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# Management Plan

## South Water Caye Marine Reserve World Heritage Site

2010 – 2015  
*DRAFT*



*Wildtracks 2009*



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## Introduction

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### Background and Context

South Water Caye Marine Reserve is the largest marine protected area in Belize, covering 117,875 acres (approximately 47,700 hectares), and was established by the Fisheries Department in 1996 (SI 118), under the Fisheries Act (Ch 210, 1983), in recognition of the exceptional integrity of the marine ecosystems, and its national, regional and international importance. The Marine Reserve is located on the shallow reef platform of the Atlantic coast of Mesoamerica, and is part of the longest barrier reef in the Western Hemisphere, stretching approximately 1,000km from the Yucatan to the Bay Islands in Honduras. This reef system, designated as the Mesoamerican Reef, is one of 233 ecoregions with biodiversity and representational values considered outstanding on a global scale, and has been recommended several times as a priority area for conservation (Olson & Dinerstein, 1998; Roberts, 2001, Kramer and Kramer, 2002). The majority of the Mesoamerican Reef lies within Belize, a country with a low population and relatively low rate of coastal development, leading to its recognition for having some of the least impacted reef areas in the region, and the highest diversity of fish species (ReefBase, 2006).

The area is highlighted under ecoregional planning initiatives for its particularly rich biodiversity (Kramer and Kramer, 2002; updated in Arrivillaga et. al, 2008), supporting an important oceanic mangrove system and extensive seagrass meadows, which provide valuable habitats for commercial and non-commercial species – including queen conch (*Strombus gigas*) and lobster (*Panulirus argus*), the foundations of the traditional fishing industry on which a number of coastal communities in Belize are dependent. The sheltered waters and mangrove systems of the Pelican cayes in the southern area of the Marine Reserve have been identified as one of the most biodiverse marine systems within the western hemisphere, supporting a number of endemic species, and species new to science.

Mangrove cayes provide nesting sites for several nationally important bird species and include Man O' War Caye, protected in its own right as a Crown Reserve. The numerous sand bores adjacent to Wee Wee Caye include an established nesting beach for the rare roseate tern (*Sterna dougallii*), and the area is also utilized by marine turtles for nesting.

The designation fulfilled the requirements of UNESCO which, in the same year, included South Water Caye Marine Reserve as one of the seven protected areas that form the **Belize Barrier Reef Reserve System World Heritage Site**. The Marine Reserve lies on Belize's continental shelf, and encompasses numerous submerged mangrove islands following the recent revision of the SI (SI 51 of 2009).

The overall goal for the management of South Water Caye Marine Reserve is:

***To provide for the protection, wise use, understanding, and enjoyment of the natural resources of South Water Caye Marine Reserve in perpetuity.***

This goal is supported by a number of objectives:

- Maintain and conserve the natural resources of South Water Caye Marine Reserve for the benefit of current and future generations
- Engage fishermen in the management of sustainable fisheries
- Provide opportunities for recreation, interpretation, education, and appreciation for all visitors
- Strengthen education and understanding of users and potential users of the dynamics of coral reef systems within South Water Caye Marine Reserve and the human impacts affecting them
- Identify, implement and strengthen priority research and monitoring through on-site activities, collaboration and partnerships

The recent revision of the Statutory Instruments define the Marine Reserve as the “Caribbean Sea, reef and cayes, excluding all private property” – an important distinction from the previous SI (SI 118 of 1996), which only stipulated the Caribbean Sea, and excluded the cayes. The SI designates three different management zones: the General Use Zone, a Conservation Zone, and Preservation Zone, with each zone having regulations defining permitted activities. The Marine Reserve designation is considered to be equivalent to IUCN category IV – a Habitat/Species Management Area, with active management targeted at conservation through management intervention (IUCN, 1994).

## **Purpose and Scope of Plan**

The management of South Water Caye Marine Reserve is guided by its categorization as a Marine Reserve (under the Fisheries Act, 1983, amended 1987), being set aside to:

*“afford special protection to the aquatic flora and fauna ...and to protect and preserve the natural breeding grounds and habitats of aquatic life”.*

Its designation as part of Belize’s World Heritage Site (1996) also brings certain criteria to be taken into consideration during the development of the management plan.

## South Water Caye Marine Reserve – Management Plan 2010-2015

Since the development of the first management plan in 1993, many legislative changes have taken place, including the declaration of the area as a Marine Reserve, and, most recently, the passing of the zoning regulations. South Water Caye Marine Reserve is part of the Southern Belize Reef Complex, with system-level management initiatives developed in 2008. The uses of the protected area and the status of the resources have also changed. Furthermore, the knowledge base has improved substantially from the many years of research and data collection carried out since 1988. The programmes in this Plan therefore addresses the current status of the Marine Reserve, and reflect the more participatory approach to management being adopted in Belize today.

This Management Plan includes general information on the physical and biological attributes of the reserve, documents the current uses and management problems, defines the goals and objectives of the Marine Reserve, summarises conservation planning outputs, outlines specific management programmes, including zoning, sets in place the means for measuring management effectiveness, and recommends an implementation schedule.

In line with Fisheries Department policies, this Management Plan has been prepared with the input of the various stakeholders of the protected area through meetings with the Advisory Committee, a series of workshops with key stakeholder components, and interviews with a wide variety of individuals, including fishermen, the tourism sector, management staff and researchers, and seeks to conserve the resources of the reserve while allowing economic benefit through sustainable fishing and tourism. The management programmes are based on the best available data and scientific knowledge, with the integration of conservation planning strategies, and fit within the scope of the current zoning scheme and regulations that govern the reserve, except where recommended management regimes are highlighted for review.

This management plan is designed to guide the management of the Marine Reserve through the next five years, providing a framework for both broad management activities as well as more specific research and monitoring activities. It is recommended that detailed operational plans should be developed on an annual basis by the Fisheries Department (the Marine Reserve management agency), 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.

# 1. Current Status

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## 1.1 Location

South Water Caye Reserve, located on the inner side of the Barrier Reef, in the area of 16°49'09.29"N, 88°05'00.68"W, is part of the Belize reef system. It lies 18km east of the mainland, and west of the most southerly of the Glover's Reef atoll (Maps 1 and 2). The Marine Reserve includes a portion of the Belize Barrier Reef, and a series of ecological important mangrove cayes, many of them submerged – Pelican Cayes, Twin Cayes and the Tobacco and Blue Ground Ranges.

Access to the Marine Reserve is only by sea, with boats originating primarily from the mainland (Sarteneja, Belize City, Dangriga, Hopkins, Riversdale and Placencia). South Water Caye Marine Reserve also attracts yachts and live-aboard dive boats from around the world. Boat access is restricted to three cuts on the western edge of the Reserve at the northern part of Blue Ground Range, south of Ragged Caye, and most commonly off the southern tip of Coco Plum Caye. Boat access from Sittee River is south of Blue Ground Range. Boats from Placencia enter the southern part of the Reserve through the main Victoria Channel or the more northerly deep channel entrance.

Access from the east is restricted to cuts in the reef at Tobacco Caye, Carrie Bow and Curlew Caye, and Grand Channel (also called South Cut).

The Rangers Station is located on Twin Cayes, providing a base of operations for the Fisheries Department from which to manage South Water Caye Marine Reserve. The station contains accommodation for its rangers and reserve manager, and a recently constructed Visitor Centre.

The main stakeholders of the Marine Reserve are the fishing, tourism, study abroad groups and research sectors, based both from the mainland, and on the cayes within the protected area.

South Water Caye Marine Reserve includes all cayes that are not private property, following the 2009 revision of the statutory instrument. A total of 66 grants and 58 leases on the cayes were identified under the previous draft management plan (Jones, 2003).

Whilst there are no communities as such within the Marine Reserve, there has been a long history of use of the cayes as recreational retreats by local Belizeans as far back as the early 1900's. The majority of these are now converted to tourism developments and resorts or private residences with local or international ownership, particularly on South Water Caye, and more recently in the Coco Plum and Ragged Cayes areas. Tobacco Caye, the most densely populated, has a seasonal community of fishermen and hotel owners/staff.

A number of research/education facilities are located within South Water Caye Marine Reserve - Carrie Bow Caye has been leased since 1972 by the Smithsonian Institute, providing a research base for long term scientific studies of the reef within the protected area. International

## South Water Caye Marine Reserve – Management Plan 2010-2015

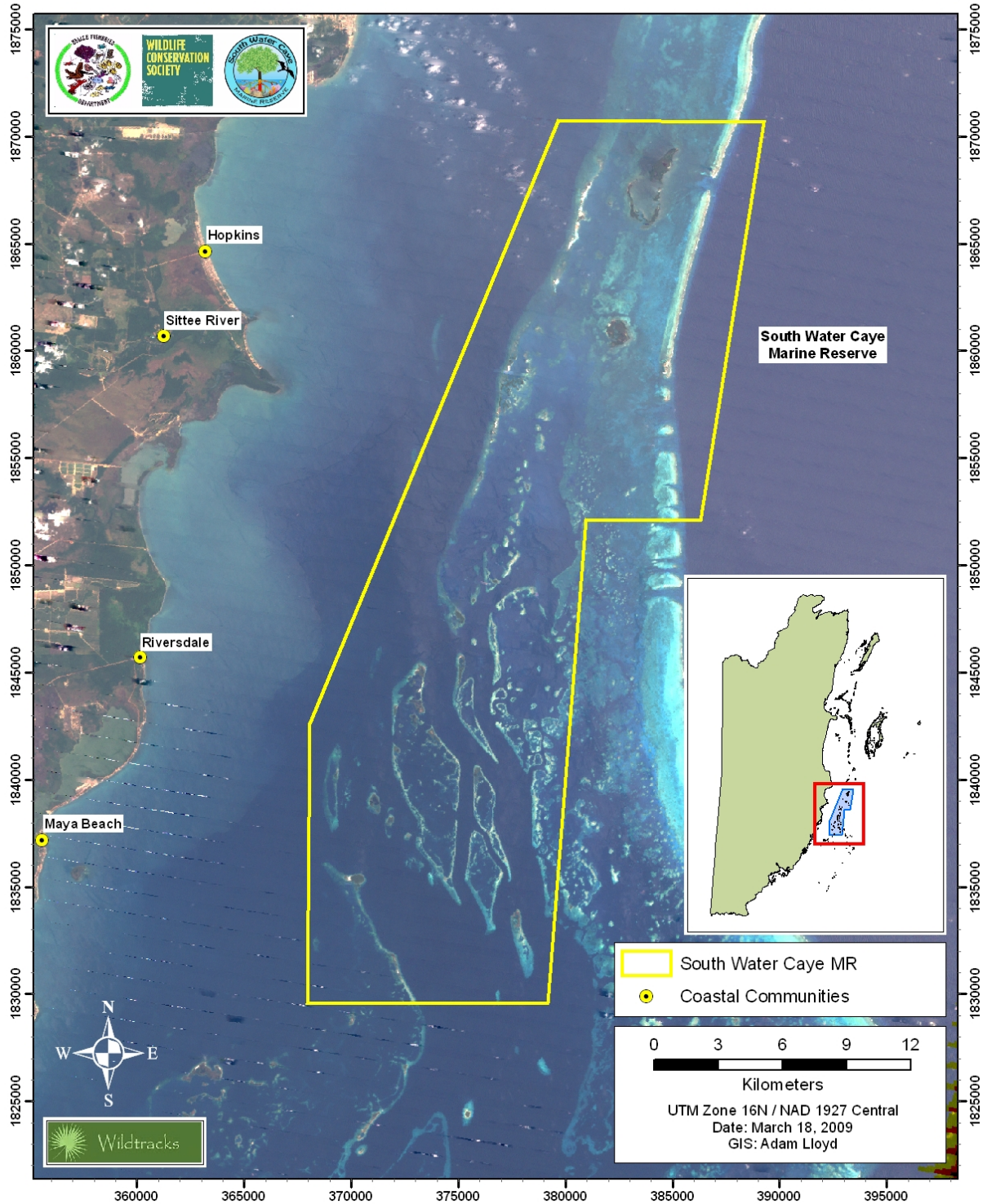
Zoological Expeditions (IZE) on South Water Caye has hosted student groups since 1970, Pelican Beach Resort also runs an eco-education facility (the University of South Water Caye), and an education field station (Wee Wee Caye Marine Lab) has been established since 1988 on Wee Wee Caye. More recently, a marine station catering for student study groups has also been established on Tobacco Caye.

Increasing development is resulting in mangrove clearance - a continuing issue in both Tobacco and Blue Ground Ranges. Fishing communities also impact the natural resources of the Marine Reserve, and are located primarily on the mainland, with the majority of boats originating from Sarteneja, Dangriga, Sittee River and Hopkins. There is also localized pressure from the residents of the cayes (particularly Tobacco Caye), who resort to fishing when tourism is low, and as a recreational activity.



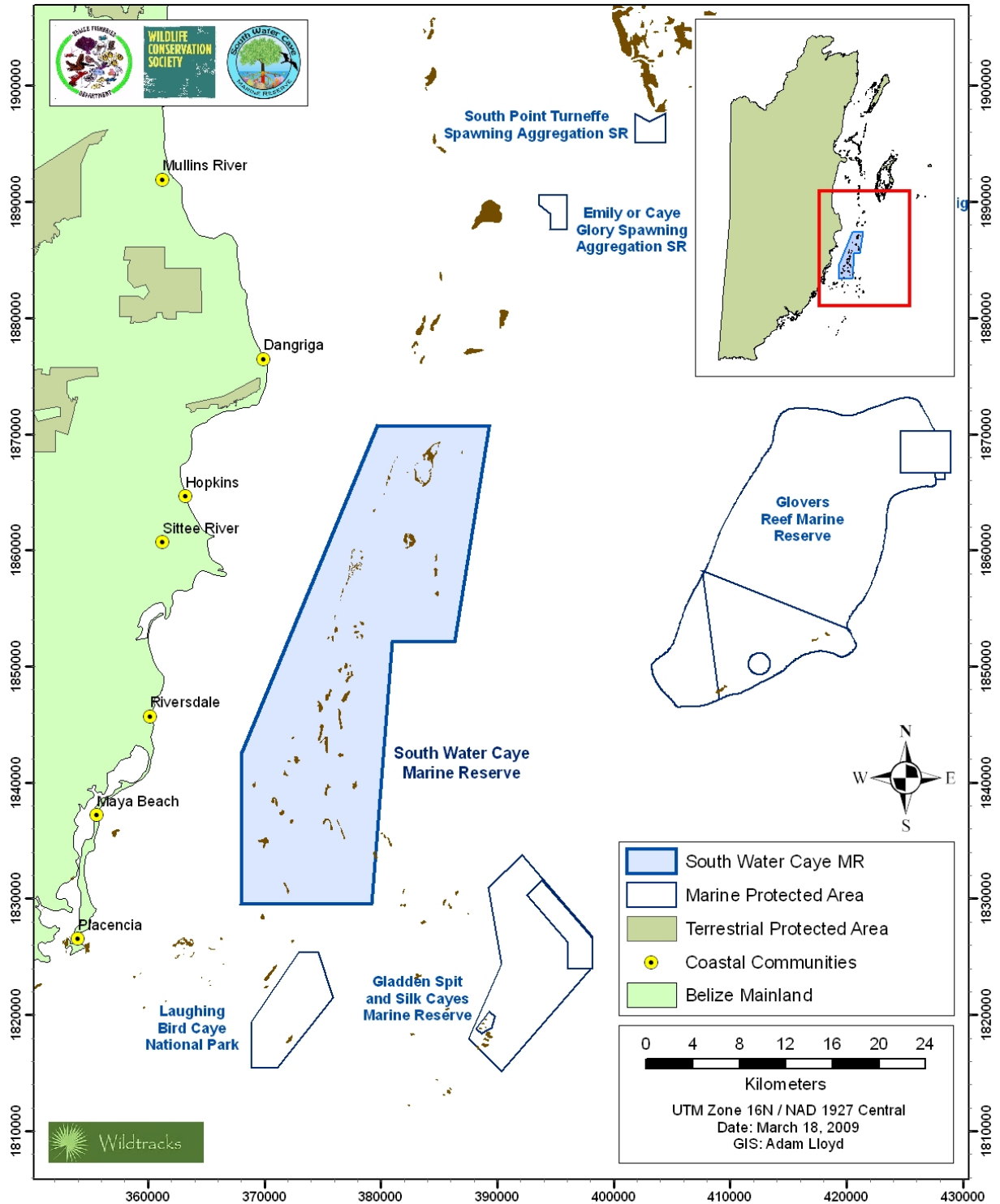
South Water Caye Marine Reserve: Landsat 2006

Landsat acquisition date: 21/03/2006  
Gap-filled SLC-off data, obtained via USGS  
Bands 3, 2, 1 as RGB respectively



Map 1: South Water Caye Marine Reserve

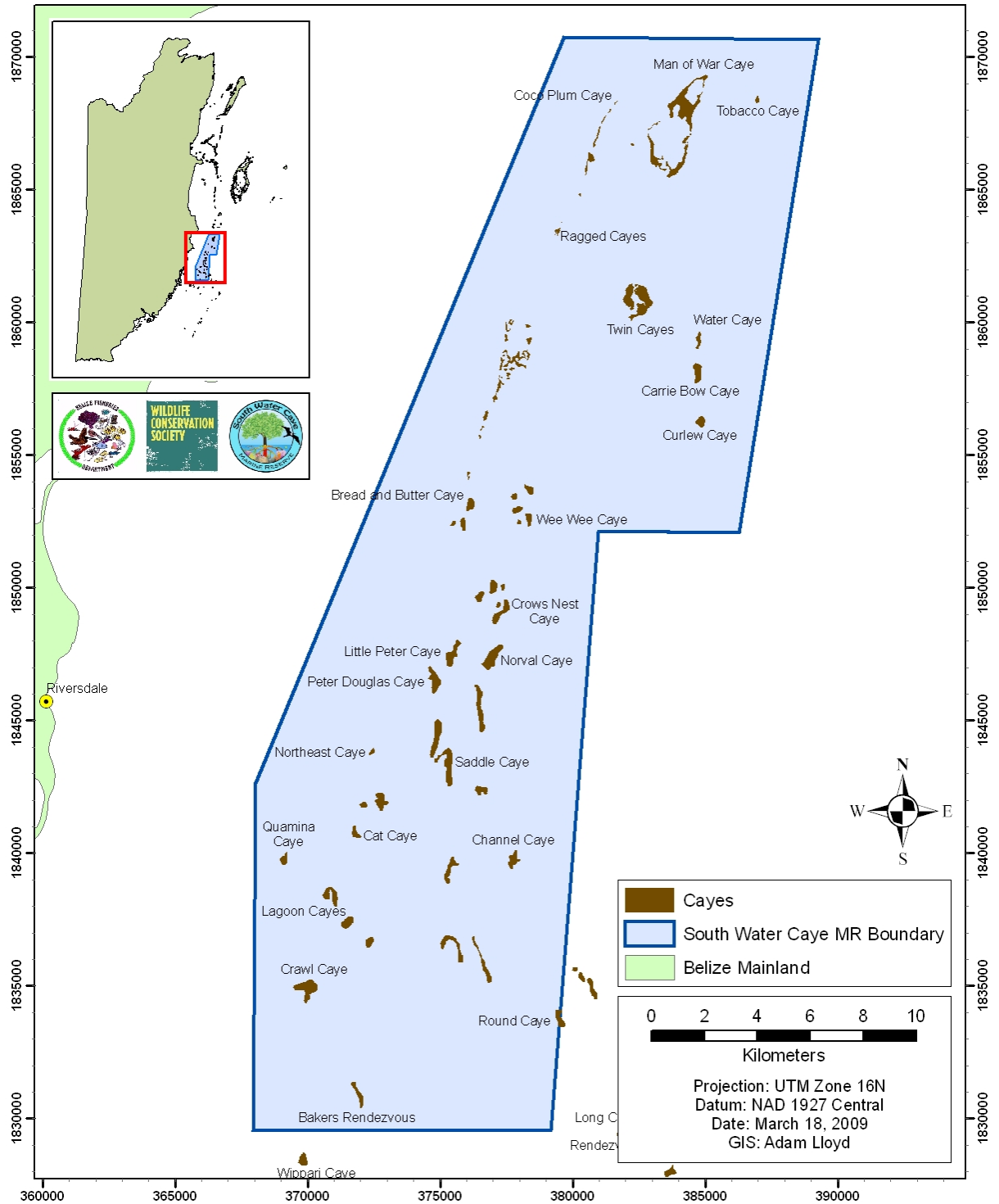
South Water Caye Marine Reserve: Location



Map 2: South Water Caye Marine Reserve – Conservation Landscape



South Water Caye Marine Reserve: Cayes



Map 3: South Water Caye Marine Reserve - Cayes

## 1.2 Regional Context

South Water Caye Marine Reserve is part of the Mesoamerican Barrier Reef System, the second largest barrier reef in the Western Hemisphere, and encompasses 32 named cayes. It contains assemblages of ecosystems of remarkable biodiversity and beauty, as well as of great scientific value, and importance for many species of conservation concern, among them the critically endangered hawksbill turtle (*Eretmochelys imbricata*) and goliath grouper (*Epinephelus itajara*), and the endangered green and loggerhead turtles (*Chelonia mydas* and *Caretta caretta*). It also protects important nursery habitat of the Queen Conch (*Strombus gigas*) and spiny lobster (*Panulirus argus*), as well as other commercially important species.

South Water Caye Marine Reserve is one of a serial nomination of seven sites that have been recognized as components of the Belize Barrier Reef System - World Heritage Site, as representative of the Belize Barrier Reef Reserve System, under criteria (iii), based on the classic examples of fringing, barrier and atoll reef types (Table 1).

Site	IUCN Category
Bacalar Chico National Park and Marine Reserve	II (National Park) IV (Habitat/Species Management Area)
Laughing Bird Caye National Park	II (National Park)
Half Moon Caye Natural Monument	II (Natural Monument)
Blue Hole Natural Monument	III (Natural Monument)
Glover's Reef Marine Reserve	IV (Habitat/Species Management Area)
South Water Caye Marine Reserve	IV (Habitat/Species Management Area)
Sapodilla Cayes Marine Reserve	IV (Habitat/Species Management Area)

The Mesoamerican Barrier Reef System stretches from the southern Yucatan in Mexico to the south of Belize, stabilizing and protecting coastal landscapes, maintaining coastal water quality, sustaining species of commercial importance, and providing employment in the fishing and tourism industries to more than a million people living in coastal areas (Global Environment Facility, 2001). It lies at the intersection of two regions – Central America and the Wider Caribbean - with characteristic flora and fauna from both, leading to the area being highlighted as a world biodiversity hotspot (Conservation International, 2003), as well as an ecoregional priority for conservation planning efforts (World Wildlife Fund, 2002).

Belize has an estimated 1,420 km<sup>2</sup> of reef within its waters - 5.5% of the reefs of the Wider Caribbean (World Resources Institute, 2004), with the lowest average incidence of coral disease in the region (Wilkinson, 2002). The Barrier Reef was included on a list of 18 richest centers of endemism and was highlighted as one of the most threatened by human impacts (Roberts et al., 2002). In the Wider Caribbean region, recent studies have shown that nearly two-thirds of coral reefs are threatened by human activities (World Resources Institute, 2004). One of the areas highlighted as having the lowest impacts is Belize, with its small population and relatively low coastal development rate. However impacts are increasing - recent quantitative data on fish populations comparing 2002 and 2008 probabilities of encounter support visual observations that indicate a staggering decline in populations of larger reef fish such as grouper, snapper, and triggerfish. It is obvious that SWCMR is suffering from serious fish population degradation, and it

is unlikely that conch and lobster numbers can withstand the extensive commercial fishing that is occurring.

In 1983, Belize signed the **Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region** (the 'Cartagena Convention') with the primary objective being protection of the ecosystems of the marine environment, following recognition of the regional importance of the Mesoamerican Barrier Reef System (MBRS), the majority of which lies within Belizean waters (Table 2).

More recently, in June 1997, with the increasing threats to the overall health of the reef system, the Governments of Mexico, Belize, Guatemala and Honduras (the four countries bordering the MBRS) committed themselves through the Tulum Declaration to the development of a 15-year Action Plan – the **Mesoamerican Barrier Reef System Project** - for the conservation and sustainable use of this ecosystem. This initiative, adopted by the Heads of State in June 1999, is supported by the **Central American Commission on Environment and Development (CCAD)**, which works to harmonize environmental policies within the region.

Conservation of this Marine Reserve is also a step towards fulfilling Belize's international commitments under the **Convention on Biological Diversity**, signed in 1992, and the **International Convention for the Protection and Conservation of Sea Turtles for the Western Hemisphere**, signed in 1997 (Table 2).

As a signatory of the **Convention for the Regulation of International Trade of Endangered Species (CITES)**, Belize is obligated to follow the CITES permitting procedures, with a permit required for every individual export of conch (*Strombus gigas*), validated by Customs Department, in order for Belize to ship this product to the USA.

<b>Table 2: International Conventions and Agreements of Relevance to South Water Caye Marine Reserve</b>	
<b>Convention on Biological Diversity</b> (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. <b><i>South Water Caye Marine Reserve provides an important and integral part in the national protected areas system, protecting biodiversity and threatened species, as per Belize’s commitment under the CBD.</i></b>
<b>Alliance for the Sustainable Development of Central America (ALIDES)</b> (1994)	Regional alliance supporting sustainable development initiatives. <b><i>Initiatives within the stakeholder communities of South Water Caye Marine Reserve are targeted for facilitation of sustainable economic and environmental development, with the support of Fisheries Department</i></b>
<b>Central American Commission for Environment and Development (CCAD)</b> (1989)	Regional organisation of Heads of State formed under ALIDES, responsible for the environment of Central America. Initiated Mesoamerican Biological Corridors and Mesoamerican Barrier Reef Systems Programmes. <b><i>Data gathered through monitoring initiatives at South Water Caye Marine Reserve have been shared regionally in the past through MBRS.</i></b>
<b>Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region</b> (Cartagena de Indias, Colombia, 1983)	Regional convention with the objective of protecting the marine environment of the Wider Caribbean through promoting sustainable development and preventing pollution. <b><i>South Water Caye Marine Reserve provides an important and integral part in the national protected areas system, protecting biodiversity and threatened species, as per Belize’s commitment under this Convention.</i></b>
<b>Convention Concerning the Protection of the World Cultural and Natural Heritage</b> (Paris, 1972)	The World Heritage Convention requires parties to take steps to identify, protect and conserve the cultural and natural heritage within their territories. <b><i>South Water Caye Marine Reserve has been accepted as one of seven sites that together comprise Belize’s World Heritage Site under the Convention. However, is has now been placed on the list of sites in Danger.</i></b>
<b>International Convention for the Protection and Conservation of Sea Turtles for the Western Hemisphere</b> (December 21 <sup>st</sup> , 1997)	To protected and conserve sea turtle species of the Western Hemisphere. <b><i>South Water Caye Marine Reserve protects important feeding and nesting areas for sea turtles, including the Critically Endangered hawksbill</i></b>
<b>The UN Convention on the Law of the Sea</b> (1982)	The Law of the Sea Convention defines the rights and responsibilities of nations in their use of the world’s oceans, establishing guidelines for businesses, the environment, and the management of marine natural resources.

## 1.3 National Context

### 1.3.1 Legal and Policy Framework

At present, Belize has over 2.6 million acres (46% of the country) of its area under some form of protection (CSO, 2000) – either as national or private protected areas. The national objectives for conservation revolve around the protection, conservation and rational use of Belize’s natural resources within the context of sustainable human development. These goals are supported by the National Protected Areas Policy and System Plan (NPAPSP, 2006), which was developed following a full review of the national protected areas system in 2005. It was accepted by Cabinet in January 2006, and centers around the following policy statement:

*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.*

Whilst the entire Barrier Reef and associated coral reef structures do not have full protected status within Belize, there are 13 marine protected areas within the system (totaling 608,742 acres). Eight of these are designated under Fisheries Department as Marine Reserves, the remaining five being under Forest Department (Table 3). A serial designation also protects identified spawning aggregation sites within Belize, important for maintaining the viability of many commercial species.

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<b>Table 3: Marine Protected Areas in Belize</b>				
<b>Protected Area</b>	<b>Mgmt. / Co-mgmt</b>	<b>IUCN Category</b>	<b>SI</b>	<b>Area (Acres)</b>
<b>Bacalar Chico National Park &amp; Marine Reserve</b>	Fisheries Dept.	IV	88 of 1996	15,765.8
<b>Blue Hole Natural Monument</b>	Forest Dept. / BAS	III	96 of 1996	1,023
<b>Caye Caulker Marine Reserve</b>	Fisheries Dept. / FAMRACC	VI	35 of 1998	9,670.2
<b>Corozal Bay Wildlife Sanctuary</b>	Forest Dept.	IV	48 of 1998	180,508.5
<b>Gladden Spit and Silk Cayes Marine Reserve</b>	Fisheries Dept. / Friends of Nature	IV	95 of 2003	25,978.3
<b>Glover's Reef Marine Reserve</b>	Fisheries Dept.	IV	70 of 1996	86,653
<b>Half Moon Caye Natural Monument</b>	Forest Dept. / BAS	II	30 of 1982	9,771
<b>Hol Chan Marine Reserve</b>	Fisheries Dept.	II	57 of 1987	3,813
<b>Laughingbird Caye National Park</b>	Forest Dept. / Friends of Nature	II	94 of 1996	10,119
<b>Port Honduras Marine Reserve</b>	Fisheries Dept. / TIDE	IV	9 of 2000	100,000
<b>Sapodilla Caye Marine Reserve</b>	Fisheries Dept. / TASTE	IV	117 of 1996	38,594
<b>Southwater Caye Marine Reserve</b>	Fisheries Dept.	IV	118 of 1996	117,875
<b>Swallow Caye Wildlife Sanctuary</b>	Forest Dept. / FOSC	IV	102 of 2002	8,972

South Water Caye Marine Reserve falls under the Fisheries Department of the Ministry of Agriculture and Fisheries, and is guided by the Fisheries Act (1948, revised 1983) and Fisheries Department policies. These allow for zoned multiple use, with areas open for extractive use, no-take areas and a preservation area, regulated under a zoning system that is embedded within the Statutory instrument for the protected area. The Department is responsible for all management activities, including enforcement of the no-take regulations of the Conservation and Preservation Zones of the Marine Reserve.

Also contributing to the conservation framework of Belize are a number of laws designed to protect wildlife and national heritage. The Fisheries Act, administered under the Fisheries Dept, is the principal governing legislation to regulate the fishing industry, and is directly concerned with maintaining sustainable fish stocks and protecting the marine and freshwater environments. It also provides protection for nesting turtles and nest sites. Marine turtles themselves have been given protection since the original Fisheries Ordinance in 1940. The Environmental Protection Act (1992) was developed under the Department of the Environment, a department of the Ministry of Natural Resources, with the aim of ensuring that development initiatives within Belize are planned for minimum environmental impact – in the context of South Water Caye Marine Reserve, this is particularly important when ensuring that the impacts from development taking place on cayes – particularly dredging - within the marine reserve are minimised.

Also under the Ministry of Natural Resources is the Forest (Protection of Mangrove) Regulations (SI 52 of 1989, under revision, 2009), provides for the protection of mangroves, with restrictions on mangrove alteration and / or clearance without permission. There is currently a moratorium on the clearance of mangroves, which has resulted in a number of stop orders for cayes within

the Marine Reserve, including the Blue Ground Range area. Before granting a permit for mangrove alteration, Belize law requires the Forest Department consider whether the project will adversely affect the conservation of the area's wildlife, water flow, erosion and values of marine productivity, and to find either (a) that the proposed alteration will not significantly lower or change water quality or (b) that the degradation of water quality is in the "larger and long-term interest of the people of Belize." (Chapter 213, Section 5.5, of Belize's Forest Act). With the designation of the Marine Reserve as part of Belize's World Heritage Site, protection of the important mangroves within the protected area should be a priority.

The Wildlife Protection Act (Chapter 220, SI 12 of 1982, revised 2000) also falls under the Forest Department, and provides protection for a number of marine species (West Indian Manatee, whales and dolphins), with the regulation of hunting and commercial extraction.

Whilst the above are the legislative Acts most relevant to the South Water Caye Marine Reserve, there are others - such as the Mines and Minerals Act (1989) and the Petroleum Act (1991), which regulate the exploration and extraction of non-renewable resources. These Acts control activities including dredging, prospecting and drilling. Dredging activities have impacted the Marine Reserve in the past, even in the highly fragile Pelican Cayes area, and current mechanisms are being developed to ensure stricter control of such activities within the protected area. The Marine Reserve has also been the site of previous oil drilling activities, and lies within a current oil exploration concession area.

Caye development is regulated through the requirement for an Environmental Impact Assessment, resulting in the production of an Environmental Compliance Plan, approved and theoretically monitored by the Department of Environment. The Department of the Environment is also responsible for responding to large-scale human impacts on the reef, such as boat groundings and fuel spills.

The Port Authority is mandated to ensure the safety of navigational channels, through the installation of navigational aids (Belize Port Authority Act, revised, 2000). It also has a role in the registration of boats and monitoring of vessels using navigational channels and the removal of boats from the reef, when groundings occur

Financial sustainability is addressed at Government level through the development of a funding mechanism to assist in management and development activities within protected areas – the Protected Areas Conservation Trust (PACT), through a 'conservation tax' of Bz\$7.50 levied on non-residents as they leave the country. South Water Caye Marine Reserve is eligible for funding from the Trust, and has received funding in the past. Fisheries Department also has its own protected area management fund, derived from entrance fees, which is then distributed among the Fisheries-managed protected areas on an 'as needed' basis.



### 1.3.2 Land and Sea Tenure

South Water Caye Marine Reserve is included in Belize's territorial waters (Maritime Areas Act of 1992). The seabed is national land, and thus any construction, such as piers, marinas, and seawalls, needs to be licensed by the Lands Department. Any mining, including beach sand mining or dredging activities, and oil exploration / drilling activities, require a license from the Geology & Petroleum Department.

Belizean fishermen have fished the area for many years, and are considered to have traditional rights to the fishing grounds, though this is regulated to some extent by the Marine Reserve zones.

In the late 1990s a moratorium was placed on the sale of National Lands on the cayes, though since then, a number of cayes have been leased and surveyed within the Marine Reserve in contravention of this policy, often leading to subsequent granting as property, to then be re-sold to investors/ speculators and developers. Between 2004 and 2008, the Belize government has issued at least 70 grants and 58 leases within the protected area (Jones, 2003; Table 4), despite the moratorium on sale of cayes, and the designation of this Marine Reserve as a World heritage Site, on the basis of the unique values the mangrove cayes exhibit.

UNESCO recommendations strongly suggest that Government consider setting a system to remove lands within the World Heritage Site completely from the jurisdiction of the Lands Department, thereby eliminating the chances of the issuing of leases or grants within the Barrier Reef System (UNESCO, 2009), and the recent revision of the Statutory Instruments now defines the Marine Reserve as the "Caribbean Sea, reef and cayes, excluding all private property" – an important distinction from the previous SI (SI 118 of 1996), which only stipulated the Caribbean Sea, and excluded the cayes. Man O' War Caye, which lies within the boundaries of the Marine Reserve, is protected in its own right as a crown reserve under SI 09 of 1977.

Under the UNESCO review of the World Heritage Site (the Belize Barrier Reef Reserve System), a recommendation is also made that protected areas within the BBRRS also be excluded from mining and oil prospecting and extraction license areas.

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<b>Caye</b>	<b>Number of Grants</b>	<b>Number of Leases</b>	<b>Total Acres</b>
Blue Ground Range	6	9	16.03
Coco Plum Caye	1	3	30.99
Spruce Caye	1	0	1.10
Carrie Bow Caye	1	0	1.00
Wee Wee Caye	0	2	0.84
Ragged Caye	1	0	2.33
South Water Caye	15	0	13.27
Tobacco Caye	27	0	5.87
Tobacco Range	10	20	99.40
Twin Cayes	3	10	20.96
Channel Caye	0	1	0.20
Peter Douglas	0	1	2.00
Northeast Pelican	1	1	4.20
Northwest Pelican	0	1	1.50
Pelican (Cat) Caye	0	1	5.24
Lagoon Caye	0	2	2.50
Quamina Caye	0	1	2.00
Saddle Caye	1	1	1.00
Slasher Sandbore	0	1	0.50
Tarpon Caye	0	1	1.00
Baker's Rendezvous North	0	1	0.22
Crawl Caye	0	2	6.12
Bread and Butter Caye	0	1	No data
Wiparri Caye	0	1	1.02
Lark Caye	3	0	No data
Peter Douglas Caye	0	2	No data
<b>Total</b>	<b>70</b>	<b>62</b>	

**Table 4: Leases and Grants given on Cayes within South Water Caye Marine Reserve  
(NB. Figures are estimates, and may not be complete)**

### 1.3.3 Evaluation of Protected Area

#### Global Importance

South Water Caye Marine Reserve has been designated as one of seven components of the Belize Barrier Reef System - World Heritage Site, in recognition of the uniqueness of its contribution to Belize’s reef system, the largest, and possibly the least impacted reef complex in the Atlantic–Caribbean area (UNESCO, 1996). It has been extensively studied through activities under the Smithsonian Institute and more recently, under the Conservation International Marine Management Area Science Programme, which provide information on a wide array of topics, including coral reef ecology and resilience to impacts such as bleaching.

The Marine Reserve is recognized for supporting extraordinarily high biological diversity and possessing a representative range of reef types in the Caribbean Sea. The protected waters of the reserve provide nursery and feeding habitats for at least twenty four species of international concern, recognized under the IUCN Redlist as Critically Endangered, Endangered or Vulnerable (Table 5; IUCN, 2008), including five species of coral, three species of turtle, fifteen species of fish and the vulnerable West Indian manatee. The faroes in the southern part of the marine reserve, and associated Pelican Cayes are recognized as particularly important, with a unique and fragile species assemblage with a species diversity unparalleled in the Caribbean.

A number of the cayes have historically provided nesting sites for hawksbill and green turtles, important to the survival of these species within the region. However, tourism developments have severely reduced the size and suitability of these beaches.

South Water Caye Marine Reserve Species of International Concern	
<b>Critically Endangered</b>	
Staghorn Coral	<i>Acropora cervicornis</i>
Elkhorn Coral	<i>Acropora palmata</i>
Goliath Grouper	<i>Epinephelus itajara</i>
Hawksbill Turtle	<i>Eretmochelys imbricata</i>
<b>Endangered</b>	
Loggerhead Turtle	<i>Caretta caretta</i>
Green Turtle	<i>Chelonia midas</i>
Nassau Grouper	<i>Epinephelus striatus</i>
Fire Coral	<i>Millepora striata</i>
Star Coral	<i>Montastraea annularis</i>
Star Coral	<i>Montastraea faveolata</i>
Great Hammerhead	<i>Sphyrna mokarran</i>
<b>Vulnerable</b>	
Queen Triggerfish	<i>Balistes vetula</i>
West Indian Manatee	<i>Trichechus manatus</i>
Marbled Grouper	<i>Dermatolepis inermis</i>
White Grouper	<i>Epinephelus flavolimbatus</i>
Snowy Grouper	<i>Epinephelus niveatus</i>
Hogfish	<i>Lachnolaimus maximus</i>
Mutton Snapper	<i>Lutjanus analis</i>
Cubera Snapper	<i>Lutjanus cyanopterus</i>
Yellowmouth Grouper	<i>Myctoperca interstitialis</i>
Whale Shark	<i>Rhincodon typus</i>
Whitelined Toadfish	<i>Sanopus greenfieldorum</i>
Rainbow Parrotfish	<i>Scarus guacamaia</i>

**Table 5: Species of international Concern of South Water Caye Marine Reserve**

## National Importance

South Water Caye Marine Reserve protects one of the best examples of the Barrier Reef, and is of particularly high ecological and touristic value. The sheltered, clear waters and the dazzling array of corals benefit Belize's growing number of tourism operations, based from both the cayes and the mainland, attracting snorkelers and divers from all over the world, as well as providing the perfect environment for kayaking packages. The area is also noted for specialized education and research value, with its own research and education facilities based on a number of the cayes within the Marine Reserve, bringing researchers and school educational groups to the area.

South Water Caye Marine Reserve was first highlighted as an area of national importance by the Belize Centre for Environment Studies for its pristine mangrove vegetation and nesting bird congregations. The Marine Reserve is one of four protected areas that form the Southern Belize Reef Complex (SBRC), which stretches southwards from the northern boundary of the reserve to the northern boundary of Port Honduras Marine Reserve, and south-eastwards from the coastline of Belize to the Sapodilla Cayes and the outer reef. This area is characterized by the variety of reef structures, important cross-shelf habitat linkages and an assemblage of ecosystems considered possibly the most biodiverse in the region. The SBRC is of great importance for many species of conservation concern, including the critically endangered hawksbill turtle (*Eretmochelys imbricata*) and goliath grouper (*Epinephelus itajara*), and the endangered green and loggerhead turtles (*Chelonia mydas* and *Caretta caretta*) (IUCN, 2008).

South Water Caye Marine Reserve is also of economic importance to Belize as a lobster, conch and fin-fish resource for traditional fishermen from mainland fishing communities - particularly



**South Water Caye Marine Reserve is known for its impressive and easily accessible reef (above; © Tony Rath, 2009), and encompasses important bird nesting colonies, including Man O' War Caye (below)**

Sarteneja, Dangriga and Hopkins, and subsistence fishing resources for people living on Tobacco Caye, South Water Caye and other cayes within the protected area. The shallow northern backreef lagoon between the reef crest and Tobacco Range supports nationally important nursery areas for the queen conch, whilst the mangroves of Twin Cayes, Tobacco and Blue Ground ranges, and the Pelican Cayes are considered particularly important for the sustainability

of commercially important species for the entire reef system – not just the Marine Reserve itself. The mangroves and seagrass provide critical nursery habitat for juvenile Caribbean

spiny lobster and commercial finfish species, forming the foundation of Belize's fishing industry.

Several coral sand cayes within the protected area have provided historical nesting sites for hawksbill

and green turtles, though the highly attractive nature of these cayes for tourism ventures has reduced much of the viability of these beaches for turtle nesting in the current trend of caye development.

A number of nesting colonies are located within the boundaries of the marine reserve - Man O' War Caye, a crown reserve in its own right, is a nesting site for both the magnificent frigatebird (*Fregata magnificens*) and the brown boobie (*Sula leucogaster*) and The marine reserve also protects nesting sites of several tern species - sand bores in the Wee Wee Caye area provide nesting sites for the bridled terns (*Sterna anaethetus*), and the reef adjacent to Tobacco Caye supports nesting populations of least terns (*Sterna antillarum*) and roseate terns (*Sterna dougalli*).

Whilst not within the Marine Reserve itself, the on-site management staff also monitor Emily Caye (otherwise known as Caye Glory), a spawning aggregation site to the north of the protected area. This site is renowned for highlighting the crash of Nassau grouper (*Epinephelus striatus*), with numbers plummeting from many thousands in the 1950's and 1960's to an estimated 21 in 2001(Paz and Truly, 2007). Recent monitoring estimates show increased numbers of Nassau Grouper with 3,000 recorded in 2009 (Table 7; Belize Spawning Aggregation Working Group, 2009). A number of other species are also known to use the site – dog snapper (*Lutjanus jocu*), red hind (*Epinephelus guttatus*), black grouper (*Mycteroperca bonaci*), yellowfin grouper (*Mycteroperca venenosa*), jolyhead porgy (*Calamus bajonado*), and permit (*Trachionatus fulcatus*) (Heyman et. al. 2003). This spawning aggregation site has been identified as of high regional ecological importance, and high vulnerability, with limited management in place (Heyman 2003).

<b>Maximum Nassau Grouper Estimates</b>	
<b>2003</b>	1,000
<b>2004</b>	1,000
<b>2005</b>	350
<b>2006</b>	7
<b>2007</b>	69
<b>2008</b>	405
<b>2009</b>	3000

**Table 7:** Grouper estimates at Emily Caye spawning aggregation site

**Environmental Services of South Water Caye Marine Reserve**

Other than the specific values of the protected area itself, the coral reef, mangrove and seagrass ecosystems provide a number of varied ecosystem services (Table 8).

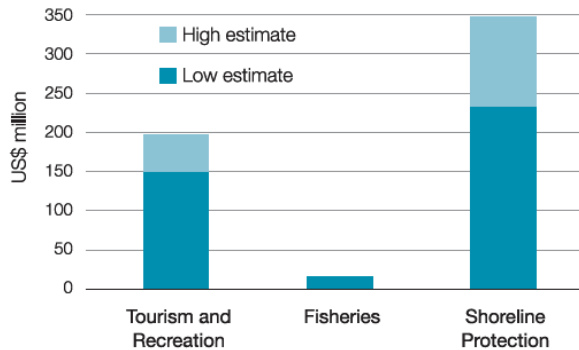
<b>Table 8: Ecosystem Services of South Water Caye Marine Reserve</b>	
<b>Regulation</b>	<ul style="list-style-type: none"> <li>▪ Protection of the coastline from storm surges and waves through the presence of the Barrier Reef</li> <li>▪ A reduction of beach erosion on cayes within the reserve, and the coastline through presence of the Barrier Reef</li> <li>▪ The reef provides coral, a major component in the formation of beaches and cayes</li> <li>▪ The prop roots of red mangroves protect the cayes from erosion</li> <li>▪ Seagrass plays an important role in stabilizing the substrate and settling turbidity in the water</li> </ul>
<b>Recruitment</b>	<ul style="list-style-type: none"> <li>▪ The coral reefs within no take zones within the protected area, ensure that there are viable populations of commercial species for subsistence and commercial fishing</li> <li>▪ Mangrove and seagrass provide important nursery areas for both commercial and non-commercial species</li> </ul>
<b>Cultural</b>	<ul style="list-style-type: none"> <li>▪ Coral reefs in the protected area are important resources for tourism and recreation</li> <li>▪ Aesthetic appreciation</li> </ul>
<b>Support</b>	<ul style="list-style-type: none"> <li>▪ Coral reefs, seagrass and mangroves play an important role in the cycling of nutrients</li> <li>▪ Coral reefs, seagrass beds and mangroves within the protected area provide ecosystems necessary for different life stages of commercial and non-commercial species</li> <li>▪ Coral reefs are among the most productive habitats, producing 2,000 decagrams of carbon per square meter per year</li> <li>▪ Mangroves provide nesting structure for several bird nesting colonies, including for the nesting colony of magnificent frigatebirds (<i>Fregata magnificens</i>) and brown boobies (<i>Sula leucogastor</i>) on Man O' War Caye.</li> </ul>
<b>Adapted from UNEP-WCMC, 2006</b>	

**Economic Value of the Protected Area**

A recent evaluation of the reef system demonstrated the economic value of Belize's reef and mangrove to the country (Cooper et. al, 2008). Based on the coastal protection provided by the barrier reef and mangroves, the support of the fisheries industry and the contribution towards providing a tourism resource, the overall value of the reef and mangroves in Belize was estimated at Bz\$790 – \$1,118 million a year (US\$395 - \$559 million a year).

**Annual Economic Contribution of Coral Reefs and Mangroves in Belize**

**ANNUAL ECONOMIC CONTRIBUTION OF CORAL REEFS AND MANGROVES IN BELIZE**



From: Cooper, E., L. Burke and N. Bood. 2008. Coastal Capital: Economic Contribution of Coral Reefs and Mangroves to Belize. Washington DC: World Resources Institute.

Coral reef- and mangrove-associated tourism contributed an estimated US\$150 million to \$196 million to the national economy in 2007 (12 percent to 15 percent of GDP).

Fishing is an important cultural tradition, as well as a safety net and livelihood for many coastal Belizeans. Annual economic benefits from reef and mangrove-dependent fisheries is estimated at between US\$14–16 million.

Reefs and mangroves also protect coastal properties from erosion and wave-induced damage, providing an estimated US\$231 to US\$347 million in avoided damages per year.

In total, reef- and mangrove-associated fisheries have an estimated direct economic impact of US\$14 to \$16 million per year. An estimated 1.2 million pounds of fish were sold to Belize’s Fishermen’s Co-ops in 2007, of which over 80% was exported, earning US\$11.2 million in gross revenue. In addition, Co-ops earned an estimated US\$1 million in local sales (Cooper et. al., 2008). Fishermen also sell their catch to local markets and restaurants, and distribute it to family and friends, estimated to contribute an additional US\$1.9 to \$3.5 million per year to the economy (Cooper et. al., 2008). As one of the largest marine protected areas within Belize, South Water Caye Marine Reserve plays an important role in management of fisheries resources.

**Value of the National Capture Fisheries Industry:**

Approximately 1.2 million pounds of fish were sold to Belize’s Fishermen’s Co-ops in 2007. Over 80% of that total was exported, earning US\$11.2 million in gross revenue. In addition, Co-ops earned an estimated US\$1 million in local sales. Fishermen also sell their catch to local markets and restaurants, and distribute it to family and friends, contributing an additional US\$1.9 to \$3.5 million per year to the economy. In total, reef- and mangrove-associated fisheries have an estimated direct economic impact of US\$14 to \$16 million per year.

**From: Cooper et.al.. 2008**

Also of economic importance is the provision of a tourism resource, of particularly importance as a direct contribution to Belize’s economy - many of these people have chosen to come to Belize specifically because of the first class diving on the reef. It is estimated that each visitor to the marine protected areas spends an average of US\$150 per day whilst in Belize (Cooper et. al, 2008). The economic contribution of the approximately 3,000 visitors recorded in 2008 to the South Water Caye Marine Reserve can therefore be estimated at over US\$450,000 for each day they are in country.



### 1.3.4 Socio-Economic Context

Belize has a low population currently estimated at approximately 301,270 (CIA, 2008), of which 52% are urban dwellers (CSO, 2004). Population densities are low, with just over 12 persons per sq. km., concentrated mostly within the northern plain, southern coastal plain, Belize Valley and Stann Creek Valley, with much of the remaining country being less suited in the coastal plains and steep terrain in the Maya Mountains. It is a country of many ethnic cultures, with Mestizo, Creole, Maya and Garifuna being the major population groups. The Maya occupants of Belize, the descendants of the Central American civilization that was at its height approximately 2,000 years ago, are subdivided into three ethnic groups – the Yucatec Maya of the north, the Mopan Maya of the west and south, and the Ketchi of the southern regions. The northern coastal fishing communities are based on the Mestizo culture, being settled in the 1850’s by refugees from the Mexican Caste War. The southern coastal communities are more Garifuna based (descendants of Black African / Carib Indian), being settled by refugees who sailed to Belize from St. Vincent’s in the West Indies.

There is an ongoing emigration of Belizeans to the United States – generally those from urban areas who have completed secondary school or have professional training. There is also a significant influx of Central American refugees – primarily from Guatemala and Honduras - contributing approximately 13% towards the total population of Belize and resulting in the relatively high population growth rate of 2.2%. At the present rate of immigration, it has been calculated that the population of Belize will double in twenty-six years, with much of this immigrant sector tending to be rural-based with low levels of education, placing far greater stress on the natural resources than currently exists.

<b>Figure 1: Belize Demographic Statistics (Average)</b>	
Population estimate (2008)	301,270
Population density (2004)	12.3 /sq. km.
Annual growth rate (2008)	2.2%
Birth rate (1996)	23.2 per 1000
Mortality rate (1996)	4.3 per 1000
Fertility rate (2000)	3 children per woman
Life expectancy (2000)	76 (female); 73 (male)
Below Poverty level (2002)	33.5%
Literacy rate (2002)	94%
Unemployment rate (2004)	11.6%
GDP (bn Bz\$) (2007)	2.6
Ref: CSO 2000 Census	
Ministry of Health	
CSO, Mid-term 2004	
CSO, Poverty Assessment Report, 2002	
CIA, 2008	

The economy of Belize has, in the past, been based largely on agriculture, with fisheries, banana, sugar and citrus forming some of the traditional exports that contribute significantly towards the GDP, though this has recently been exceeded by revenue from oil extraction. There is also an increasing reliance on the developing tourism industry, which is rapidly becoming the major foreign exchange earner.

The fishing sector that utilizes South Water Caye Marine Reserve is part of traditional industry that provides employment for over 2,150 fishers and over 120 processing plant

personnel (Ministry of Agriculture and Fisheries, 2007). The majority of the South Water Caye Marine Reserve traditional fishermen fish for fin-fish and free dive for lobster and conch, originating from the coastal communities of Sarteneja, Dangriga, Hopkins, Riversdale and Placencia. These fishermen use hand lines for finfish and shades / traps for lobster (primarily the fishermen from Dangriga and Hopkins), and free-dive for Spiny Lobster (*Panulirus argus*) and Queen Conch (*Strombus gigas*) (primarily fishermen of Sarteneja), fishing throughout the

shallow protected lagoon of the Belize Barrier Reef. Long lines are also used in the deeper channels and on the fore-reef, especially near Tobacco Caye.

**State of National Capture Fisheries (2007)**

In 2007, overall fisheries production volume decreased by 6.0% from 570.4 tonnes (1,254,861.5 lbs) in 2006 to 534.6 tonnes (1,176,033.7 lbs) in 2007. The overall monetary value of the exports of the capture fishery commodities amounted to BZ\$22,700,000. (SIB and Belize Fisheries Department 2008).

In general, lobster tail production volume increased by 10% from 190 tonnes (419,863 lbs) in 2006 to 210 tonnes (462,152.3lbs) in 2007. The increase in production volume of lobster tails also produced an increase in lobster head meat production volume, from 17.2 tonnes (37,835 pounds) in 2006 to 18.8 tonnes (41,294 lbs) - equivalent to 9.14% in weight - with an export value of \$98,480 in 2007.

Conch production volume decreased by almost 17% from 314.7 tonnes (692,302.5 lbs) in 2006 to 261.3 tonnes (574,756.1 lbs) in 2007 with an export value amounting to \$5,389,117.

Fish fillet, lobster head meat and whole fish showed an increase in production volume of 37.91 % (from 20 tonnes in 2006 to 27 tonnes in 2007), 9.14% (17 tonnes in 2006 to 19 tonnes in 2007) and 4.64% (4 tonnes in 2006 to 4.3 tonnes in 2007), respectively.

The Fisheries Sector ranked 4<sup>th</sup> in its contribution of 23% to the national GDP in 2006, with export earnings of approximately Bz\$22,400,000, primarily from the traditional lobster and conch capture fisheries (Ministry of Agriculture and Fisheries, 2007).

The primary exploited species, lobster, conch, and to a lesser extent, finfish, have both declined since the early 1980's, when the industry was at its peak. 80% of the lobster and conch is exported through the four fishing cooperatives, the remaining 20% is sold for local consumption (Cooper et. al. 2008).

Fishermen tend to be between 15 and 35 years of age, often with limited education, leaving primary school to go directly into fishing (FAO, 2005; SACD, 2009 in prep). Alternative job opportunities within many of these coastal communities are limited, though a number – Hopkins, Dangriga, Riversdale and Placencia in particular - are shifting to a greater dependence on tourism.

The developing tourism industry, one of the fastest growing sectors in Belize, is rapidly becoming the major foreign exchange earner, with over 840,000 tourists arriving in

Belize in 2008 (BTB, 2009). Only a small percentage of these visitors (less than 4%) make it to South Water Caye Marine Reserve, either as day visitors, or staying at one of the tourism, education or research facilities on one of the cayes. The majority of visitors are snorkelers, divers, kayakers, and fly fishermen, and provide substantial employment opportunities for local guides and tourism developments, both within the Marine Reserve itself, and in Dangriga, Hopkins or Sittee River.

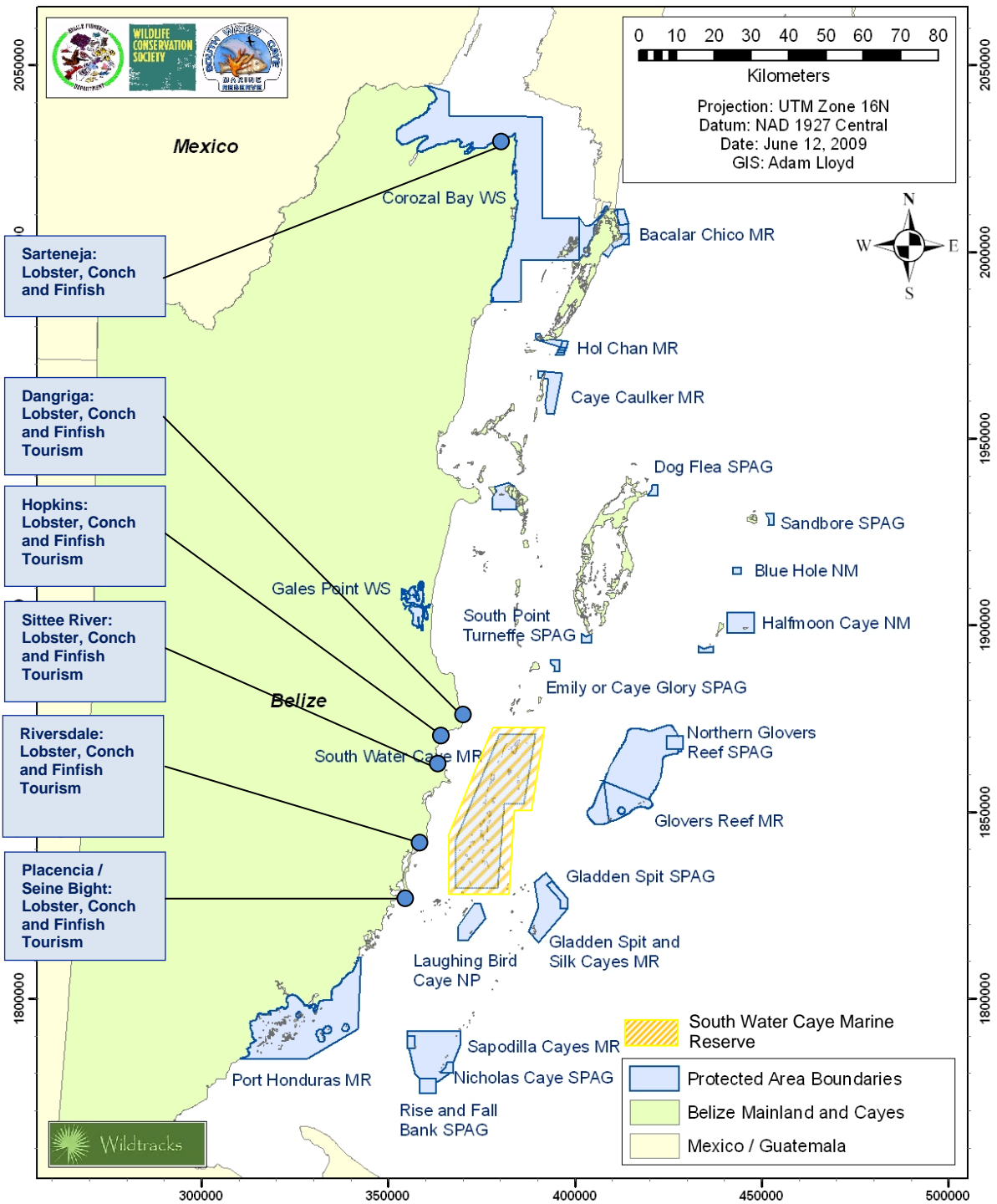
A number of communities have been highlighted as major stakeholders in the protected area, through fishing or tourism (Table 9; Map 4). A basic stakeholder analysis identifies stakeholder interests and impacts (Table 10; Table 11).

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<b>Table 9: Stakeholder Communities of South Water Caye Marine Reserve</b>				
<b>Community</b>	<b>Location (UTM) Distance (km)</b>	<b>Population (approx.)</b>	<b>Population components</b>	<b>Comments</b>
<b>Sarteneja</b>	E16 0378750 N18 2029500 (158 km NW)	2,300*	Mestizo	Largest fishing community, concentrating on lobster and conch throughout Belize waters using traditional sail boats. Largest number of fishermen utilizing natural resources of SWCMR.
<b>Dangriga</b>	E16 0370200 N18 1876300 (11.4km ESE)	11,600**	Garifuna	Fishing skiffs utilizing SWCMR – hand lines, traps and shades Tourism
<b>Hopkins</b>	E16 0363200 N 18 1864680 (13km E)	1,027**	Garifuna	Small number of skiffs, focused on SWCMR - hand lines, traps and shades Tourism developments (eg. Hamanasi)
<b>Sittee River</b>	E16 0363200 N 18 1864680 (13.3km E)	641**	Garifuna	Fishing community gradually shifting to tourism
<b>Placencia</b>	E16 03653894 N18 26544 (14.3km NE)	1,200	Predominantly Creole	Historically a fishing community – now a primarily tourism based economy
<b>Riversdale / Seine Bight</b>	E16 0363200 N 18 1864680 (8.3km E)	1,829	Garifuna	Historically a fishing community – now moving towards primarily tourism based economies
<b>Tobacco Caye</b>	E16 0386986 N18 68397 (within SWCMR)	Seasonal population of 16	Creole	Small community mostly reliant on tourism based around snorkeling and diving. Small numbers of the community still depend on fishing for subsistence.
* Sarteneja Health Committee, 2005; **CSO Census data, 2000				

# South Water Caye Marine Reserve – Management Plan 2010-2015

## Primary Stakeholder Communities of South Water Caye Marine Reserve



**Map 4: Principal Stakeholder Communities of South Water Caye Marine Reserve**

## South Water Caye Marine Reserve – Management Plan 2010-2015

A full socio-economic assessment of stakeholder communities of the marine resources of the protected area is currently being completed (CI/Catzim et. al, in prep., 2009), covering socio-economic parameters in the stakeholder communities, as well as local values and beliefs about marine resources, and understanding of impacts. Seven primary stakeholder communities were identified and assessed for South Water Caye Marine Reserve (Table 10; CI/Catzim et. al. in prep.), providing significant information on the resource users, though it should be noted that Riversdale, considered an important fishing stakeholder, was not included within the survey.

The highest number of identified users (946) are resident in Dangriga. Many of these are Government or Private Sector employees, using the Marine Reserve for recreational purposes, or as employees within the tourism sector. Sarteneja Dangriga and Placencia are identified as the primary fishing stakeholder communities (Table 10; CI/Catzim et. al. in prep.).

Household Main Source of Income	Southwater Caye Marine Reserve N=1,516						
	Communities						
	Sarteneja	Dangriga	Hopkins	Sittee River	Placencia	Independence	Punta Gorda
Self Employed (Fishing)	317	146	0	0	63	0	0
Self-Employed (Agriculture)	0	24	42	0	0	9	0
Self-Employed (Trade)	7	73	0	7	0	0	0
Other Casual Laborer	0	24	5	0	0	0	0
Government Employee	0	315	0	0	0	9	0
Private Sector Employee	0	243	21	0	12	0	26
Informal Economy	0	73	0	0	0	0	0
Pensions, Savings, Investments	0	24	5	0	0	0	13
Remittances from Abroad	0	0	0	0	6	0	0
Other Source	0	24	5	0	23	0	0
<b>Total Users</b>	<b>324</b>	<b>946</b>	<b>78</b>	<b>7</b>	<b>104</b>	<b>18</b>	<b>39</b>

**Table 10: Communities and main sources of income for households utilizing South Water Caye Marine Reserve** (A. Catzim, Isis Enterprises / Conservation International; in prep, 2009)

An assessment of the boats identified as using the protected area during 2008 (Fisheries Department, 2008) provides a random sample of fisheries users. Whilst the number of incidences of boats from the Stann Creek / southern communities (Dangriga, Hopkins, Monkey River etc.) was far higher than those from the north (54 boats reported from Stann Creek /

southern communities vs. 28 boat reports from Sarteneja), the number of Sarteneja fishermen using the area is higher than those fishermen from the Stann Creek / southern communities (176 vs. 137).

This is due primarily to the difference in fishing methods and vessel used by the two sectors. The Stann Creek / southern fishermen generally use smaller skiffs, and access the area on one day / two day fishing trips, with an average of 2.5 fishermen per boat. Fishing methods may include traps, shades and lines, as well as free diving for conch and lobster. Those from Sarteneja, however, use larger traditional sailboats to reach the Marine Reserve, and dug-out canoes, or doreys for daily fishing (one per fisherman). The average number of fishermen per sailboat is 6.3, with the highest number of fishermen for a single boat being recorded as 13. These fishermen



**Traditional Sarteneja fishing boat and crew**

camp on their boats or on adjacent cayes, spending up to 12 days at sea, free-diving for lobster and conch (depending on the season) and catching finfish, generally using spearguns (speargun use is now prohibited within Marine Reserves, as per the revised SI, 2009).

There is also a subsistence fishery based primarily out of Tobacco Caye and South Water Caye (where it is also conducted as a tourism activity – ‘catch-and-eat’ tourism), but also active wherever residents, watchmen and fishermen are present overnight within the Marine Reserve.

Table 11: Stakeholder Analysis for South Water Caye Marine Reserve				
Stakeholder	Influence or Impact of South Water Caye Marine Reserve on Stakeholder		Influence or Impact of Stakeholder on South Water Caye Marine Reserve	
<b>Community Stakeholder</b> Sarteneja, Dangriga, Hopkins,	▪ Protection of fish, lobster and conch resources within the Conservation Zone ensuring continued viability of fishery	+	▪ Low level of cooperation or openly antagonistic towards protected areas	-
	▪ Protection of important mangrove nursery sites, ensuring continued viability of fishery	+	▪ Illegal fishing within the Conservation areas	-
	▪ Exclusion from traditional fishing areas	-	▪ Fishing impacts within protected areas (including damage to coral)	-
<b>Tour Guides (including tour boat captains)</b>	▪ Benefit from having South Water Caye Marine Reserve as a major venue for snorkeling, dive- and kayak-associated tourism	+	▪ Support the conservation goals of South Water Caye Marine Reserve	+
	▪ Employment in reef-based tourism initiatives	+	▪ Provide interpretation for visitors, facilitating overall visitor appreciation	+
	▪ Income from using South Water Caye Marine Reserve for tourism	+	▪ If well trained, assist with visitor management within the protected areas through in-depth briefings	+
			▪ If poorly trained, can result in poor visitor management and increased impact on corals and associated fauna, anchor damage etc.	-
<b>Caye-based Tourism Initiatives</b>			▪ Impact behaviour of fish through feeding	-
	▪ Benefit from having South Water Caye Marine Reserve as a major venue for snorkeling, dive-, kayak- and fly-fishing associated tourism	+	▪ Support the conservation goals of South Water Caye Marine Reserve	+
	▪ Income from using South Water Caye Marine Reserve as a tourism destination	+	▪ Provide marketing of South Water Marine Reserve at both national and international level	+
			▪ Provide interpretation for visitors, facilitating overall visitor appreciation.	+
			▪ Potential impacts from pesticide / herbicide use	-
			▪ Potential impacts from dredging activities	-
			▪ Potential impacts on fish populations through mangrove clearance	-
			▪ Potential impacts of inadequate sewage disposal, grey water and detergents	-
			▪ Potential impacts of run-off following land clearance, and associated sedimentation	-
			▪ Beach use impacts on turtle nesting	-



Table 11: Stakeholder Analysis for South Water Caye Marine Reserve (cont.)				
Stakeholder	Influence or Impact of South Water Caye Marine Reserve on Stakeholder		Influence or Impact of Stakeholder on South Water Caye Marine Reserve	
<b>Local / National Tour Operators</b>	<ul style="list-style-type: none"> <li>▪ Benefit from having South Water Caye Marine Reserve as a major venue for dive- and kayak-associated tourism</li> <li>▪ Income from using South Water Caye Marine Reserve as a tourism destination</li> </ul>	<p style="text-align: center;">+</p> <p style="text-align: center;">+</p>	<ul style="list-style-type: none"> <li>▪ Provide marketing at a national level, and send visitors to South Water Caye Marine Reserve, increasing sustainability</li> <li>▪ Support the conservation goals of South Water Caye Marine Reserve</li> <li>▪ Increase the potential for exceeding the carrying capacity of the protected area</li> </ul>	<p style="text-align: center;">+</p> <p style="text-align: center;">+</p> <p style="text-align: center;">-</p>
<b>International Tour Operators</b>	<ul style="list-style-type: none"> <li>▪ Benefit from having South Water Caye Marine Reserve as a major venue for dive-associated tourism</li> <li>▪ Benefit from having South Water Caye Marine Reserve as a World Heritage Site destination – global recognition</li> <li>▪ Income from using the Marine Reserve for tours</li> </ul>	<p style="text-align: center;">+</p> <p style="text-align: center;">+</p> <p style="text-align: center;">+</p>	<ul style="list-style-type: none"> <li>▪ Provide marketing at an international level, and send visitors to the protected area, increasing sustainability</li> <li>▪ Support the conservation goals of South Water Caye Marine Reserve</li> </ul>	<p style="text-align: center;">+</p> <p style="text-align: center;">+</p>
<b>BTIA</b>	<ul style="list-style-type: none"> <li>▪ Benefit from having South Water Caye Marine Reserve as a tourism venue, and World Heritage Site, attracting visitors to the area</li> </ul>	<p style="text-align: center;">+</p>	<ul style="list-style-type: none"> <li>▪ Providing national and international marketing of South Water Caye Marine Reserve</li> <li>▪ Support the conservation goals of South Water Caye Marine Reserve</li> </ul>	<p style="text-align: center;">+</p> <p style="text-align: center;">+</p>
<b>General Belize Public (excluding primary stakeholder communities)</b>	<ul style="list-style-type: none"> <li>▪ Maintenance of fish, lobster and conch stocks</li> <li>▪ Environmental services</li> <li>▪ Cultural and aesthetic appreciation</li> <li>▪ Increased awareness through education</li> </ul>	<p style="text-align: center;">+</p> <p style="text-align: center;">+</p> <p style="text-align: center;">+</p> <p style="text-align: center;">+</p>	<ul style="list-style-type: none"> <li>▪ Support of the general public will strengthen the position of protected area</li> <li>▪ Lack of support may increase chances of dereservation</li> </ul>	<p style="text-align: center;">+</p> <p style="text-align: center;">-</p>
<b>Visitors: Tourists</b>	<ul style="list-style-type: none"> <li>▪ Enjoy South Water Caye Marine Reserve as a tourism destination</li> <li>▪ Benefit from education and awareness opportunities</li> </ul>	<p style="text-align: center;">+</p> <p style="text-align: center;">+</p>	<ul style="list-style-type: none"> <li>▪ Entrance fee contributes towards the goal of sustainability</li> <li>▪ Provide marketing nationally and internationally by word of mouth, if happy with level of product</li> <li>▪ Presence deters fishing (and other illegal activities) within protected area</li> <li>▪ Negatively impact marine and terrestrial environments</li> </ul>	<p style="text-align: center;">+</p> <p style="text-align: center;">+</p> <p style="text-align: center;">+</p> <p style="text-align: center;">-</p>

Table 11: Stakeholder Analysis for South Water Caye Marine Reserve (cont.)				
Stakeholder	Influence or Impact of South Water Caye Marine Reserve on Stakeholder		Influence or Impact of Stakeholder on South Water Caye Marine Reserve	
<b>Visitors: Researchers</b>	<ul style="list-style-type: none"> <li>▪ Benefit from being linked to South Water Caye Marine Reserve</li> <li>▪ Benefit from Smithsonian facilities on Carrie Bow Caye and other research bases</li> <li>▪ Benefit from access to a virtually pristine reef environment</li> <li>▪ Benefit from historic baseline information on past research activities within protected areas</li> </ul>	+ + + +	<ul style="list-style-type: none"> <li>▪ Conservation management benefits from data gathered, greater knowledge of marine and terrestrial environments and species within area</li> <li>▪ Benefit from increased activity within area</li> <li>▪ Possible impact of research activities on marine environments</li> </ul>	+ + -
<b>Visitors: Student Groups</b>	<ul style="list-style-type: none"> <li>▪ Benefit from access to a virtually pristine reef environment at an affordable cost</li> <li>▪ Benefit from the presence of a number of field stations established within SWCMR</li> </ul>	+ + -	<ul style="list-style-type: none"> <li>▪ Provide revenue for the marine reserve</li> <li>▪ Large groups of young people have potential to increase the visitor impact on the reef, if poorly supervised</li> <li>▪ Possible impact of poorly supervised / vetted student research activities on marine environments</li> </ul>	+ - -
<b>Sailboat Charter Companies</b>	<ul style="list-style-type: none"> <li>▪ Benefit from protection of South Water Caye Marine Reserve as a major bareboat destination, and its value as tourist attractions</li> </ul>	+	<ul style="list-style-type: none"> <li>▪ Support the conservation goals of South Water Caye Marine Reserve</li> <li>▪ Impacts of sewage and detergent, bilge water, grey water and oil</li> <li>▪ Visual impact of non-traditional sailing boats</li> <li>▪ Anchor damage on mooring sites</li> <li>▪ Potential for grounding on the reef</li> </ul>	+ - - - -
<b>Government of Belize</b>	<ul style="list-style-type: none"> <li>▪ Provides fisheries management for fishing Industry</li> <li>▪ Provides environmental services</li> <li>▪ South Water Caye Marine Reserve included within the National Protected Areas System Plan - Assists in fulfilling Belize Government's commitment to the conservation of natural resources, CCAD, CBD, MBRS, and national World Heritage sites</li> <li>▪ Income generation of significant foreign revenue</li> <li>▪ Provides employment opportunities in stakeholder communities</li> </ul>	+ + + + +	<ul style="list-style-type: none"> <li>▪ Political support (currently being strengthened through the NPAPSP)</li> <li>▪ Uncertainty of long term future commitment</li> </ul>	+ -

## 1.4 Physical Environment of Management Area

### 1.4.1 Climate

#### Temperature and Rainfall

Whilst South Water Caye Marine Reserve lies only 18 kms from mainland Belize, it has a distinct climate that differs from the rest of the Country. Selected as a long term monitoring site, information on meteorological, oceanographic, and biological conditions have been recorded for the area since 1993, under the Caribbean Coastal Marine Program (CARICOMP) - one of the longest continuous programs of its type. Principal parameters recorded are land-sea-water temperatures, water salinity (conductivity), dissolved oxygen, solar radiation, tides, wind direction and speed, and rainfall (CCRE 2002).

Rainfall varies throughout the year - there is a pronounced dry season stretching from January through to the end of April, with minimum monthly rainfall of as low as 47mm in April, the driest month. This is followed by a wetter season (May to December) with maximum monthly rainfalls in the region of 300 and 600mm, punctuated by a mini dry season in July/August. The majority of the rain falls within the hurricane season, associated with passing tropical storms, particularly between September and November (Figure 2).

Annual temperatures on Carrie Bow Cay average 27.1°C, fluctuating throughout the year from a minimum of 23.5°C in January, during the cold fronts, and a maximum in September of 29.2°C (Table 12; Caribbean Coral Reef Ecosystems Program, 2005)

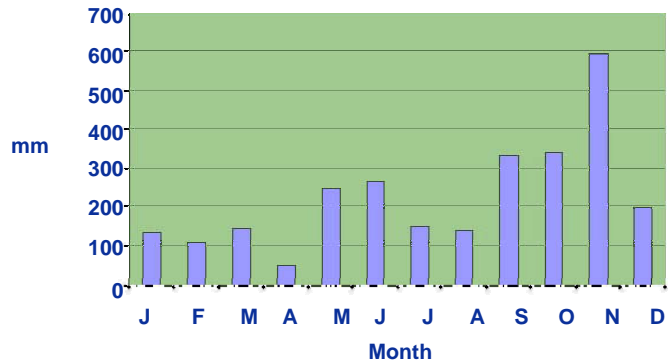


Figure 2: Rainfall - Carrie Bow Caye (2002 – 2004)

Month	Mean Temperature 2002 - 2004	Mean Total Rainfall (mm) 2002 - 2004
January	24.61	136
February	25.08	106
March	26.47	146
April	26.88	47
May	27.96	248
June	28.60	264
July	28.39	149
August	28.83	140
September	29.06	334
October	28.30	342
November	26.45	594
December	24.95	196

Table 12: Mean Temperature and Rainfall (2002 – 2004) Carrie Bow Caye, 2002 - 2004

## Weather 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, on the sea level, and on the currents around the South Water Caye Marine Reserve itself.

## Tropical Storms

Tropical storms affect Belize every year, with the effects being felt particularly strongly on the outlying cayes and atolls. 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 speed < 74 mph) to hurricanes (with sustained wind speed > 74 mph). These storms move westward towards the Caribbean, gathering strength until they hit land.

The hurricane season stretches from the month of June through November, with historical records identifying twenty four hurricanes and eleven tropical storms that have passed within a 50-km radius of South Water Caye Marine Reserve (Table 13; NHC, 2009). Whilst many hurricanes have very focused paths of destruction, their effects are wide ranging, particularly at sea. As well as the physical and mechanical damage to the coral, hurricanes also stir up the water, increasing turbidity and can reduce water clarity for a significant time after the storm event itself. Water clarity can be further reduced following tropical storms by the associated heavy rainfall, which can exacerbate erosion and increase sediment transport from the mainland via the rivers.

- **Trade Winds** – the predominant winds, blowing from the east and north-east
- **Northers** - high-pressure fronts moving down from the north, occurring between October and April
- **Tropical Storms** - occurring between June and November, originating in the mid-Atlantic

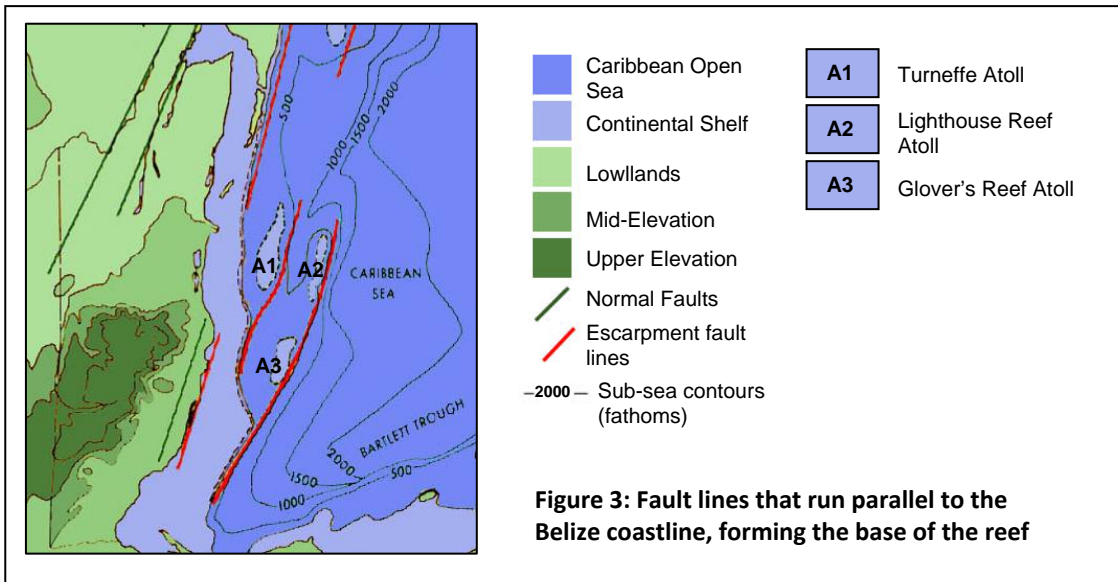
Name	Cat.	Year	Date Passed SWCMR
Not named	H2	1892	12 <sup>th</sup> October
Not named	H1	1906	13 <sup>th</sup> October
Not named	H1	1918	26 <sup>th</sup> August
Not named	TS	1921	17 <sup>th</sup> June
Not named	TS	1931	16 <sup>th</sup> August
Not named	TS	1933	30 <sup>th</sup> September
Not named	TS	1934	4 <sup>th</sup> June
Not named	TS	1938	11 <sup>th</sup> October
Not named	H1	1941	28 <sup>th</sup> September
Not named	TS	1942	22 <sup>nd</sup> September
Not named	TS	1943	22 <sup>nd</sup> October
Not named	H1	1945	4 <sup>th</sup> October
Gilda	TS	1954	27 September
Abby	H1	1960	15 <sup>th</sup> July
Anna	H1	1961	24 <sup>th</sup> July
Hattie	H4	1961	31 <sup>st</sup> October
Francelia	H2	1969	3 <sup>rd</sup> September
Edith	H1	1971	10 <sup>th</sup> September
Laura	TS	1971	21 <sup>st</sup> November
Fifi	H2	1974	19 <sup>th</sup> September
Greta	H3	1978	18 <sup>th</sup> September
Gert	TS	1993	18 <sup>th</sup> September
Kyle	TS	1996	12 <sup>th</sup> October
Mitch*	H5	1998	October
Iris	H4	2001	9 <sup>th</sup> October

TS: Tropical Storm  
H: Hurricane  
H1: Category 1: winds > 74 – 95mph  
H2: Category 2: winds 96 - 110mph  
H3: Category 3: winds 111 - 130mph,  
H4: Category 4: winds 131 – 155mph  
\*Whilst Mitch did not pass within 50km, it had a huge impact on the reef in the area

**Table 13: Hurricanes Affecting South Water Caye Marine Reserve ([www.nhc.noaa.gov](http://www.nhc.noaa.gov))**

**1.4.2 Geology**

The Belize continental shelf underlies the entire coastline of Belize and extends seaward 15-40 km from the coast. It is a complex underwater platform of Pleistocene limestone rock that ends abruptly on top of a prominent northeast-southwest fault, the first of three, running parallel to the coast, forming an escarpment that drops off to a depth of about 1km (Figure 3). An extensive reef system has developed upon the rim of this escarpment, forming the Belize Barrier Reef (Rath, 1996). The second ridge supports Turneffe Atoll, and the third, Lighthouse Reef and Glover’s Reef Atolls, then extending south to eventually underlie the Barrier Reef south of Gladden Spit and South Water Caye Marine Reserve. Beyond this, a further two deeper ridges eventually fall into the Cayman Trench, which reaches depths of up to 7.5 kilometres.



The marine reserve includes a 9km unbroken stretch of the barrier reef, running from Tobacco Caye to South Water Caye, and considered to be one of the most highly developed examples of barrier reef structure, with extensive spur and groove formation. The underlying reef structure consists of at least 16m of unlithified late Holocene sediments in the back reef and more than 18m of a mixed coral and deeper water coral-head facies in the shallow and deep forereef, with a maximum age of 7,175 ± 100 years BP (Koltes et. al. 1998).

Cayes dot the platform, some formed on mangrove peat, others from coral outcrops and sand deposition. Tobacco and Blue Ground ranges both have areas of over-washed mangrove, whereas other cayes are above sea level. Moving south of Carrie Bow Caye, and east of Wee Wee Caye, lie hundreds of sand bores, some of which break the surface. These mounds rise from water depths of 15 m and are generally separated by narrow, deep channels 20 to 30 meters across. Coral rubble and debris are piled on top of the islets, and the surrounding ecosystems are extremely complex and varied, ranging from algal-dominated to gorgonian dominated (Jones, 2003).

South of Blue Ground Range, shelf topology reaches its maximum complexity with a narrow outer platform and a maze of patch reefs, faros, and pinnacles. This complexity is driven by

karstic processes of the underlying limestone, originating from erosion impacts when the area was exposed by lower sea levels, which have resulted in unusually steep coral reefs known as faros or rhomboid reefs, averaging 2-3 m. depth in the Pelican Cayes area.

### **Soils / Sediments**

The sediments from reef and fore reef are comprised of fragments of coral, red algae and *Halimeda*. In contrast, sediments of the back reef area contain more mollusk fragments and have lower percentages of *Halimeda* (Gischler 1994).

Sediments associated with the patch reefs are poorly sorted coarse-grained carbonates, composed primarily of *Halimeda*, coral, coralline algae, mollusc and other skeletal particles.

The lagoon floor is muddy, composed of fine-grained carbonate sand, with the sand fraction rich in *Halimeda*, mollusc and foraminifer grains (James & Ginsburg 1979). Mud dominates sediments of the channel flooring - generally 80-90%. Sand forms less than 10% of seabed sediment in deep areas. Gravel is a very minor component (Nunny et al. 2002).

Submerged mangrove peat banks have been identified adjacent to a number of the mangrove peat islands. Those on the northern margin of Tobacco Range differ, however, in that they show significant slumping, with a unique formation of peat fractures in the ocean floor. In this area, the sea bottom is composed of a 1 to 7m thick consolidated fossil mangrove peat bank of tilted, slumping blocks, stretching 2km in length and 0.5km wide. The area is interspersed with fractures ranging from 0.1m to >30m in width, with steep, vertical walls (Littler et. al., 1995), and exposing small caves in the ocean floor that provide shelter for large numbers of schooling fish (Jones, 2003).

### **1.4.3 Bathymetry**

An inner channel separates the reef platform from the mainland, and is shaped like a featureless, gently sloping valley deepening toward the south, with water depth maintaining a fairly constant descent ranging from 40 to 60 feet in the north to 60 to 90 feet in the south. This is flanked on the seaward side by the barrier reef platform, which is relatively flat in this area and about 8 km wide.

Depths in the main part of the barrier reef platform average 3-5 m. with much of the reef platform being covered with sea grass meadows studded with patch reefs (Map 5).

In the southern portion of the reef, south of Blue Ground Range, a series of complex, diverse reef structures - faros, pinnacles and patch reefs - become evident, tied in with the karstic geology. This maze is intersected by deep-water channels averaging between 25-45m that can rise steeply, as around Crawl and Channel Caye.

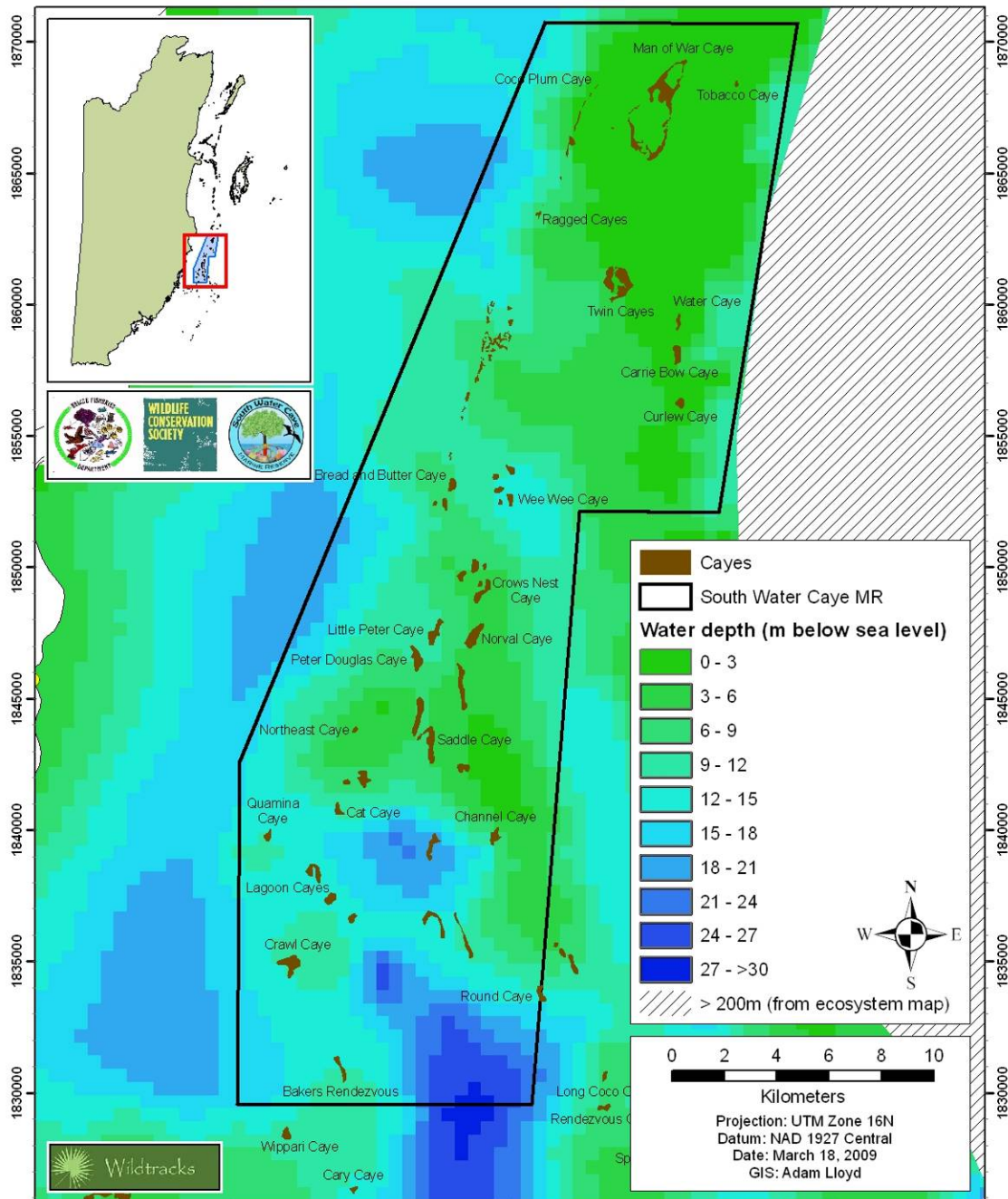
The most extensive surface-breaking reef of the inner cayes stretches from Crawl Caye to Baker's Rendezvous. Several of the cayes in this area have lagoon formations of considerable depth, mostly surrounded by reef.



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The Victoria Channel, in the south, with depths of between 30 to 44m, is essentially a large lagoon that connects to the Inner Channel in the vicinity of Crawl Caye, and extends fingers north around the Pelican Cayes. The channel also gives deepwater frontage to a number of the inner cayes on the windward side (Elbow, Channel, Crawl, and Baker’s Rendezvous), some of which are high and sandy, others low and dominated by mangrove.

### South Water Caye Marine Reserve: Bathymetry



**Map 5: Bathymetry of South Water Caye Marine Reserve (NB: The number of data reference points currently available are considered insufficient for a comprehensive bathymetry chart)**



#### 1.4.4 Tides and Water Movement

Tides in the South Water Caye Marine Reserve region of the Belize reef system are considered to be microtidal, with a mean range of 15 cm at Carrie Bow Cay (Kjerfve *et al.*, 1982) and 21 cm at Twin Cays (Wright *et al.*, 1991), averaging an estimated 30cm throughout the area (Stoddart, 1962; Caribbean Coral Ecosystems Program, 2005). The currents generated by these tides through reef cuts and at river mouths are thought to play a significant role in the spatial dispersion of sediment, nutrients, and larvae along the shallow reef flats and back reef (Heyman & Kjerfve, 2001). Local currents within the lagoon and platform are mainly wind driven whilst velocity measurements at Carrie Bow Cay indicate that currents near the cuts and barrier reef crest are considered to be strongly influenced by the tides and often reach speeds of 1.0 to 1.5 kts (Rath, 1996). Incoming currents greatly exceed ebb currents, indicating a slow continual in-filling of the lagoon with oceanic waters.

Winds may have a more influential impact on sea level than tides, with north winds resulting in lower sea levels - throughout Belize, the northerly winds are known to depress the water level on the mainland by as much as a foot, for several days at a time during the early part of the year. This is true on the reef as well, and probably has a greater influence on shallow water and reef crest biodiversity than the regular tides (Stoddart, 1962; Caribbean Coral Ecosystems Program, 2005).

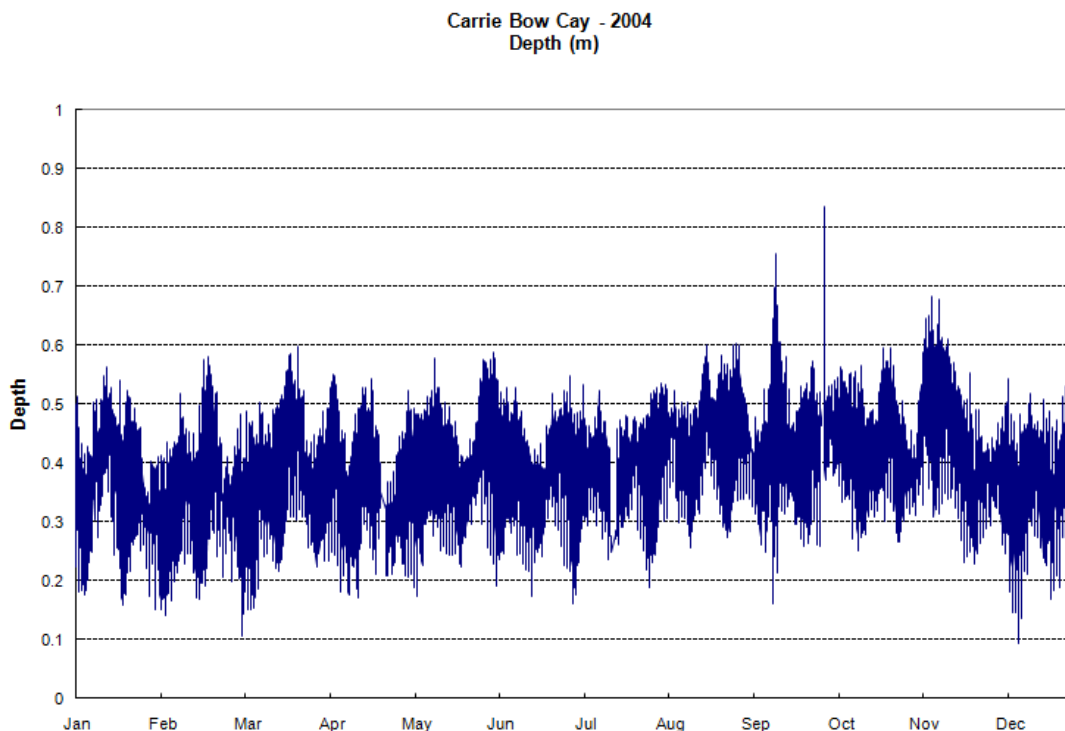


Figure 5: Tidal Range for Carrie Bow Cay (<http://cbc.riocan.com>, accessed 2009)

Knowledge of currents is essential in determining the transport of larvae, nutrients and pollutants. Water currents can also result in the spread of diseases, as was demonstrated by the rapid spread of disease in *Diadema antillarum* throughout the Caribbean region.

On a more regional scale, the main oceanic current, the warm-water Caribbean Current, flows westwards from the Lesser Antilles then northwards through the Yucatan Channel, with an average flow rate of between 38 to 43 cm (15 to 17 inches) per second, and with localized gyres and counter-currents. One such counter current is created within the Yucatan Basin / Gulf of Honduras area, throughout Belizean coastal waters, where a counter-current is created, influenced by the Caribbean Current, flowing southwards past the Belize coastline (Stoddart, 1962). This creates a low-flow area between the atolls and the shore, with circulation being predominantly wind-driven by the easterly trade winds for much of the year, resulting in a south west / south circulation in the shelf lagoon and offshore basins (Purdy et al., 1975). Strong northerly winds frequently occur during the winter months, and are associated with cold air masses from the north, shifting currents to a more southerly direction.

### 1.4.5 Water Parameters

Salinity of normal seawater is 36 parts per thousand (ppt). Throughout the Belize continental shelf, normal salinity persists except very close to the mainland (Rath, 1996). The Inner Channel is dominated by marine conditions throughout the year. Salinity rarely drops below 25 ppt (Nunny *et al.* 2001).

The Smithsonian Institute Field Station has been monitoring basic water parameters within South Water Caye Marine reserve since 1994 / 1995. Measurements in 1994 - 1996 show that mean monthly water temperatures ranged between 25.4°C – 30.3°C on the reef, and 26.2°C to 30.3°C over the drop-off, with salinity varying from 33.0‰ to 37.4‰.

Data Set	Visibility (m) (Range)	Salinity (ppt) (Mean Monthly Range)	Temperature (°C) Mean Monthly Range
Seagrass	7.0m – 15.8m	33.3‰ – 37.3‰	23.6°C – 31.3°C
Reef	-	-	25.4°C – 30.3°C
Reef Drop-off	11m – 35.5m	33.0‰ – 37.4‰	26.2°C – 30.3°C
<b>Table 14: Mean and range values of visibility, salinity, conductivity, and temperature (From: CARICOMP data)</b>			

Increasing water temperature has been linked with coral bleaching - during September, 1995, for example, sea surface temperatures reached a 12-year high of 29.9°C to the east, at Glovers Reef. Surface water temperatures over the drop-off at Carrie Bow Cay were the highest recorded since CARICOMP monitoring began in January 1993, reaching a peak of 30.4°C during the first two weeks of June 1995 (Jones, 2003). Bottom water temperatures at CARICOMP Coral Reef Site I (13m water depth) averaged 29.8°C (±0.16) during the last week of August. This coincided with the first widespread coral bleaching event within Belize reef waters. By December 1995, temperatures had fallen to a monthly average of 27.7°C, due partly to the passages of Hurricanes Opal and Roxanne across the Yucatan Peninsula in late September and early October, respectively. Follow-up surveys of coral bleaching in August 1996 and January 1997 indicated that most of the coral had recovered, but as the impacts of climate change become more pronounced, it is expected that bleaching episodes will become more frequent,

with only more resilient corals surviving (Aronson et. al., 2000). These high temperature peaks are becoming more frequent as a result of climate change.

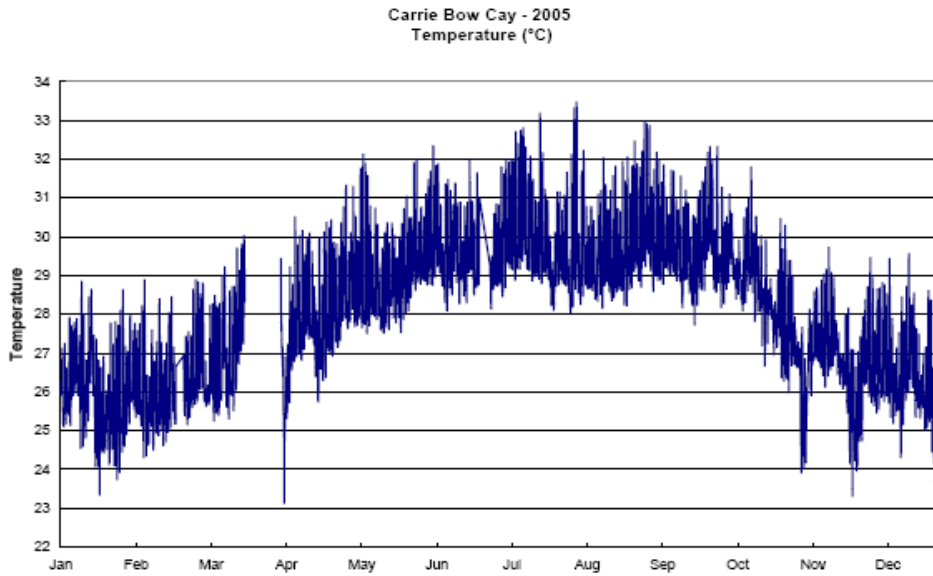


Figure 6: Water Temperature at Carrie Bow Cay (<http://cbc.riocan.com>, accessed 2009)

Water clarity ranges from 7.0m over the seagrass beds adjacent to Twin Cayes to 35.5m at the reef drop-off (Table 14; Figure 6; Koltes *et. al.*, 1998). Storm events also impact water turbidity and quality within the protected area. Following the passage of Hurricane Mitch in October 1998, Seawifs ocean colour images showed that large river plumes from Honduras extended out as far as Glover’s Reef Atoll (Andrefouet *et al.* 2002). A significant increase in turbidity was also reported after Hurricane Mitch, with impacts from both Honduras and the Belize mainland.

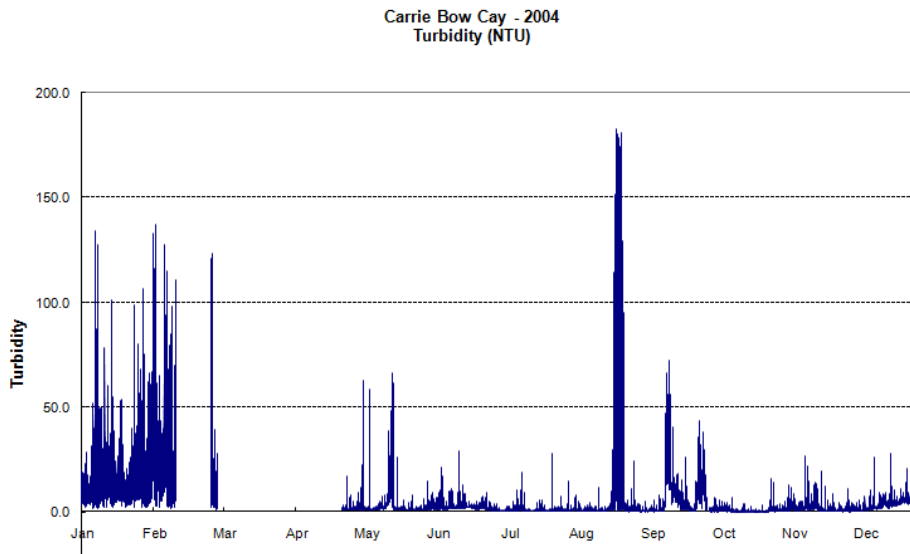


Figure 7: Turbidity at Carrie Bow Cay (<http://cbc.riocan.com>, accessed 2009)

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The increased sediment load is also accompanied by an increased pesticide load, as rain washes agrochemicals from the watersheds into the rivers (Map 5), and from there, into the sea. South Water Caye lies directly east of twelve primary watersheds (Map 6), including the North Stann Creek, which includes the principal citrus growing valley in Belize, and South Stann Creek, within which some of the largest banana farms are situated.

Salinity varies dependent on the time of year, with lower salinity during the wet season (Figure 8).

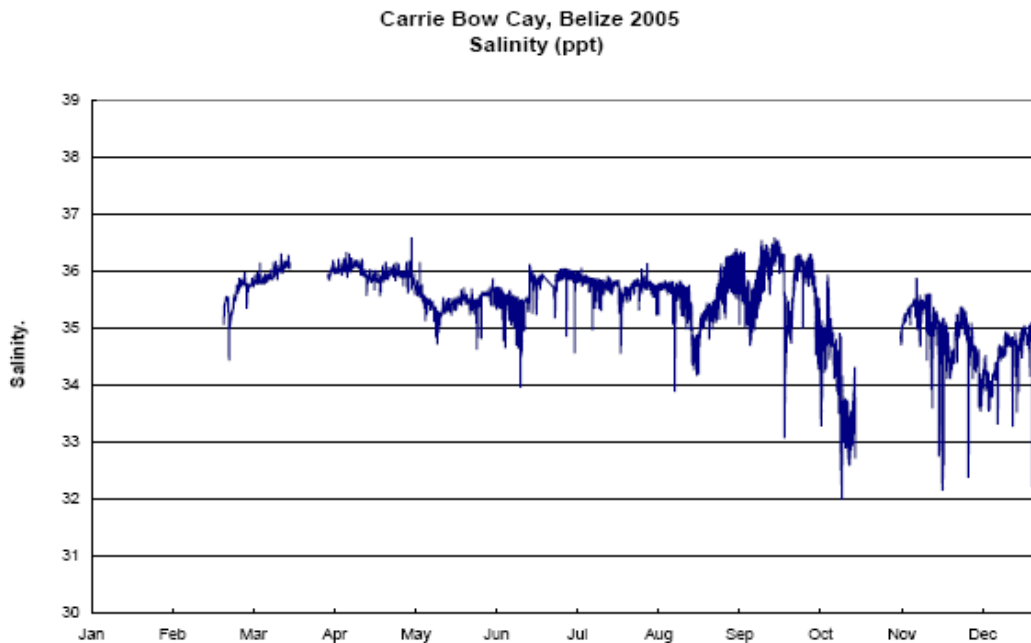
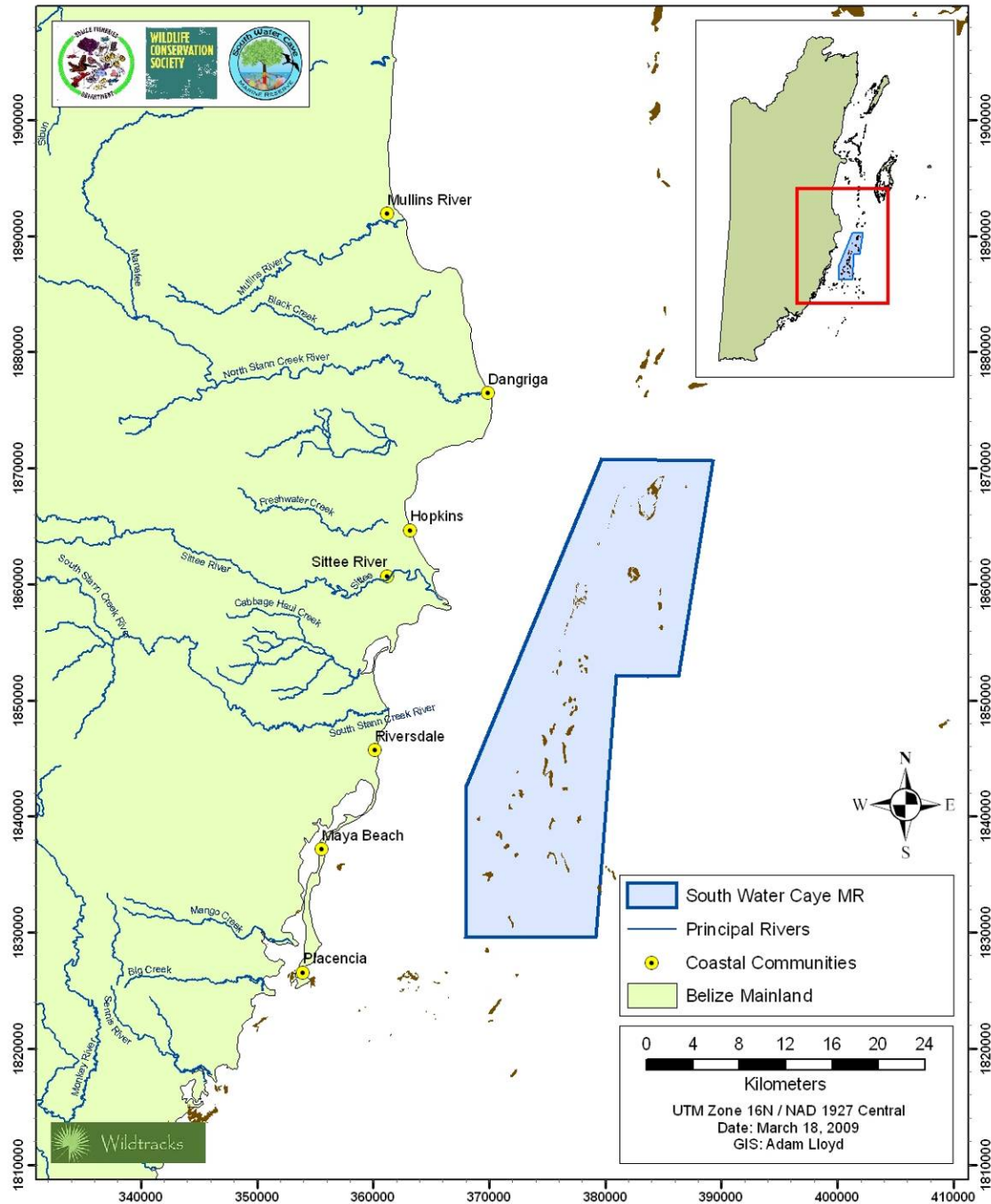


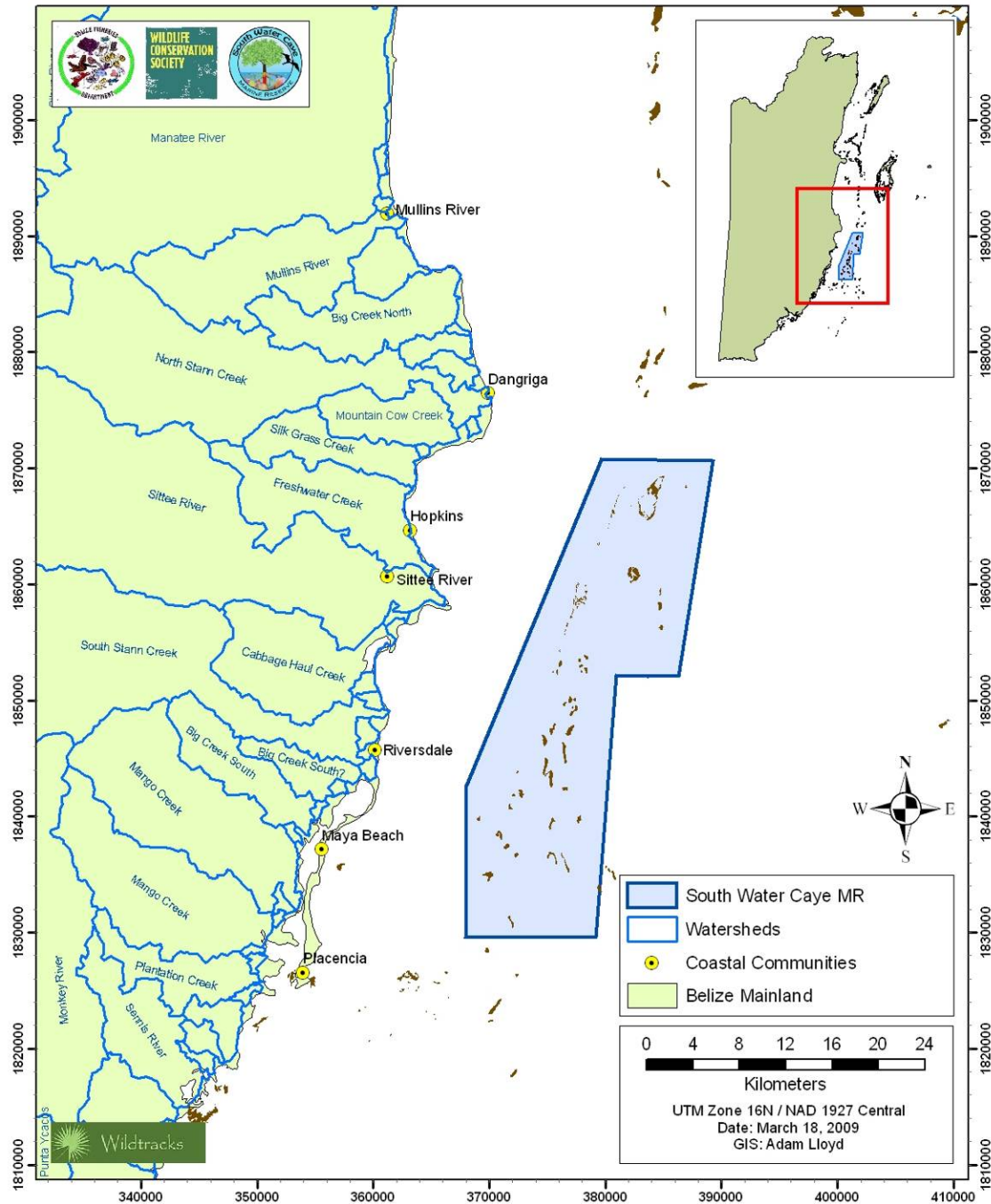
Figure 8: Salinity at Carrie Bow Cay (<http://cbc.riocean.com>, accessed 2009)

South Water Caye Marine Reserve: Nearby Rivers



Map 6: Rivers draining into the Barrier Reef Lagoon in the vicinity of South Water Caye Marine Reserve

South Water Caye Marine Reserve: Nearby Watersheds



Map 7: Watersheds flowing into the Barrier Reef Lagoon in the vicinity of South Water Caye Marine Reserve



## 1.5. Biodiversity of Management Area

A significant amount of biological information about South Water Caye Marine Reserve has been accumulated since the establishment of the Smithsonian Institute Field Station at Carrie Bow Caye in 1972. With over 900 scientific papers published on the biodiversity of the area, this section can only touch on the information available. Much of the following has been adapted from the previous draft Management Plan (Jones, 2003), from Koltes *et. al.* (1998), from Atoll Bulletins over the years, and from Caribbean Coral Reef Ecosystem reports (1996 - 1998, 2002, 2003, 2005, 2007 – 2008) which have provided in-depth descriptions of the marine protected area. A full list of reports is presented in Annex 5.

### 1.5.1 Ecosystems

National ecosystem mapping gives a broad overview of the ecosystems to be found in the South Water Caye Marine Reserve (Meerman, 2004) – the area is highlighted as one of the most biodiverse within the Mesoamerican Barrier Reef, an ecoregion that is, itself, recognized for its biodiversity and representational values, which are considered outstanding on a global scale, leading to recommendations for this to be recognized as a priority area for conservation (Olson & Dinerstein, 1998; Roberts, 2001; Kramer and Kramer, 2002).

South Water Caye Marine Reserve encompasses a range of ecosystems stretching from the bathypelagic zone of the open sea to the shallow epipelagic waters of the continental shelf:

#### **Mesopelagic / Bathypelagic Zone (200m to 2000m)**

The Mesopelagic and Bathypelagic Zones include the deeper waters to the east of the barrier reef. The mesopelagic zone extends from a depth of 200m downwards, merging into the bathypelagic zone (which begins at the edge of the continental slope and extends beyond into the deeper water). Whilst little is known of the marine life that exists here, whale sharks and other deep-water species are known to travel up and down parallel to the reef, passing inside the eastern boundaries of South Water Caye Marine Reserve.

#### **Epipelagic Zone (0m – 200m)**

The Epipelagic Zone ranges from 0 to 200m, and includes the shallow waters of the inner lagoon and the deeper waters of the fore reef. Within this zone there are an array of ecosystems that have evolved in response to the degree of exposure and impact of wave action, current direction and intensity, light intensity and light spectra, and are defined by their species composition, formation and substrate characteristics. Six broad ecosystems have been identified and mapped (Map 8; Meerman, 2004):

- Fore-reef (upper and lower reef slopes, including spur and grove topography)
- Reef crest and reef flats
- Back reef (with patch reefs)
- Seagrass
- Sparse algae / sand
- Mangrove and littoral forest



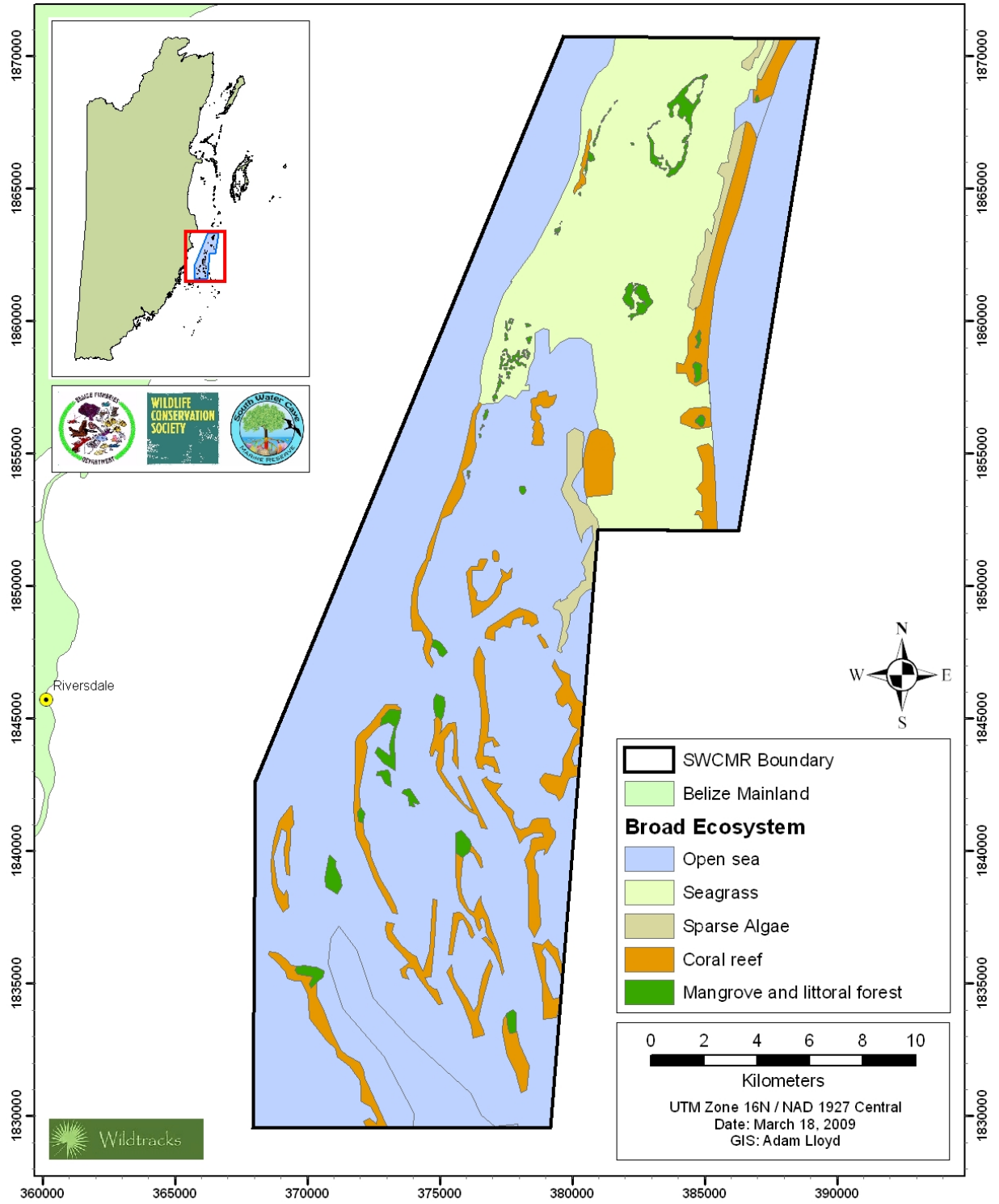
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The marine components are further categorized by into seven primary categories and twenty-one sub-categories (Mumby and Harborne,1999).

Ecosystems of South Water Caye Marine Reserve				
	Meerman (2004)		Mumby and Harborne (1999)	
<b>Terrestrial</b>	Mangrove	Coastal Fringe Mangrove		
	Herbaceous Beach Community	Sandy Beaches		
Littoral Forest				
<b>Epipelagic</b>	Reef	Shallow Coral Reef	Fore Reef	With sparse massive and encrusting corals
				With dense massive and encrusting corals
		Patch Reef	Patch Reef	Dense patch reef
				Diffuse patch reef
	Shallow Coral reef	Other Reef	Reef crest	
			Low relief spur and groove	
	Seagrass	Seagrass beds	Shallow Lagoon Floor – Seagrass dominated	Sparse seagrass
				Medium density seagrass
				Dense seagrass
				Seagrass with distinct coral patches
	Caribbean inner lagoon / Sparse Algae	Fleshy brown Algae / Gorgonians	Algal dominated	Fleshy brown Algae and sparse Gorgonians
				Green algae
		Sparse Algae / sand		<i>Lobophora</i>
				<i>Euchmea</i> and <i>Amphiroa</i>
		Sparse Algae / sand		Bedrock / rubble and dense gorgonians
Bedrock / rubble and sparse gorgonians				
Sparse Algae / sand		Bare substratum dominated		Rubble and sparse algae
				Sand with sparse algae
	Mud / bedrock			
<b>Mesopelagic / Bathypelagic</b>	Open Sea	Caribbean Open Sea	Caribbean Open Sea	Bathyal
				Mesopelagic

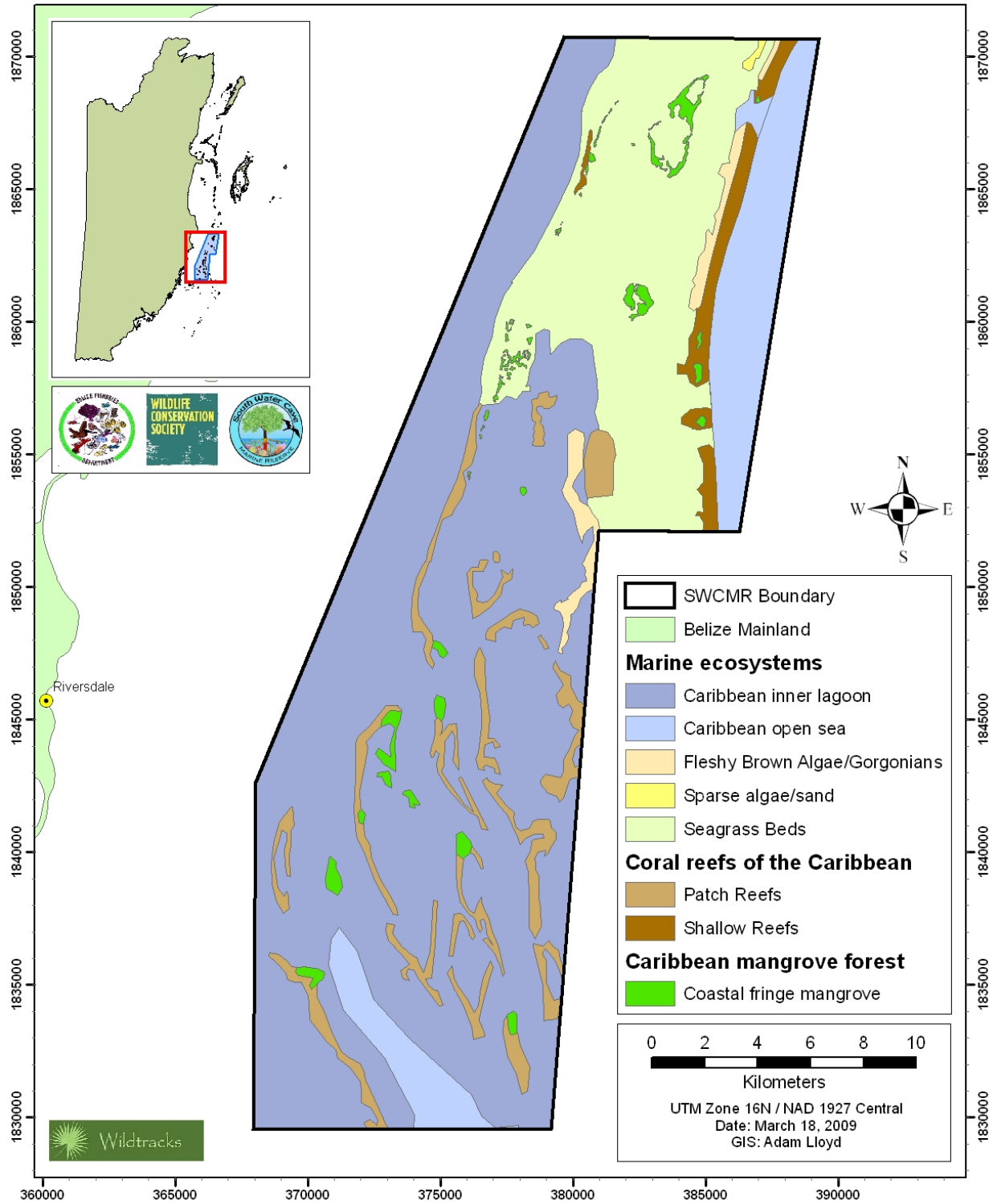
**Table 15: Ecosystems of South Water Caye Marine Reserve**

### South Water Caye Marine Reserve: Broad Ecosystems



Map 8: Broad ecosystems of the South Water Caye Marine Reserve (Based on Meerman, 2001, revised 2004)

### South Water Caye Marine Reserve: Ecosystems



Map 9: Ecosystems of the South Water Caye Marine Reserve (Based on Meerman, 2001, revised 2004)

## Coral Reef

### The Barrier Reef

Located in the central region of the Belize Barrier Reef system, the barrier reef runs northwest to south east and, within South Water Caye Marine Reserve, is considered to be one of the most highly developed examples of barrier reef formation in the Western Hemisphere. The core components, Fore Reef, Reef Crest, and Back Reef are all present.

#### Fore-reef

The fore-reef lies on the outer side of the reef crest, facing the open sea, and includes the upper and lower reef slopes. The upper fore reef begins at the outer edge of the reef crest, and extends out to a depth of 14-22m. This zone is characterised by impressive spur and groove formations, with many theories to explain how these formations have evolved, including differential erosion, differential growth of corals, a combination of these actions, or as features resulting from underlying karst morphology. The fore reef is a major tourism resource, attracting divers from all parts of the world to Belize.

The tops of these spurs are carpeted with a variety of corals and other invertebrates, with the large surface area provided by the canyon sides and currents that pass through the 'grooves' (or surge channels) providing ideal living conditions for a multitude of marine organisms. The strong currents that occur in the deep grooves sweep the floor of fine sediments, the grooves providing the most obvious pathways for sediment movement into the deep water to the east.

One hundred meters seaward of the reef crest the water drops to between 50 and 100m – the lower reef slope. Here, coral diversity and density decreases in correlation with decreasing light intensity.

Moving southward, the inner reef spur-and-groove and the outer fore reef (characterized by a sand trough and coral ridge) gradually disappear.

#### Reef Crest and Reef Flats

The reef crest and reef flats lie behind the fore-reef, and are considered typical of high energy surf zones around the Caribbean. Coral species inhabiting these areas are hardy enough to be able to withstand the breaking waves, constant strong current, exposure at low tide, and high light intensity.



**Upper slope Spur and groove formations**

2009 © Tobacco Caye Marine Station: Image and photographs by Matthew Jasinski & Michelle Smith

In much of the South Water Caye Marine Reserve, the reef crest forms a relatively unbroken barrier, protecting the back reef waters to the west. This protective formation, however, can be exacerbated at times by the piling of coral rubble in this zone by tropical storm and hurricane events, preventing the cooler oceanic waters from entering the back reef and lagoon. With much of the rubble being bio-cemented together to form an impenetrable barrier, this is currently causing concern for traditional fishermen, who correlate the decreasing coral health of the back reef north of Tobacco Caye with increasing water temperatures, following restrictions of water movement with the deposition of rubble on the reef crest by recent hurricane events.

Concerns have also been expressed over the tourism impacts caused by sport fishermen and others walking in the shallow waters of the reef crest, particularly in the vicinity of Tobacco Caye, with the recommendation by some stakeholders that this is not considered a good practice, and should not be allowed.

### Back Reef

The Back Reef includes a continuum of habitats from the algae-encrusted coral rubble near the reef crest to the sandy muds of the *Thalassia* meadows and scattered patch reefs, in waters ranging from 0.3 to 6m deep, and sheltered by the presence of the barrier reef. This is intersected in the south by deeper channels, such as the Victoria Channel, which drop to depths of 40m or more.

The sheltered waters promote the growth of spectacular coral formations and impressive sponges, with numerous patch reefs varying in size and orientation, interspersed among the seagrass meadows of the back reef. They rise from different depths off the southern platform, with crests at varying depths below sea level. A distinct lateral zonation of corals from the windward to the leeward margins of these reefs has been identified, the windward margins generally supporting a higher diversity of marine organisms, and typically include such hardy corals as elkhorn coral (*Acropora palmate*) and boulder star coral (*Montastrea annularis*). The more sheltered leeward margins support less robust corals such as staghorn coral (*Acropora cervicornis*) and *Porites spp.* (Jones, 2003).



**The sheltered back reef of South Water Caye Marine Reserve provides ideal conditions for the growth of large sponges**  
© Tony Rath, 2009

### Rhomboid Reefs of the Pelican Cayes Area

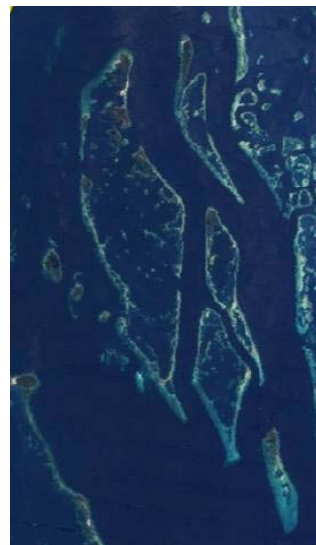
In the Pelican Cayes area lie a series of unique faro formations - unusual ring-shaped rhomboid reefs formed by differential coral accumulation on the underlying polygonal limestone karst features (Map 10).

Species richness and live surface cover of the Pelican Cayes are unparalleled in the Caribbean - layers of brilliantly colored organisms including sponges, ascidians, seaweeds, and corals cover reef, mangrove root and peat substrates. The cause of this high diversity in such a small geographic area is not well understood, but may be attributed to the unique juxtaposition of mangrove, coral, sea grass, and algal biomes under stable oligotrophic conditions (Jones, 2003).

These reefs enclose ponds that are striking in their roundness, and support cayes with some of the richest mangrove ecosystems known in the Caribbean. The Pelican Cayes ponds have a number of characteristics in common, with each having at least one opening to the surrounding seas, restricted to various degrees by coral ridges, and originally formed from *Acropora cervicornis*. Each is surrounded in part by mangrove forests composed of red mangroves and sporadic stands of black mangrove, which have formed an underlying peat substrate, usually eroded around the perimeter of the ponds and undercut to expose some of the root system of the forest above.

Bank roots, hanging roots, the back rim base, and the exposed peat bank provide substrates for sessile organisms, supporting flourishing communities of sponges, ascidians, algae, corals, and other organisms (MacIntyre et al. 2000). The limited presence of the ephemeral sheet-like and filamentous green algae indicative of eutrophic bird cayes or polluted systems (Jones, 2003) confirms the pristine nature of this area.

Fine organic sediments derived from the adjacent mangrove forest floor lie at the base of most pond rims, and are easily disturbed by any movement of the water, resulting in a cloud of suspended material that eventually settles on sessile organisms on the mangrove roots or the peat bank, (MacIntyre et al. 2000), in an ecosystem particularly sensitive to any external impacts. Mangrove clearance, dredging and other increasing human impacts have been affecting these unique ecosystems, with 30% of the mangroves of the Pelican Cayes having been cleared for caye development by April 2007 (McField, 2007), causing extensive erosion and sedimentation.



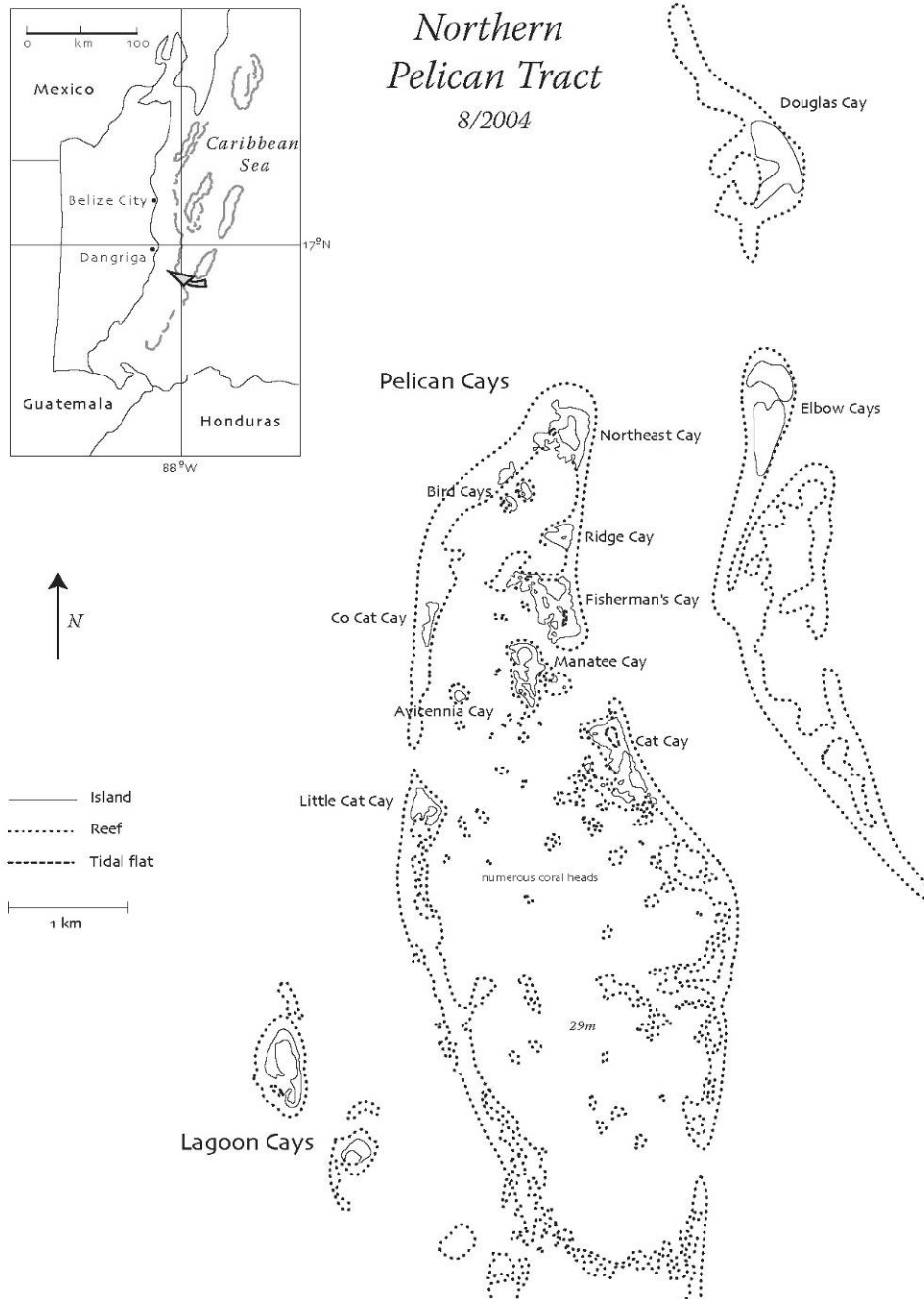
Manatee Caye (Pelican Cayes) – South Water Caye Marine Reserve (M. McField)

As with many of the reefs of the Western Caribbean, the reef communities of the Pelican Cayes area have suffered a drastic change in composition since 1986, when White Band Disease destroyed the original staghorn coral (*Acropora cervicornis*) (CCRE Report 1996-98). Throughout much of Belize, populations of this species have declined by up to 98% as a result of this disease, compounded locally by hurricanes, increased sedimentation and predation, bleaching, and other factors. Lettuce coral (*Agaricia tenuifolia*) took its place, but was itself badly affected by the bleaching event of 1998, which affected

100% of the population, with virtually all other coral species in the Pelican Cayes area also showing symptoms of coral bleaching to differing degrees. Following several months of prolonged bleaching resulting from elevated sea temperatures and increased UV light, almost all the *A. tenuifolia* was dead (Aronson *et. al.*, 2000; CCRE 2002).

Following this mortality, coral recruitment at Channel and Cat Cayes was depressed for more than two years. Persistently high densities of the sea urchin *Echinometra viridis* have kept the cover of fleshy and filamentous algae to low levels, but the cover of the encrusting sponge *Chondrilla cf. nucula* has been increasing - from 14% to 43% between October 1998 and March 2001 (Aronson *et. al.* 2000; Jones, 2003).





Map 10: The Pelican Cays (<http://cbc.riocean.com>, accessed 2009)

## Reef Health

On a regional level, two thirds of wider Caribbean reefs are said to be at risk from human activities (Burke & Maidens, 2004). Nationally, 63% of reefs in Belize are considered to be ‘at risk’ (Reefbase, 2005), this slightly lower risk level being due in part to the small human population, and relatively low levels of coastal development. There has been a general ecological shift on reefs towards algal dominance in recent years, attributed to a number of impacts including a combination of coral diseases (black and white band diseases), overfishing, the population crash in the herbivorous long-spined sea urchin *Diadema antillarum* and other environmental stressors such as, sedimentation and pollution (Liddell et. al, 1986; Aronson et. al, 1998). Overfishing of the herbivorous fish was originally considered to play a major role in the decline of reef health, but more recently, global climate change (with increasing sea temperatures and UV levels) has been identified as the biggest contributing factor (Aronson et. al., 2006).

Whilst Belize has always had the enviable reputation of having pristine reefs, in more recent years there would appear to be a shift in species composition of structural corals, with the loss of *A. cervicornis* to disease, its replacement by *A. tenuifolia*, and subsequent loss to bleaching. The increased temperatures caused by global warming results in bleaching - the expulsion of the zooxanthellae, which, if severe and prolonged enough, can affect coral reproduction, growth, and accretion rates and even lead to death (CCRE 2002). The harmful effect of increased levels of UV radiation acts synergistically with increased seas surface temperatures to exacerbate bleaching by producing harmful oxygen radicals (Lesser and Lewis, 1996), increasing coral mortality.

No global bleaching event was recorded before 1979 (McField et. al., 2007), and the Belize Barrier Reef experienced mass coral bleaching for first time in 1995 (McField, 1999). Since then, major bleaching events have been recorded in South Water Caye Marine Reserve with increasing frequency - in 1995, 1998, 2005, and 2008 - and are thought to be accentuated by increased acidification resulting from higher CO<sub>2</sub> levels (Anthony et. al., 2008).

The first event in 1995 resulted in some bleaching of hard corals, especially *Montastraea annularis*, being observed in South Water Caye Marine Reserve on CARICOMP transects in August of that year. By October, up to 90% of *M. annularis* colonies were bleached, particularly those on the shallow forereef in less than 10m water depth, where water temperature is highest. This resulted in the eventual loss of 50% of mound and boulder corals (including *M. annularis*). Extensive bleaching of *Agaricia*

**Coral Bleaching:** Corals are highly sensitive to changes in water temperature, and increases of only 1 to 2°C can have potentially lethal effects. The MAR region has experienced several large-scale bleaching events (e.g., in 1995 and 1998), causing significant coral mortality in some areas.

Human-induced global warming is widely believed to be responsible for increases in global sea surface temperature.

**Diseases:** Coral disease outbreaks are one of the single most devastating disturbances to coral reefs in the Caribbean and MAR in the recent past.

Disease has always been a natural process in regulating populations, but the recent increased magnitude of disease and resultant mortality may be unique in the last several thousand years. Disease organisms tend to thrive in higher temperatures, and some may also benefit from increased ultraviolet (UV) radiation. Both stressors (temperature and UV) may render host organisms more prone to disease.

In addition to these effects related to global climate change, diseases have also been linked to elevated nutrients (especially from sewage), sedimentation and runoff.

Similar to humans, corals seem to be more prone to disease when affected by other stressors.

**Healthy Reefs for Healthy People Initiative, 2007**

*agaricites*, *A. tenuifolia*, *Madracis* spp., and *Porites porites* was also reported.

Surveys of the forereef in December 1995 showed that bleaching was still widespread, varying with species and water depth / temperature. Heavily affected species included *Montastraea annularis*, *Agaricia lamarcki*, *A. grahamae*, *Siderastrea siderea*, and *Diploria labyrinthiformis*. Recovery after this initial bleaching episode was considered to be good.

In Autumn of 1998, a second, more severe coral bleaching event occurred, with complete bleaching of almost all plate and head-forming corals down to 21m (Aronson *et al*, 2000), making it the worst recorded event to date in Belize. Whilst the majority of areas surveyed suffered 50% loss of live coral cover (McField *et. al.*, 2007), South Water Caye Marine Reserve suffered more serious coral bleaching of reefs around the areas of Carrie Bow Caye and Pelican Caye, with bleaching of 100% of the dominant coral species – the stony coral (*Agaricia tenuifolia*) - on the lagoonal reefs in some areas (Koltes *et. al.* 1998; Aronson *et. al.* 2000), resulting in almost total mortality due to bleaching (Peckol *et al*, 1999; Aronson *et. al*, 2000).

By May 1999, the majority of *Diploria* spp. and *Siderastrea siderea* were reported to have recovered. However, *M. annularis* still showed widespread bleaching, with nearly 50% of the surveyed colonies still bleached 9 months after the warming event. The percentage of coral colonies showing signs of disease tripled during the same time interval, thought to be related to the stress of bleaching.

Analysis of past patterns of coral mortality through core sampling has show that on a time scale of millennia, the loss of *A. cervicornis* to disease, its replacement by *A. tenuifolia*, and the subsequent loss to bleaching a decade later were novel events, occurring after an extended period of stable sea level (ca 1 m. sea-level rise in the last 3,000 years). There is growing concern that the global climate change is degrading coral reef ecosystems, with scenarios including increased coral mortality from bleaching and emergent disease. (CCRE, 2002).

During 1998, the same year as the catastrophic coral bleaching episode, Hurricane Mitch, one of the most powerful hurricanes on record within the Atlantic Basin, had a significant physical impact on the reef of the Marine Reserve, especially on the shallow coral spurs. Producing waves of 5-6m high, major hurricane storms cause physical damage - coral breakage and rolling of large boulder corals, whilst the heavy rains add to sediment run off from the main land and cleared cayes. Although these negative effects resulted from the impacts of Hurricane Mitch, the hurricane also lessened the impact of previous coral bleaching through cooling the shallow waters, with the mixing of the warm shallow waters with the cooler deep waters.

Tourism and fishing have also had their effect on the health of the reef. In the past 17 – 25 years the health of the reef has severely degraded, with indigenous corals being over grown by invasive species such as blue- green algae, brown algae and sponges. Fishing of the herbivorous fish species – particularly the parrotfish, is reducing the reef's natural ability to maintain algal growth within acceptable levels. Seasonal out-breaks of



**Black Band disease affecting coral within South Water Caye Marine Reserve**  
© Tony Rath

Black Band disease (first discovered in the South Water Caye Marine Reserve area (Antonius, 1973), caused by blue green algae, have also contributed to the complete degradation of a number of reef species within South Water Caye Marine Reserve, along with impacts from other diseases.

Surveys conducted in 1999 on the fore reef by Tobacco and South Water Cayes and Curlew Bank, patch reef adjacent to Wee Wee and Bread and Butter Cayes, and coral reef ridge in the Wee Wee, Peter Douglas and Tunicate Caye areas, provide historical information on algal cover and coral recruitment over a number of transects in each location (AGGRA, 1999; Table 16).

Site	Reef Type	Algae (%)			Coral recruits (number / 0.625m <sup>2</sup> )
		Macroalgae	Turf Algae	Crustose coralline algae	
Tobacco	Forereef	33.5±4.5	33.5±4.0	35.3±4.5	0.5±0.1
South Water	Forereef	43.5±1.5	49.0±2.0	40.5±2.0	0.4±0.1
Curlew Bank	Forereef	18.5±4.5	27.5±5.0	43.0±5.5	0.5±0.1
Wee Wee Patch	Patch reef	21.0±3.5	61.0±4.5	5.0±2.0	0.4±0.1
Bread and Butter	Patch reef	37.5±5.0	48.5±4.5	9.0±3.0	0.3±0.1
Norvall	Patch reef	12.0±3.0	68.5±4.5	2.5±2.0	0.3±0.1
Wee Wee Ridge	Coral reef ridge	30.5±4.5	35.5±6.5	5.0±2.5	0.7±0.1
Peter Douglas	Coral reef ridge	2.0±2.5	54.5±11.0	4.5±3.0	0.7±0.1
Tunicate	Coral reef ridge	10.5±2.5	32.5±5.5	9.5±3.0	0.6±0.1

\*Includes acanthurids, chaetodontids, haemulids, labrids, lutjanids, pomacentrids, scarids and serranids

Table 16: AGGRA assessment of algal cover (1999)

All these shifts – in fish populations, in coral species dominance, algal growth and water parameters - lead to concerns for the future viability of the coral reef ecosystem, from a biodiversity point of view, and as an economically important fishing and tourism resource in Belize.

## Seagrass

Much of the reef platform north of Wee Wee Caye is shallow (<6.5m in depth), with a soft bottom supporting extensive meadows of seagrass. These seagrass meadows stretch from the Barrier Reef westwards across the back reef, interspersed with rubble, patch reefs, and large sponges (Rützler and Macintyre, 1982). Two species of seagrass have been identified to date within the seagrass ecosystem of South Water Caye Marine Reserve (turtle grass (*Thalassia testudinum*), interspersed with sparse strands of manatee grass (*Syringodium filiforme*)), along with algae such as *Halimeda* spp, also considered important components of this ecosystem, and distributed throughout the seagrass beds.

Seagrass meadows are essential for maintaining the ecological health of the shallow marine ecosystems, with an important role in nutrient cycling, filtration and sediment stabilization. Seagrass is also a critical ecosystem for many fish and invertebrate species - an acre of seagrass has been shown to support up to 40,000 fish and 50 million small invertebrates (Seagrass Ecosystems Research Laboratory, 2005). The highest richness and diversity within South Water Caye Marine Reserve has been identified in the Carrie Bow Caye area, whilst the beds near the Pelican Cayes have been shown to be less biodiverse (CCRE, 2002).



These seagrass beds fill a critical role as a nursery area for the commercially important conch, many reef fish (including commercial species such as tarpon, hogfish, yellowtail snapper and great barracuda), and for the key herbivore guild species assemblages - the parrotfish. The seagrass beds also provide corridors for juvenile lobsters between habitats and, close to cuts in the Barrier Reef, important settlement areas for post-larval stages of commercial species (Acosta, 2001). Epiphytic coralline algae and foraminifera form heavy encrustations of the *Thalassia* blades (Koltes *et al.*, 1998; Young and Young, 1982), though where there is heavy nutrient loading (such as the natural eutrophication in the waters around Man O' War Caye, or in human impacted areas adjacent to poorly designed caye developments), the diversity and density of epiphytic foraminifera has been shown to be higher, with suggestions that this may form a useful indicator for reduced water quality (Richardson, 2006).



Whilst generally considered in good condition, the seagrass beds are crisscrossed by a series of uncolonized sand holes from seismic surveys for petroleum exploration during the 1960s. Recolonization of disturbed areas by *Thalassia* is slow, often taking years (Zieman and Zieman, 1989; Williams, 1988), possibly due to nutrient accumulation in the sediments (Koltes *et al.*, 1998; Williams, 1990). Scarring of the seagrass beds is also found in areas where dredging has occurred, and in shallow areas of high boat activity.

**Seagrass beds off South Water Caye with sand mounds of the ghost shrimp, *Callinassia* sp.**  
© Tony Rath

### Mangrove Forests

Mangroves occur on both isolated islands and elliptical groups of predominantly inundated islands (ranges) within the Marine Reserve, several hundred meters leeward of the reef crest. The best studied are the Twin Cayes complex which, like the majority of the mangrove communities in the South Water Caye Marine Reserve, are built on a limestone platform (fossil patch reef) that was topographically high during the Late Pleistocene (Koltes *et al.*, 1998, citing Rützler and Feller, 1988; Littler *et al.*, 1995; Woodroffe, 1995). Unlike the terrestrially-derived sediments that underlie mangrove forests of the mainland, many of the mangrove forests of South Water Caye Marine Reserve are growing on mangrove-derived peat, which has accumulated to thicknesses of as much as 10m above the limestone bedrock, during the rising seas during the Holocene period (Koltes *et al.*, 1998, citing Woodroffe, 1995; Macintyre *et al.*, 1995).



**Mangroves of South Water Caye Marine Reserve**  
© Tony Rath

Red mangrove (*Rhizophora mangle*) is the dominant species, forming a fringe around the periphery of many of the cayes. The caye interiors have extensive stands of black mangroves (*Avicennia germinans*), exposed on the shore in some areas, such as Tobacco Range, as a result of shoreline erosion (Woodroffe, 1995). Scattered individuals of white mangrove (*Laguncularia racemosa*) are also present in the interior areas (Woodroffe, 1995), along with dwarf red mangroves, which dominate the low potassium hypersaline ponded areas found in the centre of the cayes. Rodriguez and Feller identified seven different communities within the Twin Cayes (Rodriguez and Feller, 2004):

- *Avicennia germinans* forest
- *Rhizophora mangle* forest
- Mixed Forest
- Agriculture (coconut)
- Water (ponds, algal mats)
- Barren (beach, clear cuts, die back)

Tobacco and Blue Ground Ranges appear to be undergoing disintegration, with extensive unvegetated flats in the interiors and dead mangrove stumps throughout the range, indicating that the pattern of mangrove distribution is changing. It is suggested that shoreline erosion and the anomalous mangrove distribution patterns on Twin Cays, as well as on other nearby mangrove ranges, may be the result of abiotic stresses in the environment, including hurricane damage, reduced tidal flushing, salinity, and soil chemistry, as well as anthropogenic clearance of mangroves (Woodroffe, 1995).



**The mangroves of Twin Cayes and Tobacco Range are dissected naturally by canals – however, many are now also divided by property survey lines**

Historically, fishermen used Twin Cays and the Ranges as bases for seasonal fishing camps, for bait collecting, and for storm shelter. Since the early 1980s, local developers have tried repeatedly to establish resorts and vacation homes in the area, and several stands of mangrove have been clear-cut and later abandoned. Although Belize's regulations regarding mangrove protection should protect the Twin Cayes complex and the other mangrove-dominated cayes from future threats of development, attempts by the Forest Department to enforce these regulations have been only moderately successful. Protection, however, is currently being strengthened the the recently revised regulations outlined in the Statutory Instrument.

Throughout the Marine Reserve, there are many examples of extensive mangrove clearance, followed in some cases by land fill, with sediment dredged from the sub-tidal area adjacent to the development site. The mangrove ecosystem is fragile, and once clear-cut, it is fundamentally disturbed and has trouble recovering. Clear cut areas can become overrun by saltwort, more toleratant of the hyper-salinity, which crowds out the slower-growing black mangroves, reducing recolonization, and where fringing red mangroves on the edge of the sea are disturbed, currents and tides rapidly erode the peat and leave a bottom that seedlings can't penetrate.



**Map 11: Twin Cays, Belize 2005 (<http://cbc.riocean.com>, accessed 2009)**

The Twin Cays, a 91.5-ha range of two large and four small intertidal islands separated by a 0.5-2.0 m deep, S-shaped navigable channel, lies within the intertidal zone and is overwashed by spring tides. These cayes have been the focus of long-term ecological studies on mangrove communities by Smithsonian Institution scientists and their collaborators at Carrie Bow Cay.



Mangroves contribute directly to soil formation and their elimination removes a major source of material critical in the maintenance of surface elevation in the coastal zone. Clearance of the mangroves will decrease the resilience of these cayes to sea level rise, negatively impacting all organisms that use mangroves for substrate, nursery, refuge, and food (CCRE 1998).

Much of the mangrove clearance is driven by the demand for properties on the cayes, and tourism facilities, with the proposed establishment of resorts and marinas, and increases the susceptibility of the cayes to storm event impacts – particularly erosion and sedimentation of adjacent reef and seagrass areas. Other threats are also increasing, particularly from the rapidly expanding tourism industry, with the dumping of substantial quantities of trash by operators of nearby resorts and sailing yachts.

Boat traffic – both the number of boats and the speed - has increased significantly since the 1980’s, primarily with the increasing tourism interest in the area. Wakes created from boats driven at high speed through the Main Channel of the Twin Cayes complex and through the Ranges result in broken mangrove roots and dislodged sessile organisms. Unfortunately, rapidly rising rates of inadequately managed tourism will likely exert increasing pressure on this and other mangrove communities in Belize (Jones, 2003).

Submerged, subtidal mangrove prop roots and mangrove island margins of Twin Cayes (Map 11), Tobacco and Blue Ground Ranges are important habitats for spiny lobster, and also provide structure for many endemic and new species of tunicates and sponges, with as many as 20%-30% of microbes, algae, sponges and worms possibly being currently undiscovered. Microbes and Teredinads (shipworms) native to the Belize mangrove system help cycle nutrients (Rutzler and Feller 1996).

In the Pelican Cayes area, red mangroves are anchored directly on the live coral reef, as opposed to the mangrove peat of the ranges, and on several of the cayes, sheltered, circular ponds are encircled by steep lush coral ridges, with red mangrove roots reaching into the water, providing a structure for colonization by sessile marine organisms. Analysis undertaken to reconstruct the history of the vegetation at Pelican Cayes has revealed a successional sequence ultimately driven by changes in sea level, but with mangrove vegetation clearly playing a major role in soil formation and vertical growth of these islands through root production and decomposition processes (McKee & Faulkner 2000).

### 1.5.2 Fauna

#### Invertebrates

South Water Caye Marine Reserve has long been recognized for its rich and diverse fauna. Species richness and live surface cover in the Pelican Cayes, for example, are thought to be unparalleled in the Western Caribbean - layers of brilliantly colored organisms including sponges, ascidians, seaweeds, and corals, cover reef, mangrove root and peat substrates, with ponds sheltered from currents and predators. The extensive barrier reef, with its spur and groove formations, is also known for its high diversity, attracting increasing numbers of tourists each year. With water depths ranging from the shallow reef flats and reef

South Water Caye Marine Reserve Coral Species of International Concern	
<b>Critically Endangered</b>	
Staghorn Coral	<i>Acropora cervicornis</i>
Elkhorn Coral	<i>Acropora palmata</i>
<b>Endangered</b>	
Fire Coral	<i>Millepora striata</i>
Star Coral	<i>Montastraea annularis</i>
Star Coral	<i>Montastraea faveolata</i>

**Table 17: Coral Species of International Concern**

crest to the open sea, and a series of interconnected complex ecosystems - mangrove, seagrass, sand and reef - the Marine Reserve has the heterogeneity for high biodiversity. Five species of coral present within the Marine Reserve are considered to be critically endangered or endangered on the global scale (IUCN, 2008; Table 17).

Two areas of the Marine Reserve have been particularly well studied – the Pelican Cayes, and the Carrie Bow Caye / Twin Cayes area. The cause of the high diversity in the Pelican Cayes area is not well understood, but the principal factors are thought to be the abundance of solid substrates (mangrove stilt roots, extended peat banks), low turbidity, and proximity of sponge-rich coral reefs. Such high biodiversity in a small geographic area may also be attributed to the unique juxtaposition of mangrove, coral, sea grass, and algal biomes under stable oligotrophic conditions (Jones, 2003). The topography of deep ponds alternating with steep coral ridges helps contain fine sediments and prevents re-suspension and silting during storms without blocking the water exchange that is necessary for importing nutrients and flushing waste (Rutzler *et al.* 2000).

70 species of Ascidians, of 30 genera have been recorded, including a new endemic – representing 60% of all known Caribbean Ascidian species. Many of these sea squirts occur as solitary individuals, but others live in colonies of varying forms - as bushy clusters, forming cushions, or growing as flat encrusting sheets, primarily inhabiting the mangrove ponds and coral ridges (Goodbody, 2002). 31 species of Bryozoans (Wilson, 2007) have been identified during preliminary surveys of 13 sites around the Pelican Cayes, as well as 52 species of Echinoderm - including 10 species not previously reported from Belizean waters. (Hendler and Pawson, 2000). 7 species of Foraminifera have also been identified - including 2 new species (Richardson, 2000). The mangrove-fringed ponds in the Pelican Cayes also support an uncommonly diverse population of 147 species of sponge, many large and colourful, and 45% of which are new species or variants (Rutzler *et. al*, 2000).



**Painted Tunicate from Pelican Cayes**  
© 2003 Tony Rath

One hundred and fifty-two species of marine macrophytes have been identified from the area - 148 species of algae and 4 vascular plants (Littler *et. al.*, 2000; McField, 2007). Of these, 64 are Rhodophytes, 59 Chlorophytes, 16 Phaeophytes, and 9 Cyanophytes; 4 Magnoliophytes were also present (Littler *et al.* 2000). Commercially valuable red algal agar-producers (*Gracilaria* and *Hydropuntia*) and carigeenan-producers (*Meristiella*) flourish near the entrances to several of the ponds. An unusual number of macro algal species attained record sizes in these ponds (Littler *et al.* 2000).

The Pelican Cayes area is thought to offer suitable substrates, calm waters, and possibly a refuge from predation for some species that are cryptic on, or completely excluded from, reef habitats (Hendler & Pawson 2002). This area has also been highlighted for the high number of endemic species identified. However, it appears that significant negative changes have occurred in the biodiversity over recent history, as identified for the Ascidian populations at Cat Caye (CCRE, 1998). These changes have accelerated as anthropogenic impacts from mangrove clearance and dredging have increased (McField, 2007).

## Fish

Whilst there have been a number of researchers studying the fish of South Water Caye Marine Reserve, much of this is focused on the identification of new species or species-specific complexes and relationships, with little focus on long term monitoring of larger-scale fish populations and the impacts of anthropogenic pressure.

Of the over 125 species included in the current species list (Annex Six), three are considered to be Critically Endangered or Endangered at global scale, including the critically endangered goliath grouper (*Epinephelus itajara*) and endangered Nassau grouper (*Epinephelus striatus*) (Table 18). Both of these species have been targeted commercially in the past, with the Nassau grouper declining nationally by more than 80% since the late 1970s, attributed primarily to fishing pressure, particularly at the spawning aggregation sites where it is most vulnerable. It is thought that one-third of all known Nassau grouper spawning aggregation sites in the Caribbean region have disappeared, with estimates that, under present management conditions, Nassau grouper (once the second most commonly caught fish in Belize) will disappear from Belize waters by the year 2013 (Paz and Grimshaw, 2001). Recent amendments to the regulations now impose size regulations, and make it illegal to take Nassau grouper during the peak spawning months - December to March.

Fish Species of International Concern	
<b>Critically Endangered</b>	
Goliath Grouper	<i>Epinephelus itajara</i>
<b>Endangered</b>	
Nassau Grouper	<i>Epinephelus striatus</i>
Great Hammerhead	<i>Sphyrna mokarran</i>
<b>Vulnerable</b>	
Queen Triggerfish	<i>Balistes vetula</i>
Marbled Grouper	<i>Dermatolepis inermis</i>
White Grouper	<i>Epinephelus flavolimbatus</i>
Snowy Grouper	<i>Epinephelus niveatus</i>
Hogfish	<i>Lachnolaimus maximus</i>
Mutton Snapper	<i>Lutjanus analis</i>
Cubera Snapper	<i>Lutjanus cyanopterus</i>
Yellowmouth Grouper	<i>Myctoperca interstitialis</i>
Whale Shark	<i>Rhincodon typus</i>
Whiteline Toadfish	<i>Sanopus greenfieldorum</i>
Rainbow Parrotfish	<i>Scarus guacamaia</i>

**Table 18: Fish Species of International Concern (IUCN, 2008)**

The third species, the endangered great hammerhead (*Sphyrna mokarran*) is also still fished within Belize, despite its global status. However, the threatened whale shark (*Rhincodon typus*) is protected under the Fisheries Act, with no fishing, or even touching, permitted. This species is an important tourism resource, especially within the spawning aggregation area of the adjacent Gladden Spit and Silk Cayes Marine Reserve, and has been reported passing through the deeper waters of the outer reef of South Water Caye Marine Reserve. A further eleven shark species have been confirmed as present within the Marine Reserve, with a further four thought to be present but yet to be confirmed (R. Graham, pers. com.).

A survey of the fish species in 1999, encompassing a number of ecosystems within the Marine Reserve (the forereef by Tobacco and South Water Cayes, patch reef adjacent to Wee Wee and Bread and Butter Cayes, and coral reef ridge in the Wee Wee Caye area), provides a baseline (AGGRA, 1999). This provides historical information on fish diversity and density over a number of transects in each location (Table 19). The survey also provided information on the presence of herbivore and carnivore species – the key components for the maintenance of the biodiversity within the Marine Reserve (Table 20).

## South Water Caye Marine Reserve – Management Plan - DRAFT

Site	Reef Type	Latitude (°N)	Longitude (°W)	Depth (m)	Number of fish species*	Fish density (number / 200m <sup>3</sup> )
Tobacco	Forereef	16.87	88.07	11 - 14	31	82.3
South Water	Forereef	16.81	88.06	10 - 14	31	50.1
Curlew Bank	Forereef	16.78	88.08	10 - 13	29	86.0
Wee Wee Patch	Patch reef	16.76	88.14	2 - 5	26	42.3
Bread and butter	Patch reef	16.77	88.16	1 - 5	22	60.3
Norvall	Patch reef	16.71	88.17	1 - 4	25	41.6
Wee Wee Ridge	Coral reef ridge	16.76	88.14	5 - 13	17	39.9
Peter Douglas	Coral reef ridge	16.71	88.17	7 - 13	14	21.7
Tunicate	Coral reef ridge	16.66	88.19	5 - 14	21	105.1

\*Includes acanthurids, chaetodontids, haemulids, labrids, lutjanids, pomacentrids, scarids and serranids

**Table 19: AGGRA data for fish populations of South Water Caye Marine Reserve, 1999**

Site	Reef Type	Herbivores (number / 200m <sup>3</sup> )		Carnivores (number / 200m <sup>3</sup> )		
		Acanthuridae	Scaridae	Haemulidae	Lutjanidae	Serranidae
Tobacco	Forereef	7.4±0.8	14.1±2.4	3.5±1.9	12.3±4.1	1.3±0.6
South Water	Forereef	6.9±0.9	12.1±1.8	1.9±0.4	4.3±1.4	0.3±0.3
Curlew Bank	Forereef	13.4±7.2	11.3±2.8	1.4±0.4	4.1±1.9	0.4±0.3
Wee Wee Patch	Patch reef	8.4±5.3	9.1±2.4	3.5±1.8	1.8±0.7	0.0±0.0
Bread and butter	Patch reef	12.5±9.8	22.5±5.9	11.4±8.8	1.6±0.6	0.8±0.4
Norvall	Patch reef	9.0±6.2	14.3±1.8	1.9±0.3	1.4±0.3	1.3±0.1
Wee Wee Ridge	Coral reef ridge	0.1±0.1	10.4±2.6	0.2±0.2	0.6±0.3	1.6±0.4
Peter Douglas	Coral reef ridge	0.0±0.0	6.7±0.8	2.8±1.2	0.8±0.3	1.3±0.2
Tunicate	Coral reef ridge	0.4±0.4	13.6±2.5	77.6±24.5	3.0±1.5	5.4±2.7

\*Includes acanthurids, chaetodontids, haemulids, labrids, lutjanids, pomacentrids, scarids and serranids

**Table 20: AGGRA data for herbivorous and carnivorous fish of South Water Caye Marine Reserve, 1999**

Anecdotal reports from fishermen, researchers and tour guides of declining populations of key species of fish within South Water Caye Marine Reserve since these initial assessments are supported by recent work demonstrating sharp drops in observations of larger species. Quantitative data on fish populations comparing 2002 and 2008 probabilities of encounter support visual observations, indicating a significant decline in populations of larger reef fish such as grouper, snapper, and triggerfish (Mumby, 2009). A shift in targeted species has been identified towards harvesting of the herbivorous Scarids as the other more favoured species decline, reducing the numbers and impacts of this important reef-maintaining guild, with a linked increase in algal growth.

### Mammals

Four species of dolphin have been reported from within the South Water Caye Marine Reserve - Atlantic bottlenose dolphin (*Tursiops truncatus*) and the Atlantic spotted dolphin (*Stenella plagiodon*) are

commonly seen inside the Belize Barrier Reef (CCC, 1993). The deeper-water rough-toothed dolphin (*Steno bredanensis*) has also been reported, as has Fraser's Dolphin (*Lagenodelphis hosei*).

Antillean (or West Indian) manatees (*Trichechus manatus manatus*) use the Tobacco Range and Twin Cayes area, and have been reported from the Pelican Cayes. The Belize coast is home to the largest population of Antillean manatee in the Caribbean (Morales-Vela *et al*, 2000), with a population estimated at between 800 and 1,000 individuals (Auil, pers. com.). Historically the manatee has been hunted for meat, with bone middens discovered on archaeological sites, and in the 17<sup>th</sup> century, it was taken to provide food for privateers and explorers (Self-Sullivan and LaCommare, 2004). Today, the Antillean manatee is considered threatened throughout its range, and is listed as 'Vulnerable' (IUCN, 2008).

## Birds

69 species have been reported from the area (Mitten *et. al*, 2004, Balderamos, pers. com. 2009). The mangrove and sand cayes and exposed reef crest provide suitable nesting sites for a number of bird species. Man O' War Caye, a mangrove caye designated as a bird sanctuary in its own right, is considered one of the ten largest nesting sites for magnificent frigatebird (*Fregata magnificens*) in the Caribbean, and also supports nesting brown boobies (*Sula leucogaster*). This Crown Reserve is an important tourism resource for local tour guides utilizing South Water Caye Marine Reserve, and a regular stop on the way to or from Tobacco Caye.

Brown pelicans (*Pelecanus occidentalis*) and a number of egret species are reported to nest in great numbers on the southern cayes of Blue Ground Range, and osprey (*Pandion haliaetus*) have been recorded nesting on Carrie Bow and Tobacco Cayes and on Tobacco Range. A single record of scarlet ibis (*Eudocimus ruber*) exists for Wee Wee Caye (BERDS, 2009) – this species has only been recorded in Belize three times, and is considered an 'accidental' transient.



**The Magnificent Frigatebirds of Man O' War Caye**  
(Janet Gibson)

Past records have shown that the exposed reef lying off Tobacco Caye has been an important colony nesting site for terns, with more than 200 breeding adult roseate terns (*Sterna dougallii*), over 50 sandwich terns (*Sterna sandvicensis*), and a number of bridled terns (*Sterna anaethetus*) reported (Balderamos, 2003). With the constant change in the availability of such sites, as exposed reef and sand bores change with the tides and tropical storms, such nesting aggregations may be opportunistic, and change location each year. The sand bores adjacent to Wee Wee Caye are also highlighted as an important breeding site for terns, with reports of nesting bridled tern.

The mangrove cayes are important as stepping stones for migratory species during southbound and northbound migrations. Many thousands of migrants follow the mainland coast southwards and meander off course each year, ending up on the cayes every spring and fall after being blown offshore by shifting winds. Others may use the cayes and ranges of South Water Caye Marine Reserve as part of a straight line migration path down the Yucatan Peninsula coastline, through Ambergris Caye and southwards, and from there to Guatemala and Honduras, where they again hook up with the mainland and its "infinite" food resources.



**Reptiles**

A total of twelve reptile species have been documented to date from South Water Caye Marine Reserve.

The herpetofauna of South Water Caye Marine Reserve is comprised entirely of reptile species. No amphibians have been recorded there, as the saline conditions, absence of freshwater sources, and distance from the mainland are the main determinants precluding their presence, and includes the critically endangered hawksbill turtle (*Eretmochelys imbricata*) and endangered loggerhead and green turtle (*Caretta caretta* and *Chelonia midas*) (Table 21).

South Water Caye Marine Reserve Reptiles of International Concern	
<b>Critically Endangered</b>	
Hawksbill Turtle	<i>Eretmochelys imbricata</i>
<b>Endangered</b>	
Loggerhead Turtle	<i>Caretta caretta</i>
Green Turtle	<i>Chelonia midas</i>

**Table 21: Reptile species of International Concern (IUCN, 2008)**

The conservation priorities for the herpetofauna of the South Water Caye Marine Reserve relate to the three species of sea turtle known to use the area: the critically endangered hawksbill (*Eretmochelys imbricata*) and the endangered loggerhead (*Caretta caretta*) and green (*Chelonia mydas*) turtles. As elsewhere, sea turtle numbers have plummeted in recent decades, having been exposed to enormous exploitation for over 250 years in Belize and adjacent countries. As relatively recently as 1925, their numbers were considered inexhaustible (Smith, *et. al.* 1992) – a far cry from the current situation with only the hawksbill still nesting within the Reserve, and in only very small numbers. Whilst now afforded full legal protection against harvesting in Belize, turtle populations remain highly threatened by loss or degradation of nesting habitat, disturbance by beach-facing lights, and by dogs. The same high, sandy beaches used for millennia by turtles are now being converted into beach properties, with all the impacts associated with human habitation.

Hawksbill turtles tend to be more confined to shallow waters than loggerhead and green turtles, and are known to venture into coastal lagoon and estuaries, where it feeds primarily upon sponges and marine invertebrates. It has a protracted nesting season of 6 months or more – peaking in June and July, with the period between nesting seasons generally being 2-4 years, sometimes longer. Nesting occurs at night, generally at high tide, with a clutch size of 50-200 eggs. Nests tend to be concealed in beach vegetation quite high on the beach and, except for a faint asymmetrical crawl leading to and from the sea, there is seldom any obvious evidence of the visiting female. In the early 1900s, the size of the turtle industry, harvesting hawksbills for their shells, supported two or more schooners at Tobacco Caye. Records indicate that there are now fewer than 25 nests per year on Tobacco Caye and Carrie Bow Caye, and only marginally more on South Water Caye (records



**Loggerhead Turtle, South Water Caye Marine Reserve**  
© Tony Rath



for 2002-2006, Fisheries Department; 2006). With a regional average of 4.5 nests per female in the years they breed, 25 nests in all probability represent only 5-6 females coming ashore to breed.

Loggerhead and green turtles still frequent the waters of South Water Caye Marine Reserve, though there are no confirmed records of nesting in recent years – the last reports of nesting being for loggerheads on Tobacco Caye in 1990, and on South Water Caye in 1989 (Smith *et. al.* 1992). Undoubtedly it is the level of human encroachment onto turtle-nesting beaches that has reduced numbers of this species. There appear to be no confirmed records of greens nesting in this area, though there can be little doubt that they did so prior to the over-exploitation of the nineteenth and twentieth centuries. Whilst the green turtle is primarily herbivorous, feeding mostly upon sea grasses and seaweeds, the loggerhead is more omnivorous, feeding on a wide range of marine invertebrates, seaweeds and turtle grass.

There are reports of the critically endangered leatherback turtles (*Dermochelys coriacea*) swimming off the Pelican Cayes (Coral Caye Conservation Expedition Report, 1993), though this species is not known to nest in Belize. Like the loggerhead, it is omnivorous, feeding on seaweeds and a variety of marine invertebrates – primarily tunicates and jellyfish.

The small raised sand-based islands and low-lying mangrove cayes dotted across the South Water Caye Marine Reserve also present potentially very good habitat for adult American crocodiles (*Crocodylus acutus*), but the absence of extensive brackish lagoons within the islands make them less than ideal in terms of juvenile nursery grounds. Whilst Tobacco Range was identified in 1990 as a nesting and feeding site for American crocodiles (CCC, 1993), a national survey of this vulnerable species, did not locate any specimens or nests within the Marine Reserve (Platt, 1997), although Coral Caye Conservation had previously reported a nest on Tobacco Caye.

A population of the morphologically distinct island boas (*Boa constrictor*) exists on Crawl Caye, Peter Douglas Caye, Lagoon and Wee Wee cayes, but has shown a steady population decline over the last 30+ years, attributed to over-collection (reportedly for the pet trade). From site visits and past collection records, it was estimated that the boa population on Crawl Caye had decreased to only 8 individuals by 2003 (Boback, 2005).

The St. George Island gecko (*Aristelliger georgeensis*), tuberculate leaf-toed gecko (*Phyllodactylus tuberculosus*), and brown anole (*Norops sagrei*) have also been recorded on these cayes (Boback, 2005). Whereas the brown anole is a human commensal, occurring on or close to human buildings along the Belize coast and cayes, formal records of the St. George Island gecko and the tuberculate leaf-toed gecko are far more limited. The Central American skink (*Mabuya unimarginata*), whilst not yet recorded for the protected area, may also occur on a number of the cayes – this species has been recorded on Caye Bokel, north of South Water Caye Marine Reserve.

There are no formal records of the black iguana (*Ctenosaura similis*) occurring on cayes within the South Water Caye Marine Reserve, however, as it occurs across most coastal habitats on the mainland, and is spread broadly across the more distant Glovers Reef and Lighthouse Atolls, it is almost certain to occur somewhere within the protected area. This species is not considered to be of conservation concern.

Two non-native reptile species occur on the cayes of South Water Caye Marine Reserve. The South East Asian House Gecko (*Hemidactylus frenatus*), an introduced species that has been spreading through mainland Belize since the early 1990's, has been recorded from South Water Caye (Meerman and Garell,

2002) and is likely to occur on the majority of the other human inhabited cayes within the protected area. The Asian tokay gecko (*Gekko gecko*) is thought to have been introduced onto South Water Caye in the early 1990's, with the first confirmed report in 1994. This aggressive and voracious exotic has the potential to not only eradicate native lizards on South Water Caye, but also to disperse across island chains and on the mainland, causing irreparable damage to native herpetofauna. It is considered a conservation management priority to instigate a programme to capture and remove or euthanize all observed specimens on South Water Caye, in an attempt to eradicate this potentially very invasive species before it is able to disperse further.

### 1.5.3 Economically Important Species

The Caribbean Spiny Lobster (*Panulirus argus*) and Queen conch (*Strombus gigas*), two invertebrate species of commercial importance to the South Water Caye Marine Reserve fishery, are both fished extensively throughout Belize.

The Caribbean Spiny Lobster fishery is the largest capture fishery in Belize, with production representing over 40% of total capture fisheries production in 2006, and an export value of US\$7.37 million (Fisheries Department, 2007). However, there are concerns over sustainability, with lobster landings peaking in 1981 at 2,204,622 lbs, and falling since then to 457,680 lbs in 2006 (Fisheries Department, 2007) – a significant decrease of almost



Traditional Conch fishing

25% in total national lobster production over this period. A recent assessment based on historical lobster landing data in Belize for the period 1932-2006 demonstrated that the largest catches were reported between 1981 and 1985 and in 1995. It was also noted that the catch decreased by 12.4% between 2004 and 2005, and a further 14.6% from that by 2006, reflecting an overall regional decrease in the Spiny Lobster population (Ministry of Agriculture and Fisheries, 2007).

Whilst there has, in the past, been continued optimism that lobsters are being harvested at a sustainable level (Gillet, 2003), there is also concern that the average size per lobster appears to be declining, and the catch per fisherman is no longer sufficient to support a fisherman and his family (anecdotal reports, Sarteneja, 2005). During community consultations with traditional lobster fishermen, more than one participant stated that they felt that there would not be sufficient lobster or conch to sustain the community of Sarteneja - a community with over 80% of families being directly reliant on the lobster and conch fishing industry - by 2010, (Sarteneja community consultation, 2005).

The Queen Conch fishery has been considered as near collapse in Belize, and efforts are being made to encourage fishermen to respect the size restrictions and no-take regulations of the protected area, through training and participation in monitoring activities. Conch landings peaked at 1,239,000 lbs in 1972, and have declined since then to 676,67lbs in 2006 (Fisheries Department, 2007). Conch production decreased by almost 17% in 2007, and it is suggested that the maximum sustainable yield for this species was reached in 2006, with the steep decline observed in 2007 being an indication of the

“maturity” of the fishing industry, and the possible overfishing of this fishery resource (Ministry of Agriculture and Fisheries, 2007). Even as far back as 1996, there was evidence that fishing pressure was too high, with the national population consisting primarily of juveniles, and recommendations for capping of the number of fishermen.

Inside the Barrier Reef just south of Tobacco Cut, the lagoon is a relatively flat grassy bed sloping slowly inland away from the reef. This area has traditionally been a fishing ground for conch, with fishermen congregating here at the start of the conch fishing season. In 1996, the area was assessed as having the highest density of conch relative to the other sections of the reef (CFRAMP, 1996). Densities in 2007 in the backreef of South Water Caye Marine Reserve were reported as approximately 99 adult conch per hectare, and 1,419 juveniles (based on ten transects of 30m x 3m; SWCMR Annual Report, 2007).

The importance of South Water Caye Marine Reserve to the conch industry is well documented - the high density of juvenile conch reported in 2006 and 2007 reflecting the extensive conch nursery areas in the shallow northern back reef areas of the protected area from Tobacco Caye to Grand Channel. These lie within the Conservation Zone (as defined through the recent revision of the Statutory Instrument). Because the current fishery contains few adults and reproduction in conch is almost never reported by fishermen, it is assumed that the adults must be occupying areas that are not currently fished - possibly on the outer shelf to the east of the reef crest, in waters deeper than 50 feet (SWCMR Annual Report, 2007). If a deep, unexploited stock of adults exists, and if current fishing is low enough to allow recruitment of juveniles into that deep-water seed stock, then production may be relatively independent of stock size. Continued recruitment in the absence of observed spawning would argue that a supporting spawning stock exist somewhere (Appeldorm & Rolke, 1996), though it is still generally considered that the conch fishery is currently over exploited.

Whilst many of the fishermen recognize the importance of these conch nursery areas, there is little collaboration with Fisheries Department towards the protection of the conservation zones, and minimal buy-in to the idea of conservation as a mechanism to manage the fisheries resources.

Finfish are also extracted from the marine protected area, and in general provide an important component of the commercial catch – most are fished using spear guns and hand lines. Much of this catch is sold in local markets and directly to hotels rather than through the co-operatives, though some is marketed for export. The targeted export species include groupers (*Epinephelus* sp. and *Mycteroperca* sp.), snappers (*Lutjanus* sp. and *Ocyurus* sp.), the hogfish (*Lachnolaimus maximus*), king mackerel (*Scomberomorus cavalla*), great barracuda (*Syhyraena barracuda*), and jacks (*Alectis* sp., *Caranx* sp. and *Trachinotus* sp.) ([www.fao.org/fishery/countrysector/FI-CP\\_BZ/en](http://www.fao.org/fishery/countrysector/FI-CP_BZ/en)). Snappers are reported to make up the largest single family of fish that are exported, with whole fish and fish fillet exports totaling 113,500 lbs in 2001, dropping to 52,316 lbs in 2006 (Belize Fisheries Dept. 2002; Ministry of Agriculture and Fisheries, 2007). Species harvested for local consumption include grunts (Haemulidae), snooks (Centropomidae), mullets (Mugilidae), porgies (Sparidae), triggerfish (Balistidae), and tarpon (Megalopidae).

Shark fishing is also conducted in the South Water Caye Marine Reserve, utilizing gill nets and long lines, particularly in the drop off to the east of the reef crest. Eleven shark species have been reported from South Water Caye Marine Reserve (Table 22) - the common species caught include bull, hammerhead, nurse, reef and lemon sharks, with the dried shark fins and salted or frozen shark meat being exported through the co-operatives, or illegally sold directly to buyers in various coastal ports in Guatemala and Honduras. Shark fishing in Belize was assessed in 2005 during the initial drafting of the National Plan of

Action – Sharks (Fisheries Department, 2005), when an estimated twenty-five fishermen were identified as being involved, originating from various communities along the coastline, with the greatest activity concentrated between December and March. In 2001, about 9,500 lbs of shark products were exported (Belize Fisheries Dept. 2002) – however, this is accepted as an under-estimation of the fishing level, as the largest market is the illegal trade with Guatemala and Honduras.

Except for the whale shark (for which there is a complete ban on fishing under the Fisheries Act), there is the recognition in Belize that sharks, in general, are under pressure from over-fishing, having a close stock-recruitment relationship, long recovery times in response to over-fishing, with few offspring and late sexual maturity, resulting in low biological productivity. This, in combination with complicated patterns of size/sex segregation and seasonal migration, raise concerns at the national levels about the sustainability of the shark fishery, particularly under the current unregulated fishing levels. The Belize Fisheries Department is developing a National Plan of Action for the shark fishery following the guidelines of the International Plan of Action for the Conservation and Management of Sharks

Shark Species of South Water Caye Marine Reserve	
<b>Documented</b>	
Bull shark	<i>Carcharhinus leucas</i>
Blacktip shark	<i>Carcharhinus limbatus</i>
Caribbean reef shark	<i>Carcharhinus perezi</i>
Tiger shark	<i>Galeocerdo cuvier</i>
Lemon Shark	<i>Negaprion brevirostris</i>
Great hammerhead	<i>Sphyrna mokarran</i>
Caribbean sharpnose shark	<i>Rhizoprionodon porosus</i>
Nurse shark	<i>Ginglymostoma cirratum</i>
Bonnethead	<i>Sphyrna tiburo</i>
Silky shark	<i>Carcharhinus falciformis</i>
Blacknose shark	<i>Carcharhinus acronotus</i>
<b>Probable but undocumented</b>	
Scalloped hammerhead	<i>Sphyrna lewini</i>
Spinner shark	<i>Carcharhinus brevipinna</i>
Galapagos shark	<i>Carcharhinus galapagensis</i>
Dusky smooth hound	<i>Mustelus canis insularis</i>
(R. Graham, pers, com.)	

Table 22: Shark species of South Water Caye Marine Reserve

(IPOA – Sharks), which is designed to achieve the conservation and sustainable use of shark species through the protection of the marine environment (ecosystems and biodiversity), with the minimization of by-catch, waste and discard, and through the adoption of selective and environmentally safe fishing practices.

### 1.5.4 Past and Present Research

There has been a long history of research activities within the South Water Caye Marine Reserve area, as well as a number of facilities that provide logistical support for student groups and field study courses. Scientific work started with the establishment of the Smithsonian Institute Field Station on Carrie Bow Caye in 1972, and during the first decade, resulted in the production of "The Atlantic Barrier Reef Ecosystems at Carrie Bow Cay, Belize, I: Structure and Communities" (Rützler and Macintyre, 1982), and providing baseline information on the marine life and physical processes of the reef. Over the decades, the station has provided a logistical base for many scientists and graduate

Research Facilities	
Carrie Bow Caye	Carrie Bow Caye Field Station
Student Study Facilities	
Wee Wee Caye	Wee Wee Caye Marine Lab
Tobacco Caye	Tobacco Caye Marine Station
South Water Caye	The Pelican’s University

Table 23: Research Facilities based in South Water Caye Marine Reserve

students, with more than 900 research papers being produced on the fauna, flora, and geology of the Carrie Bow reef tract, and Pelican Cayes area.

In the early 1980s, emphases shifted to an ecological study of Caribbean mangrove swamp communities - the Smithsonian Western Atlantic Mangrove Program (SWAMP), with the nearby Twin Cays chosen as the model mangrove system, (Rützler and Feller, 1996).

Beginning in 1985, the Caribbean Coral Reef Ecosystems (CCRE) programme was established, growing out of the previous two programmes, encompassing reef, mangrove, seagrass meadow, and plankton community studies. This was further strengthened in 2000 with the establishment of the Marine Science Network. Under this network, the CCRE programme became a component of a more regional focus, with comparative studies in Belize, Panama and the United State, focused at solving problems of coastal and marine environments from the U.S. to Central America.

An automated monitoring system for water parameters was installed on Carrie Bow Caye in 1997 and upgraded in 2000 to record principal parameters - land-sea-water temperatures, water salinity (conductivity), dissolved oxygen, solar radiation, tides, wind direction and speed, and rainfall, with data loggers being placed at several sites and depths, including Carrie Bow, Cat, Manatee, and Channel Cayes (CCRE 2002). This data is available in real time through the internet (<http://cbc.riocean.com>).



Despite the extensive information documented throughout the many years during which the Carrie Bow Caye Field Station has been functioning, much of the information has been focused on 'pure science' - taxonomic or species specific information, and does not address the primary management gaps in knowledge for conservation management, nor does it provide long term information on the status of the reef biodiversity. Access to and use of this information by the Belize Fisheries Department for the management and development of strategies towards the conservation of the Marine Reserve is limited, with little networking between the two.



**Carrie Bow Caye Field Station Facilities**

Intensive surveys of several proposed marine protected areas, including South Water Caye, were conducted between 1986 and 1998 by Coral Caye Conservation, utilizing international volunteer expeditions, providing baseline information on fish species present within each of the protected areas.

In 2008, Conservation International established the Marine Management Area Science Program, established to fill the current information gap by providing information for more effective management, through six program areas: management effectiveness, connectivity, resiliency, economic and cultural valuation, conservation and economic development, and enforcement. This program is currently ongoing.



## Caribbean Coral Reef Ecosystems Program

The Carrie Bow Cay Laboratory primarily serves to support SI marine scientists' research projects on a year-round basis. Hurricanes Fifi (1974), Greta (1978), and Hurricane Mitch (1998) could not damage Carrie Bow Cay facilities the way a devastating fire did in December 1997. Improved facilities now include dry and wet labs, housing, generator, compressor, small boats and scuba cylinders, and essential facilities such as solar power, running-seawater system, and a weather station.

**Biodiversity, Morphology and Developmental Biology.** Studies cover the evolutionary range from microbes to manatees. Several new toxic species of dinoflagellates that occur in blooms (red tides) were identified based on cytological characteristics. A study of benthic macroalgae was completed and will serve to prepare an illustrated field guide. Earlier work on sponges led to a multimedia computer key on mangrove sponges with digitized underwater color photographs. The balance of nutrient release and uptake by abundant sponges and bivalves was found to be a decisive factor in the coupling of seagrass and mangrove prop-root. Also in the mangrove, a sessile ciliate (*Zoothamnium*) symbiotic with chemoautotrophic bacteria was discovered and cultivated on sulfide-producing substrates to measure reproduction and growth rates.

**Species Interactions and Behavior.** Study of a sponge-inhabiting shrimp (*Synalpheus* spp.) confirmed its advanced social structure for the first time in a marine animal. Morphological, life-history, and phylogenetic analyses were also conducted on fishes (labrids) and a new blenny (*Acanthemblemaria*) was discovered.

**Ecophysiology and Responses to Environmental Change.** Another experimental study shows how water flow affects coral shape and growth rates, either by force and direction or by nutrient distribution. Solar radiation, including UV radiation, was measured on the Carrie Bow reef down to 39m and in experiments has been found to affect rates of photosynthesis and bleaching in symbiotic coral (*Agaricia*) and a sponge (*Calyx*). A monitoring program has been established to quantify the long-term temperature change effects on the distribution and progress of black-band disease in reef corals.

**Processes Linking Species and Environment.** Mangroves are a dominant coastal ecosystem throughout the tropics and a major research focus at Carrie Bow Cay. A large multidisciplinary team of researchers from SERC, NMMH, and several collaborating institutions are studying the control of biocomplexity of mangroves on small islands and along the mainland. The program conducts manipulative experiments on nitrogen, phosphorus and herbivores above the water, and also uses scuba to study fouling communities of the subtidal mangrove prop-roots. Several recent projects (Macintyre and Ruetzler, 2000) investigated the Pelican Cays, an undisturbed and highly diverse group of reef-mangrove islands 15km SSW of Carrie Bow Cay. The atoll-like reef structure on which the cays are located is obvious only from the air. Core drilling (to 15m) of the characteristic reef-ridge system at Manatee Cay showed an open framework construction made up of the branching coral *Acropora cervicornis* and confirmed the original hypothesis that reef ridges are all established on points of high karst relief on the underlying pleistocene limestone. *A. cervicornis* has disappeared from many Caribbean sites due to white band disease but here it has been replaced by other coral (*Agaricia* spp.) rather than by algae. High levels of herbivory by an echinoid may be responsible for this difference.

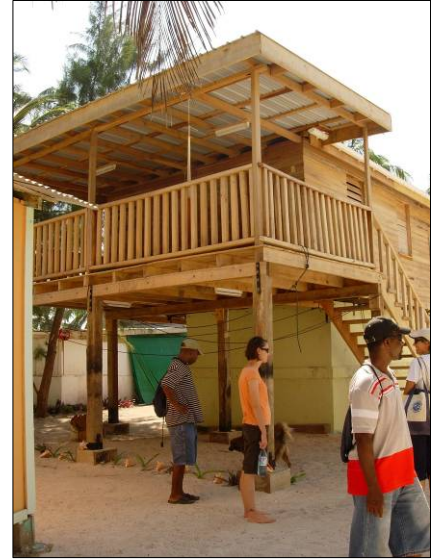
CCRE / Smithsonian Institute (downloaded, 2009)



A list of research outputs from South Water Caye Marine Reserve is included in Annex Five – whilst this covers the majority of papers produced over the years, it is accepted that there will be further work by independent researchers that it has not been possible to locate for inclusion in this list.

A number of facilities for student groups and independent researchers are also available within the Marine Reserve. The Pelican Pouch (the University of South Water Caye) on South Water Caye was established in 1977, and is designed to house self-catering groups of up to 23 people, with the option of tuition in marine ecology. International Zoological Expeditions also host researchers and students on the Caye. Wee Wee Caye Marine Lab is located within the more southerly portion of South Water Caye Marine Reserve, approximately nine miles off the coast, and was established in 1988 as a more dedicated support facility for researchers and students.

Most recently, Monkey Bay has established a satellite facility on Tobacco Caye – the Tobacco Caye Marine Station – to cater for student study groups. Whilst this facility does not include accommodation (this being provided by guest houses on the cayes), it provides structured courses on marine ecology, and also seeks to work with Fisheries Department and the local fishermen towards more effective conservation management of the reef.



**Tobacco Caye Marine Station**

## 1.6 Cultural and Stakeholder Use of South Water Caye Marine Reserve

### 1.6.1 Community and Stakeholder Use

The Belize coast and cayes have been used by local populations since the times of the early Maya. Fishing stations, trading posts, ceremonial centers, and burial grounds are found throughout coastal Belize, dating from as early as approximately 300 B.C. Maya artifacts have been found on Tobacco Range, Wee Wee Caye, and South Water Caye, indicating that the cayes of South Water Caye Marine Reserve were used during the height of the Maya civilisation.

The cayes within the marine protected area also have a long tradition of more recent use - Tobacco Caye, for example, is thought to have been settled by the Puritans in the 1600's, who provided a trading outpost for the exchange of goods – including tobacco. The complex systems of cayes within the Marine Reserve also provided safe havens for pirates, privateers and buccaneers during the 17<sup>th</sup> and 18<sup>th</sup> centuries.

In the early 19<sup>th</sup> century, the Garifuna arrived from the West Indies, settling in Commerce Bight and establishing “New Town” in the general vicinity of Sittee River. Hurricane Hattie, however, removed the settlement in 1961, forcing the inhabitants to move inland to Georgetown, or south to Hopkins. The Garifuna of both New Town and Hopkins have traditionally been subsistence fishermen, paddling in dories close to shore and rarely venturing beyond Blue Ground Range and Ragged Caye. With the arrival of outboard motors and fiberglass skiffs, however, many of today's fishing descendants are able to travel further, better utilizing the resources of the Marine Reserve. In the 1960's, the expanding footprint of the Sarteneja free-diving lobster and conch fishermen, with their traditional wooden sail boats, extended to include the Marine Reserve – this use continues today.

Tobacco Caye and South Water Caye, in particular, have been used as vacation destinations for the older established Belize families, with many of the vacation houses being adapted as tourism facilities in more recent years. The area is also still used extensively for recreational activities at a national level, particularly over Easter.

### 1.6.2 Recreation and Tourism Use

Belize is a well known tourism destination for those seeking the reef, coral sand beaches and laid-back Caribbean culture. South Water Caye Marine Reserve provides an excellent resource for marine based activities - the proximity of pristine reef, dive sites and world class sport fishing gives this marine protected area the potential to become a world-reknowned destination, though it is currently under-promoted. Snorkeling and diving tours originate from both the mainland (principally Dangriga, Placencia, Sittee River, and Hopkins), and from the cayes located within the protected area itself. Many of the larger coastal resorts, such as Hamanasi and Pelican Beach Hotel, also provide day tour packages.



Tourism facilities of South Water Caye

Caye	Hotel
<b>Hotels</b>	
South Water Caye	Leslie Cottages
	Blue Marlin Lodge
	Pelican Pouch
Tobacco Caye	Reefs End Lodge
	Tobacco Caye Lodge
	Tobacco Caye Paradise
	Gaviota Coral Reef Resort
	Lana's on the Reef
	Ocean's Edge Lodge
Coco Plum Caye	Coco Plum Island Resort
Thatch Caye	Thatch Caye Resort
<b>Student Facilities</b>	
South Water Caye	The Pelican's University
Wee Wee Caye	Wee Wee Caye Marine Lab

**Table 24: Tourism Facilities based in South Water Caye Marine Reserve**

Sailing Charter Companies	Base
TMM (Tortola Marine Management)	San Pedro Placencia
The Moorings	Placencia
Belize Charters	San Pedro
Belize Sailing Charters	Placencia

**Table 25: Sail Charter companies using South Water Caye Marine Reserve**

Overnight tourism facilities within South Water Caye Marine Reserve are concentrated primarily on Tobacco Caye and South Water Caye, though a small number of self-contained, higher-end resorts are also being established on other cayes within the protected area (eg. Thatch Caye Resort and Coco Plum Island Resort). The cheaper facilities on Tobacco Caye attract backpackers and other budget travelers, though there are concerns for the ecological sustainability of the cayes at the current and predicted future levels of tourism development and use.

Private yachts and charters also utilize the area on a frequent basis, with a number of companies providing charter services, based primarily in Placencia and San Pedro.

Tourism to the Marine Reserve has increased over the years, with ticket sales reaching over 3,000 in 2008. Accurate visitor numbers, however, are not easy to assess, as many avoid paying the entrance fees, and the size of the marine protected area and limited staff prohibits effective fee collection. Income from entrance fees has fluctuated over the years, but

generally shows an increase, currently totaling Bz\$54,688 for 2008. Visitation fluctuates over the year, too, peaking in April, when traditional local tourism to the cayes is at its highest, and when international tourism season is at its peak (Figure 9). Minimal tourism occurs between August and November - the tropical storm season – and many facilities on Tobacco Caye close down for that period.

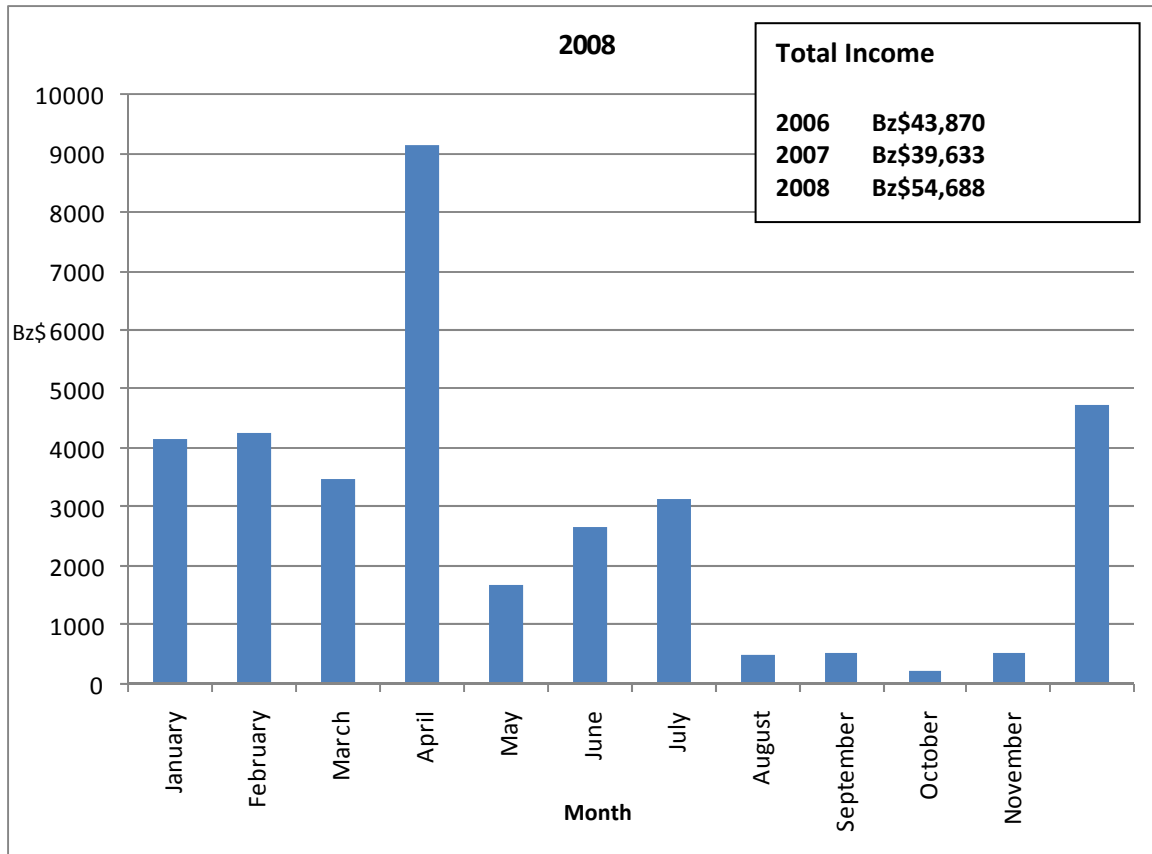


Figure 9: Monthly tourism levels in 2008 (assessed by entrance fees)

A rapid visitor assessment conducted on Tobacco Caye in 2008 showed that visitors enjoyed the caye for its authentic, friendly atmosphere and tranquil pace, and were attracted by the easy access to the reef and the option of off-shore diving (Table 26). Visitors were asked for their perceptions on the condition of the reef - 40% (those who had visited reefs before) were disappointed with the extent of dead coral, especially nearer to the island, and noted that there were fewer fish than expected, with none of the larger fish normally associated with reefs. Those who had also visited Glover’s Reef felt that the reef adjacent to Tobacco Caye was heavily impacted by the tourism pressure. The remaining interviewees, however, felt that they were happy with the health of the coral and fish, but qualified this with the fact that they had no previous experience of the reef to provide a comparison.

Several interviewees expressed dislike for the noise pollution caused by the continual use of generators, as well as concerns about poor reef etiquette by dive instructors, and the impacts this has on the heavily used reef adjacent to the caye. There was a general consensus of the need to increase awareness of the function of the Marine Reserve, and of the need for good snorkelling and dive practices, with suggestions of a centrally-located information board, or leaflets distributed through the guesthouses. The main limitation expressed by a number of respondents was the lack of facilities for accessing money on the caye.

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Visitor	Age range	Positive Comments	Negative Comments	Perception of the reef	Length of stay
1	45+	Authentic culture	Continuous generator noise	Reef appears dead nearer the caye, further into the channel, the reef is beautiful, with hundreds of fish - but all are small. No larger fish	One week
2	18-25	Friendly	No way of accessing funds on the Caye (and no prior warning that there is no where to change money)	The reef doesn't appear to be so healthy near the caye	One day
3	18- 25	Quaint. Cheap.	No way of accessing funds on the Caye (and no prior warning that there is no where to change money)	Shore diving easy access and cheap. Reef seems in good condition, but have nothing to compare it with	One day
4	18-25	Calm and relaxing, Cheap	Unnecessary to keep the generator on continuously	Beautiful. Easy access to the reef.	One day
5	26- 45	Cheap. Social, good bar. Easy access to the reef.	Generator on continuously	Good snorkeling. Shore diving. Reef seems in good condition, but have nothing to compare it with	One day
6	26-45	Off shore diving, authentic. Easily accessible.	Bad practises from dive instructors not respecting the reef, There need to be signs raising awareness of the Marine Reserve	Low number of fish and high incidence of dead coral. Glovers was better, and on a par with any other diving location in the world Would suggest using a drop in box for fee collection	Three days
7	26-45	Easily accessible off shore diving, friendly	There needs to be greater awareness of best practices within the Marine Reserve Unnecessary to keep the generator on continuously	Disappointed - not many fish, and plenty of dead coral	Three days
8	18-25	Authentic	Would like to see fishing	Healthy, easy to access	One day
9	18-25	Friendly	nothing	Healthy, easy to access	One day
10	18 - 25	Tranquil, local people show real respect for the reef	Leaflet inside hotel room to raise awareness on good snorkelling practices would be good	Easy to access, lots of small fish, healthy coral,	One week

**Table 26: Visitor Perceptions of Tobacco Caye, Rapid assessment, 2008**

### 1.6.3 Educational Use

Education of both stakeholders and visitors is an important task for effective management of the Marine Reserve, though has been limited in the past. However, there is currently a greater interpretation and education focus, with the construction of a small Visitor Centre on Twin Cayes and an interpretive boardwalk for accessing the extensive mangrove habitats in the area. The boardwalk will serve local and international students, resource managers, fishermen, and school teachers as a site for mangrove ecology courses / workshops and the opportunity to experience the mangrove habitat. It will also facilitate monitoring and research by scientists and resource managers.



South Water Caye Marine Reserve has a number of facilities that offer cheaper options for international student study groups, and forms a component of their educational visit to Belize. With the ease of accessibility, relatively pristine coral and rich biodiversity, the reefs, seagrass meadows and mangroves adjacent to these facilities offer an excellent resource for these groups. The majority of the facilities available offer logistical support, with the option of interpretation and tuition. Some also provide accommodation, whilst others, such as Tobacco Caye Marine Station, rely on guest house accommodation on the cayes.

**The Twin Cayes Boardwalk - stimulating “ local economy while increasing public awareness about the interconnectivity, vulnerability, and natural history of the mangrove and coral reef ecosystems” Fisheries Department, 2008**

Education use by local communities is more restricted, with the costs involved in transporting students to the Marine Reserve. There have been sporadic attempts over the years to increase awareness in schools of stakeholder communities, but there has been no long-term connections forged. This is not assisted by the locations of the communities, ranging from Sarteneja in the north to Punta Gorda in the south. In many of the communities, however, this role is taken on by local conservation organizations – TIDE, SEA, SACD. The main gap remaining is in Dangriga, where there is no marine-focused NGO to take on this role.



## 2. Conservation Planning

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Conservation Action Planning (CAP) is a structured approach to planning, implementing and measuring success for conservation projects at system and site level. The Nature Conservancy (TNC) CAP processes used are based on the outputs of the 2008 conservation action plan developed for the Southern Belize Reef Complex (SBRC), of which South Water Caye Marine Reserve is a component. It integrates broad scale participation from a wide range of stakeholders – community, NGO, government agency, conservation field staff, private sector business and academic, to produce a plan for the future effective management of the marine protected area, as part of the Southern Belize Reef Complex, at both system level and site level.

### Focal Conservation Targets for the South Water Caye Marine Reserve

- Turtle Nesting Beaches
- Commercial and Recreational Species
- Coral Reef Communities
- Mangroves
- Wide Ranging Large Marine Vertebrates
- Seagrass

### 2.1 Identification of Conservation Targets

Six **Conservation Targets** were identified from the SBRC targets to represent and encompass the biodiversity values of the South Water Caye Marine Reserve. These have been selected to assist in guiding conservation strategies at site level, and are the focus of the threats that are faced by the protected area. The TNC CAP criteria were adopted in target identification – that:

- **Targets should represent the biodiversity and cultural heritage of the site.** The focal targets should represent or capture the array of ecological systems, communities and species of importance of South Water Caye Marine Reserve, and the multiple scales at which they occur
- **Targets reflect ecoregion or other existing conservation goals.** Focal targets are grounded in the reasons for protection – South Water Caye Marine Reserve’s current status of protection as part of the National Protected Areas System Plan, and as one of seven protected areas within Belize’s World Heritage Site. Focal targets also reflect conservation efforts at the regional and national level, as well as system-level planning for the Southern Belize Reef Complex, national level initiatives including the National Protected Areas Policy and System Plan, and at regional level, the TNC, CI and WWF ecoregional assessments, which identify the Belize Barrier Reef as one of the region’s key marine areas of ecological, biological and social importance.
- **Targets are viable or at least feasibly restorable.** Viability (or integrity) is a measure of a target’s ability to persist for many generations. If a target is on the threshold of collapse, or conserving a target requires extraordinary human intervention, it may not represent the best use of limited conservation resources

- **Targets are highly threatened.** All else being equal, targets should focus on highly threatened species or ecosystems, ensuring that critical threats are identified and addressed through conservation actions.

All conservation targets selected to represent South Water Caye Marine Reserve are ecosystem and species assemblages, and have guided the conservation strategies at site level, being indicative of the threats faced by the protected area.

## 2.2 Assessing Biodiversity Viability

The Viability Assessment provides an objective, consistent means for determining changes in the status of each focal conservation target over time, providing baseline for the measuring of success of conservation action planning strategies.

The Conservation Action Planning process has assisted the Southern Belize Reef Complex project team in building an informed structure to guide monitoring and research in each of the marine protected areas of the SBRC. The CAP has been developed using available information on the biology and ecology of the conservation targets selected, with input from technical and field experts through a series of workshops in 2008. The results have been further adapted to be relevant at site-level for South Water Caye Marine Reserve.

The Assessment provides:

- An objective, consistent means for determining changes in the status of each focal conservation target over time, allowing the management partners to measure success of conservation action planning strategies
- A basis for the identification of current and potential threats to a target and identifies past impacts that require mitigation actions
- A basis for strategy design and the foundation for monitoring
- Guidance in summarizing and documenting knowledge and assumptions about the biology and ecology of each target, with identification of critical information gaps and research questions.

Conservation Target: Turtle Nesting Beaches		
Conservation Target	Justification for Target Selection	Species, Communities or Ecological Systems represented by Target
<p><b>Turtle Nesting Beaches</b></p> <p><b>Viability Indicators:</b></p> <ul style="list-style-type: none"> <li>▪ % of identified turtle nesting cayes without human development</li> <li>▪ Abundance of turtle nests</li> </ul> <p>Data for indicators are not yet comprehensive</p>	<p>A number of the cayes have historically provided nesting sites for critically endangered hawksbill and endangered green turtles, important to the survival of these species within the region. However tourism developments have severely reduced the size and suitability of beaches used by turtles. Limited nesting activity is, however, still seen to occur on Carrie Bow Caye and Tobacco Caye. On the latter, increased tourism, light pollution and dogs have had a major negative impact on the nesting success of turtles. The endangered loggerhead turtle is also reported to nest irregularly on Carrie Bow Caye. Data collection on patterns and success of nesting have been sporadic, and little information is available on how viable the remaining nesting sites are.</p> <p>Turtle nesting beaches and the associated herbaceous beach communities are classified within the Belize Ecosystem Map as <b><i>Tropical Coastal Vegetation on recent sediments</i></b> (Meerman and Sabido, 2001). This ecosystem is found in isolated patches on the cayes within SWCMR, and is very resilient to hurricane damage, and can become established on small, isolated cayes, with long distances between patches.</p> <p>The herbaceous beach community is considered very important for the stabilization of the turtle and crocodile nesting beaches. However, this ecosystem is found in areas targeted for residential and tourism development, where it is often subjected to extensive clearance to expose the sandy beaches.</p> <p>All three species of turtle commonly found within the waters of South Water Caye Marine Reserve have used the cayes for nesting in the past, but nesting success has been reduced significantly by human impacts – beach clearance, introduction of predators, light pollution, tourism development etc.</p>	<p>The sandy beaches of the area provide nesting sites for endangered sea turtles (green, loggerhead and hawksbill turtles) and the American Crocodile. Also nesting on some of the sandy cayes are a range of bird species – least, roseate and bridled terns among them.</p> <p>2008 data suggests that hawksbill and green turtle nesting is occurring on Carrie Bow Caye, South Water Caye, and Tobacco Caye, though in all sites, nesting success is uncertain, and the number of nest has declined significantly when compared with historical records (State of the Protected Areas Assessment, 2009, in prep).</p>

Conservation Target: Commercial / Recreational Species		
Conservation Target	Justification for Target Selection	Species, Communities or Ecological Systems represented by Target
<p><b>Commercial / Recreational Species</b></p> <p><b>Viability Indicators:</b></p> <ul style="list-style-type: none"> <li>▪ <b>Biomass of commercial fish</b></li> <li>▪ <b>Conch density</b></li> <li>▪ <b>Lobster density</b></li> </ul>	<p>The two invertebrate species of highest commercial importance extracted from the SWCMR are the <b>Caribbean Spiny Lobster</b> (<i>Panulirus argus</i>) and <b>Queen conch</b> (<i>Strombus gigas</i>), both of which are fished extensively throughout the area. The lobster fishery is the largest capture fishery in Belize, with production representing over 40% of total capture fisheries production in 2006, and an export value of US\$7.37 million (Fisheries Department, 2007). Lobster landings peaked in 1981 at 2,204,622 lbs, but have fallen to 457,680 lbs in 2006 (Fisheries Department, 2007). It is significant to note that the total national lobster production over this period has declined by almost 25%, and there are concerns for the continued sustainability of the lobster fishing industry.</p> <p>Conch, too, have declined significantly, though strict regulations and quotas are being implemented towards more sustainable use of this resource. SWCMR is highlighted for its importance in recruitment, with the presence of a critical nursery area.</p> <p>The role of many of the target fin-fish species as top predators is essential in reef community structure. Most commercially important marine species have complicated life cycles that rely on the health of the entire marine ecosystem – utilizing not just the reef, but also the seagrass beds and the mangroves at some point during their life cycles.</p>	<p>This target, commercial marine species, covers fin fish, lobster and conch – fished primarily by artisanal fishermen of the northern fishing communities (Sarteneja, Chunox and Copper Bank) and of the more adjacent coastal communities such as Dangriga, Placencia, and Hopkins, who are reliant on lobster, conch and finfish resources for their livelihoods.</p> <p><b>Caribbean Spiny Lobster</b> (<i>Panulirus argus</i>) and <b>Queen conch</b> (<i>Strombus gigas</i>), are fished extensively throughout the area. Figures show that conch density averages 44/ha in open fishing areas, and 255/ha in no take zones. The Healthy Reef target is 300 – 400 adults per hectare.</p> <p>The high diversity of fish species recorded within the SBRC includes <b>Snapper</b> (Lutjanidae) (<i>Lutjanus cyanopterus</i>, <i>L. jocu</i>, <i>L. apodus</i>, and <i>L. mahogany</i>), <b>Grouper</b> (Serranidae – <i>Myctoperca bonaci</i>, <i>M. venenosa</i> and <i>M. tigris</i>), the <b>Great Barracuda</b> (<i>Sphyrna barracuda</i>), <b>Grunt</b> (Haemulidae); <b>Goatfish</b> (Mullidae), and <b>Parrotfish</b> (Scaridae – <i>Scarus coelestinus</i>, <i>Sparisoma chrysopteron</i> and <i>S. virida</i>)</p> <p>Sport fishing is an increasing activity within the SWCMR, focusing on permit, barracuda, bonefish, tarpon, mullet, crevalle and horse-eye jacks. Trolling and line fishing is also prevalent from Tobacco Caye and South Water Caye, for consumption.</p>

Commercial / Recreational Species Indicators						
Category / Key Attribute	Indicator	Poor	Fair	Good	Very Good	Current Indicator Status
<b>Condition</b> Population Structure and Recruitment	Biomass of commercial fish  ▪ <b>SBRC Indicator</b> ▪ <b>Healthy Reef Indicator</b>	0 – 2000g/100 m <sup>2</sup>	2000 – 3000g/m <sup>2</sup>	3000 – 4000g/m <sup>2</sup>	>4000g/m <sup>2</sup>	<b>Current Status:</b> POOR. No data – rating is based on condition compared to adjacent data for Gladden Spit / LBC Rapid Assessment
						<b>Healthy Reef Goal:</b> A 20% increase regionally in commercial fish biomass to 1300g/100 m <sup>2</sup>
						<b>Healthy Reef Red Flag Warning:</b> Levels below < 1000g/100m <sup>2</sup>
						<b>SBRC Monitoring Priority:</b> High <b>SBRC Monitoring Status:</b> Ongoing
<b>Condition</b> Population structure and recruitment	Adult Conch density  ▪ <b>SBRC Indicator</b> ▪ <b>Healthy Reef Indicator</b>	<b>Current Status</b>		<i>Desired Status</i>		<b>Current Status:</b> SWCMR is rated as POOR – 2008 transects showed few conch (SWCMR Annual Report, 2008)
						<b>Healthy Reef Goal:</b> Adult conch populations of 300 – 800 individuals per hectare within the next 20-25 years
						<b>Healthy Reef Red Flag Warning:</b> Any consistent reduction in average density, correlated with a drop in production
						<b>SBRC Monitoring Priority:</b> Very High <b>SBRC Monitoring Status:</b> Ongoing
<b>Condition</b> Population Structure and Recruitment	Lobster density  ▪ <b>Healthy Reef Indicator</b>		<b>Current Status</b>	<i>Desired Status</i>		<b>Current Status:</b> SWCMR is rated as FAIR as a default rating
						<b>Healthy Reef Goal:</b> Increased average spiny lobster abundance by 30% by 2025
						<b>Healthy Reef Red Flag Warning:</b> Any consistent reduction in average density, correlated with a drop in production
						<b>Methods:</b> MBRS / LAMP protocol <b>Baseline:</b> Surveys have been conducted for lobster abundance – figures suggest 64 lobsters per survey (June, 2008). Laughingbird Caye National Park (a no take mpa) had a density of 200/ha in 2002; 100/ha in the general use zone.

Conservation Target: Mangroves		
Conservation Target	Justification for Target Selection	Species, Communities or Ecological Systems represented by Target
<p><b>Mangroves</b></p> <p><b>Viability Indicators:</b></p> <ul style="list-style-type: none"> <li>▪ <b>Total extent of mangrove ecosystem</b></li> <li>▪ <b>Abundance of juvenile fish</b></li> </ul>	<p>The prop roots of red mangroves are important in their role as a critical fisheries nursery area for commercially valuable species, and considered important in the maintenance of commercial fish and lobster stocks. They also play a key role in the maintenance of caye integrity through erosion control. The trees themselves serve as nesting structure, as seen at Man-o-War Caye, which supports a nesting colony of magnificent frigatebirds and brown boobies. The leaves provide nutrients for plankton, which serve as the basis of the detrital food chain.</p> <p>Some of the cayes – particularly Twin Cayes, Pelican Cayes and Tobacco and Blue Ground Ranges - have important oceanic red mangrove (<i>Rhizophora mangle</i>), as well as the more terrestrial white mangrove (<i>Laguncularia racemosa</i>), black mangrove (<i>Avicennia germinans</i>), and buttonwood (<i>Conocarpus erectus</i>).</p> <p>Whilst the important roles of mangroves are widely recognized, there is extensive clearance of these species within South Water Caye Marine Reserve for caye development, with the associated reduction in the essential ecosystem services they provide. The Pelican Cayes, in particular, have been highlighted for their importance and fragility, yet 29% of the mangroves have been lost since 1996, when South Water Caye Marine Reserve was first declared part of Belize’s World Heritage Site.</p>	<p>The diversity of marine organisms in the South Water Caye Marine Reserve – particularly the Pelican Cayes area - is considered unparalleled in the Caribbean, primarily due to the prop roots of the red mangrove, which provide a substrate for the mangrove oyster, shrimp, sponges and many other invertebrates – 62 species of sponge, for example, have been recorded in association with the Twin Cayes mangrove system (Fiaz and Rutzler, CCRE, 2008). The structure also provides shelter for many commercial and non-commercial fish species such as permit, lobster, snappers, and goliath grouper. Studies of mangrove root systems within SWCMR (primarily Twin Cayes) have shown a total of 142 taxa from 55 families – among the highest reported for oceanic mangroves in this biogeographic region (Taylor et. al. CCRE, 2008), and including endemics and new species.</p> <p>Species associated with the mangrove ecosystem include those marine birds that use the mangrove structure for nesting – for example, boobies and noddies, magnificent frigatebirds, brown pelicans, and double-crested cormorants. The mangroves are also important as waypoints for migrating birds.</p> <p>The mangrove-lined creeks of Tobacco Range provide sheltered protection for the West Indian Manatee and American crocodile.</p>



Mangrove Indicators						
Category / Key Attribute	Indicator	Poor	Fair	Good	Very Good	Current Indicator Status
<b>Size</b> Size / extent of characteristic communities / ecosystems	Total extent of mangrove ecosystems  ▪ <b>Healthy Reef Indicator</b>  ▪ <b>SBRC Indicator</b>		<b>Current Status</b>	<i>Desired Status</i>		<b>Current Status:</b> Clearance of mangroves for caye development is observed throughout South Water Caye Marine Reserve – even in critical areas such as Blue Ground Range and Pelican Cayes. The system is still thought to be sufficient to retain functionality and viability if active management and protection is put in place over remaining key mangrove areas.
						<b>Healthy Reef Goal:</b> Restore mangrove cover to 1990 levels <b>Healthy Reef Red Flag Warning:</b> Any decrease in current mangrove extent  <b>SBRC Monitoring Priority:</b> High <b>SBRC Monitoring Status:</b> Planned <b>Data Requirements:</b> Baseline for South Water Caye Marine Reserve of 1990 mangrove extent (if feasible) <b>Method:</b> Aerial photography – interpretation. Spectral analysis of satellite mapping – if done correctly Field reports / inspections (site level) from ongoing MPA patrols
<b>Condition</b> Population structure & recruitment	Abundance of juvenile fish (nursery functionality)  ▪ <b>SBRC Indicator</b>		<b>Current Status</b>	<i>Desired Status</i>		<b>Current Status:</b> No current status / baseline. Patchy, thought to be varied across the Marine Reserve.
						<b>SBRC Monitoring Priority:</b> High <b>SBRC Monitoring Status:</b> Planned <b>Method:</b> 3 seine net trawls per site, identification to general type (not species)

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Conservation Target: Coral Reef Communities		
Conservation Target	Justification for Target Selection	Species, Communities or Ecological Systems represented by Target
<p><b>Coral Reef Communities</b></p> <p><b>Viability Indicators:</b></p> <ul style="list-style-type: none"> <li>▪ <b>Number of coral recruits</b></li> <li>▪ <b>% survey sites showing coral bleaching</b></li> <li>▪ <b>% live coral cover</b></li> <li>▪ <b>Parrotfish density</b></li> <li>▪ <b>Biomass of adult fish (see commercial fish species)</b></li> <li>▪ <b>Water Quality (see seagrass)</b></li> </ul>	<p>An estimated 20 percent of the world's reefs are considered to be severely damaged and unlikely to recover, and about half of the remaining coral reefs are under risk of collapse (NOAA, 2009). The reef building corals of the South Water Caye Marine Reserve, and the larger scale Southern Belize Reef Complex in general, are critical to the maintenance of local biodiversity, and considered a conservation priority in ecoregional planning initiatives. Coral reefs are one of most diverse ecosystems on this planet, essential to the viability of the majority of fish and marine invertebrates living in the shallow tropical waters of Belize, providing basic structure for shelter, foraging, and reproduction.</p> <p>The coral reef is critical to the maintenance of the artisanal fishing industry, particularly for spiny lobster and finfish populations. It is also one of the most important tourism resources Belize has to offer, and supports a significant percentage of employment in coastal communities.</p> <p>Recent studies indicate that there has been an alarming increase in algal growth on the reefs of SWCMR, with live coral cover dropping from an estimated 30 – 35% in the 1970's to around 12% in 1998 (Koltes et. al., 1998). This is thought to be linked to reduced numbers of snappers, grunts and groupers, shifting fishermen's attention to parrotfish, removing these important grazers from the area (Mumby, 2009). This can be observed at the CARICOMP site in the deeper forereef areas at Carrie Bow Cay, where the majority of the <i>A. cervicornis</i> has been replaced primarily by macroalgae (principally <i>Lobophora variegata</i>, <i>Dictyota</i> spp., and <i>Halimeda</i> spp.).</p> <p>Coral reef ecosystems throughout the region, including the SWCMR, are also being impacted by warming seas and increasing acidity, causing coral bleaching and lowering resistance to disease.</p>	<p>The reef ecosystems of the SWCMR, including fore-reef, back-reef, reef slope, patch reef, are composed of many scleractinian coral species, providing a diverse range of habitats for a multitude of fish species and invertebrates, including commercially important species such as the spiny lobster, snapper and grouper. MBRS monitoring by Fisheries Department shows that <i>Montastrea annularis</i> is the most abundant species found in the four sites surveyed followed by <i>Porites astreoides</i>, <i>Siderastrea siderea</i>, and <i>Agaricia tenuifolia</i>, accounting for 72.50% of the species surveyed (SWCMR Annual Report, 2008).</p> <p>The SWCMR has exceptionally high biodiversity, with at least eighteen IUCN redlist species ranked Critically Endangered, Endangered, or Vulnerable, including the critically endangered staghorn and elkhorn corals:</p> <p><b>Staghorn Coral (<i>Acropora cervicornis</i>) CR</b>  <b>Elkhorn Coral (<i>Acropora palmata</i>) CR</b>  <b>Goliath Grouper (<i>Epinephelus itajara</i>) CR</b>  <b>Hawksbill Turtle (<i>Eretmochelys imbricata</i>) CR</b>  <b>Loggerhead Turtle (<i>Caretta caretta</i>) EN</b>  <b>Green Turtle (<i>Chelonia mydas</i>) EN</b>  <b>Nassau Grouper (<i>Epinephelus striatus</i>) EN</b>  <b><i>Millepora striata</i> EN</b>  <b><i>Montastraea annularis</i> EN</b>  <b><i>Montastraea faveolata</i> EN</b>  <b>Great Hammerhead (<i>Sphyrna mokarran</i>) EN</b>  <b>Queen Triggerfish (<i>Balistes vetula</i>) VU</b>  <b>Hogfish (<i>Lachnolaimus maximus</i>) VU</b>  <b>Mutton Snapper (<i>Lutjanus analis</i>) VU</b>  <b>Cubera Snapper (<i>Lutjanus cyanopterus</i>) VU</b>  <b>Yellowmouth Grouper (<i>Mycteroperca interstitialis</i>) VU</b>  <b>Whitelined Toadfish (<i>Sanopus greenfieldorum</i>) VU</b>  <b>Rainbow Parrotfish (<i>Scarus guacamaia</i>) VU</b></p>

Coral Reef Communities Indicators						
Category / Key Attribute	Indicator	Poor	Fair	Good	Very Good	Current Indicator Status
<b>Condition</b> Population Structure and Recruitment	Number of coral recruits  ▪ <b>SBRC Indicator</b> ▪ <b>Healthy Reef Indicator</b>	< 2 recruits/ m <sup>2</sup> - 10/m <sup>2</sup>	2 – 4.9 recruits/ m <sup>2</sup> - 15/m <sup>2</sup>	<b>5 – 9.9 recruits/ m<sup>2</sup> - 20/m<sup>2</sup></b>	>10 recruits/ m <sup>2</sup>	<b>Current Status:</b> Rating for the Southern Belize Reef Complex is considered GOOD - 5.9 recruits / m <sup>2</sup> (SEA data, 2008)
						<b>Healthy Reef Goal:</b> On par with ~2000 Caribbean average: At least 4.5 recruits per m <sup>2</sup> (for recruit size < 2 cm).
						<b>Healthy Reef Red Flag Warning:</b> A regional average of less than 3 recruits per m <sup>2</sup> (for recruit size < 2 cm)..
						<b>Methods:</b> Most recruitment data for the MAR region are based on AGRRRA / modified MBRS methods, quantifying stony coral recruits up to 2 cm maximum diameter within a 25 cm x 25 cm quadrat, every 2m along a 10m transect
						<b>Baseline:</b> 5.9 recruits / m <sup>2</sup> SBRC data for 2008
<b>Condition</b> Coral Bleaching Indicator	% survey sites showing coral bleaching  ▪ <b>SBRC Indicator</b> ▪ <b>Healthy Reef Indicator</b>			<i>Current / Desired Status</i>		<b>Current Status:</b> SWCMR is rated as GOOD – 2008 transects showed no signs of bleaching, but may not be representative of the entire mpa (SWCMR Annual Report, 2008)
						<b>Healthy Reef Goal:</b> Corals adapt to changing temperatures, and frequency of bleaching events is not more than 3 per 10 years
						<b>Healthy Reef Red Flag Warning:</b> Coral bleaching prevalence > 10%, with limited post bleaching impacts
						<b>SBRC Monitoring Priority:</b> Low
						<b>SBRC Monitoring Status:</b> Ongoing
						<b>Methods:</b> MBRS
						<b>Baseline:</b> WWF data, 2006
<b>Condition</b> Successional Dynamics	% live coral cover  ▪ <b>SBRC Indicator</b>	<10%	<b>10 – 19%</b>	20-39%	>39%	<b>Current Status:</b> SWCMR is rated as FAIR as a default rating
						<b>SBRC Monitoring Priority:</b> High
						<b>SBRC Monitoring Status:</b> Ongoing
						<b>Methods:</b> MBRS
						<b>Baseline:</b> In the adjacent Laughing Bird Caye National park, averages fall between 8 and 18% (FAIR).

Coral Reef Community Indicators						
Category / Key Attribute	Indicator	Poor	Fair	Good	Very Good	Current Indicator Status
<b>Condition</b> Present / abundance of key functional guilds	Parrotfish density  ▪ <b>SBRC Indicator</b> ▪ <b>Healthy Reef Indicator</b>	≤1250 g-100m <sup>2</sup>	1250 - 2400 g-100m <sup>2</sup>	2399 – 4800 g-100m <sup>2</sup>	≥4800 g-100m <sup>2</sup>	<b>Current Status:</b> SWCMR is rated as FAIR (2399 -2400 g-100m <sup>2</sup> ) by default.
						<b>Healthy Reef Goal:</b> Maintain current levels of parrotfish
						<b>Healthy Reef Red Flag Warning:</b> Any reduction in parrotfish density
						<b>SBRC Monitoring Priority:</b> High <b>SBRC Monitoring Status:</b> Ongoing
						<b>Method:</b> Modified MBRS protocol / LAMP/ AGGRA <b>Baseline:</b> P. Mumby, 2009..no data, but estimate from graph that range from 200 to 1200g 120m <sup>-2</sup> with a mean of (very approximately) 750g 120m <sup>-2</sup>

Viability of Conservation Targets: Wide Ranging Large Marine Vertebrates		
Conservation Target	Justification for Target Selection	Species, Communities or Ecological Systems represented by Target
<p><b>Wide Ranging Large Marine Vertebrates</b></p> <p><b>Viability Indicators:</b></p> <ul style="list-style-type: none"> <li>▪ Average travel distance recorded per wide ranging sharks (including whale sharks) and turtles</li> <li>▪ Number of feeding areas / sources for whale sharks</li> <li>▪ Number of shark species (diversity)</li> <li>▪ Number of whale sharks sighting per year within SWCMR</li> <li>▪ Population size by species</li> </ul> <p>Data for indicators are not yet comprehensive</p>	<p>This target includes those species that require larger areas than the South Water Caye Marine Reserve, with connectivity to the open oceans.</p> <p>The world’s largest fish, the whale shark (<i>Rincodon typus</i>), whilst thought to be primarily pelagic feeders, congregate at Gladden Spit each year to feed at the aggregation site, and are known to pass through SWCMR. This vulnerable species (IUCN, 2008) is considered highly migratory, travelling 1000’s of kilometers, and occurs throughout tropical and warm temperate waters around the globe.</p> <p>A number of other sharks have been recorded from the Marine Reserve, and Shark Cave, north of the Marine Reserve, has also been highlighted by tour guides of Tobacco Caye as an important shark area.</p> <p>Other sharks are also included within this target, particularly those of the <i>Carcharinus</i> and <i>Sphyrna</i> genus.</p> <p>Three species of marine turtles - green, hawksbill and loggerhead turtles (all highlighted as endangered or critically endangered by IUCN), frequent the waters of the SWCMR for feeding. These species are known to migrate between temperate and tropical zones, and are therefore also within this target.</p>	<p><b>Sharks:</b></p> <p><b>Bull Shark</b> <i>Carcharhinus leucas</i>  <b>Blacktip Shark</b> <i>Carcharhinus limbatus</i>  <b>Whitetip Shark</b> <i>Carcharhinus longimanus</i>  <b>Caribbean Reef Shark</b> <i>Carcharhinus perezii</i>  <b>Sandbar Shark</b> <i>Carcharhinus plumbeus</i>  <b>Smalltail Shark</b> <i>Carcharhinus porosus</i>  <b>Tiger Shark</b> <i>Galeocerdo cuvier</i>  <b>Lemon Shark</b> <i>Negaprion brevirostris</i>  <b>Blue Shark</b> <i>Prionace glauca</i>  <b>Scalloped Hammerhead</b> <i>Sphyrna lewini</i>  <b>Great Hammerhead</b> <i>Sphyrna mokarran</i>  <b>Smooth Hammerhead</b> <i>Sphyrna zygaena</i>  <b>Whale Shark</b> <i>Rincodon typus</i></p> <p><b>Dolphins</b></p> <p><b>Fraser’s Dolphin</b> <i>Lagenodelphis hosei</i>  <b>Bottle-nosed Dolphin</b> <i>Tursiops truncatus</i>  <b>Atlantic Spotted Dolphin</b> <i>Stenella frontalis</i>  <b>Rough-toothed Dolphin</b> <i>Steno bredanensis</i></p> <p><b>Green Turtle</b> <i>Caretta caretta</i>  <b>Hawksbill Turtle</b> <i>Eretmochelys imbricata</i>  <b>Loggerhead Turtle</b> <i>Chelonia mydas</i></p>

Conservation Target: Seagrass		
Conservation Target	Justification for Target Selection	Species, Communities or Ecological Systems represented by Target
<p><b>Seagrass</b></p> <p><b>Viability Indicators:</b></p> <ul style="list-style-type: none"> <li>▪ % sea grass cover</li> <li>▪ Seagrass density</li> <li>▪ Water quality</li> </ul>	<p>Seagrass meadows are essential for maintaining the ecological health of the shallow marine ecosystems, with an important role in nutrient cycling and sediment stabilization. The presence of extensive seagrass beds also assists with reducing shoreline erosion and in maintenance of water clarity. Seagrass is also a critical ecosystem for many fish and invertebrate species, with an acre of sea grass being shown to support up to 40,000 fish and 50 million small invertebrates (Seagrass Ecosystems Research Laboratory, 2005). In the shallow waters of the SWCMR, these beds are dominated by <i>Thalassia testudinum</i>, interspersed with sparse stands of <i>Syringodium filiforme</i> and <i>Halimeda</i> spp.</p> <p>CARICOMP sites have been established within SWCMR, and show an estimated total biomass varying seasonally from approximately 3,766 to 4,159 g m<sup>-2</sup> dry weight - among the highest reported for the Caribbean (Koltes et. al. UNESCO).</p> <p>Over 90% of the seagrass beds of SWCMR are considered to be intact, with only marginal impacts around the cayes, primarily from dredging activities associated with cayes development, and from seismic testing activities in the 1960's. However, recolonization of cleared seagrass patches is considered to be slow (Koltes et. al. UNESCO).</p> <p>Other impacts on the condition and extent of seagrass within SWCMR include poor water quality from agrochemical pollution, and increased sediment loads from both Belize and Guatemala.</p>	<p>Nested targets include the West Indian Manatee (<i>Trichechus manatus</i>), the largest of Belize's herbivorous marine mammals, as well as marine turtles. These species play a role in the maintenance of the seagrass and increase the productivity of this ecosystem through grazing.</p> <p>Seagrass beds are also essential for the Queen Conch (<i>Strombus gigas</i>), one of the most important commercial species extracted from the sea, and for the juveniles of many commercial fish species. Parrotfish, herbivores that play a critical role in maintaining the reef, also rely on the seagrass beds as juveniles.</p>



Seagrass Indicators						
Category / Key Attribute	Indicator	Poor	Fair	Good	Very Good	Current Indicator Status
<b>Size</b> Size / extent of characteristic communities / ecosystems	% seagrass cover  ▪ <b>Healthy Reef Indicator</b>  ▪ <b>SBRC Indicator</b>	< 50%	50% - 75%	75% - 90%	<b>90%-100%</b>	<b>Current Status:</b> >95% - minimal impacted area to date, primarily from dredging activities
						<b>Healthy Reef Goal:</b> No decrease in extent from 1990 levels <b>Healthy Reef Red Flag Warning:</b> More than a 5% reduction in area in any subregion’s annual or biennial assessment, compared to that subregion’s previous survey.
						<b>SBRC Monitoring Priority:</b> High <b>SBRC Monitoring Status:</b> Some ongoing, some planned. No data or initiatives within SWCMR under FD
						<b>Methods:</b> Seagrass monitoring protocol: % cover of sea grass in shallow marine areas <b>Baseline:</b> Accurate mapping of seagrass extent through satellite imagery and groundtruthing – 1990 data from CZMAI landsat data
<b>Condition</b> Primary Productivity	Seagrass density  ▪ <b>SBRC Indicator</b>	0 - 29%	30-49%	50-79%	<b>80 - 100%</b>	<b>Current Status:</b> The condition of the seagrass is considered Very Good (80 – 100%)
						<b>SBRC Monitoring Priority:</b> Low <b>SBRC Monitoring Status:</b> Some ongoing, some planned. No data or initiatives within SWCMR under FD
						<b>Methods:</b> SeagrassNet protocols for % cover and biomass 4 times a year, at Pelican Cayes (identified under SBRC planning) <b>Baseline:</b> Two permanent monitoring plots have been established in the seagrass beds approximately 100 and 150m east of the CARICOMP mangrove plot at Twin Cays.

Seagrass Indicators						
Category / Key Attribute	Indicator	Poor	Fair	Good	Very Good	Current Indicator Status
<b>Landscape Context</b> Water Quality	Water Quality  ▪ <b>Healthy Reef Indicator</b>  ▪ <b>SBRC Indicator</b>			<i>Current / Desired Status</i>		<b>Current Status:</b> The water quality is currently considered to be Good, with only localized impacts from the caye developments scattered throughout the Marine Reserve. However, the Marine Reserve is close enough to the mainland for agrochemical pollution to be a concern. With climate change, water temperature is also a concern, and the increasing potential for associated coral bleaching.
						<b>Healthy Reef Goal:</b> Monthly average temperature values no greater than 0.5°C above historical monthly average for that month. Salinity values not in excess of 34-37. For water clarity: No net decrease in “baseline” water transparency (to be determined after more data are available). <b>Healthy Reef Red Flag Warning:</b> To be developed
						<b>SBRC Monitoring Priority:</b> Very High <b>SBRC Monitoring Status:</b> Some ongoing under Smithsonian Institute (raw data available on-line), some planned under SBRC.
						<b>Method:</b> MBRS protocols. Identified monitoring sites under SBRC: Pelican Cayes, Blueground Range. Other suggested monitoring site: Tobacco Caye Smithsonian Institute monitoring by Twin Cayes <b>Data Requirements:</b> Water parameters include: Water temperature Salinity Total dissolved oxygen Nutrients (PO4) and Nitrogen (NO4) – total, inorganic, organic Turbidity, DO2, nitrates, phosphates (3), chlorophyll, E. coli, pesticides

Conservation targets have been assessed based on three criteria:

- **Size** - a measure of the area or abundance of the conservation target's occurrence.
- **Condition** - a measure of the biological composition, structure and biotic interactions that characterize the occurrence.
- **Landscape context** - an assessment of the target's environment including ecological processes and regimes that maintain the target occurrence such as water temperature and natural disturbances, and connectivity, allowing access to habitats and resources or the ability to respond to environmental change through dispersal or migration.

These define the critical requirements for each conservation target, and **indicators** have been developed to provide a means of measuring the viability status. An effort has been made throughout the viability assessment to use indicators that are measurable, precise, consistent, sensitive and technically and financially feasible, and where possible, use the outputs of current ongoing monitoring programmes within the project area.<sup>1</sup> Healthy Reefs indicators have also been taken into consideration.

A viability rating has been developed for each target, based on the following scale:

- **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 current status and goals for each indicator were developed during the system-level SBRC workshop, and have been reviewed and revised for applicability at site level for this management plan (Annex Three).

**At the site level, the South Water Caye Marine Reserve rates as FAIR - outside its range of acceptable variation, and vulnerable to serious degradation if left unchecked - requiring human intervention.**

The majority of the targets have an overall viability rank of **Fair**. Marine seagrass was one exception, the health of this system being rated as **Very Good**, with few widespread human impacts. Whilst not currently a priority target in terms of conservation action, a change from Very Good to Good in future status reviews would be of significant concern. Wide ranging large marine vertebrates also ranked higher than Fair, with a rating of **Good** (Table 27).

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<sup>1</sup> AGGRA, MBRS Synoptic Monitoring Programme, WWF, WCS etc.

<i>Summary of Conservation Target Viability for the South Water Caye</i>				
<i>Conservation Targets</i>	<i>Landscape Context</i>	<i>Condition</i>	<i>Size</i>	<i>Viability Rank</i>
	<i>Rating</i>	<i>Rating</i>	<i>Rating</i>	
<i>Turtle nesting beaches</i>	<i>Fair</i>	<i>Poor</i>	<i>Poor</i>	<i>Poor</i>
<i>Commercial / Recreational Species</i>	<i>Fair</i>	<i>Fair</i>	<i>Fair</i>	<i>Fair</i>
<i>Coral Reef Communities</i>	<i>Good</i>	<i>Poor</i>	<i>Fair</i>	<i>Fair</i>
<i>Mangroves</i>	<i>Good</i>	<i>Fair</i>	<i>Fair</i>	<i>Fair</i>
<i>Wide Ranging Large Marine Vertebrates</i>	<i>Good</i>	<i>Good</i>	<i>Fair</i>	<i>Good</i>
<i>Seagrass</i>	<i>Very Good</i>	<i>Very Good</i>	<i>Good</i>	<i>Very Good</i>
<i>Biodiversity Health Rank for South Water Caye Marine Reserve</i>				<i>Fair</i>

Table 27: Summary of Conservation Target Viability

### 2.3 Threats to Biodiversity

The SBRC CAP workshop focused on the Southern Belize Reef Complex as a whole, and assessed stresses and threats at both the technical and site management levels, with representation from researchers, Fisheries Dept, the tourism and fishing sectors, and both protected area management and field staff. The summary results from the planning process have been adapted to site level, providing each conservation target with a threat status rating (Table 28).

Outputs from the workshop identifying and assessing stresses and sources of stress allowed prioritization of conservation 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.

Site level assessment outputs for the South Water Caye Marine Reserve (Table ..) indicate that two conservation targets rate as **Very High – Commercial and Recreational Species**, and **Sandy Beaches**. One threat rates as **Very High** overall - **Caye Development**, with a further three (**fishing pressure, poor fishing practices** and **climate change**) rating as **High**. This reflects the particularly heavy pressure on the natural resources from caye developments, with impacts such as the removal of ecologically important mangrove areas, and dredging of the sea bed and shallow-water seagrass. It also highlights the impacts of over-fishing of the commercial fish stocks, and the need for tighter regulation of the number of fishermen, and more effective implementation of surveillance and enforcement activities. The impacts of climate change, and the associated increasing water temperatures, resulting in coral bleaching and coral mortality, are related to more global issues, though zoning for protection should reflect coral resilience.

Threats Across Targets	Seagrass	Mangroves	Coral Reef Communities	Wide Ranging Marine Vertebrates	Commercial / Recreational Species	Sandy Beaches	Overall Threat Rank
<b>Caye Development</b>	Medium	Very High	Very High	High	High	Very High	Very High
<b>Fishing Pressure</b>	Medium	-	High	High	Very High	-	High
<b>Climate Change</b>	-	Medium	High	Medium	High	Very High	High
<b>Poor Fishing Practices</b>	-	Low	Low	High	High	-	High
<b>Agricultural Runoff</b>	Medium	-	Medium	Medium	Medium	-	Medium
<b>Oil Spills</b>		-	Low	Medium	-	Medium	Medium
<b>Visitor Impacts (tourists, researchers etc.)</b>	-	-	Low	Low	-	-	Low
<b>Oil Exploration and Drilling</b>	Low	-	Low	-	-	-	Low
<b>Overall Threat Status for Targets</b>	Medium	High	High	High	Very High	Very High	Very High

Table 28: Threat Assessment for South Water Caye Marine Reserve

2.3.1 Caye Development

<b>Clearance of Mangrove</b>	Removal of important marine nursery areas
	Removal of important habitat for migrating birds
	Erosion of caye soils
	Removal of important habitat for lizards with limited distribution (Island leaf-toed gecko)
	Removal of important nutrient source within the marine system
<b>Destruction of Coral</b>	Live and dead coral used as land fill in poorly planned caye development
	Destruction of coral to provide boat access, and impacts of boat access on corals within seagrass beds
<b>Human Impacts on Sandy Beaches</b>	Removal of coastal strand vegetation – an ecosystem that is under-represented within the national protected areas system, and which is essential for good turtle nesting success
	Removal of critical turtle nesting habitats
	Light pollution – impacting turtle nesting and hatching success rates
	Presence of introduced predators - dogs and cats, reducing hatching success
<b>General Human Impacts</b>	Use of insecticides and herbicides and associated impacts on natural biodiversity and water quality
	Increased nutrient and sediment runoff into water, with associated accelerated algal growth and coral loss
	Reduction and pollution of freshwater lenses beneath cayes
	Increased impacts from human activity immediately adjacent to caye
	Introduction of exotics – <i>Casuarina</i> , the tokay gecko

Whilst the privately owned cayes are not, strictly speaking, part of the Marine Reserve, they do lie within the boundaries, and human activities on the cayes will impact the viability of the adjacent marine ecosystems.



**Bread and Butter Caye – illegal coral landfill (Fisheries Department, 2008)**

Habitat loss through caye development for tourism has resulted in the removal of mangroves, littoral forest and coastal strand communities throughout the South Water Caye Marine Reserve. In addition, shoreline structures such as piers, dredged access routes, marinas and seawalls have lead to loss and/or alteration of habitats. In cases of poor development practices, live and dead coral have been used as land fill.

Red mangrove, littoral forest and herbaceous beach communities play a critical role in stabilizing island structure, reducing coastal



erosion, beach loss and sedimentation as well as providing nursery functionality for many marine species. Among the most threatened ecosystems within the protected area system of Belize, their loss is accelerating as the developmental value and demand for beach frontage escalates. The sandy beaches are critical for nesting sea turtles and American Crocodiles, and the littoral forest for the Island leaf-toed gecko, a species with extremely disjointed distributions, as well as for numerous migratory bird species.

Clearance on the cayes greatly reduces connectivity within an already seriously fragmented ecosystem, reducing the scope for gene-flow and recolonization after natural and anthropogenic impacts. It also greatly undermines the stability of the islands themselves, making them, and any infrastructure thereon, a great deal more susceptible to the impacts of hurricanes and sea level rise. The long-term sustainability of caye-based tourism and residential developments can be made significantly more financially viable through the maintenance of these natural ecosystem.

**Recommendations:**

- Development / adoption and distribution of ‘Best Practices’ guidelines to caye-based establishments, with a ‘best practices’ recognition for those that follow required criteria (see Glover’s Reef / WCS guidelines)
- Create Sustainable Development Plan for Tobacco Caye in collaboration with caye residents
- Increase surveillance and monitoring of turtle nesting beaches and address human impacts, following WIDECAST guidelines

**2.3.2 Fishing Pressure**

<b>Overfishing / Illegal Fishing</b>	Overfishing for lobster, conch and commercial species of fin-fish
	Losses of by-catches from long lines, including marine turtles
	Illegal fishing within conservation zones (non-implementation of Marine Reserve regulations)
	Reduction in coral grazers, particularly the large parrotfish species, resulting in algal invasion and reduction in coral productivity and resilience
	Damage to coral from fishing activities
	Fishing by boats from Honduras

South Water Caye Marine Reserve is an important resource for a number of the coastal communities – primarily Sarteneja, Hopkins and Dangriga, with 260 or more fishermen using the area (SWCMR Annual Report, 2008). The pressure on marine stocks within the protected area is increasing, with an increasing number of fishermen, and incursions from neighbouring countries. Overfishing of commercial marine species has resulted in reduced catch per unit effort and a shift in the community and population structures of both fish and invertebrates harvested. Overfishing and illegal fishing were identified as occurring throughout the Marine Reserve, with reports of undersized and out-of-season conch and lobster. (SWCMR Annual Report, 2008).



Whilst the majority of extractors are traditional fisherman, free diving primarily for lobster and conch, and spear fishing fin-fish, the impact on the commercial marine species of the Marine Reserve has been immense, with the majority of fishermen and tour guides reporting reduced numbers of lobster and conch and commercial species (Fishermen Consultations, 2007). There is also subsistence extraction from people resident on the cayes, and fishing for tourism (catch and eat) – particularly around Tobacco Caye. A comprehensive study of fish populations, focusing on grouper and comparing numbers between 2002 and 2008/9 at 6 sites within SWCMR demonstrates a drop from an average encounter probability of 21% in 2002 to 3% in 2008 (Mumby et. al., 2009).

The large coastal sharks present in the waters around to the east of South Water Caye Marine Reserve (such as black tip, bull, tiger and hammerhead) are also considered to be overfished, both nationally and regionally.

### **Recommendations:**

- Clear zone demarcation and dissemination of zones and zone regulations to all fishermen using the Marine Reserve
- Ensure fair enforcement of zone regulations across all fishermen
- Target fishing communities for awareness activities to highlight critical state of the fisheries
- Engage fishermen in fisheries management activities
- Clear policies re. subsistence and recreational fishing by caye residents

### **2.3.3 Coral Bleaching/Warming sea temperatures**

Global climate change is predicted to have increasing impacts on the coral reef, with a greater frequency and severity of coral bleaching events, hurricane impacts, coral disease outbreaks higher ultraviolet radiation, rise in sea level and increased acidification.

Studies of *Montastraea faveolata* have shown that following a major bleaching event, coral growth rates at sites with higher local anthropogenic stressors such as overfishing, pollution and sedimentation have been shown to remain suppressed for up to four times as long as rates at sites with lower stress, which recover within 2 to 3 years (Carilli et. al., 2009). Healthy reefs are normally resilient to the past stress levels, but the current increasing levels are reducing resilience to the impacts of increasing sea temperatures, frequency of storm events and increasing acidity of the seas. It is thought that background stress reduces coral fitness and resilience to coral bleaching events. Reducing chronic stress through local coral reef management efforts may therefore increase coral resilience to global climate change, providing an opportunity for the coral to recover between bleaching events.

### **Recommendations**

- Reduce anthropogenic impacts on coral in at least 20% of the marine reserve (particularly the Conservation Zones)
- Participate in the Mesoamerican Coral reef Watch Programme / Belize Coral Watch Programme (Ecomar) for early reporting of coral bleaching episodes
- Regular monitoring of coral reef indicators

### **2.3.4 Agricultural runoff**

CZMAI and the WRIScS project both conducted water quality testing in coastal waters in the late 1990's and early 2000's (CZMAI, 1999; WRIScS, 2002) and concluded that agricultural runoff was not a significant impacting stress at that time. The WRIScS project was investigating the transport of fine sediments and associated contaminants through the river systems and coastal zone of the Stann Creek district, and concluded that

*"...there is no evidence to suggest that changed sedimentary processes resulting from farming activity to date in the Stann Creek area are having a negative impact on the Barrier Reef. The natural coastal system would appear to be effective in dealing with the impact of increased sediment yield and sediment contaminant loading produced by current land usage."*

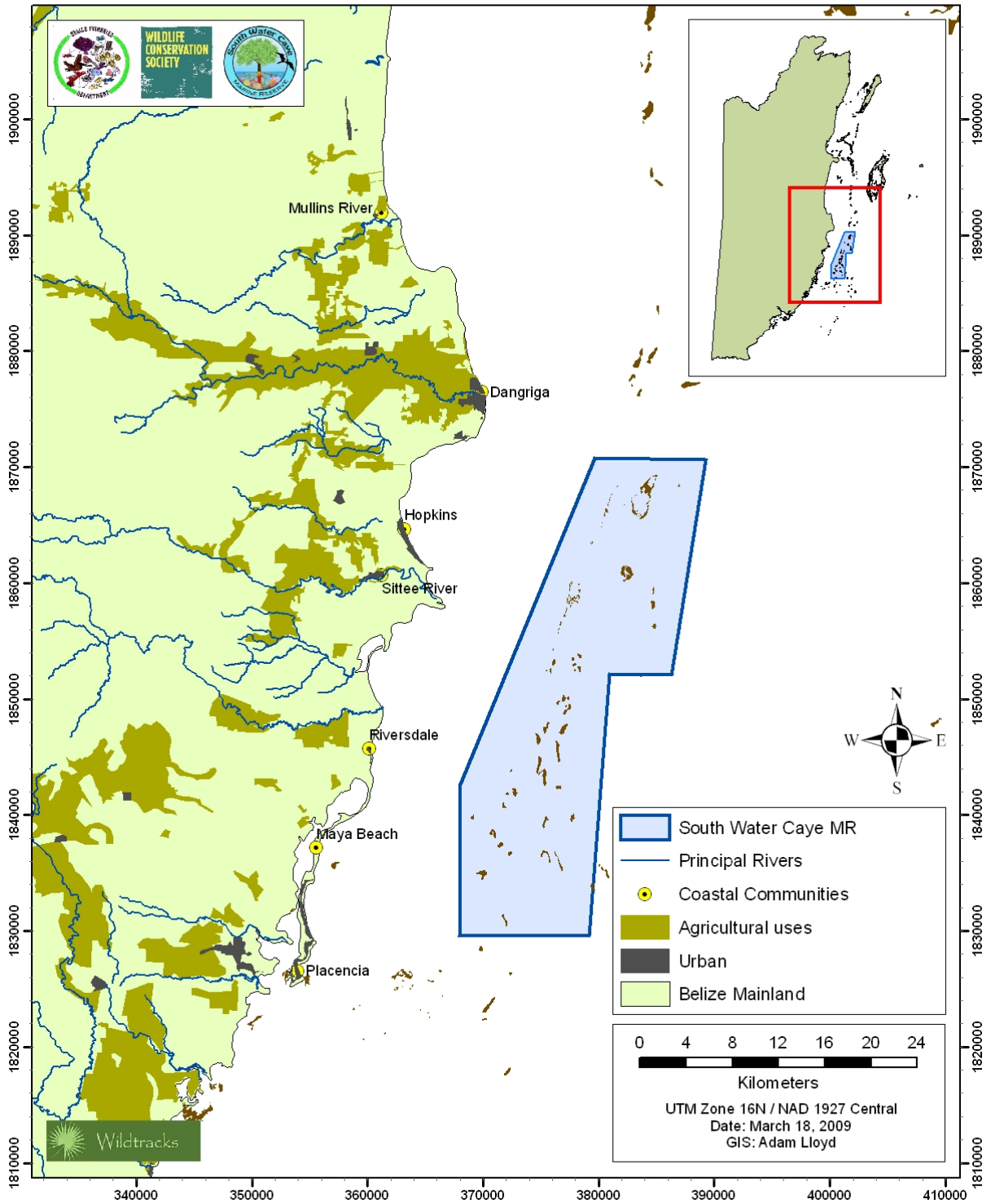
However, both studies emphasized the need for monitoring of future agricultural activities and impacts, with the predicted increase in agriculture, and the decreasing ability of the coastal zone to provide a buffer with the current accelerating land-use change, particularly for coastal tourism development.

A more recent assessment of risks from land based sources of pollution highlighted the reefs of South Water Caye Marine Reserve as at high risk from runoff from mainland agricultural areas, manifested in the form of sediment-laden river plumes rich in nutrients (effluents) that at times extend to the Marine Reserve, causing algal blooms and coral death. Definitive research to characterize the effects of pesticides and nitrate and phosphate nutrients from agriculture and aquaculture is in its early stages, but initiatives under WWF, YCT and Wildtracks are focusing on identifying and mitigating agrochemical impacts Belize, both on terrestrial and marine ecosystems, with concerns associated with the use of agrochemicals on the banana and citrus plantations and shrimp farms in the Stann Creek area, due west of South Water Caye Marine Reserve. There have also been growing concerns, given prevailing water currents, that the vast banana and pineapple plantations in Honduras are introducing pesticide and nitrification pollutants in the Belize Reef system (Map 13, WRI, 2005).

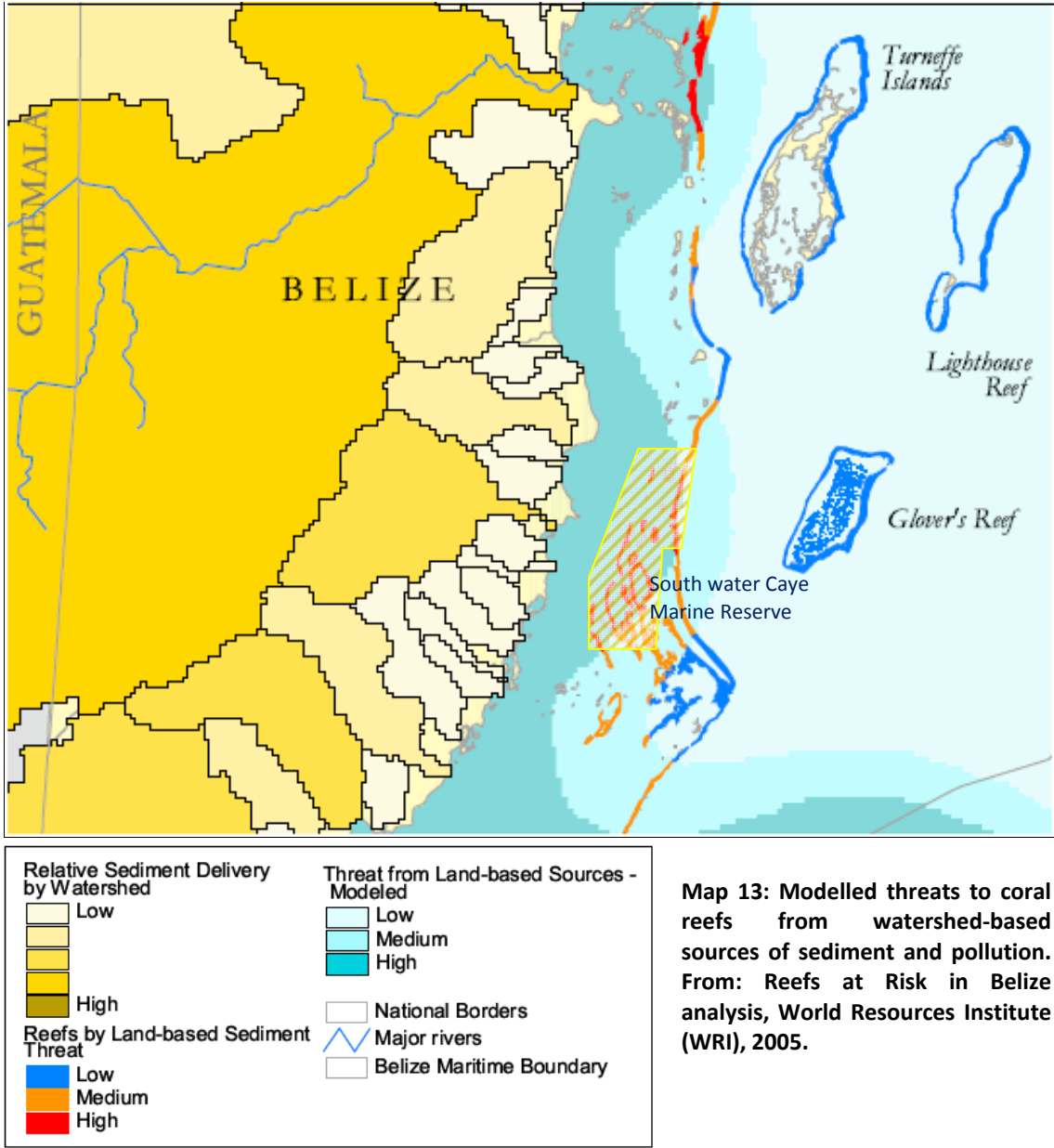
### **Recommendations:**

- Prioritise monitoring of agrochemical content in water and of fish tissue samples to identify key contaminants and current levels of contamination
- Support key research that identifies the land based sources of contamination
- Partner with organizations seeking to mitigate agrochemical contamination of waterbodies through better practices for agricultural chemical use

South Water Caye Marine Reserve: Onshore Agriculture



Map 11: Agricultural areas of the Southern Coastal Plain that have the potential to affect South Water Caye Marine Reserve



### 2.3.5 Direct Physical Damage to Coral

This type of damage is generally caused by boats and anchors, divers or snorkelers. Boats that visit South Water Caye Marine Reserve can be divided into two categories – those associated with the tourism industry (dive boats, live-aboards, independent sail boats, small cruise ships and supply boats for the tourism developments), and those associated with the fishing industry, fishing skiffs from Dangriga and Hopkins and the traditional Sarteneja sail boats.

Both categories have similar impacts with mechanical damage from anchors. Lack of sufficient mooring buoys in the more heavily used dive and snorkeling sites and areas of safe harbor, is a

major concern. Creation of new mooring buoy sites and enforcement of their use would reduce damage to reefs from anchors and anchor chains.

The increasing impact of divers and snorkelers is also of concern, particularly around the Tobacco Caye and other high-traffic visitation areas. The popular dive sites are also increasingly impacted by diver activity – particularly mechanical damage from standing on or touching corals and sediment kicked up by flippers.

### **Recommendations:**

- Install sufficient mooring buoys in critical locations – key dive sites, safe harbours
- Enforce diver and snorkeler to guide ratios
- Increase awareness of best practices for boats entering the marine reserve
- Increase awareness of best dive and snorkeling practices for divers, snorkelers and guides using the marine reserve

### **2.3.6 Introduced Species**

South Water Caye Marine Reserve has already been impacted by introduced species, some of which may be invasive, others less so. Many of these arrive in the bilge water of cargo vessels using Big Creek and passing through South Water Caye Marine Reserve. Within the last few years, for example, native populations of large *Mithrax*, *Menippe*, *Callinectes* and *Panulirus* have been reported as being replaced by the non-indigenous portunid crab, *Charybdis helleri* (CCRE, 2008). The Asian tokay gecko has been introduced to South Water Caye, where it has established a breeding population, thought to be replacing the endemic island geckos (Meerman and Garell).

The lionfish, a native of the Indian and Pacific Oceans, was first recorded in Belize in September 2001, and most recently in December 2008, with approximately a dozen confirmed sightings in the past six months. This species was introduced to Florida waters in the 1990s, and has been spreading throughout the Atlantic Ocean and Caribbean Sea via ocean currents since then. Sightings have been reported from the three atolls and main barrier reef indicating that it is spreading throughout the entire reef system. The destructive nature of the lionfish on native fish stocks and reef habitat is reportedly catastrophic, this fish being a voracious predator demonstrated to prey on a large range of juvenile fish and crustacean species much quicker than they can reproduce. With no natural predators to keep numbers of this species in balance, the population could quickly expand to wipe out local species unless some form of management control is implemented immediately.

On the cayes, introduced coconuts have already replaced the natural vegetation on significant portions of some of the cayes of South Water Caye Marine Reserve. As an invasive species, it is able to gradually out-compete natural vegetation through direct competition for light, nutrients and water, as well as smothering the regenerating herbaceous and shrub layers with heavy leaf debris. Natural vegetation has a far more extensive root system than do coconut groves, and is therefore far more effective in stabilizing the sandy soils of islands against the



impacts of tropical storms and hurricanes – invasive coconuts therefore increase the likely impacts from such storms. *Casuarina* is also invasive in the coastal strand vegetation.

**Invasive Species: Casuarina**

*C. equisetifolia* is fast-growing (1.5 to 3 metres per year), produces dense shade and a thick blanket of leaves and hard, pointed fruits that completely cover the ground beneath it. Dense thickets displace native dune and beach vegetation, including mangroves and many other resident, beach-adapted species. Once established, it radically alters the light, temperature, and soil chemistry regimes of beach habitats as it outcompetes and displaces native plant species and destroys habitat for native insects and other wildlife. Chemicals in its leaves may inhibit the growth of other plants underneath it. The ground below the tree becomes ecologically sterile, reducing the food value for native wildlife. Unlike native shrubbery, the thick, shallow roots make it much more susceptible to blow-over during high wind events, leading to increased beach and dune erosion and interference with the nesting activities of sea turtles and American crocodiles (Swearingen (1997)).

Global Invasive Species Database, 2005. *Casuarina equisetifolia*. Available from: <http://www.issg.org/database/species/ecology.asp?si=19&fr=1&sts=sss> [Accessed 25<sup>th</sup> June, 2009].

**Recommendations:**

- Increase awareness in residents and tour guides of potential impacts of lionfish
- Actively participate in removal of lionfish from the reef
- Increase awareness in residents and tour guides of the problems caused by releasing non-caye fauna and flora onto the cayes

**2.3.7 Pollution**

<b>Pollution</b>	Contamination of waters near cayes and throughout South Water Caye Marine Reserve due to inappropriate sewage and grey water treatment on cayes, leading to eutrophication
	Inappropriate solid waste disposal, particularly in the Tobacco Range area
	Contamination of waters with runoff containing herbicides, insecticides or detergents from both the cayes and the mainland
	<u>Contamination from international shipping</u>
	Garbage from the mainland and from international shipping

**Solid Waste:** Some types of garbage have been shown to be very detrimental to marine wildlife, such as plastics to sea turtles. Solid waste originating from the cayes is a concern, with dumping of household refuse from Tobacco Caye on Tobacco Range. There is also concern voiced by participants from Sarteneja over the increasing levels of solid waste accumulating on the reef crest and caye beaches, originating from international shipping, particularly with the increase in cruise shipping and freight shipping destined for, and departing from, Belize.

**Liquid Waste & Sewage:** A more insidious impact is the leaching of nutrients and chemicals into the ground water or fresh water lens of the cayes, which then percolate through the

sandy soil into the sea. Groundwater is an important source of freshwater on the cayes for maintaining natural vegetation, and is important for supplying the mangrove areas and coral reefs with fresh water. If the groundwater becomes polluted, these ecosystems are affected. The leakage of sewage from island resorts can cause algal blooms, visible as a ring around the cayes or patches of increased algal growth near the highest impacted areas, due to nutrient enrichment. Currently, this impact is considered to be relatively low due to the current small scale of operations and low level of visitation, as well as the general adoption of closed sewage systems. The exception is the areas adjacent to Tobacco and South Water Caye, where heavy algal growth indicates increased nutrient availability.

Development activities are growing in the area, but there is currently little guidance given in areas such as herbicides and pesticides, wood preservatives etc. Contamination of waters by biocides and detergents is likely to become an increasing problem as more tourism accommodation is developed on the cayes, affecting not only the waters adjacent to these cayes, but potentially all the fragile ecosystems of the Marine Reserve. Very few resorts in Belize have adequate training in chemical storage, use, and spill response, or attempt to find environmentally friendly alternatives to more toxic options - availability of alternatives in Belize is also a limiting factor. Little thought, too, is generally given to problems of chemical contamination following flooding through storm events...such as pre-empting the problem by storing bulk chemicals on the mainland, ensuring only minimal amounts are kept on the cayes.

**Oil Pollution:** The offshore area of Belize has been divided into oil blocks that are given out on concession to various oil exploration companies, with South Water Caye Marine Reserve lying within one of the exploration blocks, with past and future oil exploration planned. The impact of oil spills and drilling muds is a potential threat if there is any future active exploration. Additionally, any oil spills from passing ships due to accidental spillage or bilge clearing is a concern.

### ***Recommendations***

- Develop baseline and monitor environmental impacts of Tobacco Caye and South Water Caye on the adjacent ecosystems
- Develop an Environmental Sustainability Plan for Tobacco Caye to mitigate current impacts, and look at synergies for reducing ecological footprint
- Encourage cayes based operations to adopt WCS best practices guidelines
- Investigate possibility of excluding South Water Caye Marine Reserve from the current oil exploration area
- Develop closer links with Department of the Environment for rapid response to pollution events
- Ensure all EIAs are adequately vetted and approved, and that Fisheries Department plays a vocal part in NEAC in relation to environmental sustainability of development within South Water Caye Marine Reserve
- Monitor development activities on the cayes

2.3.8 Dredging

<b>Dredging and Associated Sedimentation</b>	Destruction of seagrass habitat, supporting many vertebrate and invertebrate species
	Sedimentation of coral, reducing coral viability
	Sedimentation of seagrass, reducing seagrass viability
	Re-suspension of pollutants

Dredging and mining of sand for use in construction and landfill associated with development on the cayes has resulted in the removal of seagrass beds, siltation on the reef, water quality degradation and smothering of benthic flora and fauna by excessive sedimentation within South Water Caye Marine Reserve. It continues to be an impact. If inappropriately managed, dredging activities within the Marine Reserve will impact areas of conservation importance such as the particularly fragile Pelican Cayes, where dredging has had a huge impact on the health of the biodiversity of the area.

In some countries, an environmental levy is placed on dredging operations in sensitive environments, to help offset the damage, and contribute towards monitoring of sensitive environments.

**Recommendations**

- Ensure adequate surveillance of caye developments
- Develop closer links with Department of the Environment for rapid response to pollution events
- Ensure all EIAs are adequately vetted and approved, and that Fisheries Department plays a vocal part in NEAC in relation to environmental sustainability of development within South Water Caye Marine Reserve
- Investigate potential of environmental levies on caye development within South Water Caye Marine Reserve towards monitoring costs

### 2.3.9 Threats from adjacent Shipping Lanes

Threats from adjacent shipping lanes cannot be ignored. The shipping lane between Belize and Honduras passes close to South Water Caye Marine Reserve, with an ever-increasing flow of cargo and passenger vessels, from oil tankers to cruise ships. The latter are a component of the passenger vessel category, which make up 13% of the world shipping fleet - with the rapid rate of increase of cruise ship visitation to Belize, this sector has started to receive far more attention in terms of the threats they pose to the environment. Any vessel traveling in the

#### **MARPOL**

(International Convention for the Prevention of Pollution from Ships, 1973/1978)

This convention concerns the prevention of pollution from oil, bulk chemicals, dangerous goods, sewage, garbage and atmospheric pollution, and includes provisions such as requiring certain oil tankers to have double hulls.

adjacent shipping lane, whether cruise ship or not, is a potential threat, though it is recognized that cruise ships tend to concentrate their activities within coastal areas, and have a higher volume of waste. The grounding in January, 2009 of the *Westerhaven* on the reef crest just off Emil Caye, not far to the north of South Water Caye Marine Reserve, highlights this problem.

The cargo vessel was passing through the English Caye Channel, the shipping route from Belize City to Guatemala, and went off course, with the destruction of an estimated 10,000 square meters of healthy reef, resulting in an estimated US \$20 million in damages to the reef, based on an internationally accepted average of US\$2,000 per square meter.

The mechanical and physical impacts of groundings are not the only threats faced from vessels passing by in the shipping lane. During a typical one-week voyage, a large cruise ship (3,000 passengers and crew) is estimated to generate 210,000 gallons of sewage, 1 million gallons of greywater (wastewater from sinks, showers and laundries); more than 130 gallons of hazardous waste; 8 tons of solid waste; and 25,000 gallons of oily bilge water (Copeland, 2005). Whilst there are international laws in place to regulate pollution of the open seas by vessels such as these (principally the 1973 International Convention for the Prevention of Pollution from Ships – MARPOL), there are also known infringements of these regulations that suggest that ships will dump waste at sea – for example, in April 2002, Carnival Corporation was fined US\$18 million for the deliberate falsification of oily bilge record books, whilst Royal Caribbean Cruises Ltd. was fined US\$9 million and US\$18 million during 1998 and 1999 respectively for discharging oil contaminated bilge waste. Incidents such as these, whether through human error, mechanical failure, negligence or deliberate, lead to skepticism about the waste handling of large ocean-going vessels. Cruise ships are self-regulated to a certain extent by the expectations of the passengers to be able to sail in unpolluted waters. Other components of international shipping have no such internal controls. Impacts can be from a variety of recognized sources from regular operations, and are normally characterized as blackwater, greywater, hazardous waste, solid waste and bilge water.

#### ***Blackwater***

Sewage, waste water from toilets and medical facilities. Release of untreated or inadequately treated sewage close to the reef can cause bacterial and viral contamination of fisheries and shellfish, and excess nitrogen and phosphorus can promote excessive algal

#### **Blackwater**

A larger cruise ship (3,000 passengers and crew) generates an estimated 15,000 to 30,000 gallons per day of blackwater waste

growth, leading to eutrophication and great algal cover, reducing coral colonization.

**Graywater**

Wastewater from sinks, showers, galleys, laundry and cleaning activities, containing a variety of contaminants such as detergents, oil, grease, metals petroleum hydrocarbons, nutrients etc. This, as with blackwater, can cause excessive algal growth and eutrophication.

**Greywater**

A larger cruise ship (3,000 passengers and crew) generates an estimated 90,000 to 255,000 gallons per day of greywater waste

**Hazardous Waste**

A number of on-board activities can produce hazardous waste from photo-processing, dry-cleaning and repainting. A wide range of substances are included within this category – hydrocarbons, heavy metals, solvents, fluorescent and mercury vapour light bulbs, and batteries included, which whilst small in volume can be extremely toxic to marine organisms if they find their way into greywater, bilge water or solid waste.

**Solid Waste**

This category includes glass, paper, cardboard, aluminium, steel cans and plastics, much of which is incinerated on board, and the ash discharged at sea - it is estimated that 24% of solid waste generated by vessels worldwide comes from cruise ships. Inadequate incineration can lead to entanglement of marine mammals, fish sea turtles and birds with plastics and other solid waste.

**Solid Waste**

A larger cruise ship (3,000 passengers and crew) generates an estimated 8 tons of solid waste during a one-week cruise.

**Bilge Water**

A frequent problem on a ship is oil leakage, or oil byproducts from engines or from engine maintenance activities which, even in minute quantities, can kill fish or cause chronic effects. Much of this ends up in the bilge water, which may also contain other chemical contaminants. The bilge space, where this contaminated water accumulates, needs to be flushed out at regular intervals to maintain the vessels stability and eliminate potentially dangerous flammable vapours. To do so, the oil needs to be extracted, and then reused, offloaded at port or incinerated, using a separator or similar mechanism – failure to do so, or mechanical faults can result in untreated bilge water being emptied directly into the sea.

**Bilge Water**

A larger cruise ship (3,000 passengers and crew) generates an estimated 25,000 gallons of oily bilge water every week of operation

### ***Ballast Water***

Ballast water, used to stabilize vessels during transport, is often taken on in coastal waters in one region, then released in another, as cargo or passengers are loaded or unloaded, resulting in changes in the amount of compensating ballast required. This has resulted in the transport of plants, animals, viruses and bacteria into areas they would not normally occur, and is considered to be the major source of invasive species in US waters (Copeland, 2005), and is also considered a problem in Belize.

This threat from current-borne pollution from international shipping will be insignificant in comparison to the devastation that would occur should an oil tanker break up in the Barrier Reef lagoon. It is recommended that an emergency plan be developed and put in place, with.

### ***Recommendations***

- Develop an emergency response plan with the input of DoE, in case a major incident should occur
- Work closely with Port Authority, Coast Guard and DoE towards mitigation of potential groundings

## **2.4 Strategies to Reduce Threats**

A series of strategies have been developed to address concerns, threats and stresses raised during the SBRC conservation planning process (Annex Four), and through consultations with stakeholders throughout the management planning process. These strategies are incorporated into the management programmes.

## **2.5 Monitoring of Success of Conservation Strategies**

The series of indicators allocated to each conservation target provides a framework for site level monitoring. A system level monitoring programme has also been developed under the SBRC to measure the success of conservation strategies, as an integrated component of the conservation planning process (Annex Four).



### 3. Management Planning

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#### 3.1 Management Goals

The overall goal for the management of South Water Caye Marine Reserve is:

***To provide for the protection, wise use, understanding, and enjoyment of the natural resources of South Water Caye in perpetuity.***

This goal is supported by a number of objectives:

- Maintain and conserve the natural resources of South Water Caye Marine Reserve for the benefit of current and future generations
- Engage fishermen in the management of a sustainable fisheries
- Provide opportunities for recreation, interpretation, education, and appreciation for all visitors
- Strengthen education and understanding of users and potential users of the dynamics of coral reef systems within South Water Caye Marine Reserve and the human impacts affecting them
- Identify, implement and strengthen priority research and monitoring through on-site activities, collaboration and partnerships

#### 3.2 Management and Organizational Background

South Water Caye Marine Reserve, established in 1996 under the Ministry of Agriculture and Fisheries, is managed by the Fisheries Department. The Fisheries Department has the mandate to sustainably manage and develop Belize's fishing sector, under the Fisheries Ordinance, Chapter 133, of 1948, and subsequent amendments and subsidiary legislation, revised in the Fisheries Ordinance, 2000, and complimented by the Fisheries Regulations of 2004.

"To provide the country and the people of Belize with the best possible management of aquatic and fisheries resources with a view to optimize the present and future benefits through efficient and sustainable management".

**Mission Statement, Fisheries Department**

The Ecosystems Management Unit is one of four units under the Fisheries Administrator (the others being the Aquaculture and Inland Fisheries Unit, the Capture Fisheries Unit, and Administration), and includes the Protected Area Management programme. Under this mandate, the Fisheries Department is able to establish and manage the marine reserves in Belize (including South Water Caye), under the Protected Area Management (Marine Reserve) programme of the Ecosystems Management Unit, which is specifically in charge of the management of the Marine Reserves, under the Marine Protected Areas Coordinator. The Department has established a staffed Fisheries Base on Twin Cayes for site-level management of the area.

**Ecosystems Management Unit**

The Ecosystems Management Unit (EMU) of the Fisheries Department consists of management of the marine reserves, marine environmental assessments, CITES marine related matters and regional fisheries policy formulation. Ecosystems management, a new management paradigm, has shifted from specific species and site protection to the protection of entire ecosystems and the regulation of the activities within those systems. The Marine Reserves are Fisheries Management Tools (FMT) implemented by the Department to ensure sustainable fishing.

[http://www.agriculture.gov.bz/Fisheries\\_Dept.html](http://www.agriculture.gov.bz/Fisheries_Dept.html)  
(Downloaded 2009)

At South Water Caye, on-site management is under the Reserve Manager, who is supported by two rangers and a marine biologist. These personnel are responsible for the on-site, day-to-day management of the reserve, and will be responsible for the implementation of the management plan through effective use of funds, staff and equipment, and supported by centralized activities such as environmental education and outreach. The Manager is required to submit annual operational or work plans, monthly progress reports, and comprehensive annual reports to the Marine Protected Areas Coordinator. Each staff position is described by a general terms of reference (Annex One).



**On-site staff of South Water Caye Marine Reserve (Fisheries Department, 2008)**

Left to Right: Jason Edwards, Samuel Novelo, Michael Sabal, Juan Chub

It is recognized that for effective management, the staff structure needs to expand with the establishment of a second base and Fisheries team, located in the southern, Pelican Cayes area of the Marine Reserve are essential if the objectives of the marine reserve are to be adequately met.

An Advisory Committee assists Fisheries Department with management recommendations, and is composed of representatives from the major stakeholder components (Table 29).

## South Water Caye Marine Reserve – Management Plan - DRAFT

This committee has been re-established after a dormant period, with the following Terms of Reference:

- Ensure regular revision and review of management plan;
- Comment on and recommend legislation and regulations (e.g. regarding extension of geographic boundaries of reserve and zoning);
- Provide advice on all applications for permits (eg dredging, mangrove clearance and leases/subdivisions) within the general boundaries of the reserve;
- Report on activities impacting the reserve and liaise with government enforcement agencies
- Assist in the development of sustainable financing mechanisms for the reserve;
- Advise on and, where appropriate, assist with administrative matters, publicity, education and interpretive programmes and
- Review and advise on research proposals and research permit applications related to the reserve.

### **Composition of the South Water Caye Marine Reserve Advisory Committee (SWCMRAC) Representation (2008)**

1. Fisheries Department
2. Coastal Zone Management Authority and Institute
3. Stann Creek Tour Guide Association
4. Belize Tourism Industry Association
5. Placencia Tour Guide Association
6. Dangriga Fishermen's Association
7. Hopkins Village Fishermen's Association
8. Riversdale Village Fishermen's Association
9. Sarteneja Fishermen Association
10. Placencia Producers Cooperative
11. Friends of Gra Gra Lagoon
12. Southern Environmental Association
13. Placencia - Village Chairman
14. Hopkins - Village Chairman
15. Dangriga Town Council
16. Smithsonian Institute
17. Representative of Private Landowners within mpa
18. Representative of Private Landowners within mpa
19. Representative of Private Landowners within mpa
20. Representative of Tourism Operators using mpa
21. Representative of Tourism Operators using mpa

**Table 29: Composition of Advisory Committee**

## **South Water Caye Marine Reserve – Management Plan - DRAFT**

The first draft management plan was prepared for South Water Caye in 1993, and revised in 2007 (Jones, 2007). This current revision (Walker, 2009) is to ensure the management plan complies with the updated objectives of the National Protected Area System Plan and National Management Planning frameworks.

### 3.3 Review of Previous Management Effectiveness

An assessment of management implementation success was conducted in 2008 / 2009, focusing on management planning activities – *Zoning, Patrols, Surveillance and Visitor Management, Research and Monitoring, Education, Administration and Financial Sustainability*.

Table 30: Programme Rating Table for 2003 Draft Management Plan					
Programme area	Total no. Action Points	Succeeded	Improved	No Change	Worse
Zoning	16	0	5	10	1
Patrols, Surveillance and Visitor Management	12	1	5	6	0
Research and Monitoring Programme	24	4	5	15	0
Education Programme	14	1	5	8	0
Administration and Maintenance Programme	11	1	2	8	0
Financial Sustainability	7	0	1	6	0
<b>Total no. Objectives / Actions</b>	<b>84</b>	<b>7</b>	<b>23</b>	<b>53</b>	<b>1</b>
<b>% of total</b>		<b>8.3%</b>	<b>27.4%</b>	<b>63.1%</b>	<b>1.2%</b>

A review of the management programmes themselves (Annex Two) suggests that of the 84 action points identified within the 2003 management plan, 8.3% have been implemented successfully, 27.4% have resulted in an improvement in the situation (partial implementation) and 63.1% showed no change, though only 1.2% (one activity) rated as having decreased in status (Table 30, Table 31).

Table 31: Summary of Success of Activities Identified from the 2003 Draft Management Plan				
	Succeeded	Improved	No Change	Worse
<b>Total No. Action Points (of 84)</b>	7	23	53	1
<b>% of total</b>	8.3%	27.4%	63.1%	1.2%
<b>% +ve change</b>	35.7%			
<b>% -ve change or no change</b>			63.3%	

Whilst the outputs from this exercise should be viewed in terms of the limited time frame available for implementation since the draft was produced in 2007, results and associated discussions suggest that all areas would benefit from strengthening, with only 35.7% of activity areas considered to have improved over the past two years (Table 31), This is particularly true for enforcement against the main perceived threat of illegal fishing, with recommendations for both on-site strengthening through increased presence (in terms of number of patrols and number of staff), and through increasing awareness of the benefits of the Conservation Zone in stakeholder fishing communities (particularly Sarteneja, with an estimated eighty to ninety fishermen reliant on the resources of the Marine Reserve, in a

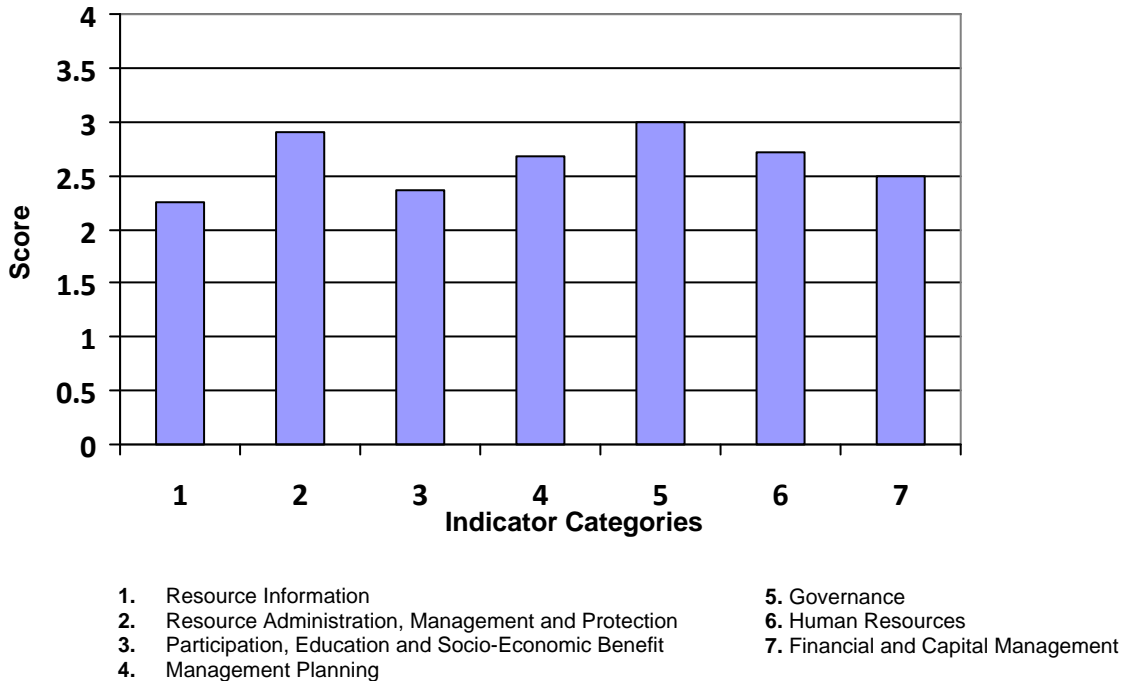
## South Water Caye Marine Reserve – Management Plan - DRAFT

community where there is very limited support for the implementation of the ‘no-take’ zone, or recognition of its importance for sustaining Belize’s traditional fishing industry).

A full management effectiveness assessment was also conducted as part of the National Status of Protected Areas assessment in May, 2009. The evaluation questionnaire for this assessment was completed by the South Water Caye Marine Reserve site manager and biologist on behalf of the Fisheries Department, with indicators being rated out of a maximum of 4 (Table 32, Figure 10).

Table 32: Individual Indicator Category* Results	
Indicator Category	Average Score
1. Resource Information	2.25
2. Resource Administration, Management and Protection	2.90
3. Participation, Education and Socio-Economic Benefit	2.36
4. Management Planning	2.67
5. Governance	3.00
6. Human Resources	2.71
7. Financial and Capital Management	2.50
<b>Overall</b>	<b>2.63</b>

\* Indicators and Indicator categories used are from Young et. al.



**Figure 10: South Water Caye Marine Reserve - Range of Indicator Category average scores for management effectiveness**

Two indicator categories rate lower than 2.5:

- 1. Resource Information
- 3. Participation, Education and Management



### 1. Resource Information

Management of South Water Caye Marine Reserve is assessed as having baseline information on physical and biodiversity components of the protected areas, but not sufficient for effective management – with gaps in data that could be strengthened, despite the presence of long-term research activities. As part of the Southern Belize Reef Complex, conservation targets were identified in 2008, and a systematic threat assessment conducted. This has been adapted for site level application. There is less information available on stakeholders and resource use –critical gaps for a Marine Reserve, where extraction is permitted in the General Use Zone, though the outputs of the socio-economic assessment under the CI initiative should provide information to fill this gap. There is also a need to strengthen data management, environmental monitoring and access to research outputs.

#### *Primary Recommendations*

- Develop and implement strategies and actions to strengthen baseline data on resource use of the marine protected area
- Effectively access and use information from Conservation International on the socio-economic context of the protected area
- Strengthen mechanisms giving access to monitoring and research outputs
- Strengthen communication and collaboration with the Smithsonian Institute, Conservation international and other researchers for filling critical information gaps.

### 3. Participation, Education and Socio-Economic Benefit

South Water Caye Marine Reserve is assessed as being moderately effective in terms of communication, but in a position to benefit significantly from strengthening in areas of stakeholder engagement and participation.

#### *Primary Recommendations*

- Develop and implement strategies and actions to strengthen engagement of local stakeholders
- Develop and implement strategies and actions to increase opportunities for socio-economic benefits
- Collaborate effectively with local NGOs and CBOs in coastal fishing communities to engage fishing stakeholders

## 3.4 Management Strategies

### 3.4.1 Management Constraints and Limitations

During the management planning process, a number of priority management constraints were identified as adversely affecting the management of the South Water Marine Reserve.

#### ▪ **Enforcement**

The limited number of reserve staff available for a continuous on-site presence, budget limitations for fuel, the time-demands of an inefficient fee collection system and the remoteness of the southern portion of the Marine Reserve are seen as severe constraints to the effective management of the reserve. This has been further compounded by the lack of implementation of zones since the initial declaration in 1996, and limited knowledge of stakeholders of the rules and regulations of the Marine Reserve. This is currently being strengthened.

#### ***Recommended Management Actions:***

- Increased staff numbers
- Establishment of second base in southern portion of Marine Reserve, with full staff compliment and required equipment
- Increased fuel allowance for patrol activities
- Continued collaboration with Belize Coastguard to supplement patrols during peak fishing times
- Continued increased communication with fishermen
- Improved communications system

#### ▪ **Personnel and Equipment**

For effective management, there should be at least two officers present in the reserve at all times. However, this is hard to achieve in reality with the current staffing levels, even though the full complement of staff has been appointed (a manager, a biologist, and two rangers). There are extended periods when the number of staff members present is too low for effective implementation of even basic management activities, being affected by officers needing to participate in meetings and training sessions, being on sick leave, or taking vacation time. As a sustained presence can be difficult to maintain under the present system, it is recommended that a third ranger be appointed for effective management of the northern portion of South Water Caye Marine Reserve.

The current staff levels are considered insufficient for even limited surveillance and enforcement activities within the more distant southern portion of the marine protected area, and biodiversity monitoring activities are restricted to the northern

area for logistical reasons. Staff limitations have also been identified for conducting biodiversity monitoring on site, with only a single staff member allocated and trained for this activity. The biologist is reliant on the availability of rangers and transport to assist in monitoring activities, which can often be in conflict with enforcement or other management activities. The staffing limitations are further exacerbated by the presence of only one boat, which is required for patrol activities, for ferrying staff and supplies to and from the mainland, and for biodiversity monitoring activities - and at times needs to be pulled up for maintenance and repairs. A second boat would assist in relieving some of the logistical limitations currently being experienced.

### ***Recommended Management Actions:***

- Greater support for staff on-site
  - Increased number of staff on-site at any one time
  - Second boat and fuel allowance
- **Greater communication and collaboration with research establishments within the Marine Reserve**

Whilst already ongoing, continued strengthening of increased communication with research organizations utilizing the Marine Reserve is considered particularly important, with improved mechanisms for feeding research information into management.

### ***Recommended Management Actions:***

- Continue increased liaison and cooperation with Smithsonian Institute, Conservation International initiative and other research operations within South Water Caye Marine Reserve
  - Strengthening of monitoring within South Water Caye Marine Reserve through collaboration with Wildlife Conservation Society
  - Investigate possibility of liaising with Tobacco Caye Marine Station and Wee Wee Caye for assistance with biodiversity monitoring
- **Stakeholder Involvement in Management Decisions**

The South Water Caye Advisory Committee (SWCAC) is currently functional, with representatives from all major stakeholder sectors. Active participation of stakeholders on the committee has improved significantly since the start of the management planning process, with the re-establishment of the committee, and highly motivated members. This motivation needs to be maintained.

The tourism and research sectors are well represented on the committee. The traditional fishermen from the key stakeholder communities are also represented on the committee, but appear less motivated to attend meetings. A specific effort was made during the management planning process to encourage their presence at meetings, and ensure that they have had significant input into the management plan, through workshops, discussions and consultations. However, whilst the fishermen are

consulted and can voice opinions at meetings, it is recognized that they often feel they have no direct involvement in the resulting decision (even though decisions may be based on their input). Many fishermen also feel at a disadvantage when communicating, often having limited education and / or English skills.

There is also increasing meeting-fatigue on the part of the fishermen, with many organizations seeking their presence at consultative meetings, but with little visible output from the consultation activities, and often no apparent changes in management procedures following their recommendations.

### ***Recommended Management Actions:***

- Ensure visible results from recommendations arising from community consultations, and feedback on areas of concern
  - Increase stakeholder participation in management decisions, management and monitoring activities
  - Ensure continued support of the Advisory Committee
  - Develop effective Communication Plan for keeping Advisory Committee members and other stakeholders informed of management activities.
- **Outreach and Environmental Education**

Environmental Education is centralized by Fisheries Department, but at site level, there has been no structured education outreach programme since 2006, and no distinct programme or structure to guide Outreach and Education activities, and no sustained effort within schools, visitors or stakeholder communities.

This is being addressed through the recently approved project titled “Towards sustainability of the Marine Reserves Network (MRN) in Belize”, under which two objectives seek to strengthen the Fisheries Department in-house capacity to increase public awareness and conduct educational outreach activities.

**Objective 4:** To increase public awareness on marine protected areas of Belize.

**Objective 5:** Enhancement of staff capacity in monitoring, research, enforcement, environmental education and public relations.

These focus on the development of an effective Information Production and Dissemination Program booklets, leaflets, brochures, posters and audio visual materials for the Marine Reserve Network.

On-site educational infrastructure includes a mangrove boardwalk at Twin Cayes focused at increasing public awareness about the interconnectivity, vulnerability, and natural history of the mangrove and coral reef ecosystems. The boardwalk will serve local and international students, resource managers, fishermen, and school teachers as a site for mangrove ecology courses workshops and the opportunity to experience the beauty of a rarely visited mangrove habitat. The boardwalk will also facilitate monitoring and research by scientists and resource managers.

### ***Recommended Management Actions:***

- Develop interpretive materials for the boardwalk and Visitor’s Centre
- Investigate opportunities for assistance in developing interpretive displays from the Smithsonian Institute
- Work with other partners of the SBRC to reach stakeholders with educational and outreach activities

### ▪ **Funding**

South Water Caye Marine Reserve, whilst generating some funding from tourism, is not considered sustainable. Entrance fees go into a Fisheries Department fund, to be accessed for site-level management costs and investments. The protected area is currently funded through Government funding, which covers basic running costs (fuel and salaries). Research and monitoring activities benefit from collaborative efforts (WCS) or targeted funding (MBRS) for specific activities.

A current large grant from the Protected Area Conservation Trust (PACT) builds the capacity of Fisheries Department for effective management of the marine protected area network, including South Water Caye Marine Reserve.

The protected area needs to seek funds over and above the basic running costs for implementing activities such as environmental education. Its current selection as a MAR Fund site for substantial investment over the next five years should ensure required infrastructure is in place and assist with increasing management effectiveness in the long term.

### ***Recommended Management Actions:***

- Improve fee collection system
- Investigate opportunities for funding and focus on proposal writing – MAR fund?
- Work with other partners of the SBRC to seek system level funding
- Seek assistance from the Advisory Committee to raise funds for smaller projects to improve site level facilities

### 3.4.2 Management Zones

#### ***Boundaries***

The South Water Caye Marine Reserve encompasses a total area of 117,875 acres, though there is limited boundary demarcation in place at the moment (May, 2009). Boundary demarcation of the Conservation Zone is considered a priority.

South Water Caye Marine Reserve is divided into three zones to allow for the management of resources for sustainability, and to provide the flexibility needed to accommodate many users:

- General Use Zone
- Conservation Zone
- Preservation Zone

Whilst initially developed several years ago (through a process that included participatory input from key stakeholders), the zones have only recently been legislated (Annex One). This legislation includes the rules and regulations for public use for each zone.

#### ***General Use Zone***

The General Use Zone covers 95,597 acres (38,687 hectares) – 81.1% of the protected area.

Fishing is permitted in this Zone by licensed fishermen, though there are gear restrictions, including a ban on gillnets, long lines and spear fishing. There is also provision for residents of the Marine Reserve to fish for subsistence purposes, under Special License.

Sport fishing is permitted within this Zone, (excluding spear fishing), but is generally catch and release, unless fish are being caught for subsistence purposes during the tour.

#### ***Conservation Zone***

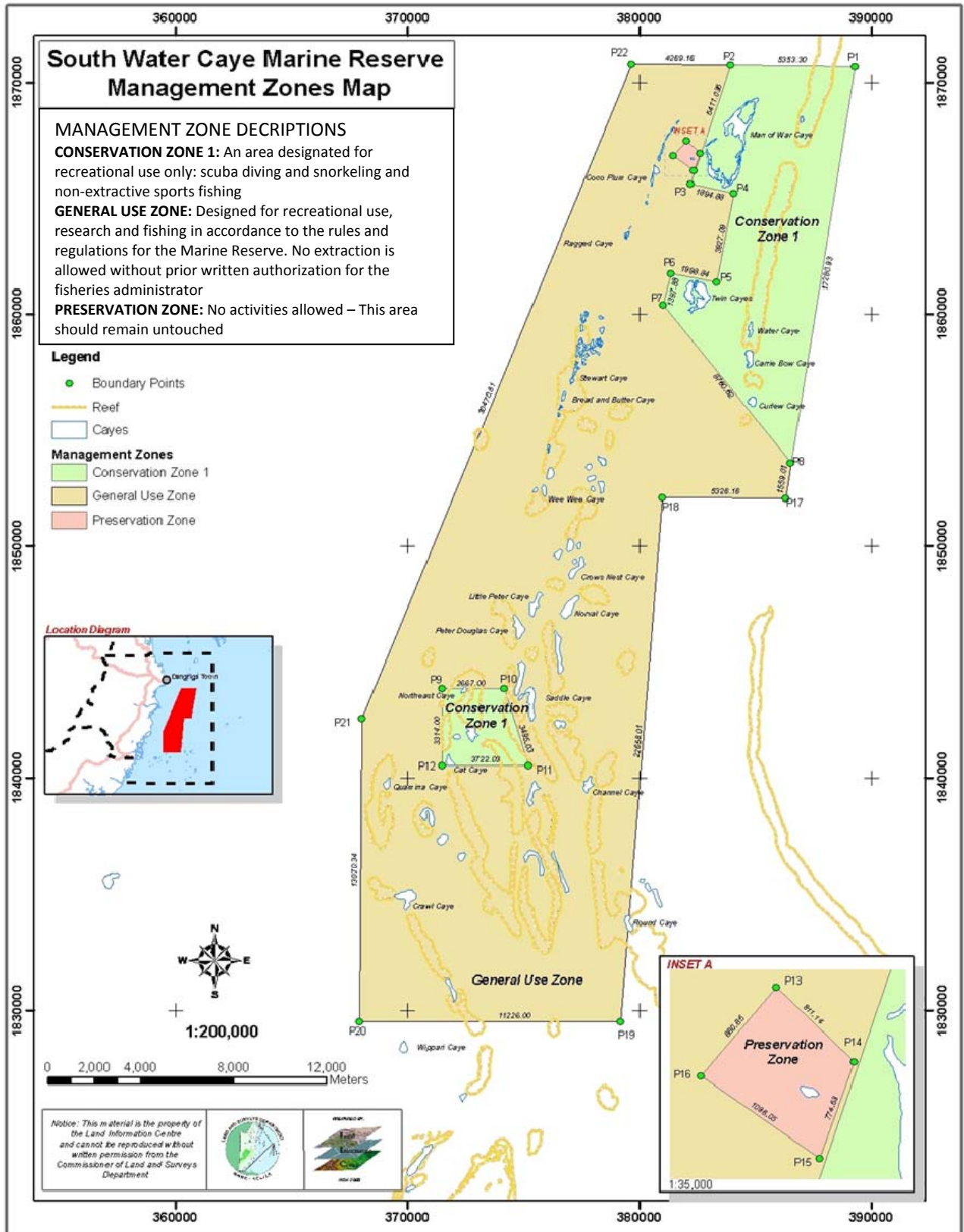
The Conservation Zone covers approximately 22,143 acres (8,961 ha, or 18.7%) of the Marine Reserve. Within this zone, Marine life is fully protected, with strict regulations stating that “no person shall harass or in any way tamper with any fauna...”

Only non-extractive recreational activities are permitted within this zone, with no commercial, sport or subsistence fishing allowed.

All boats are to be secured using officially designated mooring buoys, to prevent anchor damage to the seabed – except in emergency situations, or with prior written permission from the Reserve Manager.



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Map 14: Zones of South Water Caye Marine Reserve

A number of the Conservation Zone regulations are specific to divers:

- All divers must register with the Reserve Manager before entering the Conservation Zone
- Divers are required to be certified, or undergoing training with a certified instructor, to dive within the Conservation Zone
- Charter dive boats must obtain a license before operating in the Conservation Zone
- All dive boats should fly the “divers down” flag when they have divers in the water
- Dive guides are required to explain the rules of the Reserve to divers
- There should be no more than a maximum of eight scuba divers per dive master
- There should be no more than a maximum of eight snorkelers per licensed tour guide

All boat operators are required to register their boats with the Fisheries Administrator, and observe the low wake zone boat way when approaching snorkelers or divers.

No water skiing or jet skiing is permitted within the Conservation Zone.

### ***Preservation Zone***

The Preservation Zone covers approximately 190 acres (76.6 hectares) – 0.16% of the protected area, and has been established to protect the bird nesting colony of Man-O-War Caye – one of Belize’s original crown reserves.

Activities are restricted here, with no fishing, sport fishing, diving or any other activity permitted within the Zone.

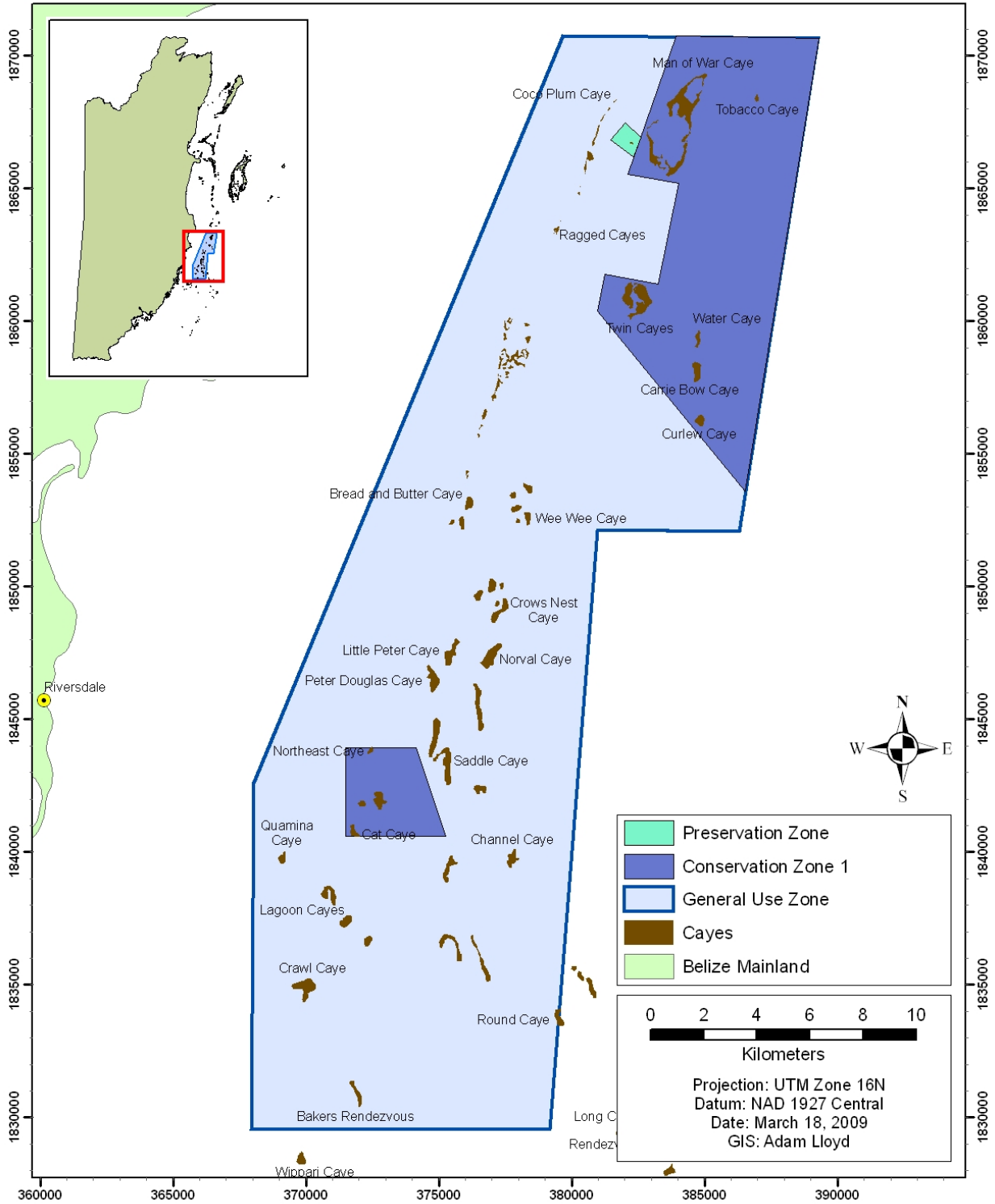
Boats operating within this Zone require written permission from the Fisheries Administrator, though this zone is currently accessed regularly by local tour guides, and no mechanism is yet in place to enforce this requirement.

### **Recommendations**

A number of recommendations have arisen from the management planning process, in response to concerns voiced by users of the resources.

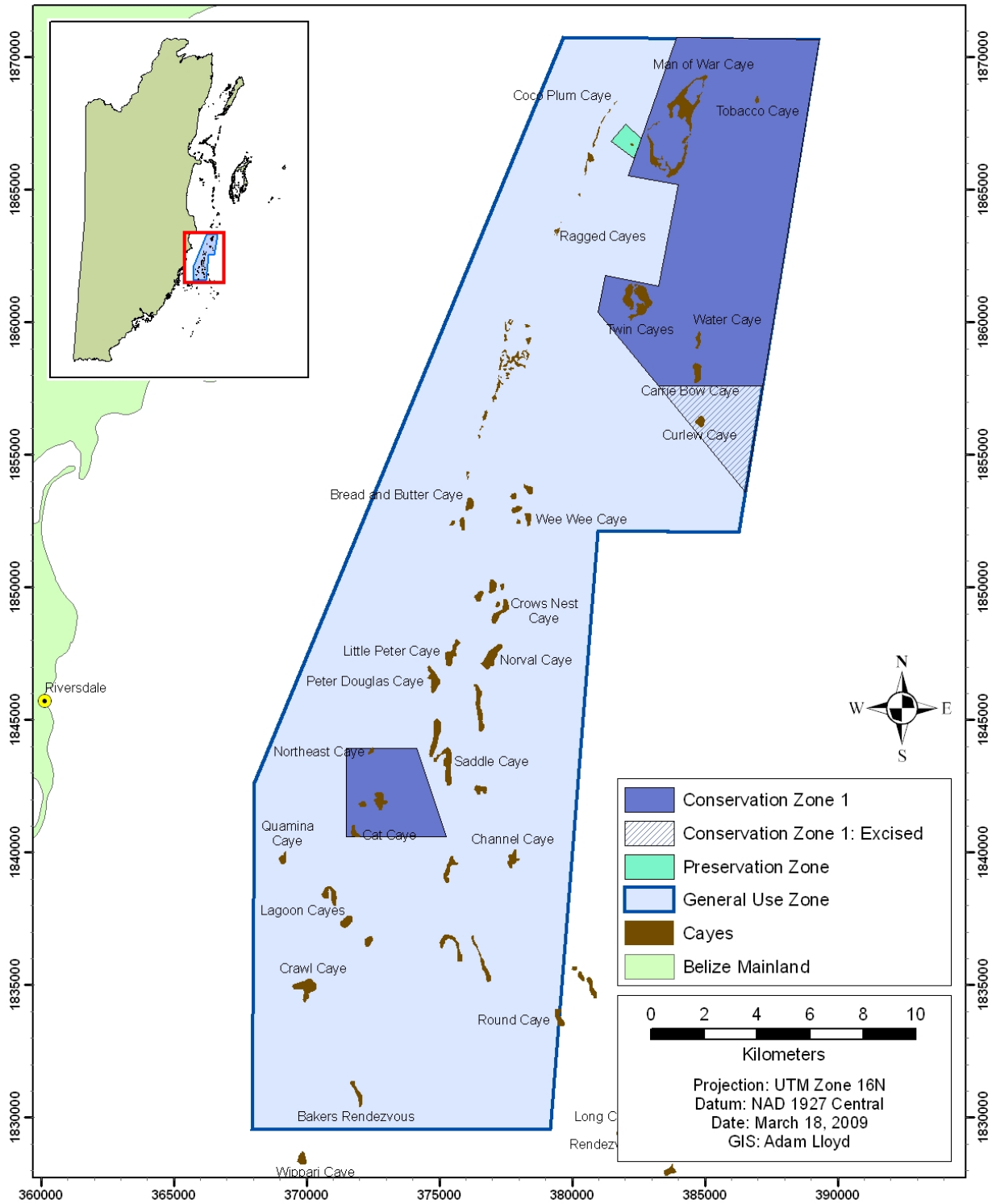
***Recommendation 1:*** Following consultations with the fishermen, it is recommended that the southern boundary of the northern Conservation Zone be re-designated as a horizontal boundary running immediately south of Carrie Bow Caye, opening one of the key fishing areas targeted at the start of the fishing season.

South Water Caye Marine Reserve: Zoning



Map 15: Current Conservation Zones

South Water Caye Marine Reserve: Amended Zoning



Map 16: Recommended amendment to northern Conservation Zone

**Recommendation 2:** Following consultation with the tourism sector, it is recommended that registered tour guides operating in the area should have access to the Preservation Zone for the purpose of taking visitors to observe the nesting bird colony on Man-O-War Caye. No other activities are recommended, and any tour guide causing disturbance to the colony should be barred from access. The Advisory Committee recommends that to enforce the recommended distance from the caye, the no-access area should be delineated clearly by marker buoys.

### **Other Recommendations:**

Tour guides have suggested the designation of a specific 'no fishing' area to encompass a popular dive site. If it is decided that this should be a recommended action, full stakeholder consensus should be sought before designation is initiated, as the area lies within the recommended re-designated fishing area.

### **3.4.3 Limits of Acceptable Change**

At present there are no carrying capacities set for activities within South Water Caye Marine Reserve – whether commercial fishing, recreational fishing activities associated with Tobacco and South Water Cayes, or tourism related activities. It has been recognized that this will need to be addressed as use of the Marine Reserve increases. Assessment of carrying capacity is therefore one of the actions included for more effective management of South Water Caye Marine Reserve, particularly in key dive sites and adjacent to the more heavily used cayes.

### 3.5 Management Programmes and Objectives

Management programmes are a means of grouping management objectives within related areas – for example, grouping objectives related to natural resource management, or to public use. 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.

Six Management Programmes are identified under the National Protected Areas Policy and System Plan framework:

- A. Natural Resource Management Programme**
- B. Research and Monitoring Programme**
- C. Community Participation Programme**
- D. Public Use Programme**
- E. Infrastructure Management Programme**
- F. Administration Programme**

As this revision of the 2007 management plan is to enable it to follow the NPAPSPS management planning framework (NPAPSP, 2005), the six categories outlined above have been used, and the current management programmes reallocated between them (Table 32).

Contributing towards the adaptive management process are the strategies defined during the conservation planning process for the Southern Belize Reef Complex (of which South Water Caye Marine Reserve is a component), which seeks to assist Fisheries Department, Forest Department and the Southern Environmental Association (co-management organization for Laughingbird Caye, Gladden Spit and Silk Cayes, and Sapodilla Cayes) in ensuring the long-term conservation of the SBRC. This framework for strategic conservation planning is part of the Government's NPAPSP initiative towards more effective management of the protected areas system through system-level planning. One of the outputs of this planning is the identification of intervention strategies that could be applied to mitigate the threats identified during the planning process – strategies that are incorporated into the management programmes, and into the measures of success programme for effective management.

Also taken into consideration are the recommendations from the recent World Heritage Site assessment team, which voiced serious concern as to the future viability of the Belize Barrier Reef Reserve System if certain steps aren't taken in the near future to safeguard the unique values of the seven nominated sites.

#### Checklist for an Effective Marine Reserve

- Be clear about objectives
- Seek local support
- Build partnerships
- Plan for financial sustainability
- Don't prohibit more than necessary
- Build for the unforeseen
- Put in place structures for conflict resolution
- Establish self-enforcement as much as possible

Adapted from Kelleher, 1999



South Water Caye Marine Reserve Management Programmes					
Natural and Cultural Resource Management Program	Research and Monitoring Programme	Community Participation Program	Public Use Program	Site and Infrastructure Management Program	Administration Program
Marine Resource Management	Research Programme	Stakeholder engagement and participation	Recreation fee collection	Staff facilities and maintenance	Salaries
Surveillance and enforcement	Monitoring Programme	Environmental education and outreach	Visitor education and interpretation	Visitor facilities and maintenance	Communication and Liaison
Zoning and boundaries	Training	Public outreach and information	Visitor safety and protection	Docking facilities	Accounting
Marine / wildlife management	Research and Monitoring Partnerships - Collaboration and Communication	Sustainable livelihoods and training		Boardwalk construction and maintenance	Human Resource Management
				Mooring buoys and navigation markers	
				Transportation	

Table 32: South Water Caye Management Programme

### 3.5.1 Natural Resource Management Programme

The Natural Resource Management Programme comes under the responsibility of the Reserve Manager and rangers, and deals with direct management of the marine environment, surveillance and enforcement, and is administered under four sub-programmes:

- **Marine Resource Management**
- **Zoning and Boundaries**
- **Surveillance and Enforcement**
- **Marine /wildlife Management**

Activities under the Marine Resource Management Sub-programme provide the framework for the Surveillance and Enforcement sub-programme, the highest priority for effective management of South Water Caye Marine Reserve. This is, itself, supported by the Zoning and Boundaries sub-programme. The rules and regulations of the various zones need to be strictly enforced at all times in combination with communication, education and public awareness activities, to ensure that all visitors to the protected area are familiar with the restrictions.

Natural Resource Management Programme, 2010 - 2014	
Marine Resource Management	
<p><b>Support and uphold Fisheries regulations relevant to maintenance of commercial species</b></p>	<ul style="list-style-type: none"> <li>▪ Ensure clear stakeholder understanding of Fisheries regulations and reasons underpinning them</li> </ul> <p><b>CORAL:</b></p> <ul style="list-style-type: none"> <li>▪ It is illegal for any person to take, buy, sell or have in his possession any type of coral.</li> <li>▪ An exception is made in the case of Black Coral (Order ANTIPATHARIA) which may only be bought, sold or exported with a licence from the Fisheries Administrator.</li> </ul> <p><b>BONE FISH (<i>Albulba vulpes</i>)</b> locally known as MACABI:</p> <ul style="list-style-type: none"> <li>▪ No person should buy or sell, any Bone Fish.</li> </ul> <p><b>CONCH (<i>Strombus gigas</i>):</b></p> <ul style="list-style-type: none"> <li>▪ Shell length should exceed 7 inches.</li> <li>▪ Market clean and fillet weight should exceed 3 and 2.75 ounces respectively.</li> <li>▪ Closed season is from 1st July to 30th September.</li> <li>▪ No fisherman shall buy, sell or possess diced conch meat</li> </ul> <p><b>LOBSTER (<i>Panulirus argus</i>):</b></p> <ul style="list-style-type: none"> <li>▪ Minimum cape length is 3 inches.</li> <li>▪ Minimum tail weight is 4 ounces.</li> <li>▪ Closed season is from 15th February to 14th June.</li> <li>▪ No fisherman shall buy, sell or possess fillet or diced lobster tail, soft shell berried lobster or lobster with tar spot</li> </ul> <p><b>MARINE TURTLES:</b></p> <ul style="list-style-type: none"> <li>▪ No person should interfere with any turtle nest</li> <li>▪ No person should take any species of marine turtle</li> <li>▪ No person shall buy, sell, or have in his possession any turtle or articles made of turtle parts.</li> </ul>

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<b>Natural Resource Management Programme, 2010 - 2014</b>	
<b>Marine Resource Management (continued)</b>	
<p><b>Support and uphold Fisheries regulations relevant to maintenance of commercial species (continued)</b></p>	<ul style="list-style-type: none"> <li>▪ Ensure clear stakeholder understanding of Fisheries regulations and reasons underpinning them (continued)</li> </ul> <p><b>NASSAU GROUPEL:</b></p> <ul style="list-style-type: none"> <li>▪ No person shall take in the waters of Belize, buy, sell, or have in his possession any Nassau Grouper (<i>Epinephelus striatus</i>) between 1<sup>st</sup> December and 31<sup>st</sup> March</li> <li>▪ No person shall take, buy, sell, or have in his possession any Nassau Grouper which is less than 20 inches and greater than 30 inches</li> <li>▪ All Nassau Grouper are to be landed whole</li> </ul> <p><b>GRAZERS:</b></p> <ul style="list-style-type: none"> <li>▪ No person shall take in the waters of Belize, buy, sell, or have in his possession any grazer (<i>Scarus</i> and <i>Sparisoma</i>) and <i>Acathuridae</i> Family, commonly known as parrot fish, angel fish and tangs.</li> </ul> <p><b>FISH FILLET</b></p> <ul style="list-style-type: none"> <li>▪ All fish fillet shall have a skin patch of at least 2 inches by 1 inch.</li> </ul> <p><b>SEA CUCUMBER:</b></p> <ul style="list-style-type: none"> <li>▪ No person shall fish for sea cucumber (donkey dung) without a special permit issued by the Fisheries Administrator and from July 1<sup>st</sup> to December 31<sup>st</sup> in any one year</li> </ul> <p><b>GENERAL</b></p> <ul style="list-style-type: none"> <li>▪ No person shall set traps outside the reef or within 300 feet of the Barrier Reef</li> <li>▪ No spear fishing within marine reserves</li> <li>▪ No fishing without a valid fisher folk or fishing vessel license</li> <li>▪ No one should fish with scuba gear</li> </ul>
<p><b>Awareness of Regulations</b></p>	<ul style="list-style-type: none"> <li>▪ Ensure all tour guides, caye residents and fishermen are aware of regulations and rationale for the Marine Reserve, through brochures, handouts and other educational material related to regulations</li> <li>▪ Ensure all resident subsistence fishermen are informed and aware of new Conservation Zone policies for subsistence fishing before implementation</li> <li>▪ Inform all visitors of rules and regulations when visiting the Marine Reserve through information board in Dangriga and on Tobacco Caye, distribution of brochures, and handouts and other educational material</li> </ul>
<p><b>Ranger Station</b></p>	<ul style="list-style-type: none"> <li>▪ Ensure Twin Cayes Ranger Station is adequately equipped</li> <li>▪ Establish, equip and staff a second Ranger Station in the Pelican Cayes area (North East Caye?) of South Water Caye Marine Reserve</li> </ul>

## South Water Caye Marine Reserve – Management Plan - DRAFT

Natural Resource Management Programme, 2010 - 2014	
Marine Resource Management (continued)	
<b>Staff</b>	<ul style="list-style-type: none"> <li>▪ Ensure protected area staff numbers are sufficient for effective management of the Marine Reserve. At minimum:               <ul style="list-style-type: none"> <li>▪ Station One (Twin Cayes): 1 Reserve Manager, 3 Rangers, 1 boat captain (on rotation);</li> <li>▪ Station Two: Reserve Assistant Manager, 3 Rangers, 1 boat captain (on rotation)</li> <li>▪ 1 marine biologist, 1 assistant marine biologist, on rotation between north and south rangers stations, 1 boat captain</li> </ul> </li> <li>▪ Investigate potential for developing volunteer rangers programme – local fishermen and tour guides</li> <li>▪ Investigate potential for recruiting international volunteers to assist with biodiversity monitoring</li> <li>▪ Develop mechanisms for addressing issues of bribery and favoritism at Fisheries Officer level, and impacts on effective management of Conservation Zones – in collaboration with fishermen</li> </ul>
<b>Equipment and Training</b>	<ul style="list-style-type: none"> <li>▪ Patrols are fully equipped and rangers fully trained for surveillance and enforcement activities (including reliable radios installed on boats)</li> </ul>
<b>Reporting</b>	<ul style="list-style-type: none"> <li>▪ Maintain log books - number of patrols, zones patrolled, number of boats checked, infractions noted, warnings given, and arrests made</li> <li>▪ Maintain log of traditional fishermen and boat presence within the South Water Caye Marine Reserve</li> <li>▪ Produce quarterly reports, and submit to Fisheries Department and Advisory Committee</li> <li>▪ Produce annual reports and submit to Fisheries Department and Advisory Committee</li> </ul>
Zoning and Boundaries	
<b>Boundaries</b>	<ul style="list-style-type: none"> <li>▪ Clearly demarcate the boundaries of the South water Caye Marine Reserve</li> </ul>
<b>Zoning</b>	<ul style="list-style-type: none"> <li>▪ Clearly demarcate northern and southern Conservation Zones with sufficient marker buoys, in collaboration with fishermen</li> <li>▪ Clearly demarcate Preservation Zone and exclusion zone, in collaboration with tour operators and Advisory Committee</li> <li>▪ Ensure fishermen have access to information on the zones and regulations (information brochure distributed from rangers station, in fishing communities, and to boats encountered during patrols)</li> </ul>
Surveillance and Enforcement	
<b>Training</b>	<ul style="list-style-type: none"> <li>▪ Rangers trained in standard procedures and guidelines for enforcement activities, as per the Fisheries Enforcement Plan</li> <li>▪ Training of local fishermen and tour guides for participation as Fisheries Officers / Special Constables</li> </ul>

## South Water Caye Marine Reserve – Management Plan - DRAFT

Natural Resource Management Programme, 2010 - 2014	
Surveillance and Enforcement	
<b>Surveillance Patrols</b>	<ul style="list-style-type: none"> <li>▪ Patrols scheduled and implemented on a regular basis (daily if possible) in northern Conservation Zone 1 and General use Zone</li> <li>▪ Regular patrols scheduled and implemented in southern Conservation Zone and General Use Zone (at least weekly, until southern rangers station is established – then daily)</li> <li>▪ Engage tour guides and fishermen in surveillance activities within the protected area</li> <li>▪ Increase surveillance of known turtle nesting beaches and address human impacts</li> <li>▪ Ensure adequate surveillance and monitoring of ongoing caye development projects</li> </ul>
<b>Enforcement</b>	<ul style="list-style-type: none"> <li>▪ Increase effectiveness of patrols (increased patrol hours, night patrols, equipment)</li> <li>▪ Enforce Fisheries Regulations in General Use Zone, including equipment restrictions (no long lines, nets or spear guns)</li> <li>▪ Ensure fair enforcement of regulations across all fishermen</li> <li>▪ Enforce anchor-use regulations</li> <li>▪ Enforce Conservation Zone regulations – only non-extractive recreational activities</li> <li>▪ Enforce recreational regulations                             <ul style="list-style-type: none"> <li>▪ Number of divers / snorkelers per licensed guide (in collaboration with BTB)</li> <li>▪ Exclusion of jet ski and water-ski use within the Conservation and Preservation Zones</li> <li>▪ Only catch and release sport fishing</li> <li>▪ Mooring buoy-use regulations at dive sites and designated safe harbours</li> </ul> </li> <li>▪ Enforce regulations in Preservation Zone, with written permission / permit for local tour guides to access Man-O-War Caye as a tourism resource</li> <li>▪ Identify level of impact of illegal fishing by Honduran / Guatemalan fishermen, and develop intervention strategies</li> <li>▪ Strengthen links with Department of the Environment for rapid response to pollution events</li> <li>▪ Liaise with Forest Department for effective enforcement of Mangrove Legislation</li> <li>▪ Liaise with Belize Tourism Board for effective enforcement of Tourism Legislation</li> </ul>
<b>Stakeholder Engagement</b>	<ul style="list-style-type: none"> <li>▪ Engage fishing stakeholders from key communities through increased awareness, participation and communication</li> <li>▪ Engage tourism stakeholders of South Water Caye Marine Reserve through increased awareness, participation and communication</li> <li>▪ Engage schools in key stakeholder communities through increased awareness, participation and communication</li> <li>▪ Continue increased communication with fishermen whilst using South Water Caye Marine Reserve</li> <li>▪ Engage key fishermen towards active participation in fisheries management activities</li> </ul>

## South Water Caye Marine Reserve – Management Plan - DRAFT

Natural Resource Management Programme, 2010 - 2014	
Stakeholder engagement for effective surveillance and enforcement	
<b>Liaison and Collaboration</b>	<ul style="list-style-type: none"> <li>▪ Continue collaboration with Belize Coastguard for surveillance and enforcement</li> <li>▪ Continue collaboration with Forest Department for surveillance and enforcement of Mangrove Regulations</li> <li>▪ Strengthen communication and cooperation for surveillance and enforcement with other stakeholders of South Water Caye Marine Reserve – fishermen, residents, and tour guides</li> </ul>
<b>Awareness</b>	<ul style="list-style-type: none"> <li>▪ Continue raising awareness in all stakeholders of the benefits of South Water Caye Marine Reserve</li> <li>▪ Increase awareness among caye owners of the biodiversity value and importance of mangrove, and encourage protection</li> </ul>
Marine / wildlife Management	
<b>Development Plans and Best Practices</b>	<ul style="list-style-type: none"> <li>▪ Facilitate residents of Tobacco Caye in the production of a Sustainable Development Plan, addressing major concerns such as the issue of sewage and solid waste disposal, and noise pollution, and identifying mechanisms and synergies for reducing ecological footprint</li> <li>▪ Develop / adopt development Best Practices (eg. WCS Glover’s Reef best Practices Guidelines)</li> <li>▪ Ensure these guidelines are followed at the Twin Cayes Ranger’s Station, and at the Southern Rangers Station once (and whilst being) established</li> <li>▪ Encourage caye-based residents / tourism developments to adopt Best Practices guidelines</li> <li>▪ Develop general guidelines to assist in review of environmental assessments and EIAs for future developments proposed within the South Water Caye Marine Reserve and other Marine Reserves</li> <li>▪ Ensure all EIAs are adequately vetted and approved, and that Fisheries Department plays a vocal part in NEAC in relation to environmental sustainability of development within South Water Caye Marine Reserve</li> <li>▪ Investigate potential of environmental levies on caye development within South Water Caye Marine Reserve towards monitoring costs</li> <li>▪ Strengthen links with Department of the Environment for rapid response to pollution events</li> <li>▪ Investigate strengthening of legislation for exclusion of marine reserves from oil exploration areas</li> <li>▪ Adopt guidelines from WIDECASST Technical Report No. 9: Best Practices for Sea Turtle Nesting Beaches</li> </ul>
<b>Invasive Species</b>	<ul style="list-style-type: none"> <li>▪ Increase awareness in staff, residents and tour guides of the potential impacts of lionfish</li> <li>▪ Actively remove Lionfish from South Water Caye Marine Reserve, with the participation of the tourism and fishing stakeholders, and in collaboration with Ecomar</li> <li>▪ Monitor <i>Casuarina</i> presence, and assess whether removal is necessary – if so, develop and implement removal plan</li> <li>▪ Removal of tokay gecko from South Water Caye</li> </ul>

## South Water Caye Marine Reserve – Management Plan - DRAFT

Natural Resource Management Programme, 2010 - 2014	
Pollution	
<b>Oil / Chemicals</b>	<ul style="list-style-type: none"><li>▪ Develop an emergency strategy in collaboration with DoE for mitigating impacts of potential oil or chemical spills</li><li>▪ Ensure safe storage of oils and chemicals on the cayes during storm events</li><li>▪ Increase awareness among fishermen on proper disposal of oil / lube containers, and effects of pollution on the marine environment</li><li>▪ Include guidelines for fogging of pesticides and use of herbicides on cayes within the Marine Reserve, and investigate the merits of using the least harmful types available, or alternatives.</li><li>▪ Partner with organizations seeking to mitigate agrochemical contamination of water bodies from land based sources through promotion of better practices in agrochemical use</li><li>▪ Develop a proactive strategy for potential mining / oil exploration</li><li>▪ Lobby for exclusion of South Water Caye Marine Reserve from oil exploration concession areas (as per WHS recommendations)</li></ul>



### 3.5.2 Research and Monitoring Programme

Research and monitoring are essential activities to ensure informed, effective management, and to assess the effectiveness of the Marine Reserve in achieving its objectives. The Research and Monitoring Programme comes under the responsibility of the Reserve Biologist, and is administered under four sub-programmes:

- **Research**
- **Monitoring**
- **Training**
- **Research and Monitoring Partnerships - Collaboration and Communication**

Research proposals are reviewed by the Fisheries Department, and if approved, a research license is granted on an annual basis. Procedures are also being established for review by the Advisory Committee. Plans are underway to establish a research review committee to carry out this function, thus expanding the knowledge base feeding into the decision-making process. Recommendations have also been made to include the Reserve Manager and Biologist on this committee (as *ex officio* members), when projects proposed for the South Water Caye Marine Reserve are being reviewed.

South Water Caye Marine Reserve has a number of research initiatives based within the Marine Reserve. A current Conservation International initiative under the CI Marine Management Area Science Programme, is focused on providing a framework for long-term monitoring of the Belize reef system in cooperation with local management agencies, with South Water Caye Marine Reserve identified as one of five survey sites. In the long term, this has the potential to provide important feedback into the adaptive management of the marine protected area. The Smithsonian Institute has an active marine research station based on Carrie Bow Caye, producing significant scientific outputs. Collaboration between Fisheries Department and the Smithsonian researchers would benefit from strengthening, with encouragement of priority research focused on providing information for identified management gaps and filling research and monitoring priorities.

## South Water Caye Marine Reserve – Management Plan - DRAFT

Research Activities 2010 - 2014	
Research	
<b>Priority Research</b>	<ul style="list-style-type: none"> <li>▪ Identify priority research activities in the South Water Marine Reserve from conservation planning and adaptive management requirements, with input from SWC Advisory Committee</li> <li>▪ Disseminate list of priority research activities to research stakeholders active</li> </ul>
Research and Monitoring Partnerships	
<b>Collaboration</b>	<ul style="list-style-type: none"> <li>▪ Continue collaborative relationship with WCS towards strengthening monitoring</li> <li>▪ Continue and strengthen collaborative relationship with Smithsonian Institute</li> <li>▪ Continue collaborative relationship with Conservation International Marine Management Area Science Programme</li> <li>▪ Strengthen mechanisms for accessing monitoring and research outputs</li> <li>▪ Strengthen communication and collaboration with the Smithsonian Institute, Conservation international and other researchers for filling critical information gaps.</li> </ul>
Specific Research Areas	
<b>Key Research</b>	<ul style="list-style-type: none"> <li>▪ Increase research into the mangrove and lagoon ecosystems of the Pelican Cayes</li> <li>▪ Investigate the effectiveness of the conservation zones in conserving the populations of spiny lobster and queen conch</li> <li>▪ Investigate the dynamics of coral recruitment, grazing, and nutrient enrichment on coral populations</li> <li>▪ Assessment of reef recovery after 1998 bleaching event and Hurricane Mitch</li> <li>▪ Assessment of shark populations</li> <li>▪ Continue investigations into the status (size, age, abundance, distribution, recruitment, etc.) of lobster, conch and main commercial species of finfish populations on the atoll, to determine the sustainable level of harvest.</li> <li>▪ Socio-economic assessment of the economic value of the Marine Reserve to the stakeholders and to the economy of the country in terms of fisheries and tourism, and also in terms of the less easily measurable factors such as recreation and storm protection</li> <li>▪ Update and further define ecosystem mapping of the Marine Reserve</li> <li>▪ Promote and support key research that identified land-based sources of water contamination</li> </ul>
<b>Tourism Impacts</b>	<ul style="list-style-type: none"> <li>▪ Investigate the impacts of sport fishing, with particular focus on reef flats bone fishing and associated trampling impacts, and use of cast nets for bait collection</li> <li>▪ Investigate the impacts of kayaking, wind surfing and sailing on ecosystems of South Water Caye Marine Reserve</li> <li>▪ Investigate the impacts of snorkeling and diving on ecosystems of South Water Caye Marine Reserve</li> </ul>

## South Water Caye Marine Reserve – Management Plan - DRAFT

Research Activities 2010 - 2014	
Monitoring	
<b>Priority Monitoring</b>	<ul style="list-style-type: none"> <li>▪ Establish monitoring of fish catch in collaboration with WCS, and with the participation of traditional fishermen</li> <li>▪ Develop monitoring programme based on current synoptic monitoring programme under Fisheries Department, and monitoring requirements under the Conservation Planning section</li> <li>▪ Initiate modified LAMP monitoring in collaboration with Wildlife Conservation Society</li> <li>▪ Continue monitoring for coral bleaching, with input into Mesoamerican Coral Reef Watch Programme (through ECOMAR) for early reporting of bleaching episodes</li> <li>▪ Implement effective water quality monitoring programme</li> <li>▪ Develop a comprehensive baseline species list of fish, corals and other invertebrates for the protected area</li> <li>▪ Collaborate with other marine protected areas of the Southern Belize Reef Complex for monitoring of system level Conservation Action Plan indicators</li> <li>▪ Continue monitoring of the Emily / Caye Glory spawning aggregation site</li> <li>▪ Monitor presence of lionfish within the marine protected area</li> <li>▪ Prioritize monitoring of agrochemical contamination in water / tissue samples</li> </ul>
Specific Monitoring Areas	
<b>Monitoring of Conservation Action Planning Indicators</b>	<ul style="list-style-type: none"> <li>▪ Total extent of mangrove ecosystem</li> <li>▪ Abundance of juvenile fish (nursery functionality)</li> <li>▪ % seagrass cover</li> <li>▪ Seagrass density (SeagrassNet)</li> <li>▪ Coral recruitment</li> <li>▪ Coral bleaching</li> <li>▪ % live coral cover</li> <li>▪ Parrotfish density</li> <li>▪ Biomass of commercial fish</li> <li>▪ Adult conch density</li> <li>▪ Lobster density</li> </ul>
<b>Adaptive Management</b>	<ul style="list-style-type: none"> <li>▪ Integrate research results into management planning process</li> </ul>
<b>Water Quality</b>	<ul style="list-style-type: none"> <li>▪ Monitor nutrient levels on a regular basis, particularly adjacent to high visitor use cayes</li> <li>▪ Monitor run-off from the southern coastal plain and northern Honduras during extreme storm events using remote sensing information (NOAA website / SERVIR, ICRAN-MAR)</li> <li>▪ Develop mechanisms for greater accessibility to Smithsonian Institute data on water parameters</li> </ul>
<b>Birds</b>	<ul style="list-style-type: none"> <li>▪ Establish monitoring programme for bird nesting colonies within South Water caye Marine Reserve</li> <li>▪ Monitor nesting success of osprey</li> </ul>

## South Water Caye Marine Reserve – Management Plan - DRAFT

Research Activities 2010 - 2014	
Specific Monitoring Areas	
<b>Turtles</b>	<ul style="list-style-type: none"> <li>▪ Monitoring of turtle nesting on the cayes</li> <li>▪ Implement turtle monitoring use of the waters of the Atoll</li> </ul>
<b>Other Reptiles</b>	<ul style="list-style-type: none"> <li>▪ Record the presence and location of crocodiles within the marine reserve</li> <li>▪ Develop accurate information on the distribution of the two native gecko species on the cayes – <i>Phyllodactylus insularis</i> and <i>Aristelliger georgeensis</i></li> <li>▪ Develop accurate information on the distribution (presence / absence) of the tokay gecko (<i>Gekko gekko</i>) across cayes of South Water Caye Marine Reserve</li> </ul>
<b>Socio Economic Monitoring</b>	<ul style="list-style-type: none"> <li>▪ Effectively access and use information from Conservation International on the socio-economic context of the protected area (CI / Catzim et. al. 2009)</li> </ul>
<b>Specific Threats</b>	<ul style="list-style-type: none"> <li>▪ Develop baseline and monitor environmental impacts of Tobacco Caye and South Water Caye on the adjacent ecosystems</li> <li>▪ Develop rapid assessment mechanisms for assessing and monitoring impacts such as ship groundings, disease outbreaks, oil spills etc.</li> </ul>
<b>Database</b>	<ul style="list-style-type: none"> <li>▪ Maintain database of GIS data, research and monitoring information in order to enhance the level of coordination between researchers, help identify gaps in information, and to provide a platform from which the results can be communicated to a wider audience</li> </ul>
<b>Integration and Dissemination of Results</b>	<ul style="list-style-type: none"> <li>▪ Continue presenting monitoring results in annual reports, and integrate into the adaptive management cycle</li> <li>▪ Use available forums for dissemination of results (eg. workshops, conferences, Advisory Committee meetings etc.)</li> </ul>

### Long Term Atoll Monitoring Programme (LAMP)

This is a physical and biological monitoring program developed for Glover's reef Atoll, for commercial species, introduced by Acosta (2001), detailed in CARICOMP Methods Manual Levels 1 and 2 (March 2001 Edition) and in Acosta (2001).

- The CARICOMP component measures productivity of corals, sea urchins, sea grasses and mangroves, and follows the CARICOMP methodology. Parameters measured include:
  - meteorological (temperature, precipitation),
  - oceanographic (temperature, salinity, turbidity)
  - biotic productivity.
- The data is comparable to those collected in 22 countries in the region, and all data are housed at the CARICOMP Data Management Centre at UWI in Jamaica.
- Additional parameters measured include plankton sampling and fisheries surveys inside and outside the Conservation Zone of the reserve. Fisheries surveys include lobster, conch and five commercial finfish species.
- WCS is willing to assist in the training of staff in the techniques for carrying out the fisheries survey component of LAMP

### 3.5.3 Community Participation Programme

South Water Caye Marine Reserve has a number of mechanisms for encouraging community participation in reserve activities. There is stakeholder representation on the South Water Caye Marine Reserve Advisory Committee (SWCMRAC), which makes recommendations towards the management of the protected area. The Advisory Committee was appointed for the South Water Caye Marine Reserve several years ago, and has gone through a number of changes during that time. It is currently comprised of twenty one members, as detailed in Section 4.2.

The Advisory Committee is “responsible for making recommendations on decisions regarding the development of policies and issues affecting the management of the South Water Caye Marine Reserve, and plays a vital role in the success of the reserve, by providing strategic support to the reserve personnel, leading to improved management on the ground and the ultimate achievement of the reserve’s management objectives. It also acts as a mechanism for strengthening participation of fishermen in the management of the area, providing a mechanism for participation”.

#### **Socio-Economic Benefit Strategies for Stakeholder Communities**

Provision of alternative livelihoods options and skills training should focus on those communities most impacted by conservation management. The marine reserve staff should therefore work closely with the ongoing programmes of several NGOs (WCS, SEA, Green Reef, TNC and SACD), strengthening collaboration in stakeholder engagement and provision of socio-economic benefits. The Advisory Committee should be instrumental in identifying such activities, and liaising with the communities to be involved.

## South Water Caye Marine Reserve – Management Plan - DRAFT

Community Participation Activities 2010 - 2014	
<b>Communication Planning</b>	<ul style="list-style-type: none"> <li>▪ Develop a Communication Plan for dissemination of information to all stakeholder sectors, to the Advisory Committee, surveillance and enforcement and research partners, funding partners, and other Government agencies (especially Coast Guard, Port Authority, Department of the Environment, Forest Department and Department of Geology and Petroleum)</li> </ul>
<b>South Water Caye Marine Reserve Advisory Committee</b>	<ul style="list-style-type: none"> <li>▪ Continue the participation of SWCMRAC in the management of South Water Caye Marine Reserve, and ensure recommendations feed into the adaptive management process</li> <li>▪ Ensure SWCMRAC members are kept informed of reserve activities and have opportunities to actively participate in relevant management decisions</li> <li>▪ Ensure SWCMRAC members are included in the review of grant and research proposals relevant to South Water Caye Marine Reserve</li> <li>▪ Work with SWCMRAC to seek funds externally for filling critical management gaps – tourism infrastructure, stakeholder engagement etc.</li> </ul>
<b>Stakeholder Communities</b>	<ul style="list-style-type: none"> <li>▪ Ensure traditional fishermen are kept informed of reserve activities and management decisions affecting them</li> <li>▪ Further develop and implement socio-economic benefit strategies to increase opportunities for alternative livelihoods in stakeholder communities</li> <li>▪ Collaborate with local NGOs and CBOs in coastal fishing communities to engage fishing stakeholders in active participation in increased management effectiveness of fisheries resources</li> </ul>
<b>Residents</b>	<ul style="list-style-type: none"> <li>▪ Ensure resort owners / managers and other residents are kept informed of reserve activities and management decisions affecting them</li> </ul>
<b>Tour Guides</b>	<ul style="list-style-type: none"> <li>▪ Ensure tour guides operating in the South water Caye Marine Reserve are kept informed of reserve activities and management decisions affecting them</li> </ul>
<b>Participation in monitoring</b>	<ul style="list-style-type: none"> <li>▪ Involve fishermen in monitoring of commercial species</li> <li>▪ Develop mechanisms for tour guides to participate in monitoring activities of turtles, coral bleaching and lionfish</li> <li>▪ Engage caye residents in the monitoring of turtles and turtle nesting</li> </ul>
<b>Participation in Surveillance and Enforcement</b>	<ul style="list-style-type: none"> <li>▪ Continue developing collaboration with residents for participation in surveillance and enforcement activities</li> <li>▪ Successfully engage fishermen in surveillance and enforcement activities, with provision of training and equipment, and, where possible, encourage self-enforcement</li> </ul>

### 3.5.4 Public Use Programme

The Public Use Programme encompasses two primary activity areas: Visitor Management, and Interpretation and Education.

Public Use Activities 2010 - 2014	
Visitor Management	
<b>General Management</b>	<ul style="list-style-type: none"> <li>▪ Develop effective mechanisms for fee collection – booth in Dangriga and on Tobacco Caye</li> <li>▪ Maintain accurate visitor records (Local and International), as well as records of visitor activities, and any enforcement action needed in respect to tourism visitation</li> <li>▪ Maintain accurate records of sport fishing fees paid, and catch according to species, size, type of fishing, etc. in order to monitor this activity. Issue licenses according to the regulations and keep records</li> <li>▪ Install sufficient mooring buoys at key snorkel / dive sites</li> <li>▪ Work closely with Port Authority, Coast Guard and DoE towards mitigation of potential groundings including the installation of marker and mooring buoys where necessary for reducing boat impacts on reef</li> <li>▪ Designate and mark key “no wake” areas in collaboration with Port Authority</li> <li>▪ Develop conflict resolution mechanisms and in-house skills for dealing with public use conflicts</li> </ul>
<b>Awareness</b>	<ul style="list-style-type: none"> <li>▪ Ensure all Reserve staff are aware of the rules and regulations of the protected area</li> <li>▪ Ensure tour guides and tour operations using South Water Caye Marine Reserve are aware of management zones, and rules and regulations</li> <li>▪ Increase good practices awareness among dive groups through development and dissemination of information (eg. from Coral Reef Alliance (CORAL: <a href="http://www.coral.org">www.coral.org</a>))</li> <li>▪ Increase awareness of visitors on live-aboard boats of good practices, management zones and rules and regulations</li> <li>▪ Ensure all researchers are aware of the rules and regulations of the Marine Reserve, and research regulations under the Fisheries Department</li> <li>▪ Ensure visitors in independent sailboats visiting South water Caye Marine Reserve are aware of management zones and rules and regulations, mooring buoy locations and mooring regulations</li> <li>▪ Develop and produce laminated poster for distribution to resorts with map of South Water Caye Marine Reserve highlighting zones, regulations, major dive / snorkeling sites, and dive best practices</li> </ul>



<b>Public Use Activities 2010 - 2014</b>	
<b>Visitor Management (continued)</b>	
<b>Carrying Capacity</b>	<ul style="list-style-type: none"> <li>▪ Develop and implement strategies and actions to strengthen baseline data on resource use of the marine protected area</li> <li>▪ Work with residents of Tobacco Caye to develop a Sustainable Development Plan for Tobacco Caye based on the outputs of a carrying capacity assessment</li> <li>▪ Develop carrying capacities and Limits of Acceptable Change (or similar) for primary dive and snorkel sites</li> <li>▪ Produce and disseminate best practices guidelines for caye-based tourism operations and other residents. WCS guidelines are recommended</li> <li>▪ Best practices policies of no cats and dogs or introduced wildlife, minimizing the clearing of vegetation, restricting fogging against insects to only the inhabited areas, permitting native vegetation to re-colonize areas not utilized</li> <li>▪ Develop 'Best practices recognition' scheme for those cayes that follow best practices criteria</li> </ul>
<b>Surveillance and Enforcement</b>	<ul style="list-style-type: none"> <li>▪ Enforcement of mooring buoy regulations, fee payment and other regulations relevant to tourism activities</li> <li>▪ Enforce 'no take' regulations for tourists and tourism operations in the Conservation and Preservation Zones</li> <li>▪ Ensure primary dive / snorkel areas are defined by tour guides with markers when in use, to avoid boat injury to visitors</li> <li>▪ Ensure enforcement of all identified and marked 'no wake' zones</li> <li>▪ Ensure dive boats fly 'divers down' flag when divers are in the water</li> <li>▪ Ensure that dive boats follow the legislated dive:guide ratio of 8:1</li> </ul>
<b>Signs</b>	<ul style="list-style-type: none"> <li>▪ Ensure there are large, clear signs with a map of the Marine Reserve, positioned at departure points (eg. Dangriga, Tobacco Caye) including fees, zones and regulations</li> <li>▪ Ensure there are 'no wake' signs in areas of safety concern – eg. dive sites and primary snorkeling areas</li> </ul>

## **Education and Outreach**

All reserve personnel are responsible for the implementation of interpretation and education activities, under the leadership of the Reserve Manager. Other than a few educational materials and a very rudimentary Visitor Center, located in the Fisheries building, this has been one of the hardest programme areas to implement, and the programme requires significant strengthening. Three main components have been identified for development: a visitor center, educational and interpretive material, and an outreach programme. Although these activities will require significant time and effort, and the reserve personnel have limited resources and time to carry them, it is recommended that education and outreach should receive greater prioritization in the annual operational plans. Funding for capacity building in the areas of education and outreach has been approved under a PACT grant (I. Majil, pers. com., 2009).

**Public Use Programme Activities 2010 - 2014**

**Increasing Awareness of South Water Caye Marine Reserve**

<p><b>Visitor's Centre / Information Centre</b></p>	<ul style="list-style-type: none"> <li>▪ Establish Visitors Centre / Information Centre on Twin Caye or Tobacco Caye</li> <li>▪ Equip Visitors Centre / Information Centre with interpretive information designed to raise awareness of the environmental and socio-economic benefits and services of the Marine Reserve – investigate possibility of assistance with display material from Smithsonian Institute</li> <li>▪ Ensure relevant information on rules and regulations is available for dissemination to fishermen, tourists and other visitors</li> <li>▪ Include information on traditional fishing, stakeholder communities, research activities</li> <li>▪ Include information targeted specifically at fishermen, using it as a platform to inform fishermen about the ongoing research being carried out, and results of conch, lobster, coral and other surveys</li> <li>▪ Change some of the displays on a regular basis to ensure there are still items of interest to attract regular visitors</li> <li>▪ Seek funds for interpretive display creation</li> <li>▪ Include a small gift shop area in the Visitor's Centre / Information Centre, as an income generating project</li> </ul>
<p><b>Educational Material</b></p>	<ul style="list-style-type: none"> <li>▪ Ensure continued production and distribution of brochures on South Water Caye Marine Reserve</li> <li>▪ Translate brochure into Spanish for distribution to Spanish speaking fishermen and visitors</li> <li>▪ Develop PowerPoint presentation on South Water Caye Marine Reserve, for use in educational talks to visitors, in schools etc.</li> <li>▪ Disseminate SWC video to schools and other organizations, and arrange showings at regular intervals to relevant stakeholders</li> <li>▪ Produce laminated fieldguides to common corals, fish, caye plants, etc.</li> <li>▪ Develop a library of key publications and videos at the Visitors' Centre as a resource for Reserve staff, visitors, students and outreach programme. Copies of all published work on South Water Caye Marine Reserve should be available in this library.</li> </ul>
<p><b>Interpretive Trail</b></p>	<ul style="list-style-type: none"> <li>▪ Maintain the interpretive boardwalk being established on Twin Caye, and install interpretive signs</li> <li>▪ Provide additional interpretive information on Twin Cayes, and the terrestrial and marine life, as a self-guided leaflet</li> </ul>
<p><b>Website</b></p>	<ul style="list-style-type: none"> <li>▪ Produce South Water Caye Marine Reserve webpages for incorporation into Fisheries Department website</li> <li>▪ Ensure all awareness documents relevant to South Water Caye Marine Reserve are available for download from the website (brochures, leaflets, regulations, posters etc.)</li> <li>▪ Develop digital library of all published work on South Water Caye Marine Reserve, and make available, where feasible, for download on line</li> </ul>
<p><b>Advisory Committee</b></p>	<ul style="list-style-type: none"> <li>▪ Ensure Advisory Committee input into the development of education and interpretive information</li> </ul>

<b>Public Use Programme Activities 2010 - 2014</b>	
<b>Outreach</b>	
<b>Schools in Stakeholder Communities</b>	<ul style="list-style-type: none"> <li>▪ Presentations targeting primary and secondary schools in stakeholder communities on South Water Caye Marine Reserve and its environmental and socio economic benefits</li> <li>▪ Liaise and collaborate with local NGOs and other SBRC partners for joint educational outreach to schools in stakeholder communities</li> <li>▪ Develop handouts (coloring books, posters etc.) for dissemination during school presentations</li> <li>▪ Design and implement a day trip for high school biology students from stakeholder communities, targeting Year 2 or 3, aimed at engaging their interest in the marine environment</li> <li>▪ Collaborate with other marine reserves in joint education activities</li> </ul>
<b>Fishermen</b>	<ul style="list-style-type: none"> <li>▪ Fishermen visiting the Marine Reserve should be encouraged to visit the Visitor's Centre / Information Centre, and presented with a boat sticker showing support for the marine reserve as they leave</li> <li>▪ Presentations on research and monitoring results, and reserve activities should be given to traditional fishermen and in stakeholder communities at least twice a year</li> <li>▪ Presentations on work at South Water Caye Marine Reserve should be given during the Northern and National Co-operative AGMs at least once every two years</li> <li>▪ Reserve staff should work closely with fishermen during training exercises for monitoring activities and workshops to ensure accurate transfer of information on rationale behind research and monitoring activities</li> </ul>
<b>General Public</b>	<ul style="list-style-type: none"> <li>▪ Ensure there is awareness of South Water Caye Marine Reserve and the environmental services and benefits it provides to the general public through use of media opportunities and posters (focusing particularly on biodiversity protection, fisheries production and tourism)</li> <li>▪ Displays and exhibits should be placed at public shows such as the Agriculture &amp; Trade Show, Earth Day, etc.</li> </ul>
<b>Keeping Stakeholders Informed</b>	<ul style="list-style-type: none"> <li>▪ Produce an annual summary flier of reserve activities and achievements should be distributed to residents, tour guides, tour operators and fishermen – to include income and expenditures for transparency</li> </ul>

### **Visitor Management**

Under the recently revised legislation, visitor management and safety is, to some extent, the responsibility of the tour guides and tour operators, with regulations covering the need for certified guides and dive instructors, and the requirement for boat captains and dive guides to explain the rules of the Reserve to a diver within the Reserve(Figure ...).

However it is also recognized that there needs to be greater education of visitors and tour guides as to Best Practices for tourism use of the marine resources for sustainability, as outlined by the CORAL guidelines.

## **Protected Area Regulations – Visitor Management**

### **Dive Groups**

If carrying passengers to dive in Reserve, the captain/guide is responsible for the following

- (i) To acquaint passengers with the rules of the Reserve.
- (ii) To moor at the buoys provided when in the Conservation and General Use Zones.
- (iii) To fly the "divers down" flag during all dives.
- (iv) Only certified scuba divers or those undergoing an approved training course will be allowed to use scuba tanks"

### **Sport Fishing**

If carrying passengers to carry out sport fishing, the captain/guide is responsible for the following

- (i) To submit details to the Reserve Manager when requested, of catch and the area where fishing took place.
- (ii) To release fish wherever possible.

### **Regulations. South Water Caye Marine Reserve**



GOOD ENVIRONMENTAL PRACTICES  
**DIVING**



*Divers are some of the strongest and most effective advocates for coral reef conservation. Please follow these simple guidelines to become a "coral friendly" diver.*

**AS A RESPONSIBLE TOURIST**

- For your vacation, choose an environmentally friendly resort or hotel; one that practices energy conservation, recycles, and treats sewage and solid waste in responsible ways.
- Choose coral friendly dive operations that practice reef conservation by:
  - Giving environmental briefings.
  - Holding buoyancy control workshops.
  - Using available moorings.
  - Using available wastewater pump-out facilities.
  - Actively supporting local coral parks.
  - Participating in local conservation projects.
- Pay user fees or make a donation when visiting coral parks and other marine conservation areas.
- Avoid purchasing souvenirs made from coral, turtles or other marine life—this is often illegal, and it's never environmentally wise.
- Learn all you can about coral reefs—they are fascinating and fragile environments.



**IN THE WATER**

- Never touch corals; even a slight contact can harm them and some corals can sting or cut you.
- Carefully select points of entry and exit to avoid areas of reef.
- Make sure all your equipment is well-secured.
- Make sure you are neutrally buoyant at all times.
- Maintain a comfortable distance from the reef.
- Practice good finning and body control to avoid accidental contact with the reef or stirring up the sediment.
- Stay off the bottom and never stand or rest on corals.
- Avoid using gloves and kneepads in coral environments.
- Take nothing living or dead out of the water, except recent garbage.

Good divers know that the best way to enjoy a reef is to slow down, relax and watch as reef creatures go about their daily lives undisturbed.

Be sure to find out about local laws and regulations as they may differ from these general guidelines.



GOOD ENVIRONMENTAL PRACTICES  
**DIVING**



**MINIMIZE CONTACT WITH MARINE LIFE**

- Never chase, harass or try to ride marine life.
- Do not touch or handle marine life.



**PHOTOGRAPHY & VIDEOGRAPHY**

Divers need advanced diving skills to take pictures and video underwater. Photographic and video equipment is cumbersome and affects a diver's buoyancy and mobility in the water. It is all too easy to touch and damage marine life when concentrating on "the perfect shot."

**ON DIVE BOATS**

- Choose dive operations whose boats make use of available moorings—anchors and chains destroy fragile corals.
- Make sure garbage is well stowed, especially light plastic items and cigarette butts.
- Be sure to take away everything you brought on board, such as packaging, used batteries and bottles.



**SHORESIDE**

- Support coral parks and other conservation projects:
  - Visit established coral parks and pay applicable user fees that support marine conservation.
  - Encourage and support the use of dive moorings.
  - Participate in local initiatives to monitor the marine environment.
  - Participate in cleanups.
  - Make a donation or volunteer your skills to support a coral park. For example, you can participate in a reef survey, conduct outreach, or help educate others about coral reef conservation.
  - Donate used equipment such as cameras, dive gear or reef identification books.
- Speak up. Make sure your dive buddies understand these simple but important conservation practices.



The Coral Reef Alliance (CORAL) is a member-supported, non-profit international organization dedicated to keeping coral reefs alive around the world. Visit our website <http://www.coral.org>



Visit the Project AWARE Foundation website at [www.projectaware.org](http://www.projectaware.org) to find out more about protecting the aquatic environment and its resources.

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CORAL RP-104-2002





## SNORKELING



*Coral reefs are among the world's most spectacular ecosystems and snorkeling is an excellent way to explore them. As coral reefs face an increasingly uncertain future, snorkelers and other coral reef visitors can play an important role in helping protect these fragile habitats. Follow these simple guidelines to become a "coral friendly" snorkeler.*



## BEFORE SETTING OUT TO EXPLORE THE REEFS

- For your vacation, choose an environmentally friendly resort or hotel; one that practices energy conservation, recycles, and treats sewage and solid waste in responsible ways.
- Pay user fees or make a donation when visiting coral parks and other marine conservation areas.
- Get the best possible snorkeling instruction you can.
- Practice snorkeling skills away from the reef.
- Make sure your equipment fits properly before you snorkel near corals—it can be very difficult to adjust in the water.
- If you feel uncertain, or are an inexperienced snorkeler, consider wearing a snorkel vest for added buoyancy.
- Learn all you can about coral reefs—they are fascinating and fragile environments.



## IN THE WATER

- Never touch corals; even slight contact can harm them. Some corals can sting or cut you.
- Select points of entry and exit to avoid walking on corals.
- Maintain a comfortable distance from the reef, so as to avoid contact.
- Know where your fins are at all times and don't kick up sand.
- Stay horizontal in the water while you're near or above the reef.
- Learn to swim without using your arms.
- Take nothing living or dead out of the water except recent garbage which does not have living organisms on it.
- Move slowly and deliberately in the water—relax as you swim and take your time.
- Avoid using gloves in coral environments.
- Remember, look but don't touch.



Good snorkelers know that the best way to enjoy a reef is to slow down, relax and watch as reef creatures go about their daily lives undisturbed.

Be sure to find out about local laws and regulations as they may differ from these general guidelines.



## SNORKELING



## MINIMIZE CONTACT WITH MARINE LIFE

- Never chase, harass or try to ride marine life.
- Never touch or handle marine life.



## ON BOATS

- Choose snorkel operations whose boats make use of available moorings—anchors and chains destroy fragile corals.
- Make sure garbage is well stowed, especially light plastic items.
- Be sure to take away everything you brought on board, such as packaging, used batteries and bottles.



## SHORESIDE

- Support coral parks and other conservation projects:
  - Visit established coral parks and pay applicable user fees that support marine conservation.
  - Encourage and support the use of boat moorings.
  - Participate in local initiatives to monitor the marine environment.
  - Participate in cleanups.
  - Make a donation or volunteer your skills to support a coral park. For example, you can participate in a reef survey, conduct outreach, or help educate others about reef conservation.
  - Donate used equipment such as cameras, dive gear or reef identification books.
- Avoid purchasing souvenirs made from coral, turtles or other marine life—this is often illegal, and it's never environmentally wise.
- Speak up. Make sure your snorkeling buddies understand these simple but important conservation practices.



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Visit the Project AWARE Foundation website at [www.projectaware.org](http://www.projectaware.org) to find out more about protecting the aquatic environment and its resources.

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### 3.5.5 Infrastructure Management Programme

The Infrastructure Management Programme covers activities such as the future infrastructure, and equipment, and maintenance of present infrastructure (buildings, jetties etc.). In general, the infrastructure for the reserve headquarters is not in good condition, and needs substantial upgrading.

Power for the ranger station is supplied by solar panel and wind turbine, and a backup generator. The ranger station is also equipped with 24 hour communication system using telephone and VHF radio, cooking facilities and beds, but has limited communication, lacking internet.

The Marine Reserve has a 25 feet vessel equipped with a 60 hp outboard Yamaha engine and radio base station, for surveillance and enforcement activities.

A small Visitors Centre exists adjacent to the staff accommodation, though this is currently not in use. There should be discussion as to whether this is best situated on Twin Caye, or would have greater use and fulfill its purpose better if situated on Tobacco Caye.

For effective management, a second ranger station needs to be established in the southern half of the protected area, in the Pelican Cayes, where surveillance and enforcement activities are limited by distance.

Visitor facilities include 3 mooring buoys, placed at Tobacco Caye and South Water Caye, and used mainly by tourists with sail boats and catamarans. These buoys are serviced throughout the year.

Infrastructure Management Programme Activities 2010 - 2014	
Infrastructure and Maintenance	
<b>General Infrastructure and Maintenance</b>	<ul style="list-style-type: none"> <li>▪ Ensure adequate infrastructure for effective management</li> <li>▪ Ensure all infrastructure is maintained in good condition</li> <li>▪ Schedule maintenance checks - routine checks of the roof and gutters, painting of the building, replacement of rotten wood, etc.</li> </ul>
<b>Infrastructure Requirements</b>	<ul style="list-style-type: none"> <li>▪ Upgrade kitchen, dining area and bedrooms for increased use</li> <li>▪ Add office facilities and improve communications through installation of internet</li> <li>▪ Resolve Visitor Centre / Information Centre situation – complete development of Visitors Centre, or develop Information Centre in new location</li> <li>▪ Install signs at major departure points and on Tobacco Caye to inform visitors of Reserve regulations, and entrance fee</li> </ul>
<b>Equipment</b>	<ul style="list-style-type: none"> <li>▪ Purchase and maintain a butane freezer for evidence and use by staff</li> <li>▪ Acquire second boat and outboard motor for monitoring activities</li> <li>▪ Ensure sufficient diving equipment is available for Reserve staff</li> <li>▪ Schedule maintenance of outboards, the generator, dive equipment, mooring and marker buoys, and other equipment, and record servicing in log book, and implement</li> </ul>



### 3.5.6 Administrative Programme

The administration of the Marine Reserve is the responsibility of the Fisheries Department, under the Ministry of Agriculture and Fisheries. South Water Caye Marine Reserve is managed under the Ecosystems Management Unit of the Department, and the Reserve Manager reports directly to the Unit's Marine Protected Area Coordinator.

<b>Administration Programme Activities 2010 - 2014</b>	
<b>General Administration</b>	<ul style="list-style-type: none"> <li>▪ Ensure adequate equipment for effective management</li> <li>▪ Develop effective mechanism for collection and recording of entrance fees</li> </ul>
<b>Staff</b>	<ul style="list-style-type: none"> <li>▪ Develop an employee handbook, covering topics such as job duties, employee policies, transport policy, gender issues and a staff appraisal process</li> <li>▪ Equip staff with uniforms</li> <li>▪ Ensure the Reserve Manager is trained in marine resource management</li> <li>▪ Ensure staff have sufficient administrative training for effective general management, fundamental accounting, budget and proposal preparation</li> <li>▪ Ensure staff have sufficient surveillance and enforcement training to be effective</li> <li>▪ Ensure staff members are trained in operation and maintenance of reserve equipment (boat handling, outboard engine repair etc.)</li> <li>▪ Ensure staff have sufficient training in monitoring protocols for effective monitoring</li> <li>▪ Ensure staff are trained in conflict resolution, consensus building and communications skills</li> <li>▪ Ensure staff are trained in CPR, First Aid and use of the oxygen kit</li> <li>▪ Ensure on-site staff have adequate support</li> <li>▪ Annual evaluation of staff performance</li> <li>▪ Annual review of staff capacity and training requirements</li> </ul>
<b>Health and Safety</b>	<ul style="list-style-type: none"> <li>▪ Ensure an effective Hurricane Plan is in place, and staff trained in implementation</li> </ul>
<b>Administration Procedures</b>	<ul style="list-style-type: none"> <li>▪ Reserve Manager to develop Annual Report, for submission to MPA coordinator</li> <li>▪ Reserve Manager to submit budget request each December for the following financial year</li> <li>▪ Reserve Manager to develop Annual Operational Plan</li> <li>▪ Reserve Manager to report to SWCMRAC</li> </ul>
<b>Financial Sustainability</b>	<ul style="list-style-type: none"> <li>▪ Investigate and implement mechanisms for more effective fee collection</li> <li>▪ Develop and implement a Financial Sustainability plan for the marine reserve</li> </ul>

### 3.5.7 Management Policies

The Belize Fisheries Department has a number of policies in place or being developed, to guide management:

#### Enforcement Policy

The Fisheries Department has developed an Enforcement Plan as an official Fisheries Department policy to guide reserve staff through standardized procedures for approaching and apprehending people in contravention of the protected area regulations.

#### Hurricane Preparedness Plan

A Hurricane Preparedness Plan is in place (Fisheries Dept., 2002) to ensure protection of life and property during hurricane events, particularly with the distance of South Water Caye Marine Reserve to the mainland.

The main elements of the Plan include the following:

- During the ***preliminary alert phase***, the reserve building, equipment and files are to be secured and the reserve staff evacuated from their base on Twin Cayes, bringing the reserve boat to Belize City.
- The boat is to be secured at the Belize Defense Force Compound in Belize City.
- In the event that Belize City is the area to be affected by the storm, the reserve boat is to be taken to Dangriga, in coordination with the Glover's Reef Marine Reserve boat. The boats are to be secured inland.
- Once the ***All Clear*** is issued, all staff members are expected to report to work within four hours, provided it is during daylight hours and road conditions permit.

The current Hurricane Plan will be revised in the near future, and reserve staff will be apprised of any relevant changes. A sub-plan also needs to be prepared specifically for the reserve that provides clear details of the how the building and equipment will be secured (e.g. what priority items will be taken to the mainland) and what emergency supplies such as extra fuel, wood and nails, First Aid kit, etc. will be kept on hand. In addition, a specific location for the boat needs to be identified in the event that it is taken to Dangriga.

### **3.6 Evaluation and Review**

Monitoring and evaluation are integral components of any management system and annual evaluations of reserve management are recommended. In the revision of this management plan, the action areas are more specific, simplifying the process of monitoring success of implementation, and providing a mechanism for continual tracking of management activities, through annual review by the reserve manager, the MPA coordinator, and the Advisory Committee.

Management evaluation is also achieved by an assessment of management effectiveness. A recent national management effectiveness assessment is being conducted in 2009. Whilst not directly comparable with past assessments it will allow incorporation of adaptive management measures into the overall management of the protected area.

### **3.7 Timeline**

A timeline for activities is developed on an annual basis as part of the Annual Work Plan (Fisheries Department).

### **3.8 Financing**

The Manager is responsible for preparing the annual budget for the reserve and submitting it to the Fisheries Administrator for approval and onward submission to the Ministry. The budget is required to be submitted in December each year, in time to form part of the government's consolidated budget, which is generally announced in February or March.

Funds for basic operational costs, such as salaries and fuel, are provided by the Government of Belize, through the Fisheries Department. Non-operational costs, however, have to be sought by the Fisheries Department, through proposals to grant-giving organizations such as PACT to cover many of the associated costs of Reserve Management. South Water Caye Marine Reserve has also been selected as one of two protected areas within Belize to benefit from substantial MAR funding over the next five years.

#### **Financial Sustainability Plan**

Most marine protected areas need to develop a diverse portfolio of funding sources in order to achieve sustainable financing to cover their expenses. In Belize, these sources have traditionally included direct subventions from government, entrance fees, some sales, and grants from national and international donors. With a decreasing government budget, this

conventional source of financial support can no longer be depended on to significantly assist marine reserves. Other innovative sources and mechanisms for revenue generation will become increasingly essential.

To provide justification for the financing of the marine reserve, an economic or cost/benefit analysis of the protected area should be prioritized, and a Financial Plan has been highlighted as required for the reserve. This would determine the direct and indirect values of the reserve and compare these to the costs of management, including the opportunity costs (e.g. foregone fish catches from areas closed to fishing) (Morris 2002). Demonstrating that the value of the reserve can be clearly shown to outweigh the management costs is a powerful argument to justify the expenditures made in protecting the reserve area, and also in providing benefits for local people who have borne some opportunity costs by the establishment of the reserve.

### Entrance Fees

Several fees and licenses apply to resource use within the reserve. However, collection of fees (particularly entrance fees) has not, until recently, been systematic in terms of record keeping and regularity of implementation.

The fee collection system has been established since 2003, and is based on a manual ticket sale system by Reserve staff, with additional ticket sales through special agreement with tourism stakeholders on the mainland – Hamanasi, for example, keeps records of guests taken to South Water Caye Marine Reserve, and pays its entrance fees once a month, based on these records. Entrance fees go to a Fisheries Department fund, and are then available to marine protected areas for priority funding requirements.

<b>Table 33: Charges for licenses and tickets</b>	
<b>Licenses / Tickets</b>	<b>Legislated Fees</b>
Commercial fishing license	\$25/annum
Sport fishing (catch & release only)	\$20/month (Belizeans) \$50/month (non-Belizeans)
Research	\$500/annum
Dive boat registration	\$100/annum
Other water recreational activities (non-Bzn)	\$10/day or \$30/week

\*The \$25 is the national fishing license. No additional costs are levied on traditional fishermen using the Marine Reserve, though they should have their licenses stamped as covering South Water Caye Marine Reserve

## **Sales and Marketing**

With the increasing number of visitors visiting South Water Caye Marine Reserve, it would be advantageous to sell promotional and educational items such as T-shirts, booklets, postcards, etc., in the Visitors Centre, particularly if this is located on Tobacco Caye.

## **Donor Contributions**

A major source of funding is grants from both national and international agencies. For example, PACT (the Protected Area Conservation Trust) has been a contributor to the reserve in the past, and MAR Fund has selected South Water Caye Marine Reserve for future funding.

The placement of Belize's World Heritage Site on the list of those in 'Danger' also provides further leverage for accessing grant funds associated with the Belize Barrier Reef Reserve System.

Accessing international donor funds is becoming more and more competitive and the marine reserve will need to demonstrate effective management to be able to successfully compete. However, the recent shift of focus onto the Belize Barrier Reef, especially in its role as a World Heritage Site, has released new funding streams accessible especially for programmes such as increasing awareness and capacity building. Proposals to international donors (e.g. WWF, Summit Foundation, and Oak Foundation) need to be prepared and submitted. Advantage should be taken of other funding opportunities offered (e.g. through NOAA, UNEP, US National Fisheries and Wildlife Foundation (NFWF), IUCN, COMPACT etc.). Collaboration with other marine reserves and NGOs through joint proposals should also be considered. Small donations, too, are equally important

Other possibilities include developing partnerships with the private sector, primarily with the tourism businesses. Hotels or tour operators operating within the Marine Reserve depend on the health of the resources for their livelihood, and often use the marine reserve, and its status as a World Heritage Site, in their marketing and promotion. They can be encouraged to assist with reserve management through maintenance of mooring buoys etc.

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**APPENDIX 2:**

**STRATEGIES – SOUTHERN BELIZE REEF COMPLEX CAP OUTPUTS**

<b>Strategies - Southern Belize Reef Complex</b>	
<b>Objective 1</b>	<b>By 2013, illegal fishing activities within the SBRC will be reduced to a level comparable with the Gladden Spit Marine Reserve's 2008 level.</b>
Strategic action	Develop and implement public awareness programme
Strategic action	Implement / enforce policies & regulations
Strategic action	Implement an effective, standardized monitoring and data management programme for the SBRC area
Strategic action	Production of Annual state of the park / SBRC reports including monitoring / research output for SBRC area
Strategic action	Create an alternative livelihood program for fisher folk within the SBRC
<b>Objective 2</b>	<b>By 2013, 15% of current and 75% of future coastal developments impacting the SBRC will meet Environmental Impact Assessment, Environmental Compliance Plan and best practices standards, with independent monitoring in place</b>
Strategic action	Develop or adopt best practices guidelines and certification programmes relating to coastal developments, and engage relevant stakeholders for implementation
Strategic action	Lobby CZMAI, local and national Gov. Representatives and agencies for policy and zoning for the SBRC area
Strategic action	Implement / enforce policies & regulations
Strategic action	Implement an effective, standardized monitoring and data management programme for the SBRC area
Strategic action	Production of Annual state of the park / SBRC reports including monitoring / research output for SBRC area
Strategic action	Develop and implement public awareness programme
<b>Objective 3</b>	<b>By 2013, all marine protected areas within SBRC will be able to obtain 50% of their annual budget through a secured diversified funding base - user fees, government, endowment, concessions, and environmental tax</b>
Strategic action	Develop and implement financial sustainability mechanisms
Strategic action	Lobby CZMAI, local and national Gov. Representatives and agencies for policy and zoning for the SBRC area
Strategic action	Develop and implement public awareness programme

<b>Objective 4</b>	<b>By 2013, the level of agricultural contamination impacting the SBRC will be reduced from 2008 levels, through collaboration with other organizations and agencies that influence agro-chemical use and application</b>
Strategic action	Ensure support of initiatives towards reducing agrochemical contamination of runoff into SBRC
Strategic action	Implement an effective, standardized monitoring and data management programme for the SBRC area
Strategic action	Production of Annual state of the park / SBRC reports including monitoring / research output for SBRC area
Strategic action	Develop and implement public awareness programme
Strategic action	Implement / enforce policies & regulations
Strategic action	Lobby CZMAI, local and national Gov. Representatives and agencies for policy and zoning for the SBRC area
Strategic action	Develop or adopt best practices guidelines and certification programmes relating to coastal developments, and engage relevant stakeholders for implementation
<b>Objective 5</b>	<b>By 2013, the management agencies of the SBRC will have the legal framework and institutional capacity to undertake effective management of marine resources</b>
Strategic action	Review and enhance administrative structure of co-management institution
Strategic action	Engaging APAMO/NPAC in completing the development of the legal co-management framework and standard co-management agreement.
Strategic action	Development of mechanisms for integrating local participation and capacity building of local expertise
Strategic action	Implement / enforce policies & regulations
Strategic action	Develop and implement financial sustainability mechanisms
Strategic action	Implement an effective, standardized monitoring and data management programme for the SBRC area
Strategic action	Production of Annual state of the park / SBRC reports including monitoring / research output for SBRC area
<b>Objective 6</b>	<b>By 2015, at least 50% of coral reefs and mangroves resilient to climate change located within the SBRC will be effectively protected.</b>
Strategic action	Develop and implement coral reef and mangrove restoration programmes
Strategic action	Lobby CZMAI, local and national Gov. Representatives and agencies for policy and zoning for the SBRC area
Strategic action	Identify and protect nursery grounds (for all marine species) from extraction / damage
Strategic action	Implement / enforce policies & regulations
Strategic action	Implement an effective, standardized monitoring and data management programme for the SBRC area
Strategic action	Develop and implement public awareness programme
Strategic action	Production of Annual state of the park / SBRC reports including monitoring / research output for SBRC area

<b>Objective 7</b>	<b>By 2019, 20% of the current area of degraded littoral forest &amp; sandy beaches within the SBRC will be restored</b>
Strategic action	Implement a restoration process for littoral forest and beach communities
Strategic action	Identify and protect nursery grounds (for all marine species) from extraction / damage
Strategic action	Lobby CZMAI, local and national Gov. Representatives and agencies for policy and zoning for the SBRC area
Strategic action	Develop or adopt best practices guidelines and certification programmes relating to coastal developments, and engage relevant stakeholders for implementation
Strategic action	Implement / enforce policies & regulations
Strategic action	Implement an effective, standardized monitoring and data management programme for the SBRC area
Strategic action	Develop and implement public awareness programme
<b>Objective 8</b>	<b>By 2019, populations of commercial / recreational species are increased by 20% from current stock assessments as a result of effective management</b>
Strategic action	Conduct an assessment of the fish stock within the SBRC
Strategic action	Implement / enforce policies & regulations
Strategic action	Identify and protect nursery grounds (for all marine species) from extraction / damage
Strategic action	Implement an effective, standardized monitoring and data management programme for the SBRC area
Strategic action	Create an alternative livelihood program for fisher folk within the SBRC
Strategic action	Develop and implement coral reef and mangrove restoration programmes
Strategic action	Production of Annual state of the park / SBRC reports including monitoring / research output for SBRC area
Strategic action	Develop and implement public awareness programme
<b>Objective 9</b>	<b>By 2019, populations of fish at Spawning Aggregation Sites will be stabilized &amp; sustained within the SBRC through good resource-use practices</b>
Strategic action	Implement / enforce policies & regulations
Strategic action	Lobby CZMAI, local and national Gov. Representatives and agencies for policy and zoning for the SBRC area
Strategic action	Identify and protect nursery grounds (for all marine species) from extraction / damage
Strategic action	Create an alternative livelihood program for fisher folk within the SBRC
Strategic action	Implement an effective, standardized monitoring and data management programme for the SBRC area
Strategic action	Production of Annual state of the park / SBRC reports including monitoring / research output for SBRC area
Strategic action	Develop and implement public awareness programme

<b>Objective 10</b>	<b>By 2019, the condition and extent of coral reef communities will be improved by 10%, through development and implementation of a coral reef restoration programme and associated public awareness activities</b>
Strategic action	Implement / enforce policies & regulations
Strategic action	Identify and protect nursery grounds (for all marine species) from extraction / damage
Strategic action	Develop and implement public awareness programme
Strategic action	Develop and implement coral reef and mangrove restoration programmes
Strategic action	Create an alternative livelihood program for fisher folk within the SBRC
Strategic action	Implement an effective, standardized monitoring and data management programme for the SBRC area
Strategic action	Production of Annual state of the park / SBRC reports including monitoring / research output for SBRC area
<b>Objective 11</b>	<b>By 2014, all marine protected areas within the Southern Belize Reef Complex will have at least 20% of their area designated as no-take</b>
Strategic action	Lobby CZMAI, local and national Gov. Representatives and agencies for policy and zoning for the SBRC area
Strategic action	Develop and implement public awareness programme
Strategic action	Implement / enforce policies & regulations
Strategic action	Implement an effective, standardized monitoring and data management programme for the SBRC area
<b>Objective 12</b>	<b>By 2010, all petroleum-associated activities -transportation, exploration and extraction - within SBRC will comply with international and national environmental regulations and safety standards</b>
Strategic action	Lobby for creation / adoption of navigation and oil exploration / extraction standards as needed, and enforce all such regulations
Strategic action	Develop or adopt best practices guidelines and certification programmes relating to coastal developments, and engage relevant stakeholders for implementation
Strategic action	Implement / enforce policies & regulations
Strategic action	Lobby CZMAI, local and national Gov. Representatives and agencies for policy and zoning for the SBRC area
Strategic action	Develop and implement public awareness programme
Strategic action	Create and adopt Contingency Plan for oil spills within the SBRC

## APPENDIX 3:

### SCIENTIFIC PUBLICATIONS

#### *Scientific Publications from Carrie Bow Caye* Caribbean Coral Reef Ecosystems Program

- Achatz, J.G., M.D. Hooge, and S. Tyler (2007). Convolutidae (Acoela) from Belize. *Zootaxa* 1479: 35-66.
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