated for their importance for specific species or ecosystems, was therefore divided into two – Wildlife Sanctuary (1) and Wildlife Sanctuary (2). The former continues to be non-extractive, but Wildlife Sanctuary (2) recognizes the rights of traditional natural resource extraction in conflict with the current designation, and provides a mechanism for continued use, based on an approved sustainable use plan. The current management planning process seeks to move Crooked Tree from a Wildlife Sanctuary to Wildlife Sanctuary (2), opening the way for sustainable resource use by traditional users, particularly for the traditional fishery.

PROTECTED AREAS CATEGORIES		
Category	**Purpose**	**Activities Permitted**
Wildlife Sanctuary (Current)	To protect nationally significant species, biotic communities or physical features.	Research, education, tourism
Wildlife Sanctuary (1)	To protect nationally significant species, biotic communities or physical features.	Research, education, tourism
Wildlife Sanctuary (2) (Current – recommended for CTWS)	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

TABLE 39: CTWS PROTECTED AREA CATEGORIES

3.2.2 SUSTAINABLE USE PLANNING

The shift to Wildlife Sanctuary (2) to allow for the recognition of traditional resource use requires a sustainable use plan…a key strategy to be developed during the first year of management plan implementation. For fishing to be termed "sustainable", it must meet the following criteria:

- 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

...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.

Sustainable management can only be achieved if based on scientific information from Catch-Per-Unit-Effort (CPUE) monitoring and stock assessments, and through provision for zoned closures to allow protection of spawning and nursery grounds. This plan seeks to provide the foundation for the development of effective sustainable management of the small scale fishery of Crooked Tree Wildlife Sanctuary, in collaboration with the local fishermen - the traditional users of the area.

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

FAO, 1998

The fish caught should therefore be of neither too young (pre-reproduction) nor too old. A number of conditions are required for a small-scale sustainable fishery initiative to succeed within the Wildlife Sanctuary. These include:

- A formalized agreement between local fishermen, Forest Department, Fisheries Department and BAS, to protect the traditional access rights of the fishermen
- the identification and engagement of key stakeholders – the traditional users
- active participation from the traditional fishermen themselves
- agreements with the relevant agencies for strategy development and management

Engaging fishermen is as a long term process, though a number of mechanisms can be used to facilitate engagement:

- Fishermen should also lead the fishery management process as much as possible, with the Fisheries Department and BAS providing assistance and guidance

- The formation of a management group for the Sustainable Fishery needs to come out of initial meetings as a requirement voiced by the fishermen, who should also participate in defining the structure and role of the management group (number / type of participants). This could be synonymous with the Managed Access Committee
  NOTE: *This step has been discussed during the management planning consultations (Crooked Tree, 2018)*

- Regular meetings should be held by the Managed Access committee for the fishers to keep them informed

- More structured meetings should not clash with fishing schedules – these meetings, too, can be held in a neutral space, outside if preferred and should be relatively informal

- There should be active and rapid follow-up on ideas put forward during meetings to show results

- Meetings should focus on the fishermen's needs
  NOTE: The need for collaboration and good, non-antagonistic communication between BAS Park Wardens and fishermen when encountering each other on the water was discussed during the consultation process

- Meetings should be facilitated so that fishermen direct the outcomes, through asking leading questions, and listening to the answers.

- Informal training can be used to build capacity for articulating ideas for those fishermen interested in playing a more active role in fishery management

- Suggest a start-up project for the management group – something small with achievable outcomes (e.g. lamination and distribution of Crooked Tree fishing regulations for posting in community; distribution of copies to fishermen; erection of Fishermen's notice board).

- Not all fishermen can be engaged at the start of the process – work with those willing and interested in more effective management of fish resources, then reach out during the baseline development process

- Ensure fishermen benefit in outputs – e.g. through stipends for participation as research volunteers, training, access to resources, alternative livelihood opportunities etc.

RELEVANT LEGISLATIVE FRAMEWORK

Belize has a strong legislative framework supporting natural resource management. Any sustainable fishery initiative needs to be managed within this framework, developing collaborative partnerships with the relevant Government agencies

- the Forest Department with the mandate for management of Wildlife Sanctuaries within Belize, and
- the Fisheries Department, with the mandate to manage fisheries resources within Belize.

Both departments lie under the umbrella of the Ministry of Agriculture, Fisheries, Forestry and Sustainable Development.

Forest Department Legislation

Under the revised National Protected Areas System Act, there is now flexibility for Wildlife Sanctuaries to be re-designated as Wildlife Sanctuary (2), allowing for traditional resource use based on an approved sustainable use plan. It is proposed that Crooked Tree move from Wildlife Sanctuary to Wildlife Sanctuary (2).

Fisheries Department Legislation

The Fisheries Act provides a framework for fishing activities within the marine environment, and is currently being revised to cover any aquatic environment. A number of legal requirements are in place throughout Belize to regulate fishing, all of which are applicable to fishing activities in the Crooked Tree Wildlife Sanctuary.

- all fishermen need to be in possession of a valid fisherman's license
- all boats and boat captains need to be in possession of the relevant valid licenses
- no fisherman can use poison or explosives in fishing
- all nets should have a minimum mesh size of 3" (preferably 4"), and be set following the Fisheries Department restrictions, which prohibit setting of nets in the following localities:
    - at river and creek mouths
    - within a mile of any community
    - in a channel
    - in spawning areas
- no fishermen should target species covered under the sport fishing legislation

The draft Fisheries Resource Bill calls for fishery management plans "*in respect of each fishery or category of fisheries*". These shall:

(a) address trends in the biological, economic and social characteristics of the fishery including issues requiring special attention;

(b) address how the fishery is to be managed using precautionary and ecosystem approaches to fisheries;

(c) address historical measures and the proposed conservation, management and development measures to be applied to the fishery;

(d) address the fish stocks, fisheries management units and management objectives;

(e) describe the processes and indicators for management and measuring management performance;

(f) make provision in relation to any other matter necessary for sustainable use of fishery resources.

National Fisheries Net Regulations SI 78 of 2011

- No gill net can be longer than 100 metres
- If gill nets are joined together, their combined length cannot exceed 100 metres
- No person can possess a gill net / gill nets which by itself, or joined to another gill net, exceeds 200 metres
- The owner of a boat cannot carry a combined length of gill nets over 200 metres
  NOTE: most nets used in Crooked Tree are over 100' in length, and fishers often have between two and four nets each (Community Consultation, 2018)
- Minimum mesh size is 3"
  NOTE: Fisher representatives suggested that 3.5" may be preferable (Community consultation, 2018)
- No gill nets should be set within one mile of a bridge

- No gill net, seine net, stop net or long line should be set more than ¼ of the way across a river creek or stream
- No gill net, seine net, stop net or long line should be set more than 1/10 of the way across a lagoon, or exceed 200 metres in total length
- ALL nets should be registered with and tagged by the Fisheries Department – registration requires presentation of a fishing license, and a fishing vessel license (if applicable)
- No net can be owned or used to take hicatee

Fishers of Crooked Tree Wildlife Sanctuary

In 2018, the first steps were taken towards the development of a sustainable fishery plan for the Crooked Tree Lagoon. An estimated 15 fishers in Crooked Tree Village itself are considered to be commercial fishers, though not all are completely dependent on the small scale fishery of the Crooked Tree Lagoon system, and not all fish throughout the year. Only 8 of these were licensed in 2017 (Table 40; Fisheries Data, 2017).

Community	Estimated number of Commercial fishermen*	Number of Licensed Fishermen in 2017**	Relative Dependency
Crooked Tree	15	8	High
Lemonal		4	Low
Biscayne	3 to 4	0	Low
Gardenia	< 3	0	Low
Isabella Bank		0	Low
Rockstone Pond		0	Low

TABLE 40: COMMUNITIES WITH FISHERS THAT USE CROOKED TREE WILDLIFE SANCTUARY

Lemonal, Isabella Bank, Biscayne, Gardenia and Rockstone Pond also have a smaller number of fishers that regularly use either the creeks and Southern Lagoon, and / or Mexico and Jones Lagoons, depending on the location of the community.

Types of Fishermen

Three types of fisherman were identified as using the Wildlife Sanctuary – those who fish for commercial purposes (either full time or part time), those who fish for recreational or subsistence home use, and a small number who fish for sport or act as sport fishing guides (Table 41). Each has a specific set of equipment, dependent on the type of fishing, and target a specific suite of species.

TYPES OF FISHERMEN – CROOKED TREE LAGOON	
Commercial	Gill net Seine net Spear gun Cast net Trap line
Non-Commercial / Recreational	Hook and line Rod and reel Hand striking Cast fishing
Sport Fishing	Rod and reel (catch and release)

TABLE 41: TYPES OF FISHERMEN (COMMUNITY CONSULTATIONS, 2018)

Commercial Fishers: The majority of the commercial fishers in Crooked Tree use gill nets (up to four nets per fisher), generally with a mesh size of between 3" and 4", set overnight along water ways. Canoes are the predominant form of transport, though a small number of fishers have small boats with 4hp outboards. As the water drains out of the system, seine nets are used to fish shallow water pan areas, before they are affected by the reduced oxygen levels. Fish is sold either to a buyer who comes to the community, purchasing up to 200 lbs at a time, or sold in adjacent communities and Orange Walk.

Crooked Tree has a small number of dedicated 'haul days' a year in front of the village held between May and June, when the lagoon water recedes to chest deep or lower and the fish start to face their annual die-off as water levels and oxygen contents drop. Each 'haul day' lasts for 4 to 6 hours, and is requested by the Village Council, in consultation with Belize Audubon Society, and authorised by the Forest Department. This is timed to coincide with the days prior to one of the local festivals… 'Tilapia Fest' (a celebration of the haul days), Cashew Fest and Easter. Seasonal changes in weather patterns have resulted in conditions not supporting a haul day in 2018, with water levels remaining too high for use of seine nets.

In the dry weather, when water is clearer in the deeper areas of lagoon and creeks, fishers will also dive using spear guns, targeting larger cichlids (predominantly *Tilapia*).

Household use (Recreational / Subsistence): Fishers will strike bay snook in shallow water inundation areas when water is high and the fish disperse to form breeding pairs. When the water starts to recede, competition for food increases, and native fish species are more likely to be caught by hook and line or rod and reel (*Tilapia* are caught less frequently on hooks). Some non-commercial fishers will also use cast nets.

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. The focus is on the large bay snook and tarpon.

Non-traditional Fishers:

There are rising concerns of the increasing number of fishers from immigrant households that access the area, using cast nets with smaller mesh size (2½"), and targeting all species, regardless of size.

Fishing Areas

A mapping exercise in the key stakeholder community of Crooked Tree demonstrates that there is a loose division of the fishing area per community (Figure 17). Fishing activities focus on freshwater fish species that move into and out of the lagoon system through Black Creek, changing seasonally, and using a variety of fishing methods and equipment. A number of other communities from across Belize access the area for fishing, primarily in dry season, but are not considered traditional users. Those identified include Sandhill, Cotton Tree, Orange Walk, Carmelita, Guinea Grass, Shipyard, and Chan Chen. Some fish throughout the year, whereas others, such as those from Sandhill, focus on fishing over the Easter period.

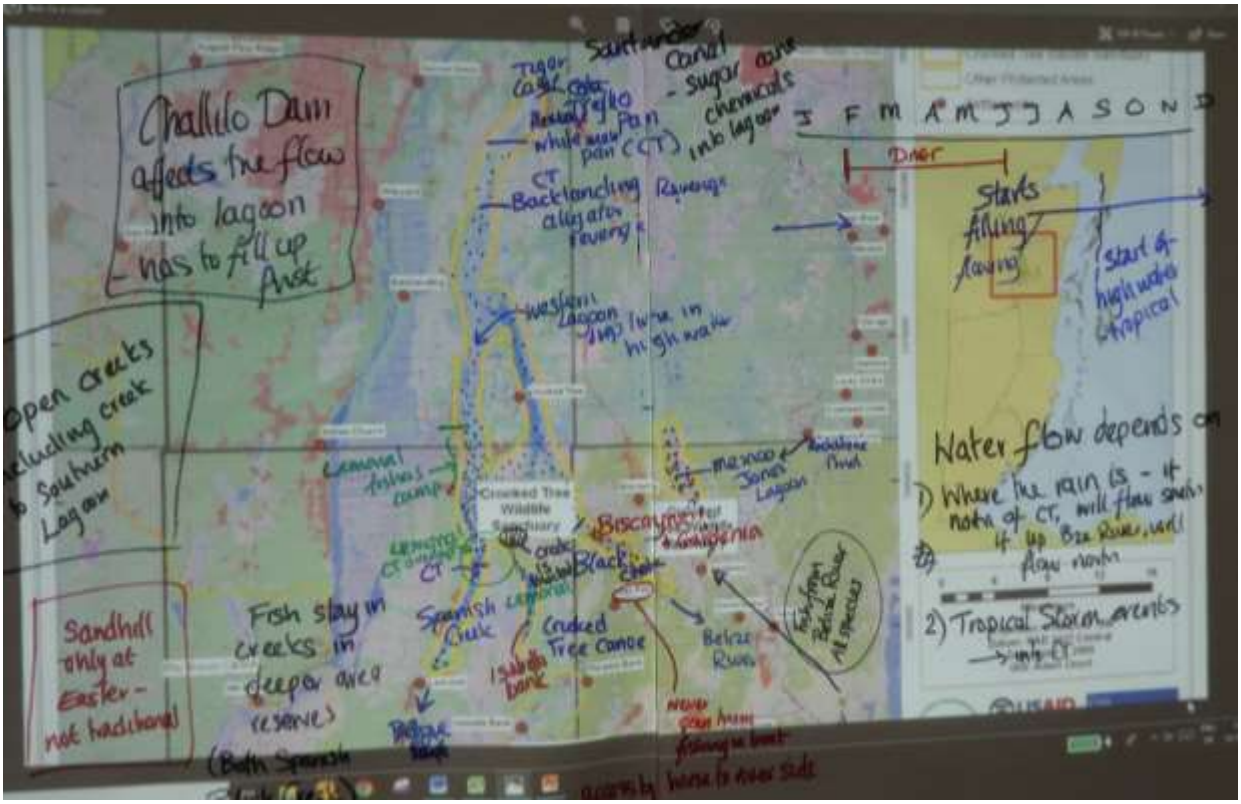


FIGURE 17: FISHING AREAS PER COMMUNITY (CROOKED TREE COMMUNITY CONSULTATIONS, 2018)

COMMUNITY	FISHING AREA(S)
Crooked Tree	The primary user of the lagoon fishery, with the largest fishing area, covering the entire lagoon. Fishers utilize the main lagoon areas from Revenge Lagoon in the north to Southern Lagoon in the south. Will also enter the top end of Black creek and Jones Lagoon, generally accessing fishing locations by canoe or small boat and establishing fishing camps in the 66' reserve.
Lemonal	Has the biggest overlap of fishing area with Crooked Tree fishers, utilizing Spanish Creek and Western Lagoon, and establishing fishing camps in the 66' reserve of Western Lagoon. This community also fishes in Southern Lagoon.
May Pen	Black Creek, accessing the area by horse or foot, and fishing from the river bank.
Rancho Dolores	Spanish Creek
Biscayne / Gardenia	Black Creek and Mexico / Jones Lagoons.
Isabella Bank	Southern Lagoon.
Rockstone Pond / Maskall	Mexico / Jones Lagoons

TABLE 42: FISHING AREAS PER COMMUNITY (CROOKED TREE COMMUNITY CONSULTATIONS, 2018)

Fishing Seasons

Fishing methods change over the year, based on the water level in the lagoon (Table 43).

FISHING SEASONS	February to June	June to October	October to December	December to February
State of Lagoon	Water drains from the lagoon / lagoon dries up. Water heats up during the dry season	As the wet season starts, the lagoon refills, with water from the surrounding wetland drainage and from the Belize River	Continued rainfall leads to the lagoon flooding, inundating the wetland areas	Water level starts to decrease
State of Fish	Annual fish die-off as the water level decreases, and oxygen content declines	Freshwater fish enter the system from the Belize River (upstream)	Fish catch declines as the fish disburse into the wetlands and are harder to catch – catch primarily support household / community needs	
Fishing Practices	Annual haul using seine nets adjacent to the CT Causeway, authorized by the Village Council. Other fishing areas become more accessible as the wetland dries. Seine nets in water pans, gill nets in creeks	Gill nets are used in the wetland areas, following trails and in clearings – use is restricted to areas where the nets can stretch to the floor. Fishers will camp out for five to 6 days at a time, watching their nets.		Spear fishing for *Tilapia*
		Spear guns are used when the water is clear, with Tilapia composing an estimated 90% of the catch		

TABLE 43: FISHING AREAS PER COMMUNITY (CROOKED TREE COMMUNITY CONSULTATIONS, 2018)

Target Species

In addition to the predominant *Tilapia*, eight species are regularly fished from Crooked Tree Wildlife Sanctuary for commercial or home-use purposes (Table 44), with estuarine species such as stone bass and jacks entering the system during the dry season, when brackish water in the Belize River reaches the Black Creek mouth.

Common Name	Local Name	Species Name
Bay snook	Bocona	*Petenia splendida*
Mayan Chiclid	Crana	*Cichlasoma urophthalmus*
Quetzal cichlid	Tuba	*Vieja synspilum*
Yellowjacket	Mosmos	*Parachromis friedrichsthalii*
Blue Catfish	Vaca	*Ictalurus furcatus*
Common Snook	Snook	*Centropomus undecimalis*
Atlantic Tarpon	Tarpon	*Megalops atlanticus*
Bigmouth Sleeper	Dormilon	*Gobiomorus dormitor*
Stone Bass		Gerridae
Jacks		Carangidae
Tilapia		*Oreochromis niloticus*

TABLE 44: SPECIES FISHED REGULARLY FROM CROOKED TREE WILDLIFE SANCTUARY (COMMUNITY CONSULTATIONS, 2018)

Recommended Site-Specific Strategies

A number of recommendations were put forward during the community consultations for developing a site specific Managed Access framework towards increasing the sustainability of the fishery, based on the traditional commercial fishing activities currently being conducted in the Crooked Tree Lagoon system. These include:

- Formation of a Managed Access committee formed from representatives from the traditional fishers (elected by the fishers), Crooked Tree Village Council, Fisheries Department, and Belize Audubon Society
- The Managed Access Committee should meet three times a year
- Identification of traditional fishers from Crooked Tree and other relevant communities, and criteria for future selection (e.g. utility bill from Crooked Tree or other traditional fishing community; letter of confirmation from village Council, resident in community for more than one year)

- All commercial fishers required to have a valid fishing license specifying Crooked Tree Wildlife Sanctuary as their fishing area
- All commercial fishers requested to attend annual meeting to review national and site specific regulations – could be combined with issuing of new licences.
- Training of BAS rangers in improved surveillance and enforcement techniques, in collaboration with Managed Access committee fisher members – less hostile, improved relationship between fishers and park wardens, working together to reduce fishing incursions from non-traditional users
- Use a three-strike rule for fishing offences by traditional fishers…verbal warning, written warning, temporary removal of licence
- Develop an appeal process for those people who are not approved as traditional fishers, or who have temporarily (or permanently) lost their right to fish due to multiple offences
- Ensure all residents have the right to fish non-commercially. Develop protocols that cover subsistence / recreational fishing, with a free permit system managed by Village Council / Managed Access Committee, based on a list of residents
- Develop protocols that cover subsistence / recreational fishing day permits for visitors (family and friends of community residents) – possibly with a charge (day permit)
- Net positions should be marked to avoid boat strikes
- Nets should not be set in creeks that are less than 6’ wide
- The small-mesh ‘Chinese nets’ are considered unsustainable, and should not be used in the lagoon system

3.3 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 environmental education. 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 to strengthen communication and collaboration between Program areas is also important, with inter-Program collaboration mechanisms for greater adaptive management effectiveness.

Six Management Programmes are identified to provide the framework for management of the Wildlife Sanctuary (Table 45):

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

The management plan identifies intervention strategies for improving conservation target viability and mitigation of threats identified during the planning process – strategies that are incorporated into the management programmes, and into the measures of success programme to ensure effective management. As well as site-specific strategies, national strategies are also taken into account, including proposed national biodiversity corridors contributing towards landscape management, and contribution to national and global development goals.

Programme Areas					
NATURAL RESOURCE MANAGEMENT AND PROTECTION	**RESEARCH AND MONITORING**	**COMMUNITY DEVELOPMENT AND OUTREACH**	**TOURISM MANAGEMENT**	**MANAGEMENT AND ADMINISTRATION**	**INFRASTRUCTURE, EQUIPMENT AND MAINTENANCE**
▪ *Surveillance and Enforcement* ▪ *Boundaries and Zones* ▪ *Management Target Management* ▪ *Addressing Specific Threats*	▪ *Biodiversity Monitoring* ▪ *Biodiversity Research* ▪ *Dissemination of results*	▪ *Environmental Education* ▪ *Stakeholder Outreach and Engagement* ▪ *Resilient Livelihoods*	▪ *Visitor Management* ▪ *Visitor Safety and Protection* ▪ *Visitor Education and Interpretation*	▪ *Planning* ▪ *General Management and Administration* ▪ *Financial Management* ▪ *Communication / Collaboration*	▪ *Operational Infrastructure* ▪ *Equipment* ▪ *Visitor Infrastructure* ▪ *Vehicle and Equipment Maintenance*

TABLE 45: MANAGEMENT PROGRAMMES OF CROOKED TREE WILDLIFE SANCTUARY

3.3.1 NATURAL RESOURCE MANAGEMENT AND PROTECTION PROGRAMME

The Resource Management and Protection Program focuses on ensuring the maintenance of healthy, functional ecosystems, through direct management of the environment and sustainable resource use, surveillance and enforcement and biodiversity management interventions. This Programme falls under the responsibility of the site manager, guided by the CTWS Management Committee. Four sub-programmes have been identified under this program.

NATURAL RESOURCE MANAGEMENT AND PROTECTION
Maintaining the integrity of species, ecosystems and ecosystem services
NRM 1: Surveillance and Enforcement **NRM 2:** Boundaries and Zones **NRM 3:** Management of Management Targets **NRM 4:** Addressing Specific Threats

The **Surveillance and Enforcement** sub-program for CTWS focused in the past on maintaining the integrity of the protected area and its biodiversity as a non-extractive Wildlife Sanctuary, primarily through surveillance and enforcement, and tourism management. Priority strategies for 2019 – 2023 include:

- Developing a Surveillance and Enforcement Plan in consultation with the CTWS fishers that focuses on supporting a Managed Access regime in CTWS, and enforces against illegal incursions by non-traditional fishers / hunters / logwood extractors
- Developing a Surveillance and Enforcement Plan through collaborative input from the CTWS Management Committee, with clearly defined roles and responsibilities
- Ensuring CTWS has the human resources, equipment and training for effective surveillance
- Strengthening the collaboration with the Fisheries and ForestDepartments for effective enforcement
- Capacity building of park wardens and fishers in reducing conflict during surveillance activities – improved methods for approaching fishers that reduce confrontation
- Building capacity for navigation, GPS use, training in NPAS and Fisheries regulations
- Determining high water mark and demarcating the **Boundaries** on the ground is critical, as many of the surveillance and enforcement activities are reliant on being able to define the location of the boundaries.

The **Habitat and Species Management** sub-program include strategies highlighted under the Conservation Planning section and addresses threats to the viability of biodiversity within the protected areas. Priority strategies for for 2019 – 2023 include:

- Restoring natural water flow in the Crooked Tree system, strengthening ecosystem services – particularly in flood control during storm events
- Restoring the riparian forest to improve forest connectivity in the landscape

- Build capacity in BAS and in the wider CTWS landscape for effective fire management
- Develop in-house and collaborative strategies with other organizations with similar agendas for:
    - maintenance of forest connectivity as part of the national corridors strategy
    - addressing threats from pollution in the CTWS drainage area
    - strengthening coordinated assistance to communities towards improved natural resource stewardship
    - protection of yellow-headed parrot nests / nestlings
    - addressing the issues of jaguar-livestock conflict

NATURAL RESOURCE MANAGEMENT PROGRAM

NRM 1: EFFECTIVE SURVEILLANCE AND ENFORCEMENT

- ☐ Develop a surveillance and enforcement plan in consultation with the CTWS fishers that supports a Managed Access regime in CTWS, and enforces against illegal incursions by non-traditional fishers / hunters / logwood extractors
- ☐ Ensure CTWS has the human resources and equipment for effective surveillance and enforcement
- ☐ Ensure surveillance activities are strategic and effective, based on surveillance data, incidence mapping and identification of hotspots, intelligence information, integration of SMART technology and inclusion of data from traditional fishers
- ☐ Maintain and strengthen collaborative partnerships with Forest and Fisheries Departments towards effective surveillance and enforcement within CTWS
- ☐ Increase collaboration with the Fisheries Department (Inland Waters) for joint patrols in support of the development and implementation of the site-specific Managed Access fishery
- ☐ Increase collaboration with the Fisheries Department (Inland Waters) for joint patrols in response to illegal fishing incursions by non-traditional fishers
- ☐ Maintain and strengthen engagement and communication with communities, with particular focus on traditional fishers / hunters / logwood extractors
- ☐ Implement effective enforcement of visitor regulations in CTWS, in collaboration with BTB (e.g. tour guide-guest ratios, licenses) and enforcement of BTB
- ☐ Increase night patrols in key areas with improved capacity through use of night vision equipment
- ☐ Increase surveillance and enforcement of creeks during times of peak fishing activity
- ☐ Increase surveillance and enforcement of yellow-headed parrot nesting sites during nesting season, in collaboration with the Crooked Tree community
- ☐ Integrate surveillance and enforcement requirements for conservation strategies – e.g. surveillance for fire

NRM 2: BOUNDARIES AND ZONES

NRM 2.1: BOUNDARIES AND ZONES

- ☐ Finalize and demarcate CTWS boundaries on the ground, in collaboration with the CTWS Management Committee, with adequate signage to ensure visual recognition of boundaries at all key points
- ☐ Request clarification from Lands Department and Department of the Environment on regulations with respect to the 66’
- ☐ Collaborate with the Lands Information Centre to update the shapefiles for CTWS in the National Protected Areas System dataset, ensuring inclusion of Southern Lagoon, clarification on apparent de-reservation of approximately 500 ha in the southern portion of the Crooked Tree island, and private land incursions
- ☐ Ensure all resource users in key CTWS stakeholder communities are consulted during the sustainable use planning and aware of the Managed Access regulations and guidelines, once finalized and approved, through effective communication, focal group meetings, printed matter and signage
- ☐ Identify zones that may be required for specific species protection – e.g. hicatee, fish nurseries

NATURAL RESOURCE MANAGEMENT PROGRAM

NRM 3: MANAGEMENT OF CONSERVATION TARGETS

NRM 3.1 WETLAND

- ☐ Engage relevant Government and local stakeholders towards Increasing the number of culverts / improving flow through the culvert of the Crooked Tree Causeway and installing culverts in the Blackburn Causeway
- ☐ Restore flow in Black Creek in partnership with the CTWS community
- ☐ Annual maintenance of Black Creek in partnership with the CTWS community
- ☐ Encourage farmers to maintain / restore creeks draining Blackburn Ridge
- ☐ Maintain flow of Spanish Creek
- ☐ Improve knowledge of wetland dynamics and water quality and communicate outputs to Crooked Tree
- ☐ Investigate potential pollution issues from Green Lands (sugar cane) and the Mennonite farm on Black Creek (rice farm, adjacent to Crocland site) and implement mitigation measures
- ☐ Support community projects that reduce pesticide use (e.g. organic farming)
- ☐ Facilitate improved septic systems for the remaining 20% pit latrines in Crooked Tree
- ☐ Improve community stewardship of the hicatee in the CTWS

NRM 3.2 PINE SAVANNA

- ☐ Build capacity of CTWS rangers for fire management through provision of training and equipment
- ☐ Build capacity for fire management in the wider landscape, with strengthened engagement of communities and adjacent landowners
- ☐ Partner / form strategic alliances with other NGOs in the landscape towards effective fire monitoring and management
- ☐ Run community fire awareness campaign before dry season to improve community awareness of the legislation relevant to fires (agricultural fires and hunting fires), including signage to improve fire awareness (Protect pine, protect cashew, no fire)
- ☐ Targeted fire awareness activities for hunters and farmers
- ☐ Identify and engage advocates (tour guides, women, church leaders) to advocate for good fire management in the community
- ☐ Integrate education and awareness activities in schools to improve knowledge of the need for good fire management
- ☐ Surveillance of fire hotspots and critical times
- ☐ Develop and implement a community monitoring plan for yellow headed parrots, in collaboration with the Forest Department and Belize Audubon Society
- ☐ Improve enforcement of Wildlife Act re. poaching of parrot nests in the Crooked Tree area
- ☐ Improve awareness in schools of wildlife legislation and pride in the Crooked Tree parrots
- ☐ Continue to pilot artificial parrot nest sites in safe locations

NATURAL RESOURCE MANAGEMENT PROGRAM

NRM 3: MANAGEMENT OF CONSERVATION TARGETS

NRM 3.4 RIPARIAN (RIVER-SIDE) VEGETATION

- ☐ Clarify 66' regulations with Lands Department and improve local awareness of these regulations, for improved management of CTWS
- ☐ Targeted surveillance and enforcement against tree clearance and /or installation of fence posts in the 66' buffer, in collaboration with the CT Village Council
- ☐ Human impact mapping of the riparian vegetation of Black Creek and Spanish Creek
- ☐ Reforestation of critical areas of Black Creek and Spanish Creek to strengthen connectivity

NRM 3.5 TRADITIONALLY HARVESTED FISH SPECIES

- ☐ Work with traditional fishers to develop a Managed Access framework and site level guidelines for Crooked Tree, for sustainable management of the fish resources (see Public Use Program)
- ☐ Effective surveillance and enforcement against illegal fishing (See surveillance and enforcement strategies
- ☐ Ensure all commercial fishers are aware of hunting regulation, and have the relevant licenses
- ☐ Provide skills training and business development opportunities for fishers to assist them in diversifying their income and reduce pressure on traditionally harvested fish species

NRM 3.6 GAME SPECIES

- ☐ Effective surveillance and enforcement against illegal hunting (See surveillance and enforcement strategies
- ☐ Develop and implement a Managed Access system that protects the traditional rights of Crooked Tree hunters and improves sustainability
- ☐ Ensure all commercial hunters are aware of hunting regulation, and have the relevant licenses
- ☐ Provide skills training and business development opportunities for hunters to assist them in diversifying their income and reduce pressure on game species

NRM 3.7 LOGWOOD

- ☐ Effective surveillance and enforcement against illegal hunting (See surveillance and enforcement strategies
- ☐ Develop and implement a Managed Access system that protects the traditional rights of Crooked Tree hunters and improves sustainability

NRM 4: ADDRESSING CONSERVATION THREATS

- ☐ Strengthen management actions and strategies to address the future impacts of climate change and build resilience, based on the Climate Change Adaptation outputs
- ☐ Develop in-house and collaborative strategies with other organizations with similar agendas for:
    - Promote maintenance of forest cover in the CTWS landscape
    - addressing threats from land-based pollution
    - strengthening coordinated assistance to communities towards improved natural resource stewardship

3.3.2 RESEARCH AND MONITORING PROGRAMME

RESEARCH AND MONITORING
Sound monitoring and research informing public perceptions and management decisions
RM1: Biodiversity Monitoring
RM2: Biodiversity Research
RM3: Limits of Acceptable Change Monitoring
RM4: Dissemination of results

Research and monitoring are essential activities to ensure informed, effective management, to inform public perceptions, and to assess the effectiveness of the protected areas in achieving its objectives. The Research and Monitoring Programme currently falls under the responsibility of the BAS Conservation Programme and the Science Director, and provides data for guiding amangement decisions and contributing to information on national biodiversity monitoring indicators, to inform and influence policy at the national level. and informing recommendations by the national working groups (jaguars and birds). Socio-economic monitoring falls under the responsibility of the Natural Resource Management and Community Outreach Programmes. Past and current activities under this programme area include:

Key Strategic Goals

- Develop and institute a standardized biodiversity monitoring program and research guidelines for BAS staff and external researchers to ensure that researchers follow procedures and protocol to guide research and minimize disturbance in the protected areas
- Build structural and technical capacity for biodiversity research and monitoring to develop in-house biodiversity research and monitoring expertise/capacity, and ensure quality of data.
- Provide information towards addressing research priorities of the National Research Agenda

- Central American Waterbird Census (monitoring waterbirds that depend on the wetlands)
- Monthly monitoring of all birds sighted within the Sanctuary
- Ecological assessment of the lagoon system
- Data collection from fish hauls
- Monitoring of water levels
- Data collected by several researchers over the years has help us to inform the management plans and has given knowledge about the wetland system for management & educational purposes

Priority strategies for 2019 – 2023

- Establish a monitoring plan to support the data needs for implementation of Managed Access
- Community training in monitoring of Yellow headed parrot nests
- Continue monitoring water-focused parameters – depth, quality - to inform management decisions
- Improved technical capacity for monitoring for mammals / wildlife in general, with standardized data collection through SMART

RESEARCH AND MONITORING PROGRAM

RM1: BIODIVERSITY AND SOCIO ECONOMIC MONITORING

RM 1.1 BIODIVERSITY

- ☐ Ensure the BAS Research and Monitoring Program is equipped and staffed for effective program management and strategy implementation
- ☐ Maintain database of GIS data, research and monitoring information for use in enhancing the level of coordination between researchers, identifying information gaps, and providing a platform from which the results can be communicated to a wider audience
- ☐ Continue implementing an effective, standardized monitoring and data management program for the CTWS
- ☐ Ensure all staff (particularly rangers) understand the reasons behind research and monitoring and are engaged and supportive
- ☐ Ensure all staff are aware of, and can articulate, basic research and monitoring outputs (e.g. fish catch increasing / decreasing)
- ☐ Integrate data collection required for indictors identified for tracking success of management plan strategies
- ☐ Continue developing indices of ecological integrity through use of bird monitoring
- ☐ Continue monitoring wildlife – livestock conflict –particularly jaguars and cattle
- ☐ Monitoring of yellow headed parrot nesting
- ☐ Standardise data collection through SMART for monitoring of key species
- ☐ Conduct an ecosystem service evaluation for the protected area
- ☐ Develop baseline mapping and mapping of anthropogenic impacts for 66' riparian belt, particularly for Black Creek

RM1.2 THREATS

- ☐ Water quality and water level monitoring
- ☐ Mapping of land use change / forest in the landscape, updated on an annual basis
- ☐ Collection of meteorological data
- ☐ Monitoring of annual fire impacts

RM1.3 SOCIO-ECONOMIC MONITORING

- ☐ Continue KAP / socio-economic monitoring, integrating management plan indicators
- ☐ Monitor tourism impact on the local economy
- ☐ Continue to monitor visitation

RM1.3 CAPACITY BUILDING FOR STAFF

- ☐ Continued training in use of SMART for biodiversity monitoring data collection
- ☐ Continued training in water quality monitoring
- ☐ Continued training in other biodiversity monitoring areas

RM2: RESEARCH

- ☐ Engage in identified research that informs public perceptions and management decisions
- ☐ Continue and strengthen the research partnership with UB-ERI
- ☐ Address research needs identified in the sustainable use planning for the Crooked Tree fishery

RESEARCH AND MONITORING PROGRAM

RM3: USE AND DISSEMINATION OF RESULTS

- ☐ Use available forums for dissemination of results (e.g. workshops, national and international conferences, school visits, community and tour guide meetings)
- ☐ Develop digital library of all published work on CTWS and make available, where feasible, for download on line
- ☐ Ensure results of monitoring and research outputs are available to the Crooked Tree community, staff at CTWS and other BAS Program Managers
- ☐ Provide CTWS data on national biodiversity indicators to the National Biodiversity Monitoring Programme
- ☐ Ensure mechanisms are in place for easy access to monitoring data
- ☐ Effectively integrate monitoring and research results into the adaptive management process
- ☐ Ensure annual data summaries / reports to the Crooked Tree community, the Fest and Fisheries Departments, staff at CTWS and other BAS Program Managers
- ☐ Continue building capacity of rangers for participation in monitoring activities

3.3.3 COMMUNITY DEVELOPMENT AND OUTREACH PROGRAMME

COMMUNITY DEVELOPMENT AND OUTREACH
Improved support for conservation / environmental stewardship in local communities and stakeholders
CDO 1: Environmental Education
CDO 2: Stakeholder Outreach and Engagement
CDO 4: Resilient Livelihoods

BAS is leading education and awareness activities in Crooked Tree and the other stakeholder communities, and firmly believes that "education is at the heart of environmentally sustainable development" (BAS Strategic Plan, 2014), and that building awareness and understanding of the environment and the benefits communities receive from it will encourage improved environmental stewardship. The BAS Environmental Education and Awareness Programme is focused primarily on the following areas:

Environmental Education
Stakeholder Outreach Engagement
Strengthening Livelihoods

Key Strategic Goals

- Inform the general public of the ecosystem services, community benefits and biodiversity protection provided by protected areas
- Encourage the involvement of local communities in the management of Crooked Tree Wildlife Sanctuary
- Build capacity among community members, enabling them to actively participate in protected areas management
- Strengthen livelihoods associated with the protected area

Implementation of BAS's environmental strategy and the management of Environmental Education activities are centralized within the Belize City office and reaches out to communities buffering all BAS protected areas.

BAS has been active in the Crooked Tree primary school with a consistent, structured programme of activities that engages youths in the community. This includes summer camps held each year since 2004, student visits to other protected areas and the formation of a Junior Bird Club, in 2008, and is active in engaging students in bird-focused activities in the community. Over the past three years, BAS has consistently engaged approximately 100 children from the community, through summer camps, the School Bird Fair, Junior Birding club and other environmental education activities.

Between 2014 and 2017, BAS has focused on strengthening bird based tourism as a conservation and sustainable development tool, engaging the community on the importance and potential of bird-based tourism and the strong link between the health of the environment and community livelihoods. Under the project, the community benefited through basic bird guide training, entrepreneurial development training (book-keeping, customer service, and marketing), a Community Bird Festival and a school bird fair. In addition, community signs were designed and installed at strategic locations and a series of environmental education activities were also coordinated and implemented.

There is interest in Crooked Tree in seeing tourism expand, with BAS facilitating the development of tourism plan for the community, and the development of a community trail linked to an income generating mechanism. Strengthening support for the implementation of the plan, building capacity within Crooked Tree for tourism-linked livelihoods (such as tour guiding, restaurants, crafts / cultural food production) and improving marketing of CTWS and the Crooked Tree community are key activities for this management plan.

Priority strategies for 2019 – 2023

- Improve engagement and building a positive partnership between BAS and the Crooked Tree stakeholder communities
- Focus particularly on engagement of youths and school students, building capacity of children and youths to become community leaders that will participate in implementation and management of CTWS into the future
- Build the capacity and engagement of community leaders for participation in implementation of the CTWS management plan
- Engage fishers in the development and implementation of a sustainable resource use plan
- Provide opportunities for community participation in active management activities
- Build the capacity of BAS CTWS staff to participate in outreach and education activities
- Continue engaging the four key stakeholder communities
- Continue inspiring students through the BAS School Outreach Programme and Summer Camps at CTWS
- Maintain and strengthen engagement of students in the stakeholder communities through the Junior Bird Club
- Develope a youth conservation group to enagage children from the Junior Bird Club after leaving primary school.
- Provide opportunities and build capacity for income diversification linked to sustainable tourism in the community
- Market Crooked Tree Wildlife Sanctuary as a key birding / cultural destination in Belize and the region

COMMUNITY DEVELOPMENT AND OUTREACH PROGRAMME

CDO 1: ENVIRONMENTAL EDUCATION

CDO 1.1: SCHOOLS

- ☐ Continue strengthening engagement of schools and implementation of school activities in CTWS stakeholder communities (with a focus on Crooked Tree Village)
- ☐ Ensure the School Outreach Programme has the human resources and equipment for effective programme implementation in CTWS stakeholder communities
- ☐ Engage teachers and increase capacity to teach basic environmental services concepts, biodiversity value, conservation, and climate change
- ☐ Increase engagement of students through the Junior Bird Club, open days and opportunities to participate in management activities
- ☐ Participate in community days with activities designed to engage community members
- ☐ Continue partnering with other agencies / local organizations working in the CTWS communities for cost-effective delivery of education and outreach programmes and activities to schools
- ☐ Improve information and displays in Visitor / Information Centre to provide learning opportunities for students, aligned with the curriculum
- ☐ Continue and increase use of CTWS as a site for the BAS Nature School Programme

CDO 2: STAKEHOLDER OUTREACH AND ENGAGEMENT

CDO 2.1 COMMUNITIES - GENERAL

- ☐ Strengthen mechanisms for ongoing, open communication with community leaders, particularly Crooked Tree Village
- ☐ Work with Crooked Tree Village Council, key community representatives (fishers / hunters, tourism and farmers), Forest and Fisheries Departments to establish a CTWS Management Committee
- ☐ Increase community awareness of basic environmental services concepts, biodiversity values of CTWS, climate change and building climate change resilience in the landscape
- ☐ Continue to build capacity of communities, particularly natural resource users, for good stewardship of biodiversity
- ☐ Provide opportunities for increasing community knowledge of climate change and building climate change resilience in the landscape
- ☐ Engage developing and established community groups and provide opportunities for active participation in protected area activities
- ☐ Participate in Forest and Fisheries Department activities for increasing awareness of wildlife and wildlife legislation and fisheries legislation in the communities

CDO 2.2 TOURISM SECTOR

- ☐ Work with community leaders and the Crooked Tree community in development and implementation of tourism planning and activities in the community.
- ☐ Strengthen engagement of tour guides, tour operators and resorts through improved communication, trainings and workshops
- ☐ Provide opportunities for increasing tour guide knowledge of basic environmental services concepts, biodiversity values of CTWS, climate change and building climate change resilience in the landscape

CDO 2: STAKEHOLDER OUTREACH AND ENGAGEMENT

CDO 2.4 AGRICULTURAL SECTOR

- ☐ Engage land owners and farmers in the CTWS landscape in maintenance of forest cover, linked to forest connectivity, water security and climate change resilience
- ☐ Engage farmers in the CTWS landscape in improved agricultural practices with maintenance of creeks and reduced pesticide use.

CDO 3: INCOME DIVERSIFICATION

CDO 3.1 PLANNING AND PARTNERSHIPS

- ☐ Develop an Income Diversification Strategy that reduces pressure on CTWS, built around bird tourism
- ☐ Establish strong, consistent partnerships with identified target groups and individuals, with clear understanding of their vision and goals, and dialogue on synergies and potential investment opportunities
- ☐ Develop and implement a marketing plan for CTWS and the Crooked Tree Village, including international marketing at bird fairs and through BTIA / BTB, based on the One Village One Product One model

CDO 3.2 CAPACITY BUILDING

- ☐ Provide capacity building opportunities for communities in areas such as best practices, governance, marketing, financial management, organizational management, First Aid / CPR
- ☐ Identify and support exchange visits and capacity building sessions for potential participants to increase knowledge/ understanding and success rate of income diversification projects, with follow-on investment to implement lessons learnt
- ☐ Build capacity for climate resilient communities and addressing natural disasters

CDO 3.3 IMPROVING EMPLOYMENT / INCOME DIVERISIFICATION OPPORTUNITIES

- ☐ Develop and implement a Crooked Tree Wildlife Sanctuary Investment Strategy built around bird tourism
- ☐ Provide training for natural resource users and their families as site-level guides, hospitality services, craft skills, food handling etc.
- ☐ Provide structured training for natural resource users and their families in business management, business startup and financial management
- ☐ Provide micro-loan / grant packages to support viable business ideas for natural resource users and their families, and to improve employment opportunities in the communities

3.3.4 TOURISM MANAGEMENT PROGRAMME

TOURISM MANAGEMENT PROGRAMME
CTWS provides a visitor destination that is appreciated and valued by the tourism sector and visitors
TMP 1: Visitor Management
TMP 2: Visitor Safety and Protection
TMP 2: Visitor Education and Interpretation

Despite being one of Belize's best birding destinations, particularly in dry season, and despite its rich cultural heritage, Crooked Tree has not yet reached its potential as a tourism destination. Between 2014-2017, BAS' work in the Crooked Tree Village was focused on re-engaging the community in support of bird-based tourism, demonstrating that livelihoods are linked to a healthy wetland ecosystem. BAS has been strengthening its support of bird-based tourism, with the training of bird-focused tour guides at the national level, ensuring that Belize can offer a professional service to birding tours.

Strengthening bird based tourism as a conservation and sustainable development tool is the key focus of tourism development for Crooked Tree Wildlife Sanctuary, but success of the strategy relies partly on engagement of the community, with reduced negative conflict between BAS and tourism / community stakeholders. Unless there is trust between partners, there will be reluctance on the part of the donors to invest in tourism projects and infrastructure linked to the protected area. Community engagement strategies are therefore critically linked to the Tourism Management Programme.

TOURISM MANAGEMENT PROGRAMME

TMP 1: VISITOR MANAGEMENT

- ☐ Construct an easily visible, permanent replacement Visitor / Information Centre at the BAS CTWS site as a focal point for the Wildlife Sanctuary, with information relevant to the bird tourism market, opportunities for sale of local crafts and produce, and linking arriving visitors with tour guides / hotels
- ☐ Provide orientation talk to visitors on arrival at CTWS to ensure awareness of regulations and update on any safety warnings
- ☐ Train all site-certified guides in best practices for minimizing impacts on the wetland
- ☐ Identify and address key needs of Advanced Bird Guides for bird tourism through consultation towards development of CTWS as a globally recognized high standard birding destination

TMP 2: VISITOR SAFETY AND PROTECTION

TMP 2.1: TOUR GUIDE BEST PRACTICES

- ☐ Ensure all tour guides guiding in CTWS have valid licenses when arriving
- ☐ Provide training for tour guides in best tourism practices for guiding in wetlands
- ☐ Continued maintenance of trails and infrastructure to acceptable safety standards

TMP 3: VISITOR EDUCATION AND INTERPRETATION

- ☐ Identify the target audiences and key messages, and develop engaging interpretive displays that address these
- ☐ Ensure information in the Visitor / Information Centre and on brochures and leaflets is high quality and provides interpretive opportunities for general visitors, bird-focused visitors and students
- ☐ Maintain the Community Bird Trail
- ☐ Engage visitors in reporting biodiversity - maintain wildlife / bird sightings book / board

3.3.5 MANAGEMENT AND ADMINISTRATION

The Management and Administration programme is focused on ensuring that the necessary administrative structure is in place for the support of management activities for CTWS and associated programme activities.

MANAGEMENT AND ADMINISTRATION
Effective management and administration of CTWS
MAP 1: Planning
MAP 2: General Management and Administration
MAP 3: Financial Management
MAP 4: Communication and Collaboration

The Forest Department, as the authority for the area, has well defined regulations and policies in place under its Protected Areas Programme. The Fisheries Department, as the authority for the inland fisheries, has regulations and policies in place relevant to the management of the CTWS fishery. Belize Audubon Society, as the co-management organization is responsible for day-to-day management of the protected area. Organizational, financial and human resource administration is centralized in the Belize Audubon Society office in Belize City. Park-specific administration is also managed from here, as part of the Protected Areas portfolio, though with frequent visits to the site by the protected area manager.

Site-level administration, the majority of fee collection activities and management is based from the office at Crooked Tree Wildlife Sanctuary itself, and implemented by the three on-site field staff – the Site Manager and two Park Wardens.

BAS has standard policies in place to assist in effective management, contained within the BAS Policy and Operations Manual. These include well defined policies in the areas of transport, health and safety, community relations and advocacy, and also provide guidance on incident management and standard operating procedures.

A key strategy is the amendment of the Statutory Instrument to re-categorize the protected area as a Wildlife Sanctuary (2), to allow for traditional use. This is to be supported by the participatory development of a Sustainable Resource Use Plan based on the Fisheries Department Managed Access framework (Natural Resource Management Programme).

An area requiring strengthening is that of financial sustainability for the protected area – visitation is low, generating only a portion of the running costs - $10,380 was generated from visitation in 2017, 10% of the $103,752 required to manage the protected area in 2017 (BAS, 2018). Two key challenges have been identified to increasing revenue:

- Avoidance of fee payment by visitors to the Wildlife Sanctuary
- Conflicts between BAS and Crooked Tree Village, resulting in reduced confidence for investment in infrastructure and marketing, and reduced visitor satisfaction

MANAGEMENT AND ADMINISTRATION PROGRAMME

MANAGEMENT STRUCTURE

MANAGEMENT STRUCTURE

- ☐ Establish the CTWS Management Committee, with a Terms of Reference established with the Belize Forest Department
- ☐ Define the scope and level of involvement of each Committee member - roles and responsibilities
- ☐ Develop and implement mechanisms to ensure effective communication and information sharing between all members
- ☐ Developing clear operational frameworks (especially for surveillance and enforcement) that address / reduce past conflicts

MAP 1: PLANNING

MAP 1.1 OPERATIONAL AND STRATEGIC PLANNING

- ☐ Amend the Statutory Instrument to support rights-based traditional resource use, based on an approved sustainable resource use plan
- ☐ Develop Annual Workplan and budget each October, based on the management plan and previous workplan M+E recommendations, and submit each November
- ☐ Develop and implement fully participatory Sustainable Resource Use Plan for CTWS
- ☐ Develop and implement 5-year Community Communication Engagement and Investment Strategy for effective engagement of CTWS communities – particularly Crooked Tree

MPA 1.2: EMERGENCY PLANNING

- ☐ Assess liability issues at CTWS annually and integrate risk reduction, into the annual workplan
- ☐ Ensure all staff have basic first aid training
- ☐ Ensure all staff have access to and are familiar with the Emergency Response Plan
- ☐ Ensure upkeep of all emergency and safety equipment
- ☐ Develop / update hurricane / flood plan for CTWS, when necessary
- ☐ Ensure that all staff are aware of hurricane / flood plan and procedures before start of each hurricane season

MPA 1.3: MONITORING AND EVALUATION

- ☐ Conduct M+E of CTWS Management Plan at mid-point (2.5 years) and adapt where necessary
- ☐ Conduct rapid annual management effectiveness assessment and submit to PA administration authority
- ☐ Evaluate workplan outputs at the end of each year and integrate recommendations into new workplan as part of the adaptive management cycle

MPA 1.4: REPORTING

- ☐ Keep site-level daily log of activities and issues for CTWS, and prepare monthly report on enforcement activities, general situation report
- ☐ Prepare site-level annual report as part of BAS protected areas reporting framework
- ☐ Ensure compliance with reporting requirements of Forest Department
- ☐ Ensure compliance with reporting requirements of Fisheries Department
- ☐ Provide annual report to all members of the CTWS Management Committee

MAP 2: GENERAL ADMINISTRATION AND MANAGEMENT

MAP 2.1 HUMAN RESOURCES

- ☐ Ensure there are sufficient staff for effective visitor and natural resource management and monitoring – at least critical, but preferably optimal level
- ☐ Ensure adequate communication and two-way flow of information between CTWS and BAS in Belize City
- ☐ Develop formal Orientation Package for all permanent staff, specific to CTWS

MANAGEMENT AND ADMINISTRATION PROGRAMME

MAP 2: GENERAL ADMINISTRATION AND MANAGEMENT

MAP 2.1 HUMAN RESOURCES

- ☐ Develop and implement site level Human Resource Development plan to maximize on present staff abilities, identifying key trainings (e.g. Hospitality training, Green Laws training, presentation skills etc.)
- ☐ Ensure all CTWS staff have training in conflict resolution and minimizing conflict when approaching fishers during interactions (in the village and on the water)
- ☐ Build capacity of staff to understand the role CTWS plays in the landscape and NPAS
- ☐ Ensure that relevant staff are trained in simple accounting procedures, and use of computer
- ☐ Staff training in conducting visitor surveys and biodiversity monitoring

MAP 3: FINANCIAL MANAGEMENT

MAP 3.1: FINANCIAL MANAGEMENT

- ☐ Prepare timely financial and management accounts and submit monthly
- ☐ Prepare, as necessary, project budgets and financial reports
- ☐ Prepare site–level quarterly report on use of annual budget, for submission to Executive Director and funding agencies
- ☐ Prepare site-level annual accounts and summary for Annual Report and auditing requirements
- ☐ Continue maintaining accurate staff payment records

MAP 3.2: FINANCIAL SUSTAINABILITY

- ☐ Develop and implement financial sustainability planning for CTWS for the next five years to set course for economic sustainability
- ☐ Construct well-situated, permanent Visitor / Information Centre at entrance to Crooked Tree to ensure more visitors stop to pay entrance fee here, and have access to an integrated gift shop
- ☐ Work with Crooked Tree hotels to ensure visitors are encouraged to pay entrance fees in support of management of the protected area
- ☐ Improve marketing of CTWS and Crooked Tree as a first class birding destination
- ☐ Ensure key travel guides to Belize and Central America are provided with accurate, updated information on visiting Crooked Tree

MAP 4: COMMUNICATION AND COLLABORATION

MAP 4.1 GENERAL

- ☐ Improve cross sectoral communication and collaborative partnerships through establishment of a Management Committee, and a structured Communication Plan targeting:
  - Forest and Fisheries Departments
  - Crooked Tree Village Council
  - Partner organizations in the Crooked Tree community
  - Natural resource users (through the proposed Managed Access Committee)
  - Other key stakeholder communities (leaders, community groups, women, teachers, youths)
  - Tourism Sector (tour Operators / tour guides / hotel / lodge owners)
  - General community members

3.3.6 INFRASTRUCTURE, EQUIPMENT AND MAINTENANCE PROGRAMME

INFRASTRUCTURE, EQUIPMENT AND MAINTENANCE
▪ Operational Infrastructure and Equipment ▪ Visitor Infrastructure ▪ Vehicle / Boat Operations ▪ Maintenance

The Infrastructure, Equipment and Maintenance Programme covers activities such as future infrastructure and equipment, and maintenance of present infrastructure (buildings etc.).

One key strategy is to construct a new Visitors / Information Centre to replace the current temporary building, and to act as an iconic entry point, building the reputation of CTWS as a world class birding destination. The Centre should also act as a reference point for visitors, linking them with local hotels, restaurants and tour guides, and providing information on activities within the community, as well as providing a space for sale of local arts, crafts and cooked wares.

INFRASTRUCTURE, EQUIPMENT AND MAINTENANCE PROGRAMME
IEMP 1: OPERATIONAL INFRASTRUCTURE
☐ Conduct boundary survey in collaboration with Crooked Tree Village Council, and ensure critical areas are demarcated with signage ☐ Install fire awareness signs, linked to fire awareness activities
IEMP 2: VISITOR INFRASTRUCTURE
☐ Maintain visitor bathroom facilities ☐ Construct new Visitors / Information Centre to act as an iconic entry point to CTWS ☐ Maintain visitor signage for Community Bird Trail ☐ Maintain boardwalk
IEMP 3: VEHICLES AND EQUIPMENT
☐ Ensure CTWS staff have the equipment for effective site management of CTWS ☐ Provide equipment and basic training for fire management ☐ Ensure there is adequate storage available for CTWS equipment
IEMP 4: MAINTENANCE
☐ Schedule preventative maintenance and upkeep of all infrastructure and equipment ☐ Employment of skilled casual labour to maintain infrastructure ☐ Build capacity of staff for care and basic maintenance of equipment

3.4 TIMELINE, EVALUATION AND REVIEW

The Management Programme provides the framework for the development of an implementation plan, to include present and desired status, responsible parties, a timeline based on the 5-year implementation period, and highlighting any limitations or context conditions that would need to be taken into consideration for successful implementation.

Monitoring and evaluation are integral components of any management system and annual evaluations of protected area management are recommended. In the development of this management plan, the action areas are relatively specific, simplifying the process of monitoring success of implementation, and providing a mechanism for continual tracking of management activities, through annual review by Belize Audubon Society.

The management plan should not be considered static, and the annual review should ensure that strategies and activities are still relevant for the changing socio-economic and climatic contexts. Some management strategies may become obsolete, whilst new management activities may need to be included.

3.4.1 MONITORING AND REVIEW

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:

- measuring success in implementing the management actions
- measuring success of the conservation strategies in addressing threats and improving target viability.

Two matrices have been developed to facilitate this process, forming the basis for the annual review of the management plan. Time should be taken to complete each one fully and as accurately as possible at the end of each year, using data from the monitoring programme. If this is maintained on an annual basis, then this will greatly facilitate any management staff transition handover.

Included is an example of the suggested structure for the implementation Plan (Table 46) and the Measures of Success matrices (Table 47, 48 and 49). The key indicators have also been identified from the Conservation Planning section, and been integrated into an Indicator framework for measuring success (Table 50).

IMPEMENTATION PLAN EXAMPLE: RESOURCE PROTECTION PROGRAMME								
MANAGEMENT ACTIVITY	**CURRENT STATUS**	**DESIRED STATUS**	**RESPONSIBILITY**	**YEAR**				
				1st	**2nd**	**3rd**	**4th**	**5th**
SURVEILLANCE AND ENFORCEMENT								
Develop a surveillance and enforcement plan in consultation with the CTWS fishers and CTVC that focuses on supporting a Managed Access regime in CTWS	There is no Managed Access framework in place for sustainable management of the fishery	A Managed Access framework exists, developed through a fully participatory process, and is being implemented, through an active MA Committee, supported by Fisheries and Forest Deps	PA Director; CTWS Site Manager, CT Village Council, Forest Department, Fisheries Department					
Ensure CTWS has the human resources and equipment for effective surveillance and enforcement	Surveillance and enforcement activities are limited by the current conflict with fishers	CTWS has sufficient trained personnel and equipment for effective surveillance and enforcement	PA Director					
Ensure surveillance activities are strategic and effective, based on enforcement data, incidence mapping and identification of hotspots, intelligence information and integration of SMART technology	Surveillance and enforcement activities are limited by the current conflict with fishers	Rangers are trained for effective use of SMART for data collection and are using data effectively to inform surveillance and enforcement activities	PA Director; CTWS Manager					
Maintain and strengthen collaborative partnerships with Forest and Fisheries Departments towards effective surveillance and enforcement within CTWS	Partnership is being strengthened through participation in CTWS Steering Committee and Conservation Planning	Surveillance activities are strengthened through joint patrols with Forest and Fisheries Department, and support for enforcement	PA Director					

TABLE 46: LAYOUT FOR IMPLEMENTATION PLAN FOR MANAGEMENT STRATEGIES AND ACTIVITIES

NATURAL RESOURCE MANAGEMENT PROGRAMME - 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**						**Comments:** Justification for Measure of Success score. Problems, concerns. Notes for inclusion in updated Management Plan
	Year						
Activity	**1**	**2**	**3**	**4**	**5**	**Desired Status**	
Surveillance and Enforcement							
Develop a surveillance and enforcement planin consultation with the CTWS fishers that focuses on supporting a Managed Access regime in CTWS						A Managed Access framework exists, developed through a fully participatory process, and is being implemented, through an active MA Committee, supported by Fisheries and Forest Departments	
Ensure CTWS has the human resources and equipment for effective surveillance and enforcement						CTWS has sufficient trained personnel and equipment for effective surveillance and enforcement	
Ensure surveillance activities are strategic and effective, based on enforcement data, incidence mapping and identification of hotspots, intelligence information and integration of SMART technology						Rangers are trained for effective use of SMART for data collection and are using data effectively to inform surveillance and enforcement activities	

TABLE 47: MATRIX FOR MEASURING IMPLEMENTATION SUCCESS OF MANAGEMENT STRATEGIES AND ACTIVITIES

NATURAL RESOURCE MANAGEMENT PROGRAMME - OUTPUTS							
Measure of Success – Outputs							
It is important to document clearly the status of each activity in terms of increasing viability / addressing threats whilst developing Annual Operation Plans, to identify areas that need prioritization, or adaptation of activities for improved success							
Management Activities **Activity**	**Present Status (2017)**	**Status (2019)**	**Status (2020)**	**Status (2021)**	**Status (2022)**	**Status (2023)**	**Desired Status (Outputs)**
Surveillance and Enforcement							
Ensure CTWS has the human resources and equipment for effective surveillance and enforcement	Fishing is currently illegal in CTWS, requiring a revision of the SI to reflect status as a Wildlife Sanctuary (2). Surveillance activities until then are minimal, with the need for a high level of engagement of fishers moving forward.						Informed surveillance and enforcement activities support Managed Access, and are supported by traditional fishers. No incursions by non-traditional fishers
Strengthen intelligence-based enforcement, with input from the enforcement team and integration of analyzed SMART data							
Conduct daily patrols and surveillance to enforce rules and regulations of CTWS to prevent illegal activities							

TABLE 48: MATRIX FOR MEASURING OUTPUTS OF MANAGEMENT STRATEGIES AND ACTIVITIES

NATURAL RESOURCE MANAGEMENT PROGRAMME – OUTCOMES / IMPACTS							
Measure of Success – Outcomes / Impacts							
It is important to document clearly the status of each activity in terms of achieving outcomes / impacts whilst developing Annual Operation Plans, as this allows highlighting of areas that need prioritization							
Management Activities **Activity**	**Present Status (2018)**	**Status (2019)**	**Status (2020)**	**Status (2021)**	**Status (2022)**	**Status (2023)**	**Desired Status (Outcome)**
Surveillance and Enforcement							
Ensure CTWS has the human resources and equipment for effective surveillance and enforcement	Current traditionally harvested fish species are rated as FAIR. Fishers consider their income to have decreased.						Improved status of traditionally harvested fish species to GOOD Increase in catch / income of traditional fishers
Strengthen intelligence-based enforcement, with input from the enforcement team and integration of analyzed SMART data							
Conduct daily patrols and surveillance to enforce rules and regulations of CTWS to prevent illegal activities							

TABLE 49: MATRIX FOR MEASURING OUTCOME / IMPACT SUCCESS OF MANAGEMENT STRATEGIES AND ACTIVITIES

INDICATOR	FREQUENCY	CURRENT STATUS (END OF 2019)
BIODIVERSITY / THREAT INDICATORS		
BOUNDARY DEMARCATION		
Revised SI / map of CTWS	Once	
CTWS demarcated on the ground	Once	
% of fishers / hunters / logwood extractors and tour guides who know locations of CTWS boundaries	Every two years	
% of fishers / hunters / logwood extractors and tour guides who know CTWS regulations	Every two years	
GAME SPECIES / HUNTING / FISHING		
Target game/ fish species abundance	Ongoing – analyse data annually	
Abundance of wildlife in buffer areas (camera traps)	Ongoing – analyse data annually	
% of CTWS fishers / hunters / logwood extractors fully engaged and supportive of Managed Access	Annual	
% of CTWS fishers consider that the CTWS MA Committee is active and effective	Annual	
% of fishers / hunters / logwood extractors operating with relevant licenses / permits	Annual	
# traditional users compliant with MA data collection and reporting procedures	Annual	
# of patrols per year in CTWS	Annual	
Number of boat-to-boat conversations per month / year	Monthly / Annual	
# incidences of illegal fishing / hunting/ logwood extraction per year	Annual	
Number of fishing incursions addressed successfully by surveillance and enforcement activities	Annual	
Quantity of fish extracted per year	Annual	
Quantity of logwood extracted per year	Annual	
Average annual catch per fisher per year	Annual	
Extent / density of logwood	Every five years	

TABLE 50: CONSERVATION PLANNING INDICATORS FOR MEASURING OUTCOME SUCCESS OF MANAGEMENT STRATEGIES AND ACTIVITIES

INDICATOR	FREQUENCY	CURRENT STATUS (END OF 2019)
BIODIVERSITY / THREAT INDICATORS		
FOREST / FOREST CONNECTIVITY		
Extent of intact forest / natural vegetation in the CT buffer	Annual	
Extent of intact riparian forest	Annual	
Extent of largest block of connected forest within CTWS / Blackburn Ridge	Annual	
% of farmers who understand the reasoning for and supportive of maintaining forest corridors	Every two years	
% of targeted farmers leaving / restoring buffer corridors	Every two years	
Abundance of wildlife in buffer areas (camera traps)	Annual	
% of Blackburn Ridge within and adjacent to CTWS boundary that is managed for maintenance of forest cover	Annual	
Number of howler monkey troops reported from CTWS	Every two yeas	
WATERFLOW		
Feasibility study for installation of culverts	Once	
% identified required culverts are in place / modified in causeways, and are fully functional	Annual	
% of identified key blockages in Black Creek removed	Annual	
Annual clearance maintenance of Black Creek	Annual	
% of natural resource users (fishers / tour guides / post cutters) surveyed who think that water flow has improved	Annual	
% of CT surveyed who understand the need to maintain water flow	Every two years	
Report on water dynamics	Once	
Annual report on rainfall / water quality / water level	Annual	
FIRE		
# of fires impacting CTWS each year	Annual	
# acres per ecosystem impacted by fire	Annual	
Fire Awareness campaign implementation report	Once	
Fire Management Plan	Once	

INDICATOR	FREQUENCY	CURRENT STATUS (END OF 2019)
BIODIVERSITY / THREAT INDICATORS		
FIRE		
Pre and post community survey to measure knowledge of legislation / regulations relevant to fire	Every two years	
% of total students in school participating in activities focused on fire awareness per year	Annual	
# of community members participating in activities focused on fire awareness per year	Annual	
# of persons engaged as advocates for good fire management	Annual	
# of patrols that include a focus on enforcement of fire regulations	Annual	
# / area of prescribed burns	Annual	
% of target areas for prescribed burns recommended by protocol that are implemented	Annual	
Annual assessment of availability of firefighting equipment	Annual	
URBAN / AGRICULTURAL DEVELOPMENT		
Population of stakeholder communities within the Crooked Tree drainage area	Every five years	
Number of acres impacted by anthropogenic land use change within the Crooked Tree drainage area	Every five years	
Annual draw from lagoon / ground water for irrigation of agricultural areas within the Crooked Tree drainage area	Annual	
% of farmers considered to be engaged in reducing pesticide use in the CTWS landscape	Every two years	
% of septic systems that are pit latrines in Crooked Tree Village	Every two years	

TABLE 50: NATURAL RESOURCE INDICATOR FRAMEWORK

3.5 FINANCING

BAS faces ongoing challenges in securing the necessary finances to continue and further develop its management of the protected areas under its custodianship. As with most participants in the conservation process in Belize, BAS has developed the management of the protected areas under its mandate, its staff and as an institution, largely upon external grants and, more recently, with the re-investment of entrance fees. As the leading national environmental NGO, entrusted by the Government of Belize to manage some of the most prominent national protected areas, BAS has a good record of success in securing international funding to support its management of the parks.

FINANCIAL ASSESSMENT

This analysis uses income and expenditures in 2017 to provide a financial snapshot of the protected area.

Income: In 2017, the non-project income for Crooked Tree Wildlife Sanctuary was Bz $10,549, based primarily on entrance fees. This supported approximately 10% the funds required for implementation of activities within the protected area (BAS data, 2018), with 10% of these entrance fees being allocated to Crooked Tree Village Council for social investment on an annual basis.

A further **Bz $41,816** was located through grant support from a variety of sources. BAS is also able to access funds from international agencies for implementation of cross-cutting strategies through the BAS programme areas - Research and Monitoring and Education and Awareness, with activities supported through inclusion of Crooked Tree Wildlife Sanctuary. Belize Audubon Society has been able to maintain loyal donor support, with consecutive grants from a number of international donor agencies over the years. Combined, grants and income revenue give a total income for Crooked Tree Wildlife Sanctuary of **Bz $52,365**.

Expenditures: Expenditure for Crooked Tree Wildlife Sanctuary was reported as **Bz $93,579** (excluding depreciation) in 2017. A breakdown of site-specific expenditures across five general accounting areas shows that funds were focused primarily on one expenditure category, with 75% was allocated to staff costs (salaries, social security, insurance and casual labour) (Figure 18; BAS data, 2018).

Funding Gap: The funding gap between income and expenditure is therefore estimated at **Bz $41,214,** covered by funds from Belize Audubon Society. Until CTWS can start fulfilling its potential as a key bird tourism destination, this gap cannot be addressed adequately.

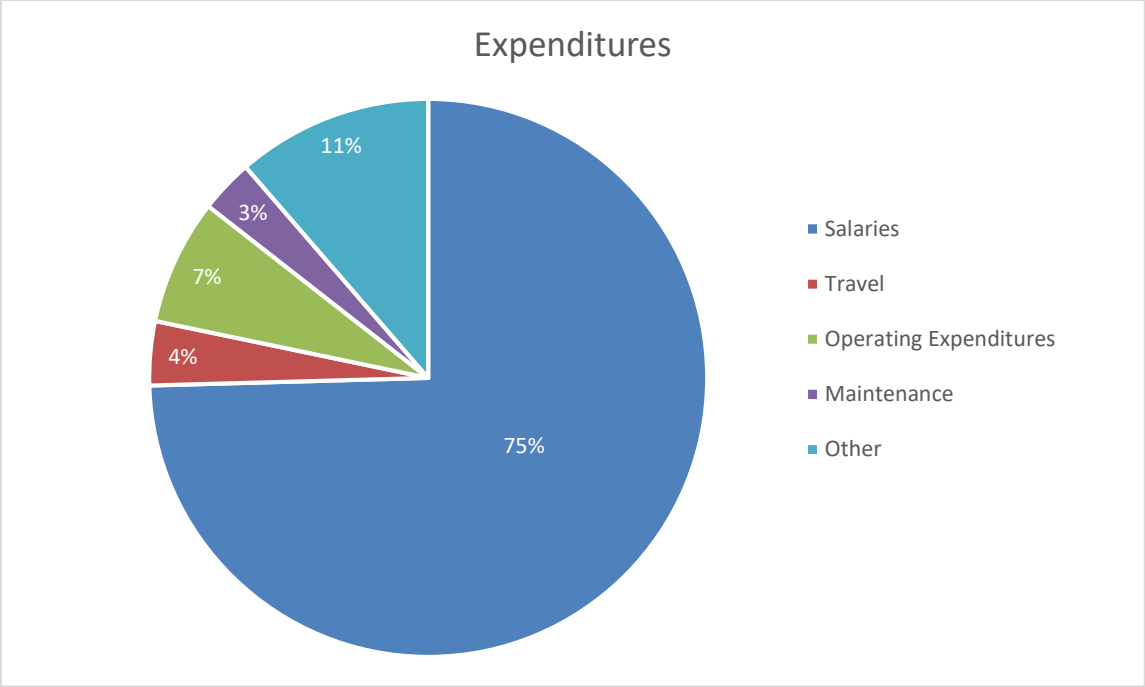


FIGURE 18: BREAKDOWN OF EXPENDITURES FOR CTWS (BAS DATA, 2018)

With the uncertainties that still surround management of Crooked Tree Wildlife Sanctuary and the recent conflictious management situation, Belize Audubon Society has not been in a position of invest in infrastructure and capacity building in the community to further develop and support tourism. CTWS will be reliant on grant income and support from the central BAS funds in the near future. Tourism does, however, still provide the primary option for improved sustainability, and many of the strategies identified to assist in improving financial sustainability over the next five years are tourism-focused:

- Develop and implement financial sustainability planning for CTWS for the next five years to set course for improved economic sustainability
- Construct well-situated, permanent Visitor / Information Centre at entrance to Crooked Tree to ensure more visitors stop to pay the entrance fee, provide interpretation and access to an integrated community gift shop
- Work with Crooked Tree hotels to ensure visitors are encouraged to pay entrance fees in support of management of the protected area
- Improve marketing of CTWS and Crooked Tree as a first class birding destination
- Ensure key travel guides to Belize and Central America are provided with accurate, updated information on visiting Crooked Tree

In its role as an important component of flood control for a large percentage of Belize's population, CTWS is in a position to be able to leverage climate change finance towards

restoration of the wetlands and flood-sink functions. BAS as an organization, is also identifying mechanisms for improved financial sustainability at the organizational level, towards improved sustainability for all its protected areas in the medium to long term.

4. IMPLEMENTING THE PLAN

The following outline presents the first steps toward implementing the management plan.

At the Start of the Management Plan Period

1. Develop the implementation plan and timeline for all programme areas and activities (Table 46).

2. Develop the three Measures of Success tables for all program areas and activities, defining the current and desired status, and developing implementation, output and outcome indicators (Tables 47, 48 and 49).

3. Identify those activities scheduled for implementation in the first year and develop the first annual workplan.

4. Develop a baseline for the indicators (expand Table 50), and identify information gaps, and in which year this information will be gathered.

5. Implement the Annual Workplan.

At the End of the First Year

1. Update the Measures of Success tables for all programme areas and activities.

2. Define the current status, and status of implementation, output and outcome indicators.

3. 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, incorporating adaptive strategies from the workplan review.

5. Implement the second Annual Workplan.

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