



Management Plan (2018-2023) Volume One

GLADDEN SPIT SILK CAYES MARINE RESERVE

BACKGROUND, TECHNICAL SECTIONS, & APPENDICES



Protected Area Data Sheet		
Date	July 18, 2018	
Name of Protected Area	Gladden Spit Silk Cayes Marine Reserve	
Location of Protected Area	Southern Belize Reef Complex (Stann Creek District)	
Date of establishment	May 2000 (SI 68 of 2000) * Spawning Aggregation Site (SI 162 of 2003)	
Size of Protected Area	26,000 acres (10,523 ha) Conservation Zone 378 acres (153 ha) General Use Zone 25,622 acres (10,370 ha)* * includes the overlapping Gladden Spit 1,280 acres (518 ha)	
Land Tenure	Silk Cayes – national land and private land	
Management Authority	Southern Environmental Association	
Affiliations/ Partnerships with other organizations	Government of Belize (under Co-Management Agreement)	
Number of Staff	Permanent: 16	Temporary: 12
Annual Budget (BZ\$) for management of protected area	c. BZ\$\$165,169.84 (This is the average for 2017-2018)	
Designation	Marine Reserve: <ul style="list-style-type: none"> • IUCN Category IV (NPAPSP designation, 2005) • IUCN Category VI (recommended realignment) 	
Reasons for Designation	To allow for extractive/non-extractive use, and conservation protection, with use concentrating on sustainable fishing, tourism, research and education.	
Brief Details of Past Funding	Mix of donor agency, private donation and funding via domestic sources (e.g., PACT), private foundations (e.g., Oak) and international conservation organizations, plus self-generated income.	
Brief Details of Present Funding	As above	
Brief Details of Future Funding	Self-generated income prioritized, supplemented by donor/charitable support.	
List the primary protected area objectives:		
1. Effectively manage the natural resources of Gladden Spit and Silk Cayes Marine Reserve, with the participation of all stakeholders.		
2. Effectively manage the commercial marine resources for sustainability, and for the benefit of traditional users of the Marine Reserve.		
3. Effectively manage recreational opportunities for environmental sustainability, visitor appreciation and socio-economic benefit to local stakeholders.		
4. Effectively manage the spawning aggregations for sustainability of commercial fish stocks and individual species.		
5. Provide opportunities for interpretation, education and increased awareness of the Marine Reserve and its environmental services.		

6. Effectively manage the natural resources of Gladden Spit and Silk Cayes Marine Reserve, with the participation of all stakeholders.

List the top two most important threats to the protected area (and indicate why these were chosen):

Erosion and loss of vegetation, which could eventually result in disappearance of the Silk Cayes, and loss of turtle and bird nesting sites at the Silk Cayes, respectively.

Human impacts (tourism-related and overfishing), which may cause irreversible impacts to whale shark presence and bird/turtle nesting, and reduction of commercial fish species (grazers and other species), respectively.

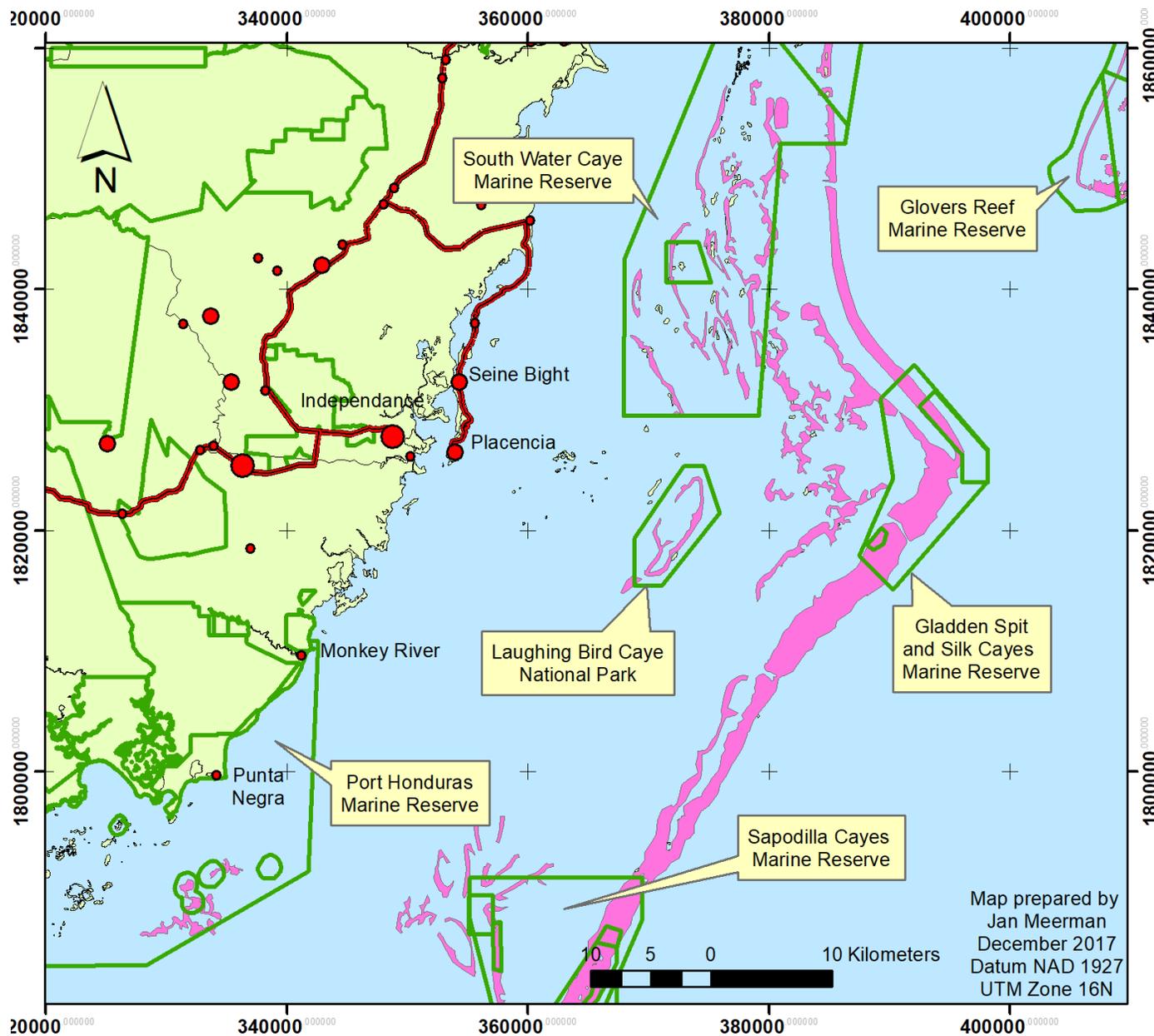
List the top two critical management activities:

Resource mobilization strategy – ecotourism to give secure/reliable budgetary underpinning to sustain conservation management programmes.

Minimize visitor use impacts on the Marine Reserve (particularly the Silk Cayes) by implementing carrying capacity management recommendations.

Name/s of assessors and people consulted: Osmany Salas, Valentino Shal, Dr. Robin Coleman, and Jan Meerman in consultation with senior SEA administrative and field staff.

Contact details: Arreini Palacio-Morgan, Executive Director, SEA, Placencia Village, Stann Creek District.



Legend

POPULATION

- 0-800
- 800-3,000
- 3,000-7,000
- 7,000-25,000
- 25,000-70,000

Roads

- Paved Road
- ▭ Protected Area

ECOSYSTEM

- Coral reef
- Mainland Belize

Map prepared by
Jan Meerman
December 2017
Datum NAD 1927
UTM Zone 16N

ACKNOWLEDGEMENTS

Special appreciation goes to the staff members of the Southern Environmental Association and, in particular, the Executive Director, Arreini Palacio-Morgan, for going beyond the call of duty to support our work throughout the management planning process.

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Special mention goes to Petrona Coy and the rest of SEA's office and field staff for providing other relevant information that was required.

We extend our appreciation to the various GSSCMR stakeholders, in particular fishermen and tour guide representatives, who contributed some of their valuable time to share their ideas, views, concerns and aspirations pertaining to the management of the GSSCMR. Your dynamic participation at the various meetings was invaluable to the planning effort, and resulted in the updating of the GSSCMR management plan for the next five years and beyond.

And last but certainly not least, we extend our gratitude to the Protected Areas Conservation Trust for its financial support.

Thank you,

praxi5 Advisory Group Ltd.

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ACRONYMS

BAS	Belize Audubon Society
BFD	Belize Fisheries Department
BTIA	Belize Tourism Industry Association
CARICOM	Caribbean Community and Common Market
CARICOMP	Caribbean Coastal Marine Program
CBD	Convention on Biological Diversity
CC	Climate Change
CCAD	Comisión Centroamericana para el Desarrollo
CCRE	Caribbean Coral Reef Ecosystems Program
CITES	Convention of the Regulation of International Trade of Endangered Species
CSME	Caribbean Community Single Market and Economy
DOE	Department of the Environment
ECP	Environmental Compliance Plan
EIA	Environmental Impact Assessment
FAMRACC	Forest and Marine Reserves Associations of Caye Caulker
FD	Forest Department
FOSC	Friends of Swallow Caye
FON	Friends of Nature
GDP	Gross Domestic Product
GSSCMR	Gladden Spit and Silk Cayes Marine Reserve
IUCN	International Union for Conservation of Nature
LAMP	Long-term Atoll Monitoring Program
LBCNP	Laughing Bird Caye National Park
MBRS	Mesoamerican Barrier Reef Systems
MPA	Marine Protected Areas
NPASP	National Protected Areas Policy and System Plan
PA	Protected Areas
PACT	Protected Areas Conservation Trust
SACD	Sarteneja Alliance for Conservation Development
SBRC	Southern Belize Reef Complex
SEA	Southern Environmental Association
SI	Statutory Instrument
SPAG	Gladden Spit Spawning Aggregation
TASA	Turneffe Atoll Sustainability Association
TAMR	Turneffe Atoll Marine Reserve
TASTE	Toledo Association for Sustainable Tourism and Empowerment
TIDE	Toledo Institute for Development and Environment
UTM	Universal Transverse Mercator

1. INTRODUCTION

1.1. Background and Context

Gladden Spit and Silk Cayes Marine Reserve (GSSCMR) was originally established in May 2000 following lobbying from Friends of Nature (FoN), a local, community based organization, for the protection of the Gladden Spit spawning aggregation site, the congregating whale sharks, and the tourism value of the Silk Cayes. Statutory Instrument (SI) 68 of 2000 designated the area as a Marine Reserve and defined the boundaries of the General Use and Conservation Zones. The regulations for the Marine Reserve were legislated three years later (SI 95 of 2003) as was the overlapping, seasonally protected Gladden Spit spawning aggregation site.

The primary focus of the Marine Reserve is the spawning aggregation site, located along one of the best developed sections of the Belize Barrier Reef, a unique geological promontory that drops to a depth of 250 m to the east, resulting in the water current conditions required for the highest priority spawning aggregation site in Belize. Gladden Spit and Silk Cayes Marine Reserve is world famous for the whale sharks that congregate at the Gladden Spit promontory.

The idyllic sand beaches of the Silk Cayes, the shallow clear waters, vibrant coral reefs and prolific sea grass provide habitats for many marine species. These islands are also an increasingly important tourism destination. For ten days after the full moon of each lunar cycle between March and June, the whale sharks gather, feeding on the spawn produced by thousands of fish that form the Gladden Spit spawning aggregation (SPAG). Many of these are commercially important species that support the traditional fishing industry in Belize.

To the west, the shallow lagoon is protected behind the barrier reef, and is considered an excellent example of a barrier reef platform. Situated on this platform within the Marine Reserve are the Silk Cayes - three sand cayes (Northern, Middle and South Silk Caye) that change shape with each major tropical storm that sweeps the area, with the core components of fore-reef (with extensive spur and groove formation), reef-crest, and back-reef all being present. Sea grass beds, important for connectivity and for the maintenance of commercial species such as conch, lie in the shallow back-reef lagoon. These ecosystems support many marine species important for both the commercial fishing and tourism industries as well as species of international concern (critically endangered, endangered or vulnerable (IUCN, 2018)) – including the Hawksbill turtle, goliath grouper and whale shark.

The Marine Reserve has clear zones embedded in the legislation that allow for extractive/non-extractive use, and conservation protection, with use concentrating on sustainable fishing, tourism, research and education.

The management regime has changed from a volunteer base under Friends of Laughing Bird Caye to the more organized FoN, to a merger of FoN and Toledo Association for Sustainable Tourism and Empowerment (TASTE) to form the Southern Environmental Association (SEA). SEA is responsible for day-to-day management of the Reserve, including activities such as patrols and fee collections.

1.2. Purpose and Scope of Plan

Gladden Spit and Silk Cayes Marine Reserve is one of three protected areas managed by SEA, and a component of the Southern Belize Reef Complex. The purpose of this five year management plan is to provide a framework for the sustainable use of the GSSCMR's natural resources and to provide guidance to SEA and the Belize Fisheries Department towards effective management of the Marine Reserve and the associated spawning aggregation site.

Since the establishment of the Marine Reserve, and development of the first management plan in 2003 (Friends of Nature, 2003), the level of use of the protected area and the status of the resources have changed, and the knowledge base has improved from the interim years of research and data collection. Over the years, the management plan has been revised based on the expansion of the knowledge base with the most recent plan being the 2011-2016 GSSCMR Management Plan (Wildtracks, 2011).

The 2011-2016 Management Plan provides very detailed information on the physical and biological aspects of the Marine Reserve. This five-year (2018-2022) Management Plan serves to update the 2011-2016 plan by incorporating new knowledge on environmental and socio-economic trends, and emerging management issues based on literature reviews, a Rapid Ecological Assessment, field visits to the site and a series of meetings and workshops with stakeholders.

The Management Plan was developed based on the National Guidelines for Development of a Management Plan (National Protected Areas Policy and System Plan (NPASP), 2005). The plan has three main sections. The Current Status section includes information on the national, global and regional context of the Marine Reserve, as well as the physical and biological attributes and cultural and socio-economic values. The Conservation Planning section

summarizes the process and results of identifying and prioritizing conservation targets and climate change assessment outputs. The Management Planning section defines the management goals of the Marine Reserve and outlines specific management programmes and objectives including the means for measuring management effectiveness.

The Management Plan has been developed using a participatory approach and prepared with the input of the various stakeholders through meetings with SEA staff, a series of workshops with key stakeholders, and interviews with a wide variety of individuals, including fishermen, the tourism sector, management staff and researchers.

2. CURRENT STATUS

2.1. Location

Gladden Spit and Silk Cayes Marine Reserve is located on the Barrier Reef (UTM 389 135 N, 1819 200 W (16°27'08.04"N, 88°02'25.35"W), 36 km offshore, east of the village of Placencia, in the Stann Creek District (Figure 1). Encompassing a total of 10,523 ha, the area is zoned and demarcated by buoys. Conservation Zone 1, 153 ha surrounding Middle Silk Caye, is a no take zone, and the main focus of tourism activities. The remainder of the Marine Reserve is designated as a General Use Zone, open to regulated fishing activities.

The General Use Zone is utilized by fishermen from central Belize (Hopkins to Monkey River) primarily during the spawning aggregations and opening of lobster and conch seasons. The area is also used by fishers from the northern communities - Sarteneja, Chunox and Copper Bank – who fish from sailboats throughout the year, free diving for lobster and conch.

The sand beaches and shallow, clear waters of the two other Silk Cayes (North and South), are also important features of the area, attracting heavy day-tourism use, primarily for snorkeling.

There are no permanent settlements within the Marine Reserve, but a number of communities exist on the mainland to the west on the southern coastal plain – primarily Placencia, Riversdale, Hopkins, Sittee River, Independence, Big Creek and Seine Bight - that utilize the resources of the Marine Reserve.

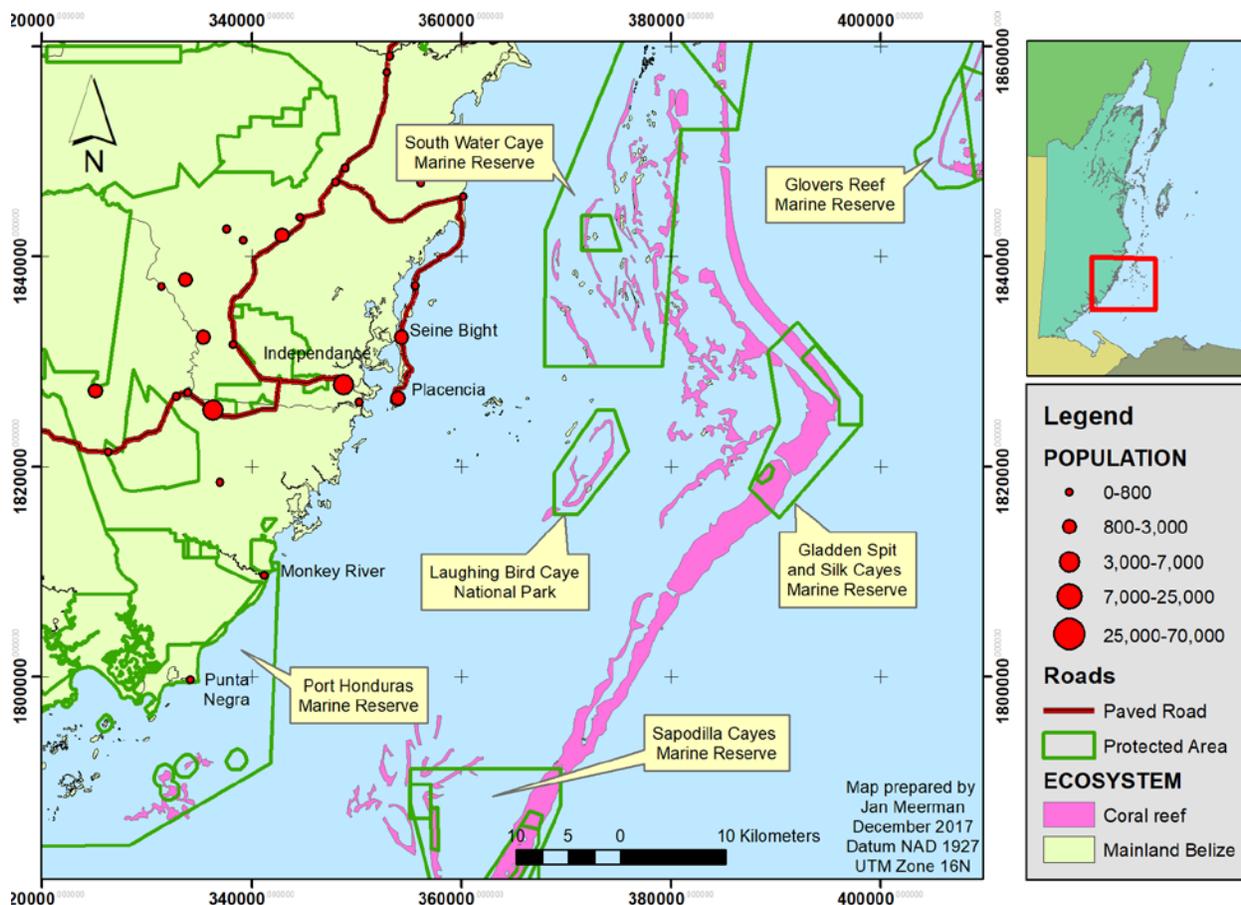


Figure 1: Gladden Spit and Silk Cayes Marine Reserve (General Location)

2.2. Global and Regional Context

Gladden Spit and Silk Cayes Marine Reserve is part of the Meso-American Reef (MAR), which stretches for more than 1,000 km along the coast of Belize, Guatemala, Honduras and Mexico. One of the most diverse ecosystems on earth, the MAR is considered outstanding on a global scale, and a priority for conservation action, 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, in GSSCMR Management Plan – 2011-2016).

Belize has an estimated 1,420 km² of reef within its waters - 5.5% of the reefs of the Wider Caribbean (World Resources Institute, 2005). The Belize Barrier Reef is included on a list of 18 richest centres of endemism and has been highlighted as one of the most threatened by human impacts (Roberts *et al.*, 2002). The recent Mesoamerican Reef Report Card (McField *et al.*, 2018) shows that of the 94 sites studied along the Belize Barrier Reef, only 12% of sites are

in good condition, while 29% are in fair condition; 59% of the sites are in poor or critical condition. However, the Southern Belize Reef Complex, within which GSSCMR is located, has seen an overall improvement of reef health compared to the previous Report Card. The 2018 results are as follows: 12% live coral cover, 22% fleshy macroalgae cover, 2,002g/100m² commercial fish, and 4,194 g/100m² herbivorous fish. This is the only reef sub-region in Belize that is in good condition with a Reef Health Index (RHI) of 3.8. The Southern Barrier Reef Complex also has the highest RHI in the entire Mesoamerican Reef region (Mesoamerican Reef Report Card, 2018). See Section 2.3.1 for more information about the Southern Belize Reef Complex.

The GSSCMR is highlighted as an eco-regional priority for conservation planning efforts (World Wildlife Fund, 2002), particularly for the role of the spawning aggregations in the maintenance of regional commercial fish stocks – one of the most active and viable in the region (Heyman & Requena, 2002). It is also recognized for the global importance of the whale shark congregation and feeding area. The Marine Reserve contains assemblages of regionally important ecosystems of remarkable biodiversity and beauty, as well as of great scientific value, and importance for many species of global conservation concern, among them the critically endangered hawksbill turtle (*Eretmochelys imbricata*) and goliath grouper (*Epinephelus itajara*), and the endangered green turtle (*Chelonia mydas*). The no-take area, whilst small, also contributes towards the regional viability of important commercial species, including the Queen Conch (*Strombus gigas*) and spiny lobster (*Panulirus argus*).

Belize has been a signatory to a number of regional and international conventions. In 1983, Belize signed the **Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region** (the ‘Cartagena Convention’) with the primary objective of protecting the ecosystems of the marine environment, following recognition of the regional importance of the Mesoamerican Barrier Reef System (MBRS), the majority of which lies within Belizean waters (Table 1). 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.

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 internationally. The Belize Fisheries Department has

developed a sustainable use strategy for this species, in order to maintain its export market. Belize is also a signatory to the **Treaty of Chaguaramas** which establishes the Caribbean Community (CARICOM) and the Caribbean Community Single Market and Economy (CSME).

Table 1: International Conventions and Agreements of Relevance to GSSCMR

Convention	Description and Relevance to Gladden Spit and Silk Cayes Marine Reserve (GSSCMR)
<p>Convention on Biological Diversity (Rio de Janeiro, 1992) Ratified in 1993</p>	<p>To conserve biological diversity to promote the sustainable use of its components, and encourage equitable sharing of benefits arising from the utilization of natural resources. <i>GSSCMR 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></p>
<p>Alliance for the Sustainable Development of Central America (ALIDES) (1994)</p>	<p>Regional alliance supporting sustainable development initiatives. <i>Initiatives under the Southern Environmental Association within the stakeholder communities of GSSCMR are targeted for facilitation of sustainable economic and environmental development, with the support of Fisheries Department</i></p>
<p>Central American Commission for Environment and Development (CCAD) (1989)</p>	<p>Regional organization of Heads of State formed under ALIDES, responsible for the environment of Central America. Initiated Mesoamerican Biological Corridors and Mesoamerican Barrier Reef Systems Programmes. <i>Data gathered through monitoring initiatives GSSCMR have been shared regionally in the past through MBRS.</i></p>
<p>Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (Cartagena de Indias, Colombia, 1983)</p>	<p>Regional convention with the objective of protecting the marine environment of the Wider Caribbean through promoting sustainable development and preventing pollution. <i>GSSCMR is an important and integral part of the national protected areas system, protecting biodiversity and threatened species, as per Belize’s commitment under this Convention.</i></p>

Convention	Description and Relevance to Gladden Spit and Silk Cayes Marine Reserve (GSSCMR)
International Convention for the Protection and Conservation of Sea Turtles for the Western Hemisphere (December 21, 1997)	To protect and conserve sea turtle species of the Western Hemisphere. <i>GSSCMR protects important feeding area for sea turtles, including the Critically Endangered hawksbill</i>
The UN Convention on the Law of the Sea (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.
Caribbean Community (CARICOM) (Revised Treaty of Chaguaramas, 2001)	Promotes economic and social development in the Caribbean through regional cooperation and integration of the economies of state parties as the Caribbean community. Includes provisions for management of natural resources.
Caribbean Regional Fisheries Mechanism (CRFM) Agreement (2002)	Targeted at the efficient management and sustainable development of marine and other aquatic resources, as well as cooperative management of shared/migratory resources.
Organizacion del Sector Pesquero y Acuicola del Istmo Centroamericano (OSPESCA)	To promote the coordinated and sustainable development of fisheries and aquaculture as part of the Central American integration process.

2.3. National Context

2.3.1 Legal and Policy Framework

National Framework

Belize has an impressive record of establishing protected areas, with a total of 103 protected areas within the National Protected Areas System (NPASP, 2015). 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 objectives are guided by the National Strategy on Biodiversity, through the National Biodiversity Strategy and Action Plan (Jacobs and Castaneda, 1998) (though this was never ratified at Government level), and the updated National Protected Areas System Plan (NPASP, 2015).

The overall goals of both the National Biodiversity Strategy and the NPASP reflect the national objectives – ecological and economic sustainability over the long-term, with the development of human and institutional capacity to effectively manage the biodiversity resources within Belize. The management of these resources has also been largely decentralized, with a strong focus on co-management partnerships (such as that between SEA and the Fisheries Department), community-based participation and equitable benefit from conservation efforts.

Box 1: NPASP Statement, 2015

The National Protected Areas System Plan reflects the Constitution of Belize and is founded on the need to ensure that biodiversity conservation becomes an important and integral part of national social and economic development. The guiding principle is to ensure that the potential contribution of the protected areas system to national development and poverty alleviation is maximized, thereby putting it on a sound and rational footing.

Gladden Spit and Silk Cayes Marine Reserve is an important component of Belize’s strategies for conservation of the marine environment. Whilst the entire Barrier Reef and associated coral reef structures do not have full protected status within Belize, there are 14 marine protected areas within the system. Nine of these, including Gladden Spit and Silk Cayes Marine Reserve, are designated under Fisheries Department as Marine Reserves, the remaining five being under Forest Department (Table 2). The Fisheries Department has also established 11 protected Spawning Aggregation Sites – the majority of the sites known within Belize waters, and a further 2 have seasonal protection for Nassau Grouper.

Table 2: Marine Protected Areas in Belize

Marine Protected Areas in Belize				
Protected Area	Mgmt. / Co-mgmt.	IUCN Category	SI	Area (Acres)
Bacalar Chico National Park & Marine Reserve	Fisheries Dept.	IV	88 of 1996	15,765.8
Blue Hole Natural Monument	Forest Dept. / BAS	III	96 of 1996	1,023
Caye Caulker Marine Reserve	Fisheries Dept. /FAMRACC	VI	35 of 1998	9,670.2
Corozal Bay Wildlife Sanctuary	Forest Dept.	IV	48 of 1998	180,508.5

Marine Protected Areas in Belize				
Protected Area	Mgmt. / Co-mgmt.	IUCN Category	SI	Area (Acres)
Gladden Spit and Silk Cayes Marine Reserve	Fisheries Dept. /SEA	IV	95 of 2003	25,978.3
Glover's Reef Marine Reserve	Fisheries Dept.	IV	70 of 1996	86,653
Half Moon Caye Natural Monument	Forest Dept. / BAS	II	30 of 1982	9,771
Hol Chan Marine Reserve	Fisheries Dept.	II	57 of 1987	3,813
Laughing Bird Caye National Park	Forest Dept. / SEA	II	94 of 1996	10,119
Port Honduras Marine Reserve	Fisheries Dept. / TIDE	IV	9 of 2000	100,000
Sapodilla Caye Marine Reserve	Fisheries Dept.	IV	117 of 1996	38,594
South Water Caye Marine Reserve	Fisheries Dept.	IV	118 of 1996	117,875
Swallow Caye Wildlife Sanctuary	Forest Dept. / FOSC	IV	102 of 2002	8,972
Turneffe Atoll Marine Reserve	Fisheries Dept. / TASA	IV	95 of 2003	25,978.3

National Planning Strategies

Under the National Protected Areas System Plan, the Government of Belize seeks to increase management effectiveness through grouping protected areas into system level management units. GSSCMR is one of four protected areas that together form the Southern Belize Reef Complex, transcending site-level administrative categories (Figure 2). Also covered within the scope of the SBRC are four legally protected critical spawning aggregation sites – the three sites within the Sapodilla Cayes Marine Reserve and Gladden Spit.

Two other such system-level units are currently being established to increase management effectiveness by reducing overlap and maximizing on synergies – the Maya Mountains Massif and the Maya Mountains Marine Corridor (Table 3; Figure 2).

Conservation Planning initiatives for these system level management units

recognize that resources exist in a larger landscape beyond the boundaries of the protected areas themselves, and set out discrete goals and objectives at system rather than site-level, increasing management effectiveness through the development of mechanisms for collaboration for surveillance and enforcement, biodiversity monitoring, education, outreach, and management.



System Level Management Units	
	Maya Mountains Massif
	Maya Mountains Marine Corridor
	Southern Belize Reef Complex

Figure 2: System Level Planning Units

Table 3: System Level Management Units

System Level Management Units	
System Level Management Unit	Protected Areas
<p>Southern Belize Reef Complex</p> <p><i>Total number of PAs: 4 (including Spawning Aggregation Sites)</i> <i>Total PA area: 182,447 acres</i> <i>Total seascape area: 779,682 acres</i></p>	<p>Laughing Bird Caye National Park; South Water Caye Marine Reserve, Gladden Spit and Silk Cayes Marine Reserve, Sapodilla Cayes Marine Reserve Spawning Aggregations: Rise and Fall Bank, Nicholas Caye, Seal Caye, Gladden Spit Bird Sanctuary: Man O' War Caye</p>
<p>Maya Mountains Massif</p> <p><i>Total number of PAs: 14</i> <i>Total PA area: 1,260,800</i> <i>Total landscape area: 1,260,800 acres</i></p>	<p>Bladen Nature Reserve; Chiquibul Forest Reserve; Chiquibul National Park; Cockscomb Basin Wildlife Sanctuary; Columbia River Forest Reserve; Deep River Forest Reserve; Maya Mountain Forest Reserve; Mountain Pine Ridge Forest Reserve; Noj Kaax Me'en Elijio Panti National Park; Sibun Forest Reserve; Sittee River Forest Reserve; Victoria Peak Natural Monument; Vaca Forest Reserve; (also includes Caracol Archaeological Site/IOA)</p>
<p>Maya Mountain Marine Corridor</p> <p><i>Total number of PAs: 10</i> <i>Total PA area: 619,933 acres</i> <i>Total landscape area: 729,630 acres</i> <i>Total seascape area: 100,000 acres</i></p>	<p>Bladen Nature Reserve; Chiquibul Forest Reserve; Chiquibul National Park; Cockscomb Basin Wildlife Sanctuary; Columbia River Forest Reserve; Deep River Forest Reserve; Maya Mountain Forest Reserve; Mountain Pine Ridge Forest Reserve; Noj Kaax Me'en Elijio Panti National Park; Sibun Forest Reserve; Sittee River Forest Reserve; Victoria Peak Natural Monument; Vaca Forest Reserve; (also includes Caracol Archaeological Site/IOA)</p>

The Southern Belize Reef Complex

The **Southern Belize Reef Complex** (SBRC) stretches southwards from the northern boundary of South Water Caye Marine 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 (Figure 3). 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 scientific value and importance for many species of conservation concern, including the critically endangered hawksbill turtle (*Eretmochelys imbricata*) and goliath grouper (*Epinephelus itajara*), and the endangered green turtle (*Chelonia mydas*) (IUCN, 2018).

The SBRC encompasses Gladden Spit and Silk Cayes Marine Reserve and three other marine protected areas - Sapodilla Cayes Marine Reserve, South Water Caye Marine Reserve and Laughing Bird Caye National Park. Laughing Bird Caye National Park, Sapodilla Cayes Marine Reserve and South Water Caye Marine Reserve are part of a serial nomination of seven sites that are recognized as components of the Belize Barrier Reef System - World Heritage Site, representing classic examples of fringing, faro and barrier reefs. Also covered within the scope of the SBRC are four legally protected critical spawning aggregation sites – the three sites within the Sapodilla Cayes Marine Reserve, and Gladden Spit, the largest aggregation known in the Mesoamerican Reef ecoregion.

Within the SBRC, the estuarine and coastal areas are considered important for the West Indian Manatee, whilst the sandy beaches have a history of use as nesting sites for all three marine turtle species. The near shore mangrove nursery areas and seagrass are regionally important for recruitment for a significant number of the commercial marine species. These resources are an integral part in the support of the cultural traditions of the coastal fishing communities.

As part of the Southern Belize Reef Complex, management of Gladden Spit and Silk Cayes Marine Reserve needs to be aligned to the SBRC vision, with the SBRC goals and objectives for system level management being incorporated into the management planning process.

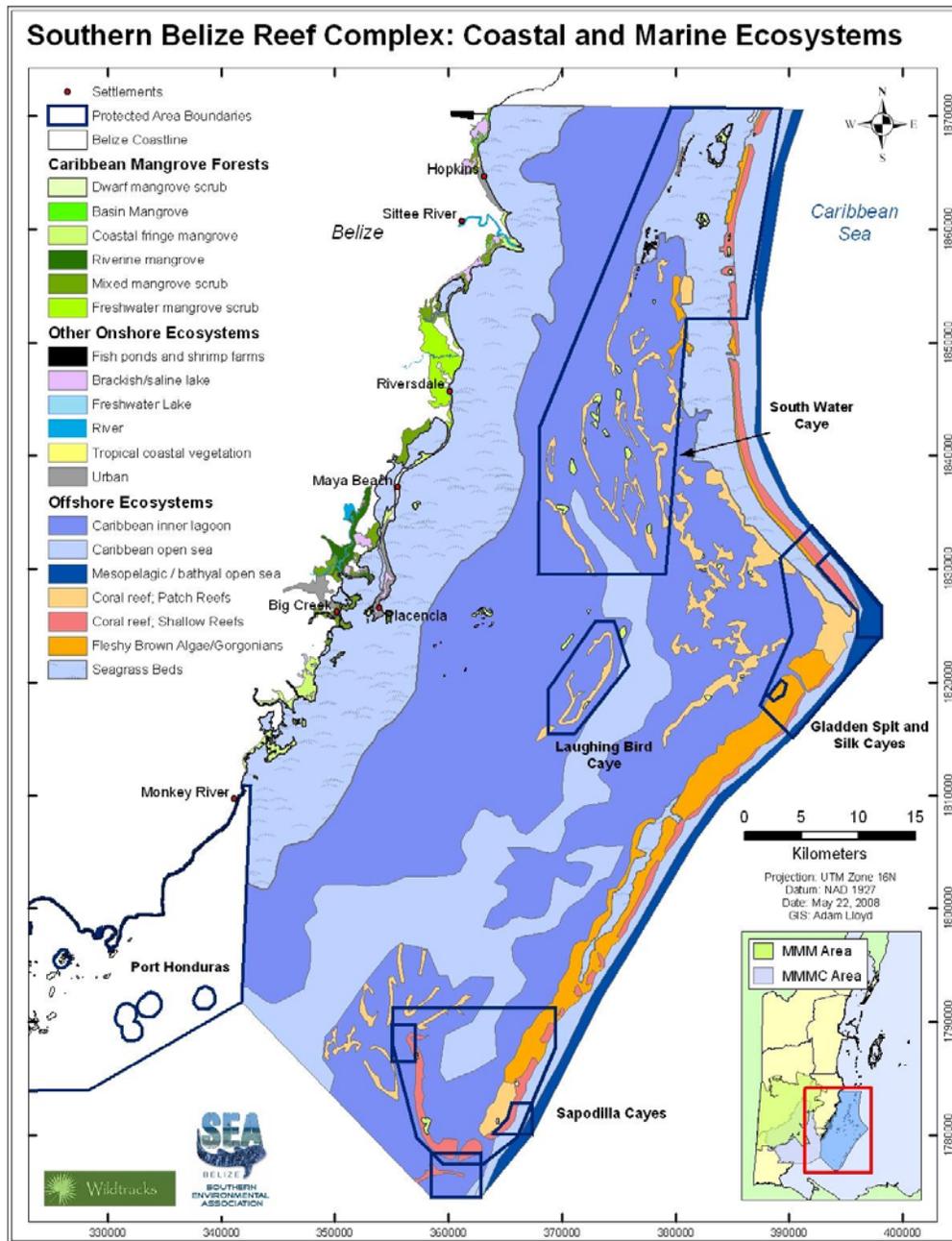


Figure 3: Southern Belize Reef Complex

Legal Framework

The conservation framework of Belize is supported by a number of laws designed to protect wildlife and national heritage within the country. The **National Protected Areas System Act** (2015), is responsible for the establishment and management of protected areas (including Gladden Spit and Silk Cayes Marine Reserve). This Act provides for “the maintenance of coordinated management of a system of protected areas that is representative of internationally agreed categories, effectively managed, ecologically based, consistent with international law, and based on best available scientific information and the principles of sustainable development for the economic, social and environmental benefit of present and future generations of Belize”. The Act repeals the National Parks System Act (CAP 215, Revised Edition 2011) and amends the Fisheries Act (CAP 210, Rev Ed 2011) and the Forests Act (CAP 213, Rev Ed 2011).

The **Maritime Act** claims sovereignty over the territorial sea of Belize, including the airspace and the seabed. The **Fisheries Act** (currently revised as the Aquatic Resources Living Act (2012), administered under the Fisheries Department, is the principal governing legislation to regulate the fishing industry, and is directly concerned with management and sustainable use of marine resources and conservation of the marine and freshwater environments. It also provides protection for nesting turtles and nest sites (SI 66 of 2002). Marine turtles themselves have been given protection since the original Fisheries Ordinance in 1940. A number of statutory instruments also provide more specific protection for some species, for example Nassau grouper and parrotfish. The **Sport Fishing** regulations (SI 114 and 115 of 2009) serve to better manage the sport fishing species in Belize, and specifically addresses the three major sport fish – bonefish, tarpon and permit. These species can only be caught under ‘catch and release’ fishing methods.

The **Forest (Protection of Mangrove) Regulations** (SI 52 of 1989, revised 2010) provide for the protection of mangroves, with restrictions on mangrove alteration and/or clearance. 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 ‘that the proposed alteration will not significantly lower or change water quality’ or that the degradation of water quality is in the "larger and long-term interest of the people of Belize" (Chapter 213, Section 5.5, Belize's Forest Act).

The **Wildlife Protection Act** (CAP 220, Revised Edition 2010) falls under the

Forest Department, and addresses the need to protect wildlife resources, primarily terrestrial wildlife, but also a number of marine species (West Indian Manatee and dolphins).

The **Environmental Protection Act** (CAP 328, Rev Ed 2011) was drawn up under the Department of the Environment (DoE) with the aim of ensuring that development initiatives within Belize are planned for minimum environmental impact. In the context of Gladden Spit and Silk Cayes Marine Reserve, this is particularly important when ensuring that the impacts on the protected area from development in adjacent areas are minimized – particularly dredging.

Caye development is regulated through the requirement for an Environmental Impact Assessment (EIA), under the associated **Environmental Impact Assessment Regulations** (SI 105 of 1995) which controls and regulates the EIA process. Under this legislation, an accepted EIA results in the production of an Environmental Compliance Plan (ECP), which is then to be approved and monitored by the DoE. The DoE is also responsible for responding to human impacts on the reef, such as pollution, boat groundings and fuel spills. DoE has a mechanism in place for assessment of damage from boat groundings, based on the area impacted.

The **Mines and Minerals Act** (CAP 226, Rev Ed 2011) and the **Petroleum Act** (CAP 225, Rev Ed 2011) regulate the exploration and extraction of all non-renewable resources, including petroleum.

The **Petroleum Operations (Maritime Zone Moratorium) Act** of 2017 was enacted effective December 29, 2017. This Act imposes an indefinite moratorium on the exploration for and exploitation of petroleum and other petroleum operations in the maritime zone of Belize.

The Port Authority is mandated to ensure the safety of navigational channels, through the installation of navigational aids (**Belize Port Authority Act**, 1976; revised, 2003) and installation and maintenance of demarcation buoys. 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 partially addressed at Government level through the development of a funding mechanism to assist in management and development activities within protected areas – the Protected Areas Conservation Trust (**PACT Act**, 1996), through a ‘conservation tax’ of Bz \$7.50 levied on non-residents as they leave the country. The Southern Environmental Association, as the co-

management partner, is eligible for funding from the Trust, and has received funding in the past.

There is currently significant fragmentation in decision making, with these different Acts falling under different Ministries. This is being partially addressed through the implementation of the **National Protected Areas System Plan** (NPASP, 2015), currently guided by the National Protected Areas Secretariat, and passage of the National Protected Areas System Act (see above), which repealed and replaced the National Parks System Act.

Site Status

Gladden Spit and Silk Cayes Marine Reserve is a national protected area, established in 2000 (SI 68 of 2000) under the **Fisheries Act** (1948), the SI including two management zones – the General Use Zone and the Conservation Zone. The area is designated as a ‘Marine Reserve’ under the mandate of the Belize Fisheries Department (Ministry of Fisheries, Forestry, the Environment and Sustainable Development). The protected area is currently managed by the Southern Environmental Association and Belize Fisheries Department, through a co-management agreement. The Marine Reserve designation is considered to be equivalent to **Category IV: – A Habitat/Species Management Area**, with active management targeted at conservation through management intervention (NPAPSP, 2005; IUCN, 1994).

SI 68 of 2000 designated the area as a Marine Reserve and defined the boundaries of the General Use and Conservation Zones. A series of rules and regulations established in 2003 (SI 95 of 2003) guide both tourism related and commercial fishing practices within the protected area (Appendix 1). The Marine Reserve also includes one of the eleven legislated spawning aggregation sites established under SI 161 of 2000 (Table 4), and considered vital for the maintenance of Belize’s commercial finfish stocks. The Southern Environmental Association, in partnership with Fisheries Department, is responsible for all management activities for the marine protected area and the spawning aggregation sites.

Table 4: Spawning Aggregation Sites Protected under SI 161 of 2003

Spawning Aggregation Sites Protected under SI 161 of 2003			
Protected Area	Location / Affiliated Management Unit	Adjacent to/within MPA	Area (Acres)
Rocky Point	Bacalar Chico Marine Reserve / BFD / Green Reef	Yes	1,402
Dog Flea Caye	Turneffe / BFD	No	1,424
Caye Bokel	Turneffe / BFD	No	1,402
Sandbore	Lighthouse Reef / FD / BAS	No	1,288
South Point Lighthouse	Lighthouse Reef / FD / BAS	No	1,378
Emily/Caye Glory	South Water Caye Marine Reserve / BFD	No	1,351
Northern Glover's	Glover's Reef / BFD	Yes	1,779
Gladden Spit	Gladden Spit and Silk Cayes Marine Reserve/ BFD/SEA	Yes	1,280
Rise and Fall Bank	Sapodilla Cayes Marine Reserve / BFD / SEA	Yes	4,250
Nicholas Caye	Sapodilla Cayes Marine Reserve / BFD / SEA	Yes	1,664
Seal Caye	Sapodilla Cayes Marine Reserve / BFD / SEA	Yes	1,600
BAS: Belize Audubon Society; BFD: Belize Fisheries Department; FD: Forest Department			

2.3.2 Land and Sea Tenure

Gladden Spit and Silk Cayes Marine Reserve is a national protected area, included in Belize's territorial waters (Maritime Areas Act, CAP 11, Rev. Ed. 2011). The seabed is national land and therefore 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 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 regulations and zones.

2.3.3 Evaluation of Protected Area

Global Importance

GSSCMR was declared in recognition of the importance and unique nature of the Gladden Spit spawning aggregation site and the natural beauty of the Silk Cayes. The aggregation site itself is the site of remarkable spawning aggregations, and has been extensively studied. Spawning behavior has been recorded in over twenty species of reef and near shore pelagic fish species.

Gladden Spit is also one of the few locations in the world known to have predictable aggregations of whale sharks (*Rhincodon typus*), which feed on fish spawn during April, May and June and visit the area year round.

The protected waters of the reserve provide nursery and feeding habitats for at least twenty nine species of international concern recognized under the IUCN Redlist as Critically Endangered, Endangered, Vulnerable or Near Threatened (Table 5; IUCN, 2018). The reserve also protects the three small sandy Silk Cayes - popular destinations for day trips from Placencia.

Table 5: GSSCMR Species of International Concern

GSSCMR Species of International Concern	
Critically Endangered	
Staghorn Coral	<i>Acropora cervicornis</i>
Elkhorn Coral	<i>Acropora palmata</i>
Goliath Grouper	<i>Epinephelus itajara</i>
Hawksbill Turtle	<i>Eretmochelys imbricata</i>
Endangered	
Green Turtle	<i>Chelonia mydas</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>
Scalloped Hammerhead	<i>Sphyrna lewini</i>
Whale Shark	<i>Rhincodon typus</i>

GSSCMR Species of International Concern	
Vulnerable	
Lamarck's Sheet Coral	<i>Agaricia lamarcki</i>
Loggerhead Turtle	<i>Caretta caretta</i>
Rough Cactus Coral	<i>Mycetophyllia ferox</i>
Pillar Coral	<i>Dendrogyra cylindrus</i>
Elliptical Star Coral	<i>Dichocoenia stokesii</i>
Montastraea coral	<i>Montastraea franksi</i>
West Indian Manatee	<i>Trichechus manatus</i>
White Grouper	<i>Epinephelus flavolimbatus</i>
Snowy Grouper	<i>Epinephelus niveatus</i>
Hogfish	<i>Lachnolaimus maximus</i>
Cubera Snapper	<i>Lutjanus cyanopterus</i>
Yellowmouth Grouper	<i>Myctoperca interstitialis</i>
Whiteline Toadfish	<i>Sanopus greenfieldorum</i>
Near Threatened	
Queen Triggerfish	<i>Balistes vetula</i>
Marbled Grouper	<i>Dermatolepis inermis</i>
Mutton Snapper	<i>Lutjanus analis</i>
Rainbow Parrotfish	<i>Scarus guacamaia</i>

National Importance

Gladden Spit and Silk Cayes Marine Reserve protects Gladden Spit, a promontory formed when the reef makes an almost ninety degree turn about 40 km off the coast of Placencia. This site has been fished by local fishermen since the 1920s but has risen to prominence in recent years due to the seasonal presence of whale sharks at the spawning site, and its socio-economic value to local communities as a tourism attraction. Over the past ten years, whale shark tourism has become a major part of Belize's tourism economy.

The Gladden Spit spawning site is world renowned in its diversity with over

twenty species of reef fish and near shore pelagics including jacks, grouper and snapper- observed displaying spawning behavior. These spawning events and the whale sharks they attract have drawn international attention and have been featured on a number of prominent documentaries. The Southern Environmental Association has worked closely with the Belizean authorities and community members to ensure careful management of the spawning aggregation including the development of specific tourism guidelines and fishing regulations.

Gladden Spit and Silk Cayes Marine Reserve has an estimated yearly use value of approximately BZ\$2.50 million per year to the tourism industry, and provides over BZ\$136,000 (US\$68,000) in ticket revenue (in GSSCMR Management Plan – 2011-2016). Diving, snorkeling and whale shark tourism is a major draw for many visitors to Placencia, and other parts of southern Belize, with over 12,375 guests visiting in 2017. GSSCMR is also of economic importance as a lobster, conch and fin-fish resource for traditional fishermen from mainland fishing communities - particularly Sarteneja, Hopkins, Placencia and Monkey River. Although the small cayes within the reserve boundaries are uninhabited, many of the cayes surrounding the reserve have been and continue to be used as fishermen’s camps.

The GSSCMR, as part of the Southern Belize Reef Complex (SBRC), contributes to the variety of reef structures, important cross-shelf habitat linkages and an assemblage of ecosystems considered possibly the most biodiverse in the region. GSSCMR itself protects a number of high quality coral reefs including some large stands of critically endangered staghorn (*Acropora cervicornis*) and elkhorn (*Acropora palmata*) corals. Endangered hawksbill and green turtles frequent the reserve along with dolphins and a variety of ray and shark species. The small Silk Cayes also provide protected nesting sites for various Terns (*Sterna spp.*), Laughing Gull (*Leucophaeus atricilla*) and the Caribbean subspecies of Osprey (*Pandion haliaetus ridgwayi*).

2.3.4 Socio-Economic Context Update

Belize has a rich diversity of peoples, languages and cultures and has the distinction of being the only country in Central America whose official language is English. The total land area is almost 22,860 km² with the population estimated to be around 387,879 inhabitants (Figure 4). Belize is also home to the second largest barrier reef in the world with more than 100 small cayes located offshore.

The region in which Belize now exists was once part of the Maya civilization which was at its height between 250–900 A.D. The descendants of this civilization are

now subdivided into three ethnic groups – the Yucatec Maya of the north and west, the Mopan and Q’eqchi Maya of the south. The northern coastal fishing communities are based on the Mestizo culture, being settled in the 1850’s by refugees from the Caste War of Yucatan, Mexico. Communities in central Belize, particularly those of the Belize River Valley, are predominantly Creole, founded by descendants of slaves brought to Belize direct from Africa, or via the West Indies, to work in the logging industry in the late 1700/early 1800s. The southern coastal communities are more Garifuna based (descendants of Black African/Carib), being settled by refugees who sailed from St. Vincent in the Caribbean to the coast of northern Honduras, southern Guatemala and southern Belize.

There was a significant influx of Central American refugees during the late 1980’s when countries in the region were going through civil wars. Most of those immigrating to Belize come primarily from Guatemala, El Salvador and Honduras. Many Guatemalans and Hondurans also come to Belize as seasonal workers in the banana and citrus industries based in the Stann Creek District. Many of course, don’t return to their home country but rather settle in Belize permanently.

Figure 4: National Social and Economic Indicators

Population and Social Indicators	
Area (sq.km.)	22, 860
Adult literacy rate, 15 and up (percent), 2010	75.1
Human development index (rank), 2014	101
Population (thousands), Sep. 2015	378
Unemployment rate, September, 2016	11.1
GDP per capita, (current US\$), 2015	4,698
Life expectancy at birth (years), 2014	73.7
Access to improved water sources (% of population), 2012	99.3
Under-five mortality rate (per thousand), 2013	17
Poverty (%of total population), 2009	42

Source: World Bank, 2018

Belize has a small open economy of about BZ\$3 billion that is supported primarily by natural resources with major sectors being agriculture (citrus, sugar, bananas, fisheries), manufacturing (including petroleum) and tourism (tertiary sector). The mining/petroleum sector enjoyed a robust but short growth over the period 2006 to 2011 having discovered oil in commercial quantities in 2005. Since the start of petroleum extraction in 2006 the value of exports rose from BZ\$77.0 million to BZ\$203.2 million in 2008. Oil production however has now levelled off and is rapidly declining. Over the last 30 years Belize’s economy has been slowly shifting over from “traditional” commodity exports to service exports. For instance, oil and tourism went from 1% of total exports at the time of Independence to approximately 60% thirty years later in 2010 (in GSSCMR Management Plan 2011-2016).

Tourism is now one of the main engines of growth in the Belizean economy and the principal source of foreign exchange. It is estimated that more than 25% of the employed labour force is related to or driven by this particular sector. In 2015, the overnight tourism industry experienced an overall growth of 6.2% or 19,900 over 2014. Cruise tourism has also become an important feature of the overall industry. In 2015, there was a total of 957,975 cruise passenger arrivals recorded. This was only slightly lower compared to 2014 (Belize Tourism Board (BTB), 2018). Overnight tourism also shows a distinct seasonality, with the majority of visitors arriving in the first quarter of the year. The lowest months are September and October, the main tropical storm season. This is reflected in the visitation to the Gladden Spit and Silk Cayes.

Only a small percentage of these visitors (less than 1%) make it to Gladden Spit and Silk Cayes Marine Reserve, primarily as day visitors. The majority of visitors are snorkelers and divers, with a small number of kayaking groups, and provide substantial employment opportunities for local guides and tourism developments on the mainland. Gladden Spit and Silk Cayes Marine Reserve, with its dual benefits of idyllic cayes in crystal clear waters, is an important tourism attraction in Belize. The once popular Whale Shark watching has significantly declined as a touristic activity as Whale Sharks have largely become absent from the area.

Placencia, the main departure point for tours to GSSCMR, started as a small fishing community with 10 hotels (with 58 beds) in 1988, and has since developed into a major tourism destination, with 155 hotels (with 1,416 beds) (BTB, 2016) by 2016 . Reef based tourism now provides substantial employment opportunities for local guides, tour operators and tourism developments on the mainland. In 1994, tourism in Placencia provided an estimated 19 people with direct employment, steadily increasing to 429 in 2008. By 2016, an estimated 1,399 persons were working in the tourism industry in Placencia clearly indicating a significant shift from fishing to a tourism-based economy. Placencia accounts for 12.9% of the BZ\$245 million generated by the accommodations sector nation-wide.

Similarly, the fisheries sector (capture fisheries), though small, remains an important part of Belize's economy. In 2017, the sector brought in approximately BZ\$15.2 million to the local economy which is significant but much lower than the BZ\$29 million contributed in 2012.

Most of the benefits obtained go to coastal fishing communities who are active in harvesting marine resources. The majority of the fishers that use the Gladden Spit and Silk Cayes Marine Reserve originate from the mainland central

communities of Placencia, Independence and Monkey River and to a lesser extent, Riversdale. Fishers from the northern coastal community of Sarteneja are also major users, and to a lesser extent, neighbouring Copper Bank and Chunox.

There seems to be a decline in the overall contribution of the fisheries sector to the national economy. In 2012, fisheries contributed about 2.9% to Belize's Gross Domestic Product (GDP) which is significantly lower when compared to 5% in 2003. Figures released by the Belize Fisheries Department reveal a 0.45% decline in the total lobster production for Belize for 2014 – 2015 season when compared to that of the 2013-2014 season. In 2017, the fisheries sector produced approximately 1,648,434 lbs of seafood products including conch and lobster. The Spiny Lobster remains as one of the top marine exports for Belize, with earnings for the 2017-2018 season amounting to an estimated BZD\$11.4 million. This represents a total of 958,490.27 lbs of lobster head meat, lobster tail and whole lobster. According to the Fisheries Department lobster production has remained relatively stable over the past 28 years within the production range of 400,000 – 600,000 lbs of lobster tails. Most of the production is exported to United States of America. Total fishery earnings (export and local) were \$25.95 million in 2011 and \$15.1 million in 2017 (Belize Fisheries Department, 2018).

According to the Fisheries Department reports, most of the export product comes from the northern waters of Belize, while the majority of the product fished in Placencia, Ambergris Caye and Caye Caulker was consumed as tourism products instead of being exported by the national market. This means that fisheries helps to maintain the tourism industry in the central region where the GSSCMR is located. The fishing sector that utilizes Gladden Spit and Silk Cayes Marine Reserve is part of traditional industry that provides employment for an increasing number of person. There were over 2,759 licensed fishermen in 2012, compared to 1,731 licensed fishermen in 2004.

Fishing techniques vary, with the more southerly communities using hand lines for finfish, particularly the traditional fishers permitted to use the spawning aggregation sites during the spawning season. There is a switch to free-diving for spiny lobster and queen conch at the opening of lobster and conch seasons, though some fishermen use shade and traps. Fishermen from the northern communities focus more on lobster and conch, and fish these more intensively during the open season, throughout the shallow protected lagoon of the Belize Barrier Reef, including Gladden Spit and Silk Cayes Marine Reserve. Fishermen tend to be between 15 and 35 years of age, often with limited education. Alternative job opportunities in many of these coastal communities, particularly those of the north, are limited, with many fishermen leaving primary school to go directly into fishing (in GSSCMR Management Plan 2011-2016).

Due to its location within the Gulf of Honduras, Gladden Spit experiences significant impact from Honduran and, to a lesser extent, Guatemalan fishermen, who, whilst fishing illegally, are still in a sense stakeholders due to their impact on the protected area and whose activities needs to be addressed. Their incursions predominantly occur at night, and are part of organized businesses operating out of these neighboring countries. SEA has increased its monitoring of these incursions, especially at night, with the support of the Belize Coast Guard. Placencia is just one of eight communities that have been identified as major stakeholders in the protected area, directly through tourism and/or commercial fishing (Table 6).

Table 6: Stakeholder Communities of GSSCMR

Community	Location (UTM) Distance (km)	Population (approx.)	Population components	Comments
Placencia - includes Riversdale	E16 03653894 N18 26544 (16 km west)	1,753	Predominantly Creole	Historically a fishing community – now a primarily tourism based economy. Main promoter and user of GSSCMR. (Includes Riversdale).
Sarteneja	E16 0378750 N18 29500 (210 km north)	1,824	Mestizo	Largest fishing community, concentrating on lobster and conch throughout Belize waters using traditional sail boats. Largest number of fishermen utilizing the SBRC.
Independence	E16 0348723 N18 27872 (20 km west)	4,014	Mixed primarily Creole	Primarily a residential area for employees in Placencia and Big Creek, and in the citrus industry. Some tourism, mostly associated with Placencia, and a small number of fishermen, who target the areas around GSSCMR.
Seine Bight	E16 0363200 N 18 64680 (20 km west)	1,310	Garifuna	Historically a fishing community – now moving towards a tourism-based economy.
Hopkins	E16 0363200 N18 64680 (25 km north)	1,610	Garifuna	No traditional or recent use of GSSCMR, but benefits from participation in SEA educational activities.
		439	Predominantly	Fishing community gradually

Sittee River	E16 0363200 N18 64680 (13.3km)		Creole	shifting to tourism. Current impacts on manatee population – illegal slaughter for meat (2010).
Monkey River	E16 0341187 N18 09691 (km)	196	Predominantly Creole	Fish the aggregation sites and at start of open season and at start of open season for lobster and conch.
Belize Housing and Population Census Country Report, 2010.				

A basic stakeholder analysis identifying stakeholder interests and impacts is presented below in Table 7.

Table 7: Stakeholder Analysis for GSSCMR

Stakeholder Analysis for Gladden Spit and Silk Cayes Marine Reserve				
Stakeholder	Influence or Impact of Gladden Spit and Silk Cayes on Stakeholder		Influence or Impact of Stakeholder on Gladden Spit and Silk Cayes Marine Reserve	
Community Stakeholder Hopkins, Sittce River, Seine Bight, Riversdale, Placencia, Monkey River, Independence, Sarteneja	Management of reef for tourism and as a fisheries source area	+	Active cooperation and collaboration of tourism and fisheries stakeholders towards effective protected areas management	+
	Providing community residents with an opportunity to shift income base from fisheries dependency to tourism, with increased economic benefits	+	Reduced impact of reef tourism activities and fisheries through compliance with management regulations and awareness	+
	SEA, as co-management agency, focused on education and awareness for schools and local residents associated with the protected area	+	Illegal fishing within the marine reserve	-
	Protection of reef resources and commercial fish species in perpetuity for future generations	+	Anchor damage to coral and seagrass	-
	Exclusion from traditional fishing areas	-		
	Environmental services – coastal protection and climate regulation	+		
	Commercial Fishermen	Protection of fish, lobster and conch resources within the marine reserve ensuring continued viability of fishery	+	Support for effective management of protected area (southern communities)
Exclusion from traditional fishing areas		-	Illegal harvesting of fishery products within the marine reserve	-
			Anchor damage to reef	-
Tour Guides (including tour boat captains)	Benefit from having Gladden Spit and Silk Cayes as a major destination for snorkeling, diving and associated tourism	+	Support the conservation goals of Gladden Spit and Silk Cayes Marine Reserve	+
	Benefit from the management of tourism access to whale shark congregation at Gladden Spit as a tourism feature activity	+	Provide interpretation for visitors, facilitating overall visitor appreciation	+

Stakeholder Analysis for Gladden Spit and Silk Cayes Marine Reserve			
Stakeholder	Influence or Impact of Gladden Spit and Silk Cayes on Stakeholder		Influence or Impact of Stakeholder on Gladden Spit and Silk Cayes Marine Reserve
	Employment and income from reef-based tourism activities	+	Assist with visitor management within the protected area through in-depth briefings
			If poorly trained, can result in poor visitor management and increased impact on corals and associated fauna, anchor damage etc.
			Impact behaviour of fish through feeding
			Anchor damage to coral and seagrass
			Illegal harvesting of fishery products within the marine reserve from overnight sail charters
			Potential impact on spawning aggregation and whale shark from noise pollution
Local / National Tour Operators	Benefit from having Gladden Spit and Silk Cayes Marine Reserve as a major venue for diving and snorkeling-associated tourism	+	Provide marketing at a national and international levels, and send visitors to Gladden Spit and Silk Cayes Marine Reserve
	Income from using Gladden Spit and Silk Cayes Marine Reserve as a tourism destination	+	Support the conservation goals of Gladden Spit and Silk Cayes Marine Reserve
	Benefit from the management of tourism access to whale shark congregation at Gladden Spit as a tourism feature activity	+	Contribute to the financial sustainability mechanism for management of the protected area through visitation
			Increase the potential for exceeding the carrying capacity of the protected area
International Tour Operators	Benefit from having Gladden Spit and Silk Cayes Marine Reserve as a major venue for diving and snorkelling-associated tourism	+	Provide marketing at an international level, and send visitors to Gladden Spit and Silk Cayes Marine Reserve
	Income from using Gladden Spit and Silk Cayes Marine Reserve as a tourism	+	Support the conservation goals of Gladden Spit and Silk Cayes Marine Reserve

FINAL DRAFT

Stakeholder Analysis for Gladden Spit and Silk Cayes Marine Reserve			
Stakeholder	Influence or Impact of Gladden Spit and Silk Cayes on Stakeholder	Influence or Impact of Stakeholder on Gladden Spit and Silk Cayes Marine Reserve	
	destination		
	Benefit from the management of tourism access to whale shark congregation at Gladden Spit as a tourism feature activity	+	Contribute to the financial sustainability mechanism for management of the protected area through visitation +
			Increase the potential for exceeding the carrying capacity of the protected area -
BTIA	Benefit from having Gladden Spit and Silk Cayes Marine Reserve as the whale shark congregation as a tourism destination	+	Provide marketing at national and international of Gladden Spit and Silk Cayes Marine Reserve +
			Support the conservation goals of Gladden Spit and Silk Cayes Marine Reserve +
General Belize Public	Maintenance of commercial fisheries stocks (fish, lobster and conch stocks)	+	Support of the general public will strengthen the position of protected area +
	Environmental services – coastal protection and climate regulation	+	Lack of support may increase chances of de-reservation or degradation -
	Cultural and aesthetic appreciation	+	
	Increased awareness through education	+	
Visitors: Tourists	Enjoy Gladden Spit and Silk Cayes as a tourism destination for leisure	+	Entrance fee contributes towards the goal of sustainability
	Benefit from education and awareness opportunities	+	Provide marketing nationally and internationally by word of mouth, if happy with quality of tourism product +
			Presence deters illegal fishing within the protected area +
			Negatively impact marine and terrestrial environments within the protected area -
Government of Belize	Provides fisheries management for fisheries industry	+	Political support through the national protected areas system plan and legislation +
	Provides environmental services for the social and economic benefit of Belize	+	Lack of political support for and understanding of conservation -
	Gladden Spit and Silk Cayes included	+	Lack of support in day to day management -

Stakeholder Analysis for Gladden Spit and Silk Cayes Marine Reserve			
Stakeholder	Influence or Impact of Gladden Spit and Silk Cayes on Stakeholder	Influence or Impact of Stakeholder on Gladden Spit and Silk Cayes Marine Reserve	
	within the National Protected Areas System Plan - assists in fulfilling Belize Government’s commitment to the conservation of natural resources, and international conventions and agreements (CCAD, CBD, and MBRS)		of protected area
	Income generation of significant foreign exchange tourism expenditure and fisheries exports	+	Uncertainty of long term future commitment especially in regards to financing of management activities -
	Provides employment opportunities in stakeholder communities	+	
	Collects taxes from business and entities in the tourism and fisheries sector who use the protected area as a tourism destination and a fishing area	+	

2.4. Physical Environment of Management Area

2.4.1 Climate

Temperature and Rainfall

Whilst Gladden Spit and Silk Cayes Marine Reserve lies only 36 km from Placencia on mainland Belize, it has a distinct climate that differs from the rest of the country. Carrie Bow Caye, 35 km to the north, within the adjacent South Water Caye Marine Reserve, has been selected as a long-term monitoring site with information on meteorological, oceanographic, and biological conditions having 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 (in GSSCMR Management Plan 2011-2016).

Rainfall varies throughout the year - there is a pronounced dry season stretching from January through to the end of April, with minimum monthly rainfall as low as 47 mm 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 600 mm, 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.

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 (in GSSCMR Management Plan 2011-2016).

Weather Systems: Belize is affected by three very distinct seasonal weather systems: 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); and tropical storms (occurring between June and November, originating in the mid-Atlantic). All three have an influence on the rainfall and temperature patterns, on the sea level, and on the currents around the Gladden Spit and Silk Cayes 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 ten hurricanes and nine tropical storms that have passed within a 50-km radius of Gladden Spit and Silk Cayes Marine Reserve (Table 8; NHC, 2018). While 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.

The most recent extreme hurricane impacts have been from Hurricane Mitch (1998) and Hurricane Iris (2001). In late October 1998, shortly after peak bleaching temperatures, Hurricane Mitch swept across the Gulf of Honduras. The storm then stopped for 2 days adjacent to the Bay Islands of Honduras, approximately 244 km (150 miles) south west of Gladden Spit. The storm tide at Gladden Spit was reported to reach 2.8 m, with up to 29% of coral colonies showing signs of mechanical damage (in GSSCMR Management Plan 2011-2016). In 2001, Hurricane Iris passed almost directly over Gladden Spit, with waves of between 4 and 5.5 m above normal (Bood, 2001). As with Hurricane Mitch, the event occurred shortly after a period of unusually high water temperatures, the increased hurricane activity being correlated with the same high water temperatures that caused the bleaching event. Survey sites within Gladden Spit and Silk Cayes Marine Reserve reported a 58% incidence of coral bleaching, with no significant increase in bleaching following the hurricane. The most recent hurricanes, Richard (2010) and Earl (2016) passed to the north of the cayes with minimal impact.

Table 8: Hurricanes Affecting GSSCMR (<50km) (www.nhc.noaa.gov)

Name	Cat.	Year	Date passed near GSSCMR
Not named	H1	1906	13 October
Not named	H1	1918	25 August
Not named	TS	1934	4 June
Not named	TS	1934	8 June
Not named	TS	1938	11 October
Not named	H2	1941	28 September
Not named	TS	1943	22 October
Not named	H1	1945	4 October
Gilda	TS	1954	27 September
Abby	H1	1960	15 July
Anna	H1	1961	24 July
Francelia	H2	1969	3 September
Laura	TS	1971	21 November
Fifi	H2	1974	19 September
Greta	H3	1978	19 September
Gert	TS	1993	16 September
Kyle	TS	1996	12 October
Mitch*	H5	1998	
Iris	H4	2001	9 October
Matthew	TS	2010	25 September
Richard	H1	2010	25 October
Harvey	TS	2011	20 August
Earl	H1	2016	4 August
<p>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</p> <p>*Whilst Mitch did not pass within 50km, it had a huge impact on the reef in the area</p>			

2.4.2 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 the first of three northeast-southwest escarpments that lie off the coastline. The first escarpment runs parallel to the coast, dropping off to the east to a depth of about 1 km. An extensive reef system has developed upon the rim of this escarpment, forming the Belize

Barrier Reef (Rath, 1996, in GSSCMR Management Plan 2011-2016), sheltering the lagoon to the west. Cayes dot this platform, some formed on mangrove peat, others from coral outcrops and sand deposition.

The second ridge supports Turneffe Atoll, and joins the main barrier reef escarpment north of South Water Caye Marine Reserve. The third provides the foundation for Lighthouse Reef and Glover's Reef Atolls, and then extends south to eventually intersect the Barrier Reef at Gladden Spit itself, forming the 'elbow', providing the conditions required for the regionally important spawning aggregation site. At this point, the escarpment drops to the east to a depth of 250 m. Beyond this, a further two deeper ridges eventually fall into the Cayman Trench, which reaches depths of up to 7.5 km.

The central province, in which the northern portion of Gladden Spit and Silk Cayes Marine Reserve is located, contains some of the most spectacular reef development, with an almost continuous well-developed barrier reef, three sand cays and numerous patch reefs and seagrass beds in the center and landward edge of the barrier platform (Burke, 1982; Macintyre and Aronson, 1997; in GSSCMR Management Plan 2011-2016). To the south of the Spit, the barrier reef is less well formed. The dividing point – Gladden Spit itself - is a unique geological feature with a series of mid-shelf reefs (Kramer and Kramer, 2002, in GSSCMR Management Plan 2011-2016).

2.4.3 Bathymetry

Belize has an extensive maritime area of 10,000 km² (Hartshorn *et al.*, 1984, in GSSCMR Management Plan 2011-2016). Unique to this area is a 250 km long barrier reef that extends from the tip of the Yucatan Peninsula southward into the Gulf of Honduras (Burke, 1982). Seaward of the reef crest are three coral atolls: Glover's Reef, Lighthouse and Turneffe Islands Atolls.

The barrier reef complex has been divided into three provinces based on their community distribution and geomorphic characteristics: Northern, Central, and Southern Provinces (Burke, 1982). The protected area spans both the Central and Southern Provinces, with Gladden Spit forming the division between the two. The depths of the water over these reefs are less than 5 m forming exposed reefs during low tides. Depth contours for the inner lagoon increase from 10 to 40 m toward the center of the lagoon. Outside the main barrier, the reef slopes gradually from 10 to 50 m (Figure 5). Within the Marine Reserve, there is a clear distinction between the reef lagoon and the reef drop-off (Figure 6).

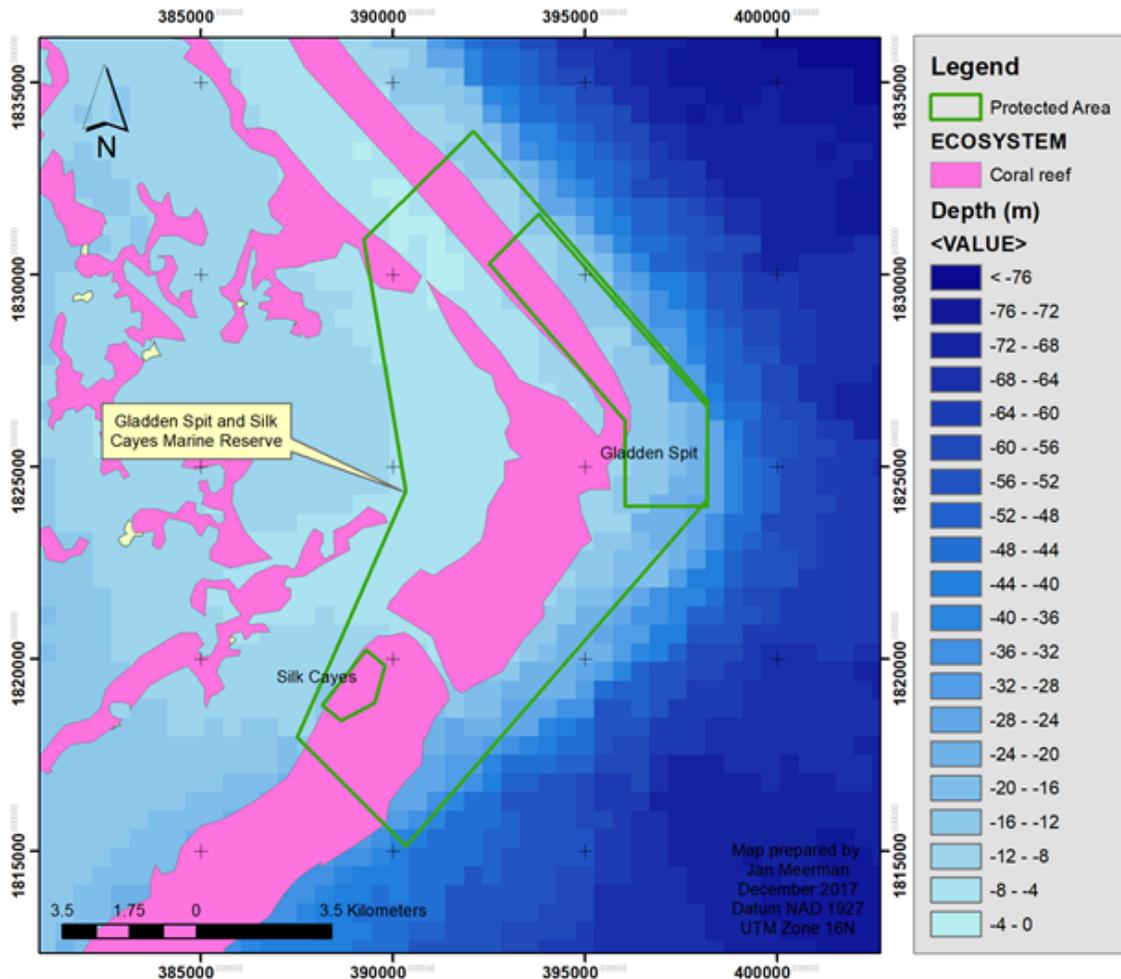


Figure 5: Gladden Spit and Silk Cayes Marine Reserve: Bathymetry

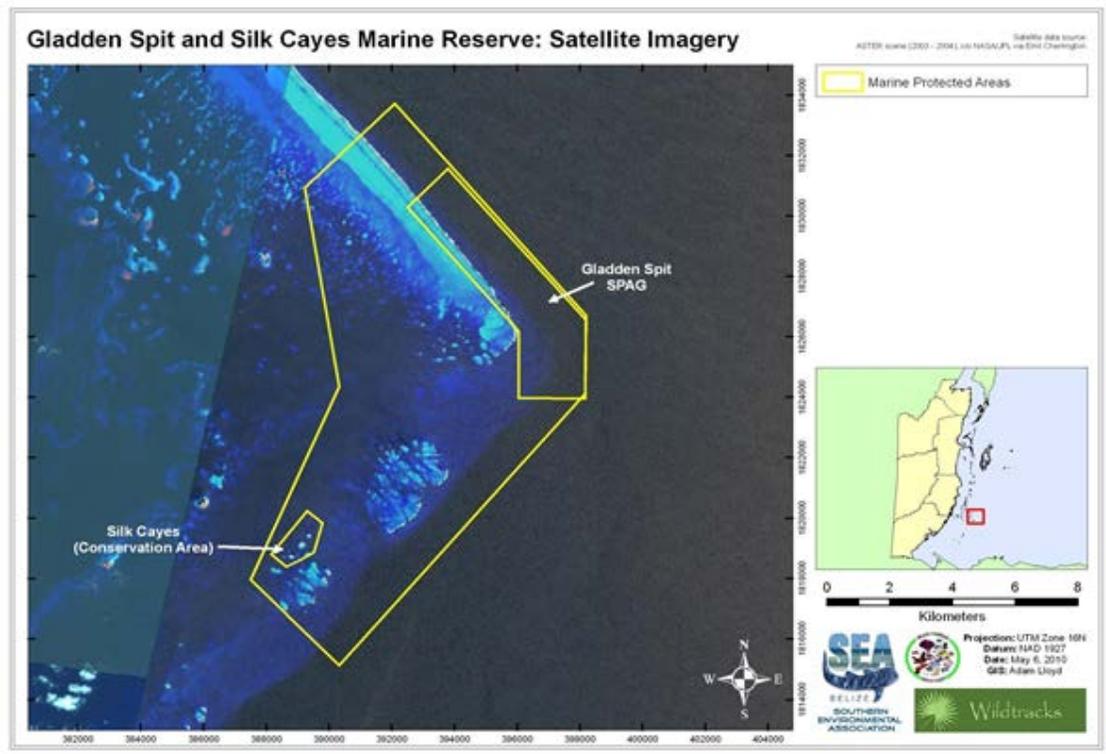


Figure 6: Satellite imagery showing Reef Lagoon and Drop-off at GSSCMR

2.4.4 Tides and Water Movement

Knowledge of currents is essential in determining the transport of larvae, nutrients and pollutants, as well as abetting the spread of disease and invasions (demonstrated by the rapid spread of disease in *Diadema antillarum* throughout the Caribbean region in the 1980s). Connectivity through currents has also resulted in the rapid invasion of Belize by the lionfish (*Pterois volitans*) as part of a larger, regional invasion. An initial, isolated report of its presence was recorded in 2001, in the Laughing Bird Caye area (B. Sutton/ Ecomar), though no more were seen until 2009, when populations have grown exponentially.

On a regional scale, the main oceanic current, the warm-water Caribbean Current, forms the main surface circulation in the Caribbean Sea, flowing westwards from the Lesser Antilles towards southern Belize, then northwards offshore, beyond the atolls, eventually through the Yucatan Channel, with an average flow rate of between 38 to 43 cm (15 to 17 inches) per second. This creates a counter clockwise gyre in the Gulf of Honduras area, including much of the coastal waters of Belize, which flows south/southwest-wards past the Belize coastline and Barrier Reef (Heyman *et al.*, 2000; Stoddart, 1962; in GSSCMR Management Plan 2011-2016), in the shelf lagoon and offshore basins (Purdy *et al.*, 1975), with strong currents up to 5 knots in the reef channels especially during low tides.

Tides in the central region of the Belize reef system are considered to be micro-tidal, and averaging an estimated 30 cm throughout the coastal shelf (Stoddart, 1962; Caribbean Coral Ecosystems Program, 2005, in GSSCMR Management Plan 2011-2016). The currents generated by these tides as they pass 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).

Winds may have a more influential impact on sea level than tides, with strong north winds resulting in currents shifting to a more southerly direction, and 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).

2.4.5 Water Parameters

SEA has been conducting monthly water quality testing in the GSSCMR since 2013 in an effort to collect baseline data which would be used to determine if there are any changes in the oceanic conditions. Furthermore, it can be used to make management decisions for these protected areas for continued marine resource/ecosystem sustainability. Effectively, SEA is thus building up a baseline data set for sea-water quality in the area. Unfortunately, the data do not automatically lend themselves for taking management decisions.

Water Temperature

The Smithsonian Institute Field Station has been monitoring basic water parameters within the Southern Belize Reef Complex since 1994/1995. While this is in the central reef region, this monitoring site also provides an indication of conditions within the southern reef region, in the absence of other long-term data. Measurements in 2015–2016 showed that mean monthly water temperatures ranged between 23.2 – 33.6 °C at a depth of 13 m at the Carrie Bow Cay Field Station (CCRE, 2017). Belize’s reefs, including those at GSSCMR were impacted by the third global coral bleaching event in 2015/2016. The coral bleaching event was not as severe as the 1995 and 1998 events and no coral mortality was recorded at surveyed sites.

Sedimentation/Turbidity

Sedimentation and agrochemical contamination from mainland watersheds have been highlighted as perhaps one of the greatest impacts on the Belize reef, after

climate change (Figure 7). Gladden Spit and Silk Cayes Marine Reserve lies east of five watersheds – South Stann Creek, Santa Maria Creek, Mango Creek, Sennis Creek and Monkey River (Figure 8, WRI 2006, in GSSCMR Management Plan 2011-2016), which drain some of the principal citrus and banana growing areas of central Belize (Figure 9).

Following storm events, the increased sediment load of these rivers is also accompanied by an increased pesticide load, as rain washes agrochemicals from the watersheds into the rivers, and from there into the sea. Generally occurring between August and October, these events impact water turbidity and quality within the Marine Reserve, as seen following the passage of Hurricane Mitch in October 1998.

Sediment core analysis of two sites within the Belize reef system (Turneffe Atoll and Sapodilla Cayes), indicate that sediment and agrochemical runoff onto the reef has increased relatively steadily over time, consistent with historical and current land use trends. Sediment supply to the reef is greater in the south, in the Sapodilla reef area with greater urgency for action to reduce runoff impacts (Carilli *et al.*, 2009), though the Gladden Spit and Silk Cayes area is also affected seasonally.

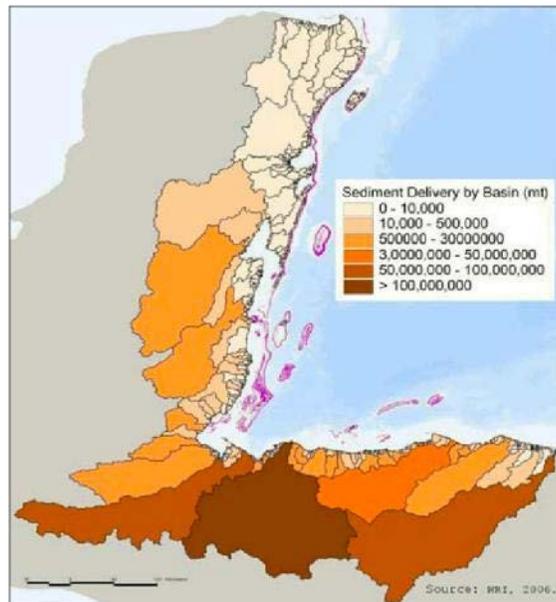


Figure 7: Sediment Delivery by watersheds¹

¹ After Burks and Sugg/WRI, 2006.

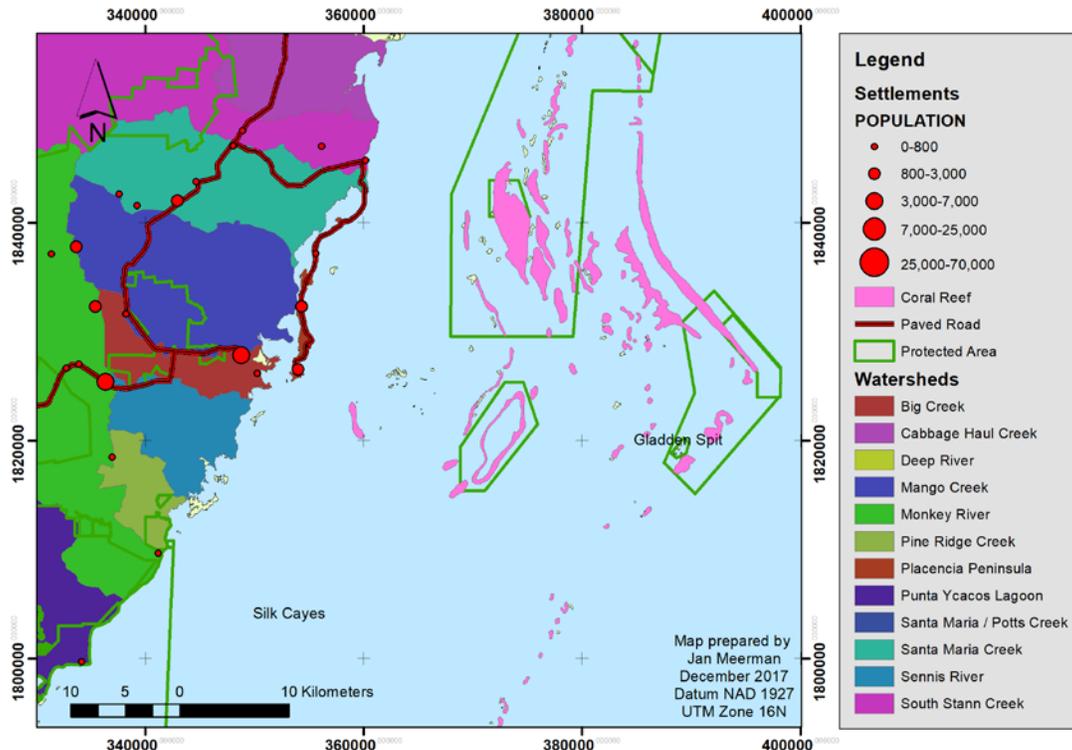


Figure 8: Gladden Spit and Silk Cayes Marine Reserve: Watersheds

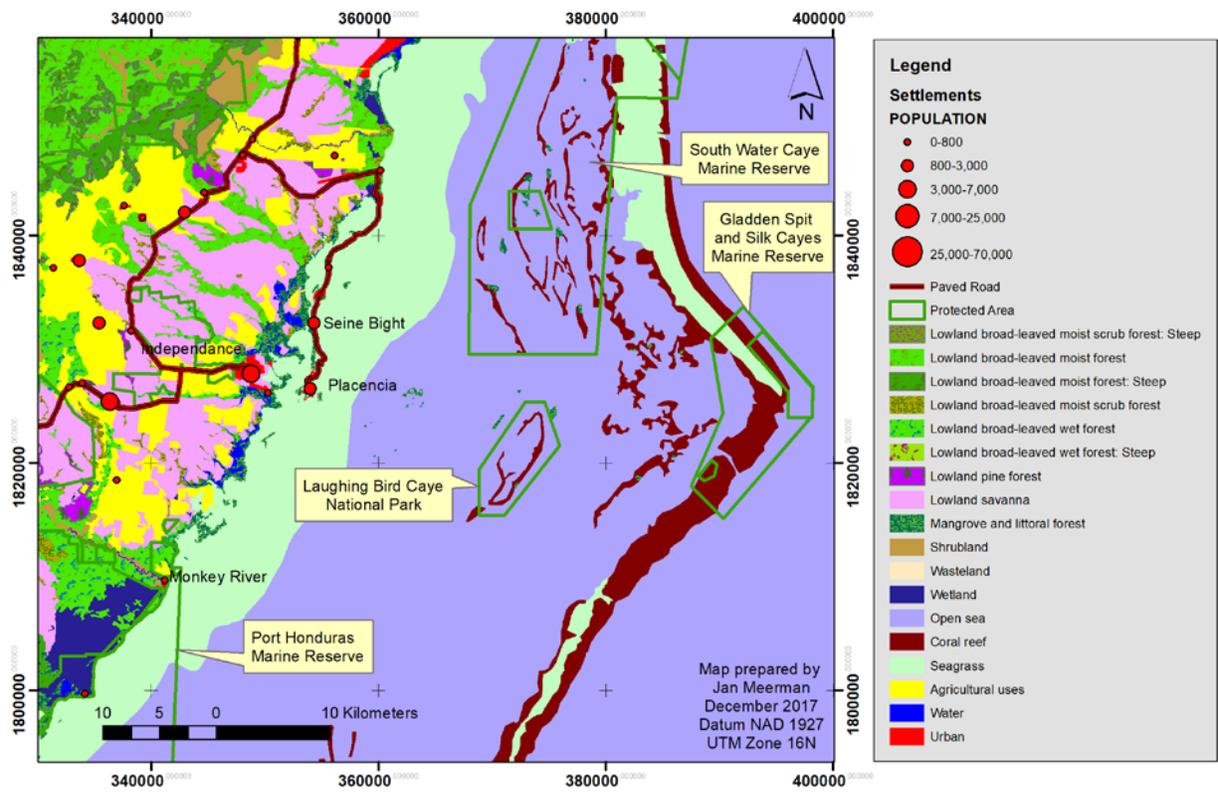


Figure 9: GSSCMR—Landscape Context

SeaWiFS ocean colour images also shows that a large pulse of river water extends from the Guatemalan and Honduran rivers, stretching all the way to Gladden Spit and Silk Cayes Marine Reserve, and even out as far as Glover’s Reef Atoll, during these storm events (Soto *et al.*, 2009; WRI/ICRAN, 2006, in GSSCMR Management Plan 2011-2016; Andrefouet *et al.*, 2002, in GSSCMR Management Plan 2011-2016).

Connectivity was tracked using the proxy of weekly mean chlorophyll-a concentrations, derived from satellite imagery over a nine-year period. These studies indicated that Honduran river plumes, particularly that of the Ulu´a River, reached the southern part of the Belize Reef 61% of the time. This provides further support for WRI studies on the origins of impacting watershed run-off on the Mesoamerican Reef (Figure 10).

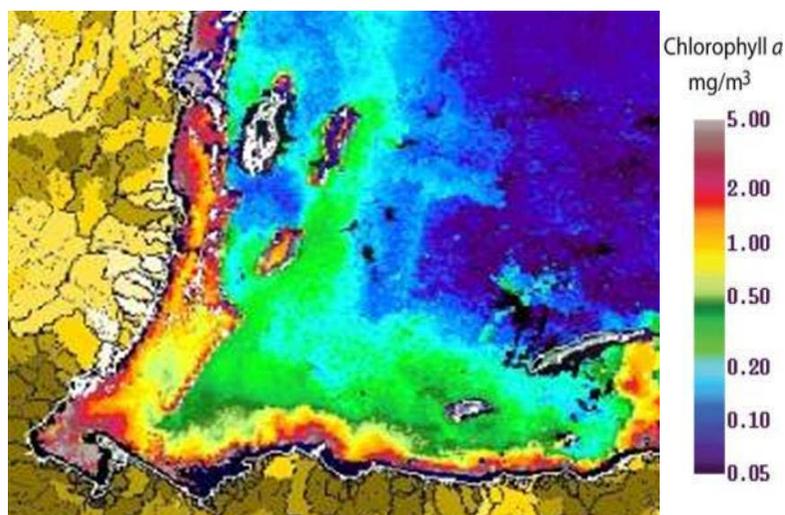


Figure 10: SeaWiFS Chlorophyll a.²

Salinity

Salinity varies dependent on the time of year, with lower salinity during the wet season (Figure 11). The salinity of normal seawater is 36 parts per thousand (ppt), with variation from 33.0‰ to 37.4‰. This range of salinities persists throughout the Belize continental shelf, including the Laughing Bird Caye area (Rath, 1996).

² After Shank *et al.*, 2010/ Soto *et al.*, 2009

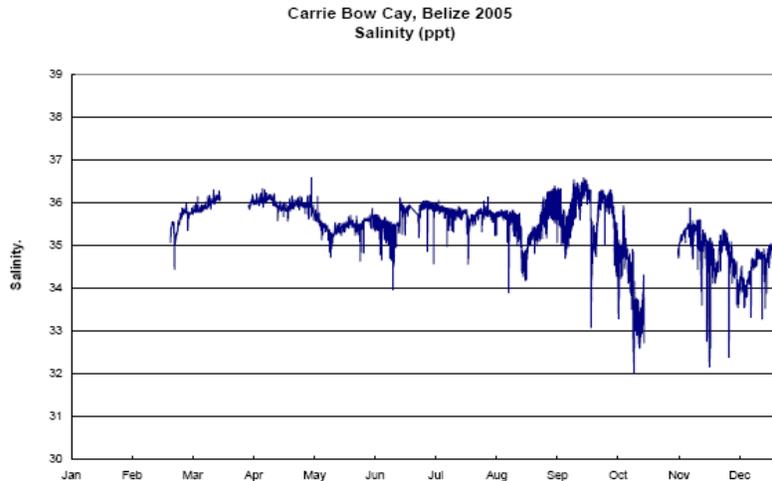


Figure 11: Salinity at Carrie Bow Caye³

pH

The general pH is 7.2 in the vicinity of the reef and surrounding areas. The alkaline pH is attributed to the high calcium carbonate saturation along the reef. There is a growing global concern about ocean acidification, with the increasing absorption of carbon dioxide from the atmosphere, which is predicted to result in the inhibition of growth of reef builders. Whilst predictions are not yet considered as accurate, the process was identified and flagged as a concern as long as 40 years ago (Kleypas *et al.*, 2006). Studies in Australia have demonstrated that there has been a 13.3 percent drop in calcification over a twenty year period, (1990 – 2009), an unprecedented decline in at least the past 400 years (De'ath *et al.*, 2009), and extrapolations suggests that calcification rates may decrease by up to 60% within the 21st century, with ocean pH levels expected to drop by another 0.3 units by 2100.

2.5. Biodiversity of Management Area

As outlined in the 2011-2016 GSSCMR Management Plan, biological information about GSSCMR has been accumulated over the years by a variety of researchers and organizations. Significant focus has been on research associated with the spawning aggregation site and the whale shark congregation, as well as monitoring the health of the reef and target species (primarily coral, commercial species and parrotfish). The area was 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, in GSSCMR Management Plan

³ <http://cbc.riocean.com>, accessed 2009

2011-2016; Roberts, 2001; Kramer and Kramer, 2002). Since then, biodiversity monitoring has continued, but no up to date analysis is available, and as such it will be difficult to notice changes since the previous management plan.

2.5.1 Ecosystems

The national ecosystem mapping gives a broad overview of the ecosystems to be found in the Gladden Spit and Silk Cayes Marine Reserve (Meerman, 2005), which 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 (200 m and deeper) The Mesopelagic and Bathypelagic Zones include the deeper waters to the east of the barrier reef. The mesopelagic zone extends from a depth of 200 m downwards, merging into the bathypelagic zone (which begins at the edge of the continental slope and extends beyond into the deeper water). The deep waters to the east of the ‘elbow’ provide the geomorphology and oceanographic current conditions required by many species for the formation of spawning aggregations (Heyman *et al.* 2008, in GSSCMR Management Plan 2011-2016) – Gladden Spit is recognized for its importance as the most active, species-diverse aggregation within Belize, and within the region (Heyman *et al.* 2002, in GSSCMR Management Plan 2011-2016). These deep-water aggregations also attract whale sharks, and other deep-water species are known to travel up and down parallel to the reef, passing inside the eastern boundaries of Gladden Spit and Silk Cayes Marine Reserve.

Epipelagic Zone (0 m – 200 m) The Epipelagic Zone ranges from 0 to 200 m in depth, and includes the shallow waters of the inner lagoon and the deeper waters of the fore-reef. Within this zone there is 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.

Broad Ecosystems

Six broad ecosystems have been identified and mapped (Figure 12; Meerman, 2005). The marine components are further categorized into seven primary categories and twenty-one sub-categories (Table 9 and Figure 13; Meerman, 2005; and Mumby and Harborne, 1999, in GSSCMR Management Plan 2011-2016).

Broad Ecosystems

- 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
- Herbaceous Beach Community

Table 9: Ecosystems of GSSCMR

Ecosystems of Gladden Spit and Silk Cayes Marine Reserve				
	Meerman (2004)		Mumby and Harborne (1999)	
Terrestrial	Herbaceous Beach Community	Sandy beaches Littoral Forest		
Epipelagic	Reef	Patch Reef	Patch Reef	Dense patch reef Diffuse patch reef
		Shallow Coral reef	Other Reef	Reef crest Low relief spur and groove
		Shallow Coral reef	Fore Reef	With sparse massive and encrusting corals With dense massive and encrusting corals
		Seagrass	Seagrass beds	Shallow Lagoon Floor – Seagrass dominated Sparse seagrass Medium density Seagrass Dense seagrass Seagrass with distinct coral patches

Ecosystems of Gladden Spit and Silk Cayes Marine Reserve				
	Meerman (2004)		Mumby and Harborne (1999)	
	Caribbean inner lagoon / Sparse Algae	Fleshy brown Algae/Gorgonians Sparse Algae / sand	Algal dominated	Fleshy brown Algae and sparse Gorgonians Green algae <i>Lobophora</i> <i>Euchmea</i> and <i>Amphiroa</i> Bedrock / rubble and dense gorgonians Bedrock / rubble and sparse gorgonians
			Bare substratum dominated	Rubble and sparse Algae Sand with sparse algae Mud / bedrock
Mesopelagic/ Bathypelagic	Open Sea	Caribbean Open Sea	Caribbean Open Sea	Bathyal Mesopelagic

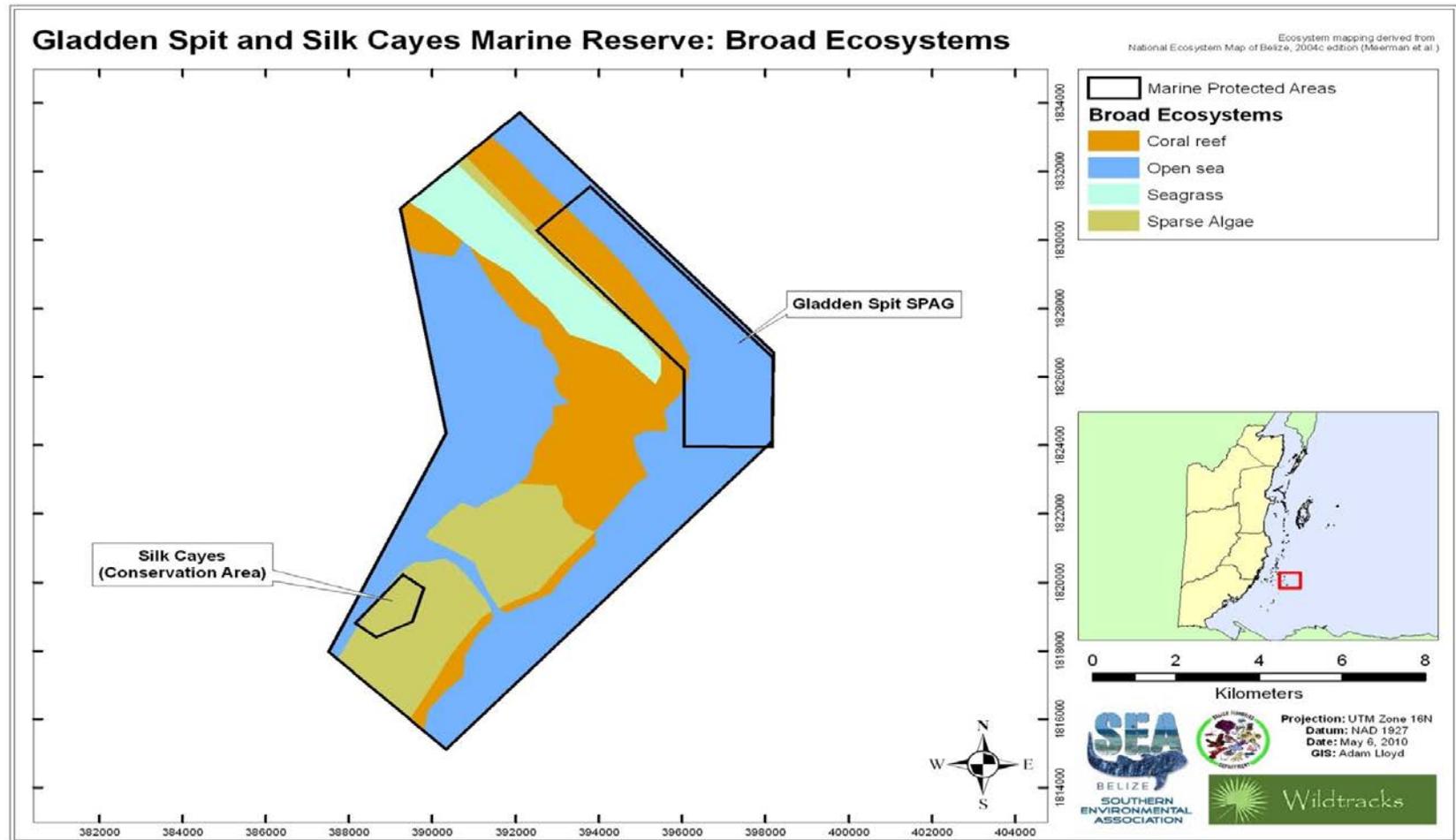


Figure 12: GSSCMR – Ecosystems (coarse – Meerman, 2004)

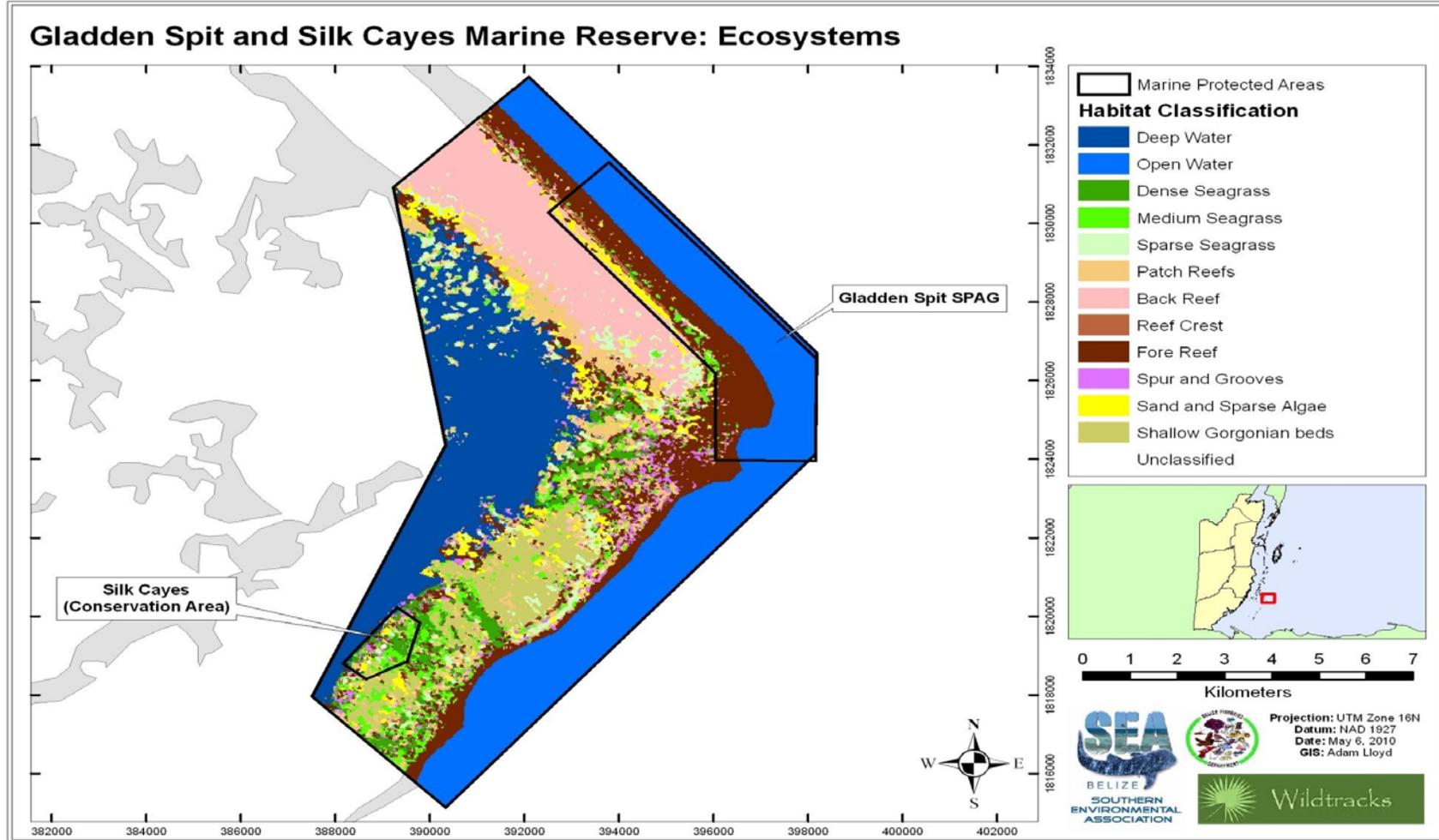


Figure 13: GSSCMR: Ecosystems (fine detail – UNESCO)

Coral Reef

The Barrier Reef

Located at the intersection of the central and southern regions of the Belize Barrier Reef system, the barrier reef runs northwest to south east and, within the northern portion of Gladden Spit and Silk Cayes Marine Reserve, is considered to be one of the most highly developed examples of barrier reef formation in the Western Hemisphere. The core components, Forereef, Reef Crest, and Back Reef are all present.

Forereef

The forereef lies on the outer side of the reef crest, facing the open sea, and includes the upper and lower reef slopes. The upper forereef begins at the outer edge of the reef crest, and extends out to a depth of 14-22 m. This zone is characterized by impressive spur and groove formations, and 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.

Moving southward to and beyond the promontory, the inner reef spur-and-groove and the outer forereef gradually becomes much less well formed. East of the reef crest the water drops to between 50 and 100 m – the lower reef slope. Here, coral diversity and density decreases in correlation with decreasing light intensity. Beyond this, the reef drop-off extends to depths of 700 m and more.

Reef Crest and Reef Flats

The reef crest and reef flats lie behind the forereef, 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. In the northern portion of the Gladden Spit and Silk Cayes Marine Reserve, the reef crest forms a relatively unbroken barrier, protecting the back-reef waters to the west, with few channels allowing water flow between the fore and back reefs. South of the promontory, the reef crest becomes very fragmented, and is bisected by a number of larger reef channels such as Tarpon Swash and Big White (McField, 2002; FoN, 2003; in GSSCMR Management Plan 2011-2016). The reef crest has suffered significant hurricane damage over the years, and corals are slowly starting to recover – with lettuce coral (*A. tenuifolia*) as the predominant species,

replacing the previously dominant elkhorn coral (*A. palmata*) (McField, *et al.* 2008 (ed. Wilkinson *et al.*), in GSSCMR Management Plan 2011-2016; Carne in 2011 management plan).

Back Reef

The Back Reef includes a continuum of habitats in waters ranging from 0.3 to 6 m deep sheltered by the presence of the reef crest, from the algae-encrusted coral rubble near the reef crest to the sandy mudflats of the *Thalassia* meadows and scattered patch reefs. The sheltered waters of the back reef promote the growth of spectacular coral formations and impressive sponges, with numerous patch reefs varying in size and orientation. This is intersected in the south by deeper channels.

Benthic Cover

SEA has developed a baseline of overall benthic cover within GSSCMR - a combination of back reef, shallow fore-reef and deep fore-reef (Figure 14). A new in-depth assessment would be required to see how much this benthic picture has changed.

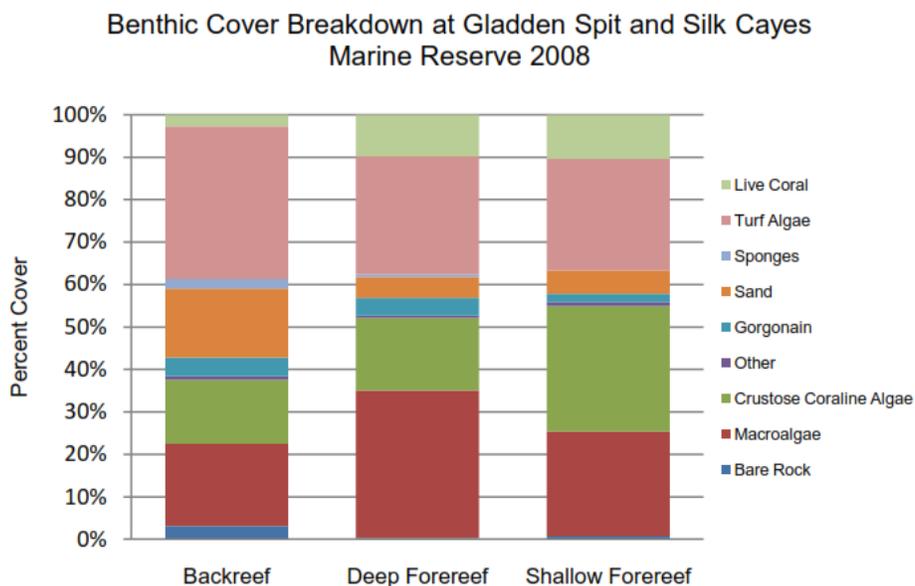


Figure 14: GSSCMR – Benthic Cover % per reef site⁴

On a regional level, two-thirds of wider Caribbean reefs are said to be at risk from human activities (Burke & Maidens, 2004, in GSSCMR Management Plan 2011-2016), a figure that has probably increased since that assessment. In general, reefs in Belize are perceived to be at slightly lower risk, due in part to

⁴ SEA data, 2008

the small human population, and relatively low levels of coastal development, and were once considered amongst the better reefs of the Caribbean. However, in recent years coral health has generally been on a par with, or slightly below, the rest of the Caribbean, with impacts from a combination of disturbance events (primarily hurricanes) and chronic stressors, leading to declining coral cover and increases in macro-algae (McField, *et al.* 2008, in GSSCMR Management Plan 2011-2016).

An ecological shift towards algal dominance on coral reefs has occurred across the Caribbean in recent years, attributed to several impacts. These include coral diseases (black, white and yellow band diseases), overfishing, the population crash of 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, in GSSCMR Management Plan 2011-2016). Overfishing of the herbivorous fish is also thought to have played a 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, in GSSCMR Management Plan 2011-2016), overlying all other stresses. Belize has always had the enviable reputation of having pristine reefs, but in more recent years there would appear to be a shift in species composition of structural corals, with the loss of *A. cervicornis* has been lost to disease, and replaced by *A. tenuifolia*.

The increased temperatures also caused by global warming results in bleaching in corals - the expulsion of the zooxanthellae which provide essential nutrients to the coral polyps. If severe and prolonged enough, bleaching 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 sea surface temperatures to exacerbate bleaching by producing harmful oxygen radicals, increasing coral mortality (Lesser and Lewis, 1996; Marshall *et al.*, 2006). No global bleaching event was recorded before 1979 (McField *et al.*, 2007), and the Belize Barrier Reef experienced mass coral bleaching for the first time in 1995 (McField, 1999). Since then, major bleaching events have been recorded in Gladden Spit and Silk Cayes Marine Reserve with increasing frequency - in 1995, 1998, 2005, 2008, 2009, 2011, 2015, 2016⁵ and 2017 - and are thought to be accentuated by increased acidification resulting from higher CO₂ levels (Anthony *et al.*, 2008). The first recorded bleaching event in 1995 resulted in large-scale bleaching of hard corals in Belize, especially *Montastraea annularis*. Bleaching of *Agaricia agaricites*, *A. tenuifolia*, *Madracis* spp., and *Porites porites* was also reported in 1995 (McField, 2000). Other areas

⁵ Monitoring data gathered by SEA indicate that in 2016 15% of measured corals were affected by bleaching and or disease.

in the Southern Belize Reef Complex (in the more northerly South Water Caye Marine Reserve) reported loss of up to 50% of the large corals, with partial mortality reported in 10% of corals throughout the country.

Given the impacts of the hurricane on the Southern Barrier Reef it is logical that it experienced the greatest loss (62%), followed by the Northern Barrier Reef (55%), atolls (45%) and Central Barrier Reef (36%). *Agaricia tenuifolia* and *Acropora cervicornis* were the coral species most heavily affected by bleaching in 1998 (Wilkinson *et al.*, 2008). The variation in these responses was attributed to varying wave energies from the hurricane and differences in the resiliency of the reef communities. With no observed phase-shift to macroalgal domination during the 1998 event, the prognosis was considered favorable for the recovery of these reefs. However, a resample of sites in 2005 indicated that recovery from the 1998 event has been slow (McField, *et al.* 2008 (ed. Wilkinson *et al.*)).

In 2008, the National Coral Reef Monitoring Network implemented a national bleaching monitoring program with SEA conducting monitoring at three marine protected areas including Gladden Spit and Silk Cayes Marine Reserve. The highest percentage of bleaching (29%) was observed in the shallow reef areas, with 18% in deeper waters at the Gladden Spit and Silk Cayes Marine, recorded during October of 2008 (SEA, 2009, in GSSCMR Management Plan 2011-2016). Recovery from bleaching events has been good, with bleaching dropping to a minimal average of 1.5% and 3%, respectively four months later in February 2009. Looking at the data it appears that bleaching has become part of the reef's annual cycle, tied into annual water temperature cycles. Bleaching occurs during the warmer months of September to November and recovery occurs during periods of cooler waters in December-March, but it is unclear whether corals will be able to continue to recover from what may become chronic annual bleaching. Generally, shallow-living corals of Gladden Spit and Silk Cayes Marine Reserve show lower levels of bleaching than those that live at deeper levels. Live coral cover is a popular measure for coral reef health. At the GSSCMR the percentage of live coral cover seems to be directly related to site selection with surveys by different agencies giving different snapshots of the status of the reef.

According to 2007/2008 assessments of 96 sites across Belize, percentage live coral cover for Gladden Spit and Silk Cayes Marine Reserve averaged 11% (McField, *et al.* 2008 (ed. Wilkinson *et al.*), lower than the national average of 16.6% (McField, *et al.* 2008 (ed. Wilkinson *et al.*). A more recent survey in 2010, estimates the average live coral cover of the marine protected area at 13.6%, ranging from 18.1% on the outer barrier reef (at a depth of 10 m), and 8.3% on the shallow back reef. An average algal cover of 18.7% macro algal cover was recorded at the same monitoring sites (SEA data, 2010).

In October 2014, reef health monitoring took place at 5 sites at Gladden Spit and Silk Cayes Marine Reserve using the MBRS (Mesoamerican Barrier Reef Systems) synoptic monitoring program protocol. The percentage cover by coral and macroalgae is shown below (Table 10, Figure 15). Note that the coral cover percentages in this study are higher than the data provided by McField *et al.* (2008), probably due to a difference in protocol which makes it difficult to compare the data.

Table 10: Results from 2014 benthic cover data collected during MBRS monitoring

Site Code	Site Description	% Coral Cover	% Macro-algal Cover
GSMBRS1	Shallow reef (5m) at Silk Cayes	20.67	11.17
GSMBRS2	Shallow reef (5m) at Silk Cayes	21.83	9.5
GSMBRS3	Outer barrier reef, 10m depth	35	29
GSMBRS6	Outer barrier reef, 10m depth	11.33	60.17
GSMBRS9	Back reef site, 2m depth	37.33	16.5

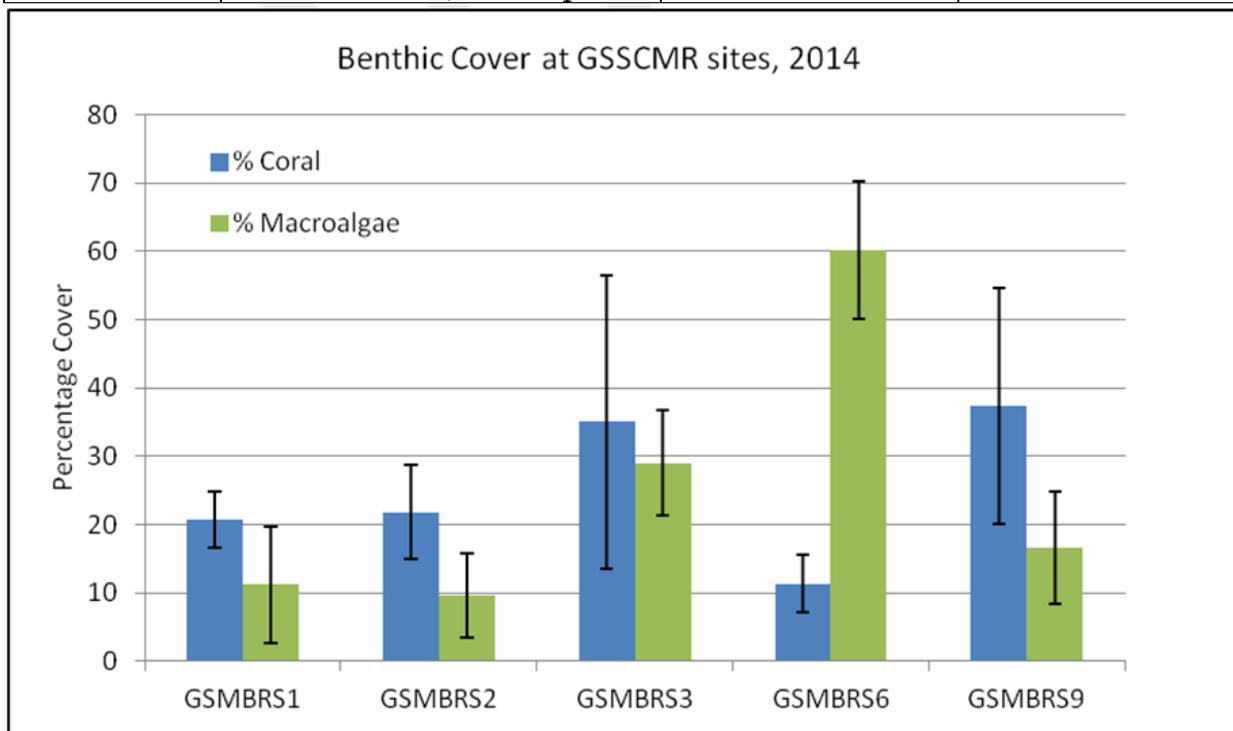


Figure 15: Benthic cover data collected during MBRS monitoring in 2014
Note: Mean percentage cover for coral and macro-algae, ± 1 standard deviation

Average live coral cover ranged between 11% and 37%, (highest at the shallow back reef site GSMBRS9) and macroalgal cover ranged between 10% and 60%. The highest macroalgal cover was recorded at the outer barrier reef site (GSMBRS6), and this was the only site at which macroalgal cover exceeded coral cover.

Fluctuations in coral and macroalgae percentage cover are seen between years at all sites. Between 2012 and 2014, an increase in coral cover is seen at 3 of the sites (GSMBRS2 - shallow reef (5m) at Silk Cayes; GSMBRS3 - Outer barrier reef, 10m depth; and GSMBRS9 - back reef site, 2m depth;) and a decrease in coral cover was observed at two of the sites (GSMBRS1 - shallow reef (5m) at Silk Cayes and GSMBRS6 - outer barrier reef, 10m depth) (Figure 16).

A decrease in macroalgal percentage cover was seen at three out of five sites between 2012 and 2014 (Figure 17). Until the 2014 surveys, 2011 showed the highest macroalgal cover, and highest macroalgal cover was recorded at site GSMBRS6. The high macroalgal coverage during this year could be attributed to the high nutrient levels that were experienced during summer 2011, which led to the poor water quality event at that time. In 2014, site GSMBRS3 had macroalgal cover of 29%, which was nearly as high as in 2011 at that site. The peak in 2014 was also at site GSMBRS6, but it reached 60%, which was 1.5 times the coverage recorded in 2011.

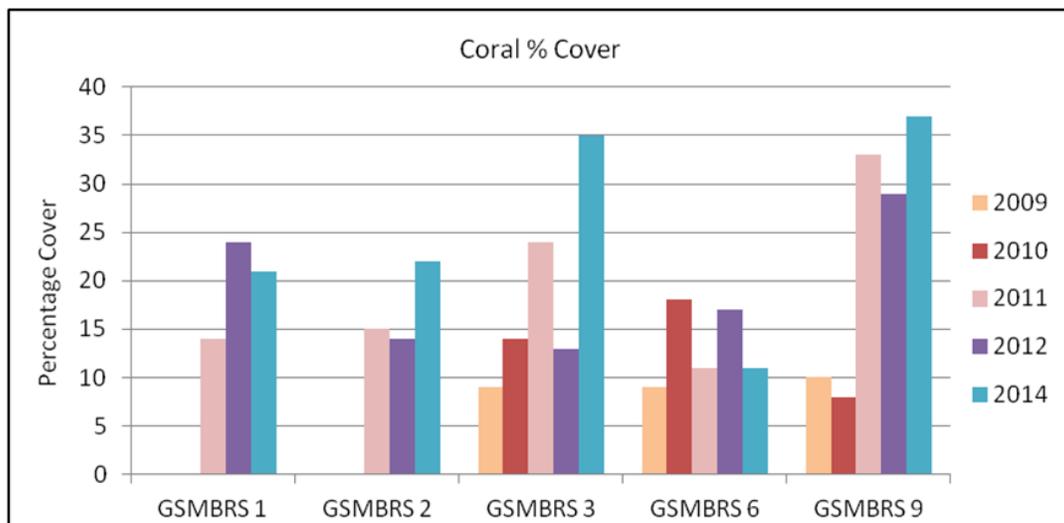


Figure 16: Inter-annual variation in percentage coral cover at GSSCMR MBRS monitoring sites, 2009-2014⁶

⁶ Note: No MBRS surveys were conducted in 2014

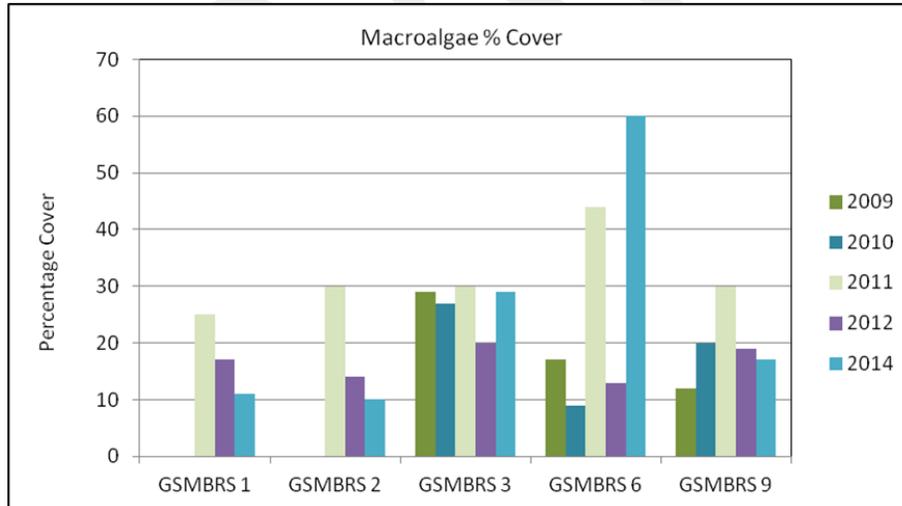


Figure 17: Inter-annual variation in percentage macroalgal cover at GSSCMR MBRS monitoring sites, 2009-2014

With improper sanitary facilities as they are on South Silk Caye, there is a risk of eutrophication similar to the one reported from around Laughing Bird Caye where repeated outbreaks of fleshy macro-algae are attributed to high nutrient levels caused by inappropriate sanitary facilities on the island (Guardian, 2017). Unfortunately, there are no water quality data to support or contradict this. See the section on “Past and Present Research” for a discussion on this.

GSSCMR hosts ten species of coral considered critically endangered, endangered or vulnerable on the global scale (IUCN, 2018).

Table 11: GSSCMR Coral Species of International Concern (IUCN Red List 2018)

GSSCMR Coral Species of International Concern	
Critically Endangered	
Staghorn Coral	<i>Acropora cervicornis</i>
Elkhorn Coral	<i>Acropora palmata</i>
Endangered	
Boulder Star Coral	<i>Montastraea annularis</i>
Star Coral	<i>Montastraea faveolata</i>
Fire Coral	<i>Milepora striata</i>

Vulnerable	
Lamarck's Sheet Coral	<i>Agaricia lamarcki</i>
Pillar Coral	<i>Dendrogyra cylindrus</i>
Elliptical Star Coral	<i>Coral Dichocoenia stokesii</i>
Montastraea Coral	<i>Montastraea franksi</i>
Rough Cactus Coral	<i>Mycetophyllia ferox</i>

More recently, the Healthy Reefs Initiative has provided regional-level data, developing a reef health report card as recent as 2015. Based on the data in its online database, the situation of all coral monitoring sites within the Gladden Spit and Silk Cayes Marine Reserve is “Critical”, indicating a continued further decline in coral quality and presenting an alarming trend (Figure 18).

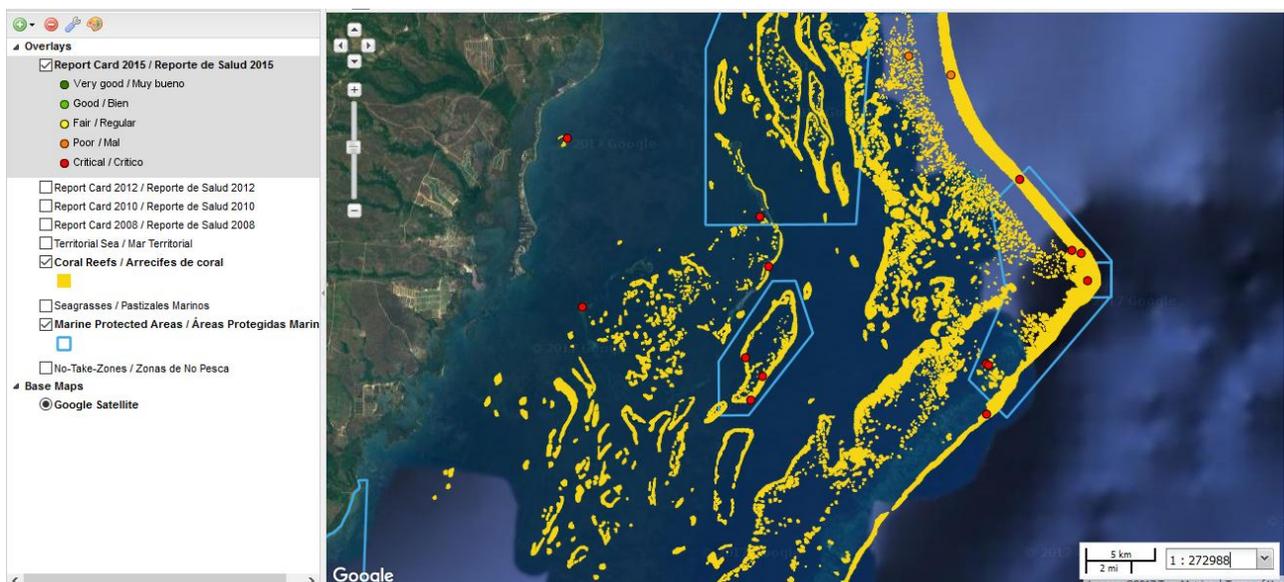


Figure 18: Status of coral reefs in the project area (2015)⁷

⁷ Derived from the Healthy Reefs database (October 2017)

Seagrass

Much of the reef platform north of the promontory is shallow and sheltered from strong waves and currents, with a soft bottom supporting extensive meadows of seagrass. These seagrass meadows stretch from the reef crest westwards across the back reef, interspersed with rubble, patch reefs, and large sponges. Two species of seagrass have been identified to date within the seagrass ecosystem of (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 create high diversity habitats in shallow marine ecosystems, with important roles in nutrient cycling, filtration and sediment stabilization (Bos *et al.*, 2007). Seagrass also provides a critical habitat 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, in GSSCMR Management Plan 2011-2016). This ecosystem fills 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 important settlement areas for post-larval stages of commercial species (Acosta, 2001, in GSSCMR Management Plan 2011-2016). Seagrass areas of Gladden Spit and Silk Cayes Marine Reserve are considered to be in very good condition, with minimal human impacts, (SEA, 2010), with impacts restricted to scarring of the seagrass beds in shallow areas of high boat activity.

Seagrass is being monitored following the seagrassnet.org protocols. Little is known about that apart from that seagrass data used to be collected and entered into the www.seagrassnet.org database. Apparently, no analysis of entered data has ever been conducted.

Terrestrial Ecosystems

The terrestrial vegetation of the three Silk Cayes is constantly changing over time, as past and current storm events change the shape, height and substrate of the caye (SEA staff, 2010; Stoddart, 1963). Comparing historical data (Stoddart, 1961) with measurements taken during fieldwork in 2017, all three cayes were dramatically reduced in size (Figures 19, 20 and 21).

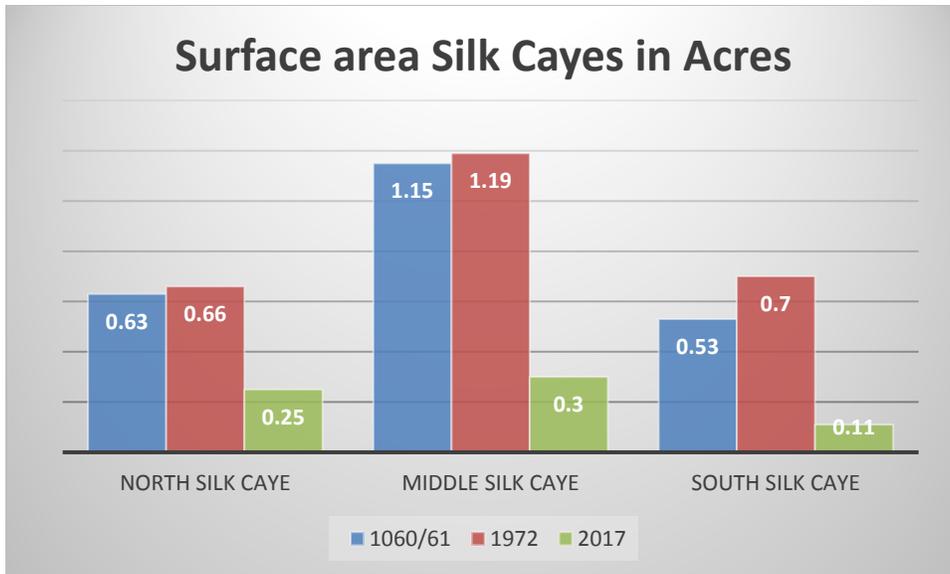


Figure 19: Change in size of the Silk Cayes since 1060/61 and 2017

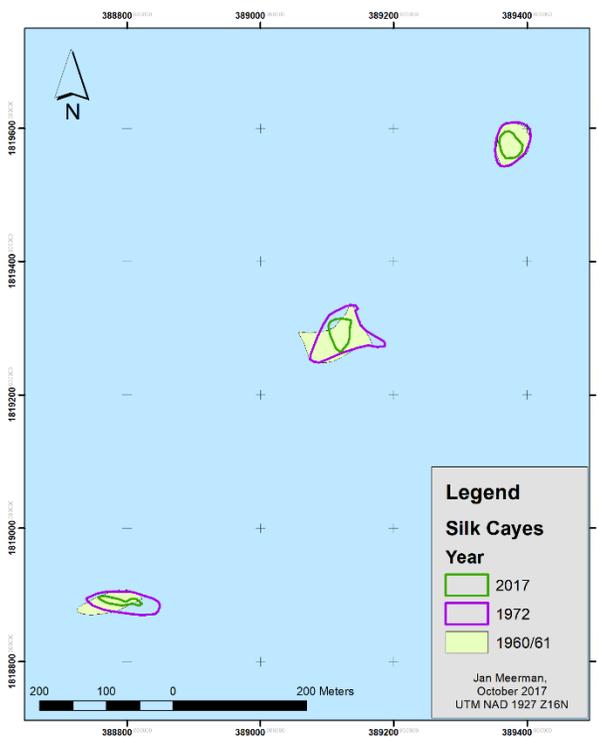


Figure 20: Silk Cayes, with historical and current (2017) size indicated⁸

⁸ Note: Any horizontal shift is not reflected here.

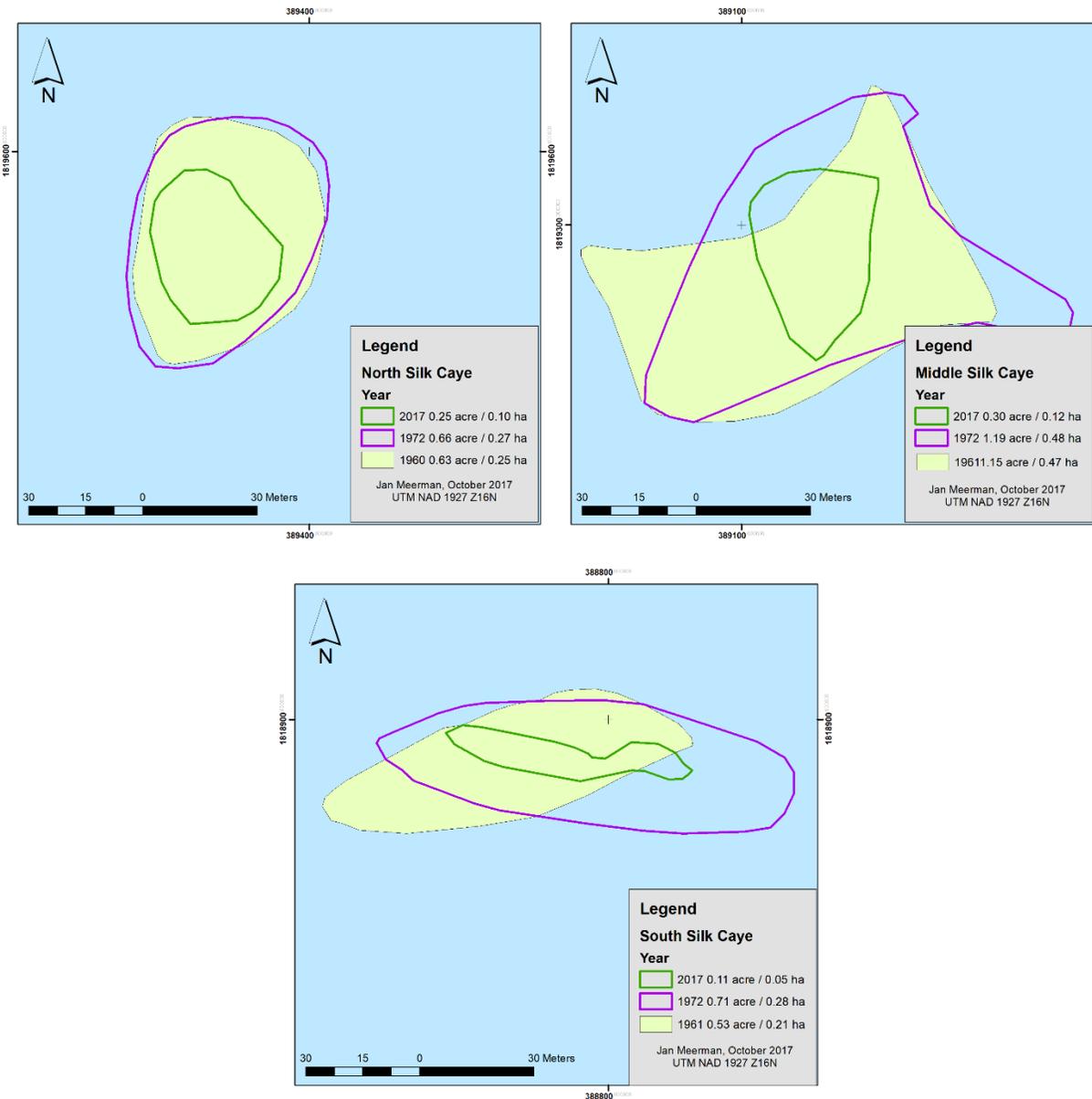


Figure 21: The Silk Cayes (North, Middle and South Silk Cayes)⁹

These changes, though dramatic, may be natural, but there appears to be a strong observed link between replacement of the original littoral forest/vegetation on South Silk Caye to make way for coconut plantations (Stoddart, 1964) while stating “indications are that the dominants of natural littoral thicket are well adapted to resist storm action”.

Another factor in the altering of Belize’s cayes is sea-level rise. Global sea level has been rising over the past century, and the rate has increased in recent

⁹ Note: Historical and current (2017) size indicated; Any horizontal shift is not reflected here

decades. In 2014, global sea level was 2.6 inches (6.6 cm) above the 1993 average—the highest annual average in the satellite record (1993-2014). Sea level currently rises at a rate of about one-eighth of an inch (0.3 cm) per year¹⁰. While this does not sound like much, sea level rose by 6 cm during the 19th century and 19 cm in the 20th century (Jevrejeva *et al.*, 2008). The level of sea-level rise varies per location on earth, and there are no good data for Belize, but in the 55 years between the Stoddart mission and today, it is conceivable that the sea-level rose at least 10 cm, which is more than enough to explain the observed erosion of the Silk Cayes.

Historical records show that the Silk Cayes were until fairly recently covered by Mangrove and beach vegetation (North Silk Caye), Littoral Forest/Beach vegetation (Middle Silk Caye) and ‘Coconut woodland’ on South Silk Caye, with relatively few plant species recorded (Stoddart, 1961). Officially labeled as **Tropical Littoral Forest and Beach Communities**, or **Tropical Coastal Vegetation on Recent Sediments** (Meerman, 2004), this ecosystem typically includes herbaceous ground-cover plants and vines on the upper beach, grading into woody shrubs with a relatively open canopy of salt tolerant trees. Herbaceous beach vegetation is highly under-represented under the National Protected Areas System - the target protected coverage is 60%, but in fact only 8.6% is included within current protected areas, and even this is often poorly protected because of the economic pressure to provide white sandy beaches and (non-native) coconuts for visitor appeal. The vegetation on the Silk Cayes has been heavily impacted by both tropical storms and clearance for tourism. Whilst small, these cayes are recognized as critical nesting habitat for several species of marine birds, endangered marine turtles, as well as an important re-fueling station for migratory birds.

Based on the 2017 site visit of the consulting team, 23 species have historically been recorded for the Silk Cayes, but currently, the individual islands themselves only have a maximum of 6 species (Table 12).

The above and below ground structure of littoral forest /herbaceous beach vegetation is important in providing protection against the beach erosion caused by storm events. Natural vegetation has been removed completely from South Silk Caye, whilst North Silk Caye, although much reduced in size, still retains characteristic plants of the natural herbaceous beach community. Middle Silk Caye appears to have suffered recent erosion and is now largely a sand island (Figure 22). When South Silk Caye was cleared and maintained as sandy beaches

¹⁰ <https://oceanservice.noaa.gov/facts/sealevel.html>

with coconut trees, the caye was significantly destabilized and exposed to greatly increased risk of erosion or complete loss.

Table 12: Vegetation of the Silk Cayes¹¹

	North Silk Caye	North Silk Caye	North Silk Caye	Middle Silk Caye	Middle Silk Caye	Middle Silk Caye	South Silk Caye	South Silk Caye	South Silk Caye
	1961	1972	2017	1961	1972	2017	1961	1972	2017
<i>Avicennia germinans</i>	x	x							
<i>Chamaesyce cf blodgettii</i>						x			
<i>Chamaesyce mesembrianthemifolia</i>					x			x	
<i>Chamaesyce sp.</i>				x					
<i>Coccoloba uvifera</i>							x	x	
<i>Cocos nucifera</i>		x		x	x	x	x	x	x
<i>Conocarpus erectus</i>	x	x	x		x				
<i>Cyperus planifolius</i>		x	x		x			x	
<i>Cyperus sp.</i>	x								
<i>Distichlis spicata</i>									x
<i>Eragrostis prolifera</i>					x			x	
<i>Erithalis fruticosa</i>	x				x				
<i>Hymenocallis littoralis</i>		x				x	x	x	
<i>Ipomoea macrantha</i>		x			x				
<i>Ipomoea pescaprae</i>					x				
<i>Ipomoea sp.</i>	x	x		x	x				
<i>Paspalum distichum</i>		x			x				
<i>Portulaca oleraceae</i>		x	x			x		x	x
<i>Rhizophora mangle</i>	x	x							
<i>Sesuvium portulacastrum</i>	x	x	x	x	x	x	x	x	
<i>Surania maritima</i>	x	x	x	x	x		x	x	

¹¹ Source: Stoddart 1961 and Fieldwork Meerman 2017

	North Silk Caye	North Silk Caye	North Silk Caye	Middle Silk Caye	Middle Silk Caye	Middle Silk Caye	South Silk Caye	South Silk Caye	South Silk Caye
	1961	1972	2017	1961	1972	2017	1961	1972	2017
<i>Tournefortia gnaphalodes</i>	x	x	x	x	x				
<i>Sphagneticola trilobata</i>					x				
Total Species:	9	13	6	6	14	5	5	9	3



Figure 22: Middle Silk Caye in 2010 and 2017¹²

2.5.2 Fauna of GSSCMR

Gladden Spit and Silk Cayes Marine Reserve has long been recognized for its regionally important, species diverse spawning aggregation and the associated whale shark congregation, as well as for its rich and diverse reef fauna. Conch, lobster and commercial finfish species are covered under Commercial Species.

Fish

The main focus of attention at Gladden Spit and Silk Cayes Marine Reserve has been the spawning aggregation and the seasonal whale shark congregations. More than 260 fish species are included in the current species list (see Appendix 2) which now also includes the invasive Lionfish (*Pterois volitans*). Of this list, 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*), great and scalloped

¹² Left photo: 2010 Management Plan; right photo: O. Salas.

hammerheads (*Sphyrna mokarran* and *S. lewini*¹³) (Table 13), all of which have been targeted commercially in the past. Nassau grouper has declined within Belize by more than 80% since the late 1970s, primarily due to fishing pressure at spawning aggregation sites where it is most vulnerable (Paz and Grimshaw, 2001).

In 2001 it was predicted that under the existing management conditions, Nassau grouper (once the second most commonly caught fish in Belize) would disappear from Belize waters by the year 2013 (Paz and Grimshaw, 2001). In light of these concerns amendments made to the regulations now impose size limits and make it illegal to take Nassau grouper during the peak spawning months of December to March, though it can still be fished outside of this time. The regional outlook is similarly bleak - it is thought that one-third of all known Nassau grouper spawning aggregation sites in the Caribbean region have disappeared. Herbivorous fish populations – such as the parrotfish (Scaridae) and surgeonfish (Acanthuridae) - are considered important for the maintenance of the health of the reef, being the dominant grazers of the ecosystem, keeping algal growth under control, and have been shown to effectively reduce algal cover in the Bahamas (Mumby *et al.*, 2006, in GSSCMR Management Plan 2011-2016).

¹³ Plus, possibly an as yet undescribed species

Table 13: Fish Species of International Concern of GSSCMR (IUCN, 2017)

Critically Endangered	
Goliath Grouper	<i>Epinephelus itajara</i>
Endangered	
Nassau Grouper	<i>Epinephelus striatus</i>
Whale Shark	<i>Rhincodon typus</i>
Splendid toadfish	<i>Sanopus splendidus</i>
Scalloped Hammerhead	<i>Sphyrna lewini</i>
Great Hammerhead	<i>Sphyrna mokarran</i>
Near threatened	
Queen Triggerfish	<i>Balistes vetula</i>
Mutton Snapper	<i>Lutjanus analis</i>
Marbled Grouper	<i>Dermatolepis inermis</i>
Rainbow Parrotfish	<i>Scarus guacamaia</i>
Vulnerable	
Hogfish	<i>Lachnolaimus maximus</i>
Cubera Snapper	<i>Lutjanus cyanopterus</i>
White Grouper	<i>Epinephelus flavolimbatus</i>
Snowy Grouper	<i>Epinephelus niveatus</i>
Yellowmouth Grouper	<i>Mycteroperca interstitialis</i>
Whitelined toadfish	<i>Sanopus greenfieldorum</i>

As part of the monitoring efforts carried out by SEA, it becomes clear that the decline in commercial fish species has not halted since the inception of the Spawning Aggregation Sites. Data for the spawning aggregations for commercial fish species in 2016 revealed extremely low numbers. The Dog Snapper showed the highest encounter numbers with its peak in November after a notable low earlier in February. On the other hand, figures for the Nassau Grouper remained low and effectively this species is still in a process of collapse (Figure 23).

Nassau Grouper Fish Spawning over a twelve year period

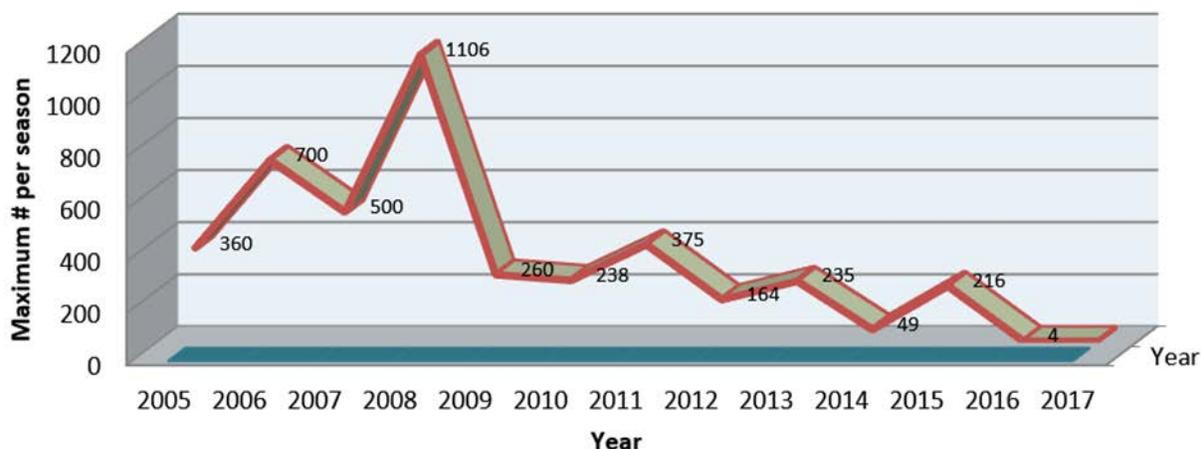


Figure 23: Annual numbers of Nassau Groupers observed at Gladden Spit

The world’s largest fish, the whale shark (*Rhincodon typus*) is the flagship species of Gladden Spit and Silk Cayes Marine Reserve, forming congregations at full moon each year to feed on spawn at the aggregation site during the ten days of the full moon in May, June and July. This Endangered species (IUCN, 2017) is considered highly migratory, travelling 1000’s of kilometers, and occurs throughout tropical and warm temperate waters around the globe. The 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 Gladden Spit and Silk Cayes Marine Reserve, and has been reported passing through the deeper waters of the outer reef. Whale shark tourism is a highly lucrative industry based on an ecologically vulnerable species that is sensitive to anthropogenic impacts. The whale shark congregation at Gladden Spit provides a focus for tourism for adjacent communities – particularly Placencia – and is managed by SEA.

However, recent reports seem to indicate a decline in whale sharks seen, leading to complaints from tourists. The sharks are either deeper or just stay away. To get a grip on this, for the 2014-2015 whale shark monitoring, tour operators were interviewed by SEA and the outcomes indicated that for the peak month of May, there were 78 sightings in 2014 and 6 sightings in 2015. This tremendous decline in whale shark sightings was a major disappointment for tour operators and tourists. In 2015 the majority of the whale sharks were apparently seen 2 to 3 miles off the reef, the assumption of many stakeholders was that the whale sharks were seeking alternative food sources (such as jelly fish). If the results of the Spawning Aggregation monitoring are any indication, something like this

may well be the case. A collapse in the spawning fish population will inevitably affect the food source of the Whale Sharks and thereby the attractiveness of Gladden Spit for this species.

Nevertheless, dips in the Whale Shark Sightings have happened before, such as in 2004 (Figure 24), but the overall trend appears to be one of a rapid decline.

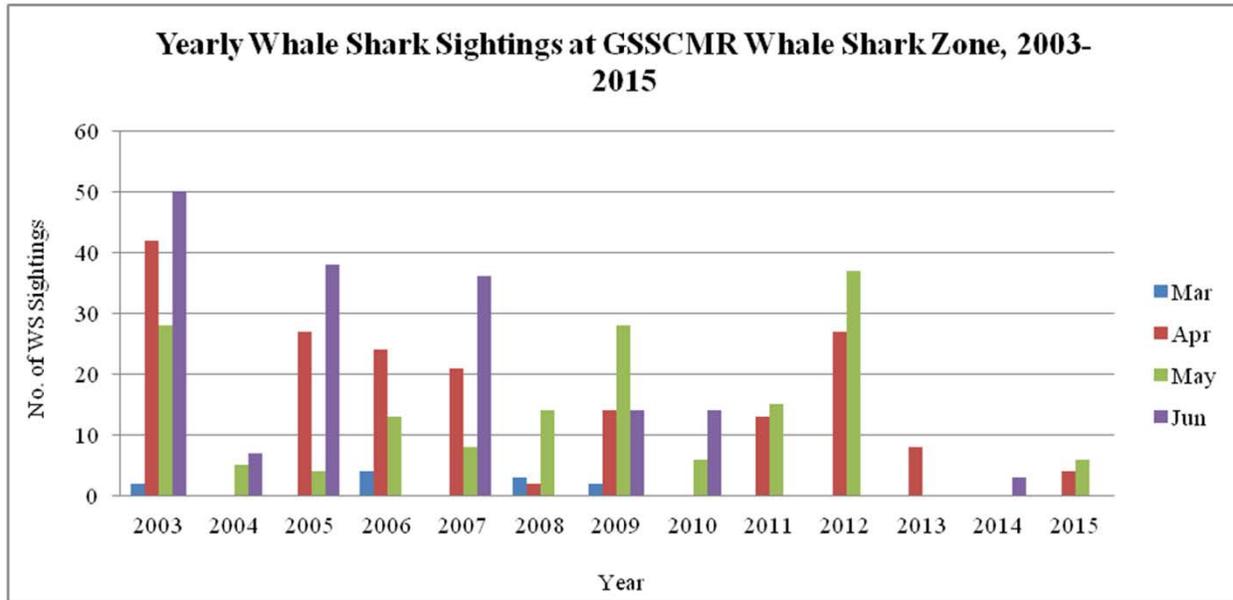


Figure 24: Tour Operator Whale Shark Sightings in GSSCMR

Access to the whale shark congregation area is strictly regulated by SEA, with a cap on the number of tours allowed to use the area at any one time or on any one day, to minimize impacts on whale shark behaviour, or on the behaviour of spawning fish at the aggregation site.

A further eleven shark species have been confirmed as present within the Marine Reserve, with four others (deep water species) thought to be present but yet to be confirmed (R. Graham, reported in 2011 management plan). These include endangered great and scalloped hammerheads (*Sphyrna mokarran* and *S. lewini*), which have both been reported at Gladden Spit. These species are still fished within Belize, despite their global status.

Mammals

Four species of dolphin have been reported from within the adjacent South Water Caye Marine Reserve, two of which (Atlantic bottlenose dolphin (*Tursiops truncatus*) and the Atlantic spotted dolphin (*Stenella plagiodon*)) are commonly seen inside the Belize Barrier Reef (CCC, 1993, in GSSCMR Management Plan 2011-2016). The deeper-water rough-toothed dolphin (*Steno bredanensis*) has also been reported, as has Fraser's Dolphin (*Lagenodelphis hosei*), though presence of these dolphins within the protected area boundaries still requires confirmation. In August 2017, a dead Sperm Whale (*Physeter macrocephalus*) was discovered near the Silk Cayes.

Antillean (or West Indian) manatees (*Trichechus manatus manatus*) have been reported from the Silk Cayes area, and as far west as the inside of the barrier reef in the Gladden Spit area. The Belize coast is home to the largest population of Antillean manatee in the Caribbean (Morales-Vela *et al.*, 2000, in GSSCMR Management Plan 2011-2016), 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 17th century, it was taken to provide food for privateers and explorers (Self-Sullivan and LaCommare, 2004, in GSSCMR Management Plan 2011-2016). Today, the Antillean manatee is considered threatened throughout its range, and is listed as 'Vulnerable' (IUCN, 2017), but is fully protected under the Wildlife Act.

Birds

The birds of the Silk Cayes are an underappreciated resource. Relatively few records exist of the birds of these islands starting in 1998 with the last record in October 2017 as part of the field work of the consultant team (Table 14). Through these efforts 26 bird species are currently known from the islands (Table 15). Most of these are typical marine/sea shore birds but there is a component of small migratory birds as well that use the cayes as a short stopover point on their migration.

Many of the bird records are now being maintained in through the citizen science effort eBird (<http://www.ebird.org>) and future researchers should be encouraged to log their data into this global database.

Table 14: Bird records for the Silk Cayes¹⁴

Date	Observer
28-May-98	Lee Jones
25-Nov-11	Elmer Requena and Mario Muschamp
15-Nov-15	Andy D.
9-Jun-16	Roni Martinez
22-Jun-16	Helen/Victor/Gracia
21-May-17	Roni Martinez
11-Jun-17	Roni Martinez
3-Oct-17	Jan Meerman

The number of migratory songbirds on the caye’s species list has the potential to increase as observations continue and being lodged in eBird.

The Silk Cayes are of critical importance to a number of sea birds namely:

- Laughing Gull
- Bridled Tern
- Royal Tern
- Brown Noddy
- Sooty Tern (Figures 25 and 26)
- Roseate Tern
- Sandwich Tern (Figure 27)

Historically, Belize must have housed numerous sea bird colonies, but many of the cayes being converted to tourism destinations and others being in use as fishing camps, these colonies have all but disappeared and the Silk Cayes are currently the very last remnant of this once abundance of sea birds.

While none of the species listed are reported as being highly threatened, Belize has an obligation to protect this last foothold of these birds, especially in a situation where they are already within a protected area.

¹⁴ Listing the observer(s) and the dates of the records

Table 15: Birds recorded from the Silk Cayes as per October 2017

	28-May-98	25-Nov-11	15-Nov-15	9-Jun-16	22-Jun-16	21-May-17	11-Jun-17	3-Oct-17
Brown Pelican	6	x		11		10		
Magnificent Frigate Bird			10	7		2	5	3
Brown Booby	1	x	5	7			1	
Great Blue Heron		x						
Yellow-crowned Night Heron								1
Green Heron							2	
Osprey	2	2	1		2	1	2	2
Peregrine Falcon		x						
Laughing Gull	2			11	16	8	7	
Bridled Tern	15					3	4	
Royal Tern		x	1			3	2	1
Brown Noddy				278	"Lots"	255	278	
Sooty Tern				327	>200	325	325	
Roseate Tern				2		78	18	
Sandwich Tern				89	1	80	2	
Common Tern						1	3	
Least Tern					4			
Spotted Sandpiper			1					
Ruddy Turnstone							5	14
Belted Kingfisher			1					
Red-Eyed Vireo	1							
Eastern Kingbird	1							
Yellow Warbler	2							
American Redstart								1
Chestnut-sided Warbler								2
Yellow-rumped Warbler		x						



Figure 25: Sooty Terns, Brown Noddy's, at North Silk Cay¹⁵



Figure 26: Sooty Terns, Brown Noddy's, at North Silk Cay¹⁶

¹⁵ Roni Martinez, 9 June 2016

¹⁶ Ibid.



Figure 27: Sandwich Terns at Middle Silk Cay¹⁷

The bird nesting is concentrated on North and Middle Silk Caye. With these two islands having different vegetation profiles, the birds nest accordingly (Table 16). South Silk Caye is too crowded with tourist to allow nesting of these birds, but it is a potentially suitable location.

When nesting is in progress, visitation to Middle Silk Caye is not permitted, ensuring the nesting season is successful (Figure 28¹⁸). In 2016 there was a sign in place identifying the closed nesting site. But effectively, both North Silk Caye and Middle Silk Caye should be off-limits throughout the year until more clarity exists about the actual breeding seasons.



Figure 28: No Entry sign at Middle Silk Cay

¹⁷ Roni Martinez 9 June 2016

¹⁸ Ibid.

Table 16: Ecological preference of the various sea-birds nesting on the Silk Cayes

Species	Scientific name	Nesting preference	Preferred Caye
Brown Noddy	<i>Anous stolidus</i>	<i>On rock, ground or in vegetation</i>	<i>North Silk Caye</i>
Roseate Tern	<i>Sterna dougallii</i>	<i>On ground under vegetation cover or on bare sand</i>	<i>North Silk Caye / Middle Silk Caye</i>
Sooty Tern	<i>Onychoprion fuscatus</i>	<i>On ground between vegetation</i>	<i>North Silk Caye</i>
Bridled Tern	<i>Onychoprion anaethetus</i>	<i>On ground between rocks or vegetation</i>	<i>North Silk Caye</i>
Laughing Gull	<i>Leucophaeus atricilla</i>	<i>On ground among vegetation</i>	<i>North Silk Caye</i>
Sandwich Tern	<i>Thalasseus sandvicensis</i>	<i>On ground in the open</i>	<i>Middle Silk Caye</i>
Royal Tern	<i>Thalasseus maximus</i>	<i>On ground in the open</i>	<i>Middle Silk Caye</i>

Reptiles

A total of four reptile species have been documented to date from Gladden Spit and Silk Cayes Marine Reserve, including the critically endangered hawksbill turtle (*Eretmochelys imbricata*), endangered green turtles (*Chelonia midas*) and vulnerable (*Caretta caretta*) (Table 17). 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. In the early 1900s, the size of the turtle industry, harvesting hawksbills for their shells, supported two or more schooners in Belize, based out of Tobacco Caye, having a mass impact on the turtle populations of the entire Belize shelf. As relatively recently as 1925, their numbers were considered inexhaustible in Belize (Smith *et al.* 1992) – a far cry from the current situation.

Table 17: Reptile Species of International Concern (IUCN, 2017)

GSSCMR	
Reptiles of International Concern	
Critically Endangered	
Hawksbill Turtle	<i>Eretmochelys imbricata</i>
Endangered	
Green Turtle	<i>Chelonia midas</i>
Vulnerable	
Loggerhead Turtle	<i>Caretta caretta</i>

The high sandy beaches of the Silk Cayes have been used historically by green and hawksbill (GSSCMR Management Plan 2011-2016; Smith *et al.*, 1992), though numbers have been small (between one and three nests reported in any one year). Although SEA does sea-turtle monitoring, the records are not filed in a way allowing easy analysis.

Whilst now afforded full legal protection from harvesting in Belize, turtle populations remain highly threatened by loss or degradation of nesting habitat - 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 on mainland beaches and inhabited cayes outside of the protected area, increasing the critical importance of maintaining those characteristic of the Silk Cayes that increase nesting success, and balancing this with tourism activities in the area.

The Hawksbill turtle tends to be more confined to shallow waters than loggerhead and green turtles, 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. With a regional average of 4.5 nests per female in the years they breed, 1 to 3 nests in all probability represent only 1 or 2 females coming ashore to breed. 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. SEA monitoring data indicates that small numbers still do nest on the Silk Cayes (3 nests confirmed in 2016).

Loggerhead and green turtles still frequent the waters of Gladden Spit and Silk Cayes Marine Reserve, and green have reported as nesting on the cayes (Smith *et al.*, 1992). 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 adjacent 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 brown anole (*Norops sagrei*) is the fourth reptile species to have been recorded on the cayes (GSSCMR Management Plan 2011). This human commensal occurs on or close to human buildings along the Belize coast and cayes but was not again noted in a 2017 site visit.

2.5.3 Economically Important Species

The Gladden Spit and Silk Cayes Marine Reserve plays an integral role in maintaining the viability of the Belizean fishery, particularly for the Caribbean Spiny Lobster (*Panulirus argus*) and Queen conch (*Strombus gigas*), two invertebrate species of commercial importance fished extensively throughout Belize. The conch and lobster fisheries form the two most important components of the capture fisheries in Belize, with production representing over 90% of total capture fisheries production in 2008, and an export value of Bz\$20.30 million (Ministry of Agriculture and Fisheries, 2009, in GSSCMR Management Plan 2011-2016). Lobster landings peaked in 1981 at 2,204,622 lbs, but fell to 457,680 lbs in 2006, with 484,891 lbs harvested in 2014/15 season (Belize Fisheries Department, 2015).

It is significant to note that the general trend of total national lobster production is a decline, and there are concerns for the continued sustainability of the lobster fishing industry. Whilst in the past there has been continued optimism that lobsters are being harvested at a sustainable level (Gillet, 2003, in GSSCMR Management Plan 2011-2016), 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, 2009) – representative of a community with over 80% of families directly reliant on the lobster and conch fishing industry (Sarteneja community consultation, 2005), and the largest fishing stakeholder community of the Belize reef (Catzim, 2009, in GSSCMR Management Plan 2011-2016).

Lobster has traditionally been a major fisheries target at the Gladden Spit and Silk Cayes Marine Reserve. Most lobster fishermen within the GSSCMR use hook sticks to free dive for lobster. Over the past years commercial species

monitoring has been occurring within the GSSCMR but data are not stored in a way that allows easy analysis.

As with lobster, national conch landings have declined significantly, peaking at 1,239,000 lbs in 1972, and subsequently declining by over 50% to 574,756 lbs in 2008. The 2015-2016 conch season produced 794,369 pounds indicating an increase in production. It has been suggested that the maximum sustainable yield for this species was reached in 2006, with the steep decline of 17% observed in 2007 serving as an indication of the “maturity” of the fishing industry, and the possible overfishing of this fishery resource (Ministry of Agriculture and Fisheries, 2007, in GSSCMR Management Plan 2011-2016). Even as far back as 1996, there was evidence that fishing pressure was too high, with the national population consisted primarily of juveniles, resulting in recommendations for capping of the number of fishermen. Strict regulations and quotas are now being implemented towards more sustainable use of this resource, and an increase in production was noted in 2008 (Ministry of Agriculture and Fisheries, 2009, in GSSCMR Management Plan 2011-2016), though the number of fishermen has still not been capped.

SEA monitoring data for the GSSCMR appears to indicate a complex relationship in lobster abundance between no take (replenishment) – reserve – and open zones (Figure 29). Numbers seem to be lowest in the no take (replenishment) zone. Infrequency of sampling efforts and possible differences in micro-ecosystems may be responsible for this. But as it stands now, the available data does not appear to lend any credence to a beneficial effect of the no-take zone.

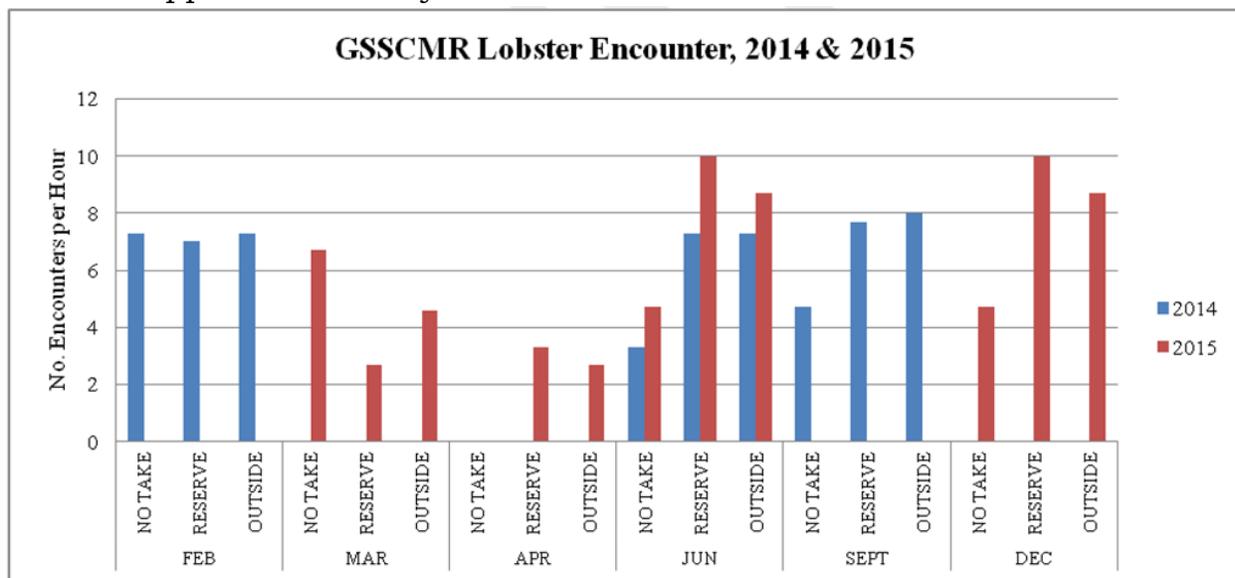


Figure 29: GSSCMR Lobster Encounter (2014 & 2015)

Conch landings, too, have declined significantly, peaking at 1,239,000 lbs in 1972, and subsequently declining to 574,756 in 2008 (Ministry of Agriculture, 2008, in GSSCMR Management Plan 2011-2016), representing a drop of over 50%. It has been suggested that the maximum sustainable yield for this species was reached in 2006, with the steep decline of 17% 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, in GSSCMR Management Plan 2011-2016). 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. Strict regulations and quotas are being implemented towards more sustainable use of this resource, and an increase in production was noted in 2008 (Ministry of Agriculture and Fisheries, 2009, in GSSCMR Management Plan 2011-2016). SEA has conducted monitoring of conch populations within the Gladden Spit and Silk Cayes Marine Reserve, but an analysis of data is not available.

Earlier comparison of the existing SEA data between the no-take preservation zone and the fished general use zones has indicated that there appears to be some correlation between the size and age of conch within each of the zone types. The results indicate a trend towards larger conch in the no-take zones indicating some kind of a reserve effect. However, over the period 2014/15 such an effect was not apparent in the monitoring data, while in 2016 it appeared to be present again for at least part of the year (Figure 30).

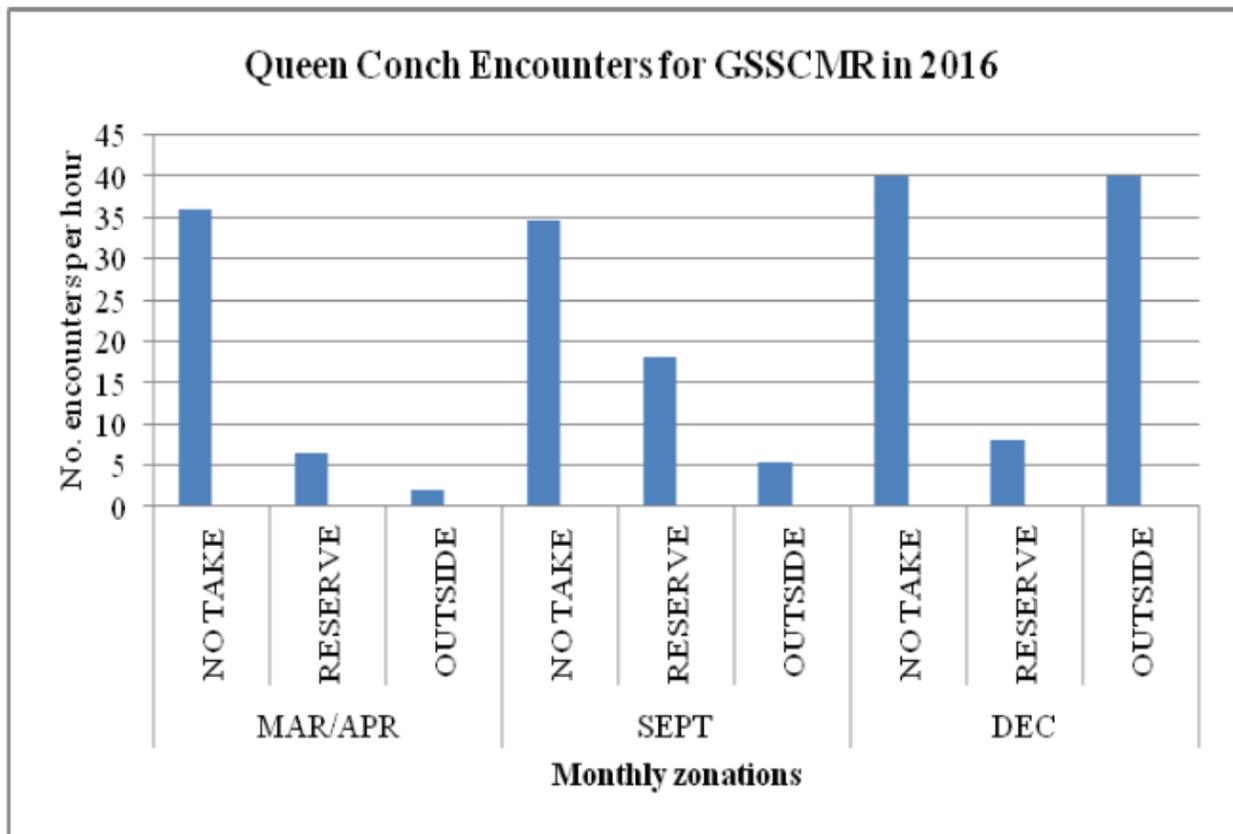


Figure 30: Queen Conch Encounters for GSSCMR in 2016

Finfish are also extracted from the marine protected area, and in general provide an important component of the commercial catch – most are fished using 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/FICP_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, in GSSCMR Management Plan 2011-2016). Species harvested for local consumption include grunts (Haemulidae), snooks (Centropomidae), mullets (Mugilidae), porgies (Sparidae), triggerfish (Balistidae), and tarpon (Megalopidae).

Management of the Gladden Spit and Silk Cayes Marine Reserve has historically centered on the internationally recognized spawning aggregation site. GSSCMR is the site of remarkable spawning aggregations, with over thirty species of reef

fish and near shore pelagics – including jacks, grouper and snapper- observed displaying spawning behavior.

The area of Barrier Reef around Gladden Spit contains the best-developed and most continuous reef due to its elevation, good water quality, and modified wave regime. The southernmost tip of this area sticks out and is called The Elbow or Gladden Spit. In 1992-1993, tourists were beginning to be taken out to Gladden Spit to see the whale sharks. Foreign fishers from Honduras and Guatemala were also operating in the area. By 1995, tourism was increasing to see the whale sharks. In 1999, Friends of Nature with support from The Nature Conservancy began lobbying government for the declaration of the Gladden Spit and Silk Caye Marine Reserve. The area was declared a marine reserve in 2000. In 2002, FoN was given delegated co-management of the GSSCMR, making the NGO responsible for day-to-day management of the park. An additional ten spawning aggregation sites were declared protected by the Government of Belize in 2002, making eleven spawning sites within Belize protected from overfishing. The spawning aggregation site at Gladden Spit attracts over thirty species of reef fish and near shore pelagics.

Since 2002, SEA with support from the Nature Conservancy as well as other local partners has conducted monthly monitoring of the SPAG site at GSSCMR. This monitoring has followed the Reef Fish Spawning Aggregation Monitoring Protocol for the Mesoamerican Reef and the Wider Caribbean. Monitoring has been targeted at the days surrounding the full moon and is conducted monthly as weather permits. This monitoring, which has occurred consistently over the past five-years, has allowed for the compilation of a significant data set.

Although a wide number of species are known to aggregate at the Gladden Spit, four species of commercial importance have often attracted the most attention and will be discussed here. These include the Nassau Grouper (*Epinephelus striatus*), Mutton Snapper (*Lutjanus analis*), Dog Snapper (*Lutjanus jocu*) and Cubera Snapper (*Lutjanus cyanopterus*). Nassau grouper is currently listed on the IUCN red list as endangered and has been a conservation target across the region and Belize due to impacts from fishing. Mutton snapper has been a fishing target for fishermen at GSSCMR for many years and has been the focus for managers of the site. Dog snapper is a prevalent species at GSSCMR and is known to spawn through-out the year, however due to its smaller size it has not been specifically targeted by fishermen. Finally, spawning Cubera snapper are thought to be the major draw for the whale sharks which are found in their greatest density during the peak months for Cubera. These four-fish species have been the main management focuses of SEA at Gladden Spit.

Relating enforcement efforts directly to the increase in fish observed at the spawning site is tenuous at best. The location of GSSCMR and the abundance of fish recorded during the spawning period make Gladden Spit a prime target for illegal fishing activities. Located relatively close to both Guatemala and Honduras it is clearly a popular destination for unlicensed or illegal fishermen from these two countries as well as local Belizean fishermen.

It is clear that further protection for some species, specifically the Nassau grouper is warranted, however continued investment in effective enforcement should help efforts to conserve these unique locations. Because of the value of Gladden Spit as an active spawning aggregation fishery from March to June, special regulations have been developed by Southern Environmental Association and the Fisheries Department to ensure that fishing at this sensitive location is closely monitored. This includes the granting of special licenses to traditional fishermen, careful enforcement of fisheries laws and the prohibition of night fishing. Due to these regulations the vast majority of fish targeted by local fishermen are mutton snapper, not the cubera and dog snapper which are the major attraction for whale sharks. For a number of years, at first in collaboration with researchers and now as part of SEA's monitoring program, data have been collected about fishers' catches at the fishermen's camp on Buttonwood Caye.

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.

2.5.4 Past and Present Research

There are no established research facilities within the Marine Reserve, though a number of organizations have ongoing research programmes, primarily targeting the spawning aggregation site, and resulting in a number of papers focusing on the whale sharks, spawning aggregation, currents, physical oceanography, and connectivity. Principal long-term researchers include Rachel Graham and B. Kjerfve.

Every year, SEA conducts commercial species survey quarterly, with its focus of monitoring for this survey on the Queen Conch, lobster and finfish at both LBCNP and GSSCMR. This survey is conducted by means of doing a 30-minute timed swim for each site in accordance with Dr. Charles Acosta's Long-term Atoll Monitoring Program, otherwise known as LAMP. There is a total of 24 sites,

12 in GSSCMR and another 12 in LBCNP. With respect to GSSCMR, 3 sites are within the “no take” zone, 6 falls in the general use zone and the final 3 are referred to as “control” sites since these are located outside the reserve. Given that LBCNP is smaller in size, there are 5 “control” sites (outside the park) and 7 sites located within the park. Normally, this survey is conducted by a team of four persons; three divers and one boat captain. The depth of each site varies from 12 to 31 feet with the survey conducted during daylight hours only.

The spawning aggregations survey is another of the key surveys. It is divided into two survey seasons; namely, Nassau Grouper (*Epinephelus striatus*) Survey Season which is monitored from November to February and the Snapper Species Survey Season, which is monitored from March to June each year. The methodology utilized for this survey is the one adapted by the Spawning Aggregations Working Group (Heyman *et al.*, 2004). Monitoring is done twice daily with the first dive done around midday and second dive done in the late evening between 5-6 PM. The type of data collected includes fish species, size, abundance and behavior such as change in spawning time, depth, reduced/increased spawning, etc.).

SEA is a member of the National Coral Reef Monitoring Network, which is the national body responsible for coordinating national monitoring efforts. In conjunction with the efforts of the National Coral Reef Monitoring Network, Ecomar coordinates bleaching data and lionfish reports for Belize. Data from Ecomar will be submitted to the Environmental Research Institute, once it has been fully established. GSSCMR encompasses three Healthy Reef monitoring sites developed to provide an indication of the status of the coral reef throughout the region.

SEA has been conducting monthly water quality testing since 2013 in an effort to collect baseline data which would be used to determine if there are any changes in the oceanic conditions. Furthermore, it can be used to make management decisions for these protected areas for continued marine resource/ecosystem sustainability.

Testing is conducted for a mixture of both physical and chemical parameters as follows:

- pH
- Dissolved Oxygen (DO) in % and mg/l
- Temperature (degrees Celsius)
- Conductivity (SPC us/cm)
- Sea Level Atmospheric Pressure (inHg)
- Turbidity (meters)
- Nitrate (mg/l)

- Phosphate (mg/l)
- Salinity (ppt)

Majority of these parameters are tested using the YSI ProPlus Quattro water monitoring probe at varying depths; surface, 0.5 m, 1 m, 2 m, 5 m, 10 m, 15 m and 20 m (if depth allowed) for which a 500-ml sample is collected at each site. The testing for the chemical parameters for nitrate (Cadmium Reduction/UV VIS Spectro), phosphate (PhosVer/Orthophosphate/UV VIS Spectro) and salinity (Mercuric Nitrate Titration) is done at the Belize Aquaculture Limited Water Quality Laboratory.

Effectively, SEA is thus building up a baseline data set for sea-water quality in the area. Unfortunately, the data do not automatically lend themselves for taking management decisions. Based on the location of the water monitoring sampling sites (Figure 31), it would be necessary to have an additional number of sampling sites immediately next to South Silk Caye combined with a higher sampling frequency. In this way it might be possible to identify whether visitation (and resulting bath-room use) have a measurable effect on the water quality and thereby being able to possibly link algae outbreaks to any increases in nutrient input.

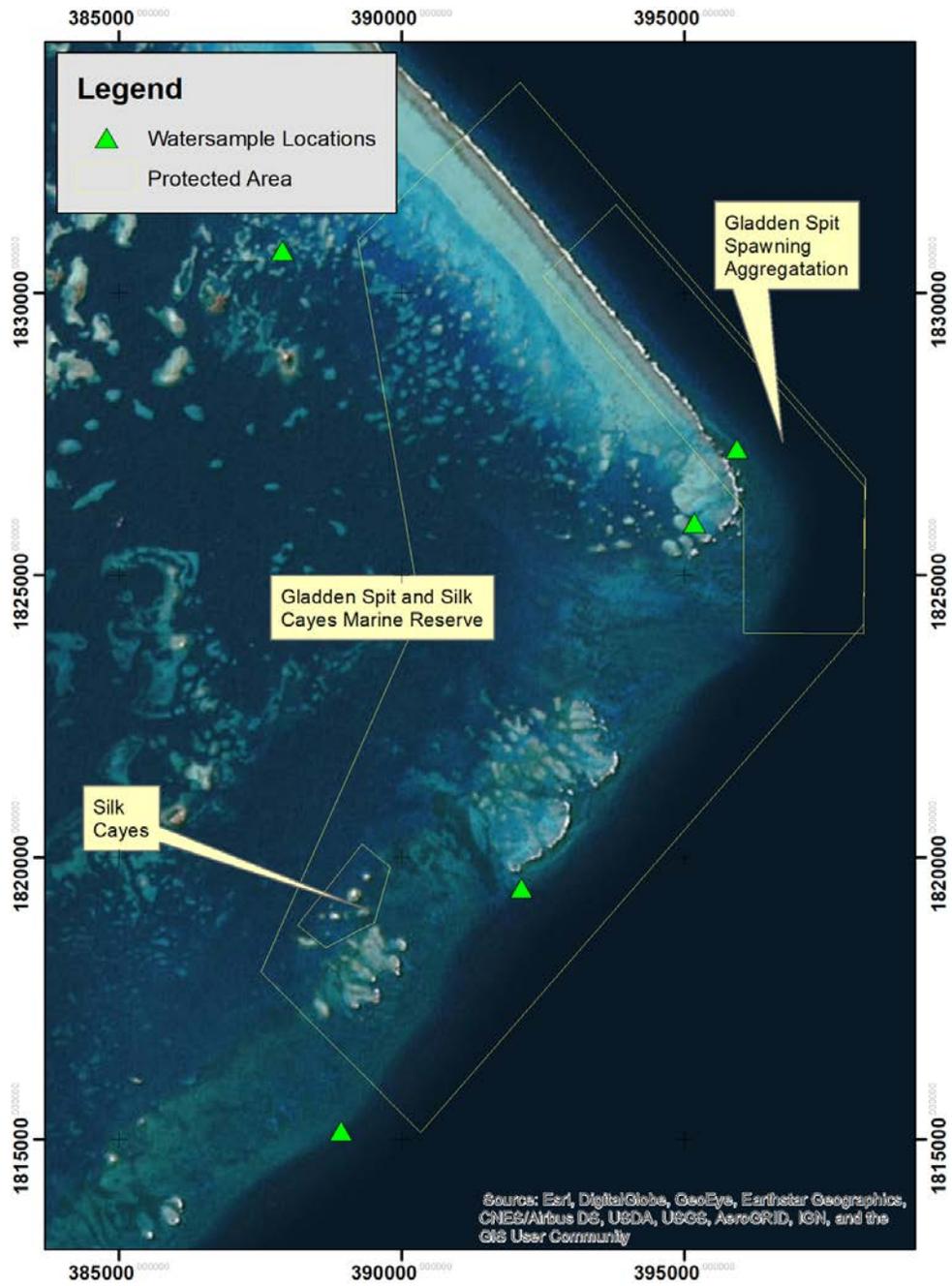


Figure 31: Water Quality Monitoring Sampling Sites at GSSCMR

2.6. Cultural and Stakeholder Use of GSSCMR

2.6.1 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., with many of the cayes used during the height of the Maya civilization.

From the early 19th century, the coastal communities of the central coastal plain from Dangriga to Placencia, and down to Monkey River, have traditionally been subsistence fishermen, paddling in dories close to shore and rarely venturing beyond Ragged Caye. In the 1960s, 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. With the arrival of outboard motors and fiberglass skiffs, many of today’s fishing descendants from the stakeholder communities near the reserve are able to travel further, better utilizing the resources of the marine reserve.

This has included use of the spawning aggregation site at Gladden Spit under a special permit, and harvesting of finfish, lobster and conch throughout the area. With the designation of the marine reserve, fishing became more restricted, with surveillance and enforcement patrols ensuring that fishermen complied with fisheries laws, and setting aside a Conservation Zone for resource protection and tourism use, centered on the Silk Cayes.

The seasonal protection of the spawning aggregation site in 2003 and subsequent management, with access being restricted to traditional fishermen, is seeking to ensure the sustained viability of the fish stocks in the long-term, though there is general agreement that management of the permit system needs to be overhauled to ensure its effectiveness for conservation.

Fishing Patterns

There are approximately 64 commercial fishing vessels reportedly using Gladden Spit and Silk Cayes Marine Reserve. The fishing boats originate primarily from communities on the central coastline, with Placencia and Independence having the highest number of boats and fishers using the area. Other communities such as Riversdale and Monkey River use the GSSCMR to a lesser extent. Use of the area by the residents of Seine Bight is almost non-existent due the drastic decline of fishers coming from that community. The central fishermen generally use smaller skiffs, and access the area on one day/two-day fishing trips, with

between 2 and 4 fishermen per boat. Fishing methods may include traps, shades and lines, as well as free diving for conch and lobster. The use of spear gun is now prohibited within marine reserves, as per the revised Statutory Instrument of 2009.

The largest number of boats originate from Sarteneja, to the north of Belize. The Sarteneja fishers use larger traditional sailboats to reach the marine reserve, and dug-out canoes, or dories for daily fishing (one per fisherman). The number of fishermen per sailboat varies from a minimum of 3 to 18 - the highest number of fishermen recorded for a single boat in 2008. These fishermen 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.

2.6.2 Recreation and Tourism Use

Belize is a well-known tourism destination for those seeking the reef, coral sand beaches and laid-back Caribbean culture. Gladden Spit and Silk Cayes Marine Reserve provides an excellent destination for marine based activities - the proximity of pristine reef, dive sites, whale sharks and world class sport fishing draws many visitors to the area. Snorkeling and diving tours originate from the mainland (principally Dangriga, Placencia, Sittee River, and Hopkins), with many of the larger coastal resorts, such as Hamanasi (Hopkins) and Pelican Beach Hotel (Dangriga) providing day tour packages.

In 2009, there were approximately 8,580 visitors to GSSCMR meanwhile in 2017, there were about 12,375 visitors which represents a significant increase. While some data for this period is incomplete, it still shows an upward trend in terms of visitation. See Figure 32 below. Tourism is a significant income generation mechanism for SEA, as the co-manager of the GSSCMR.

Visitation to GSSCMR varies across the year with increases generally starting around November and generally peaking between March and April (Figure 33). The lowest visitation occurs generally during September.

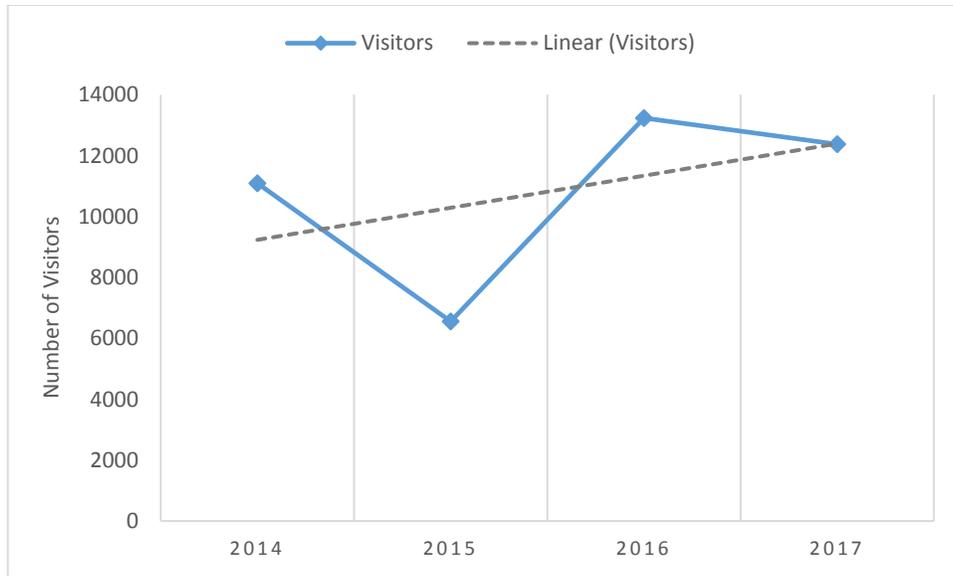


Figure 32: GSSCMR Visitation 2014-2017¹⁹

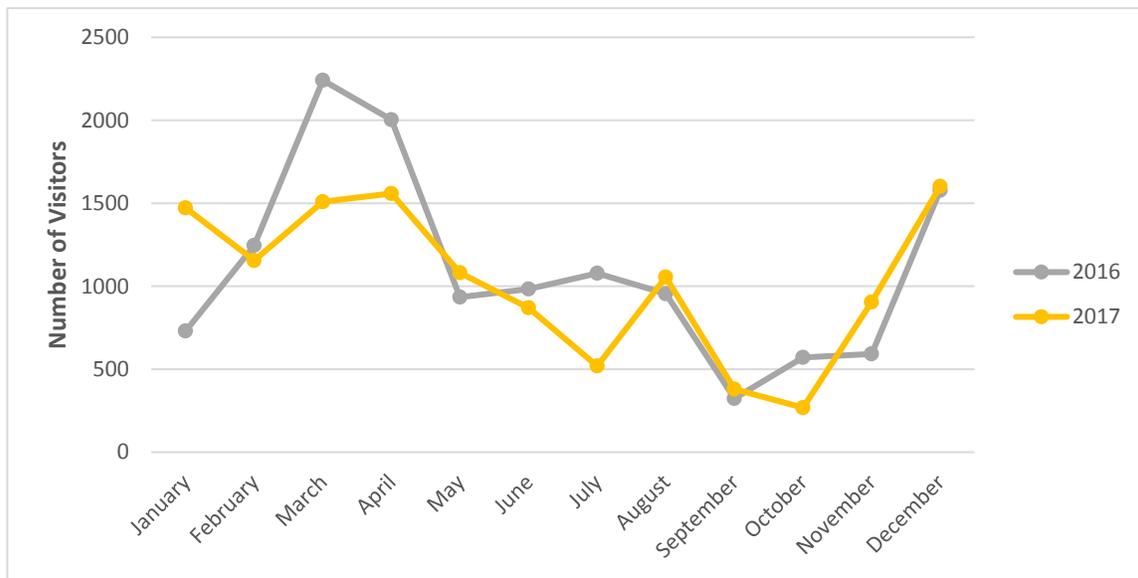


Figure 33: GSSCMR Monthly Visitation (2016 & 2017)²⁰

Tourism is also an important source of revenue for the tour operators, hotels and associated tourism businesses of central Belize – particularly Placencia. Private yachts and charters also utilize the area on a frequent basis, with a number of companies providing charter services, based primarily from Placencia and San Pedro.

The majority of visitors are focused on day trips, snorkeling in the Silk Cayes area

¹⁹ Source: SEA, 2018. Data for 2014 and 2015 in some months is incomplete.

²⁰ Source: SEA, 2018

and, if it is within the whale shark season, in the whale shark zone. Whale shark visitation is strictly controlled through a series of regulations agreed to by the tour operators, and stiff penalties if these regulations are broken. While whale shark tourism continues, there has been a significant decline in whale shark congregation sightings within the last three years.

2.6.3 Educational Use

SEA continues to work closely with communities and local partners to promote education, and community engagement in the management of the protected areas, and in the education of both stakeholders and visitors for effective management.

There are limited visitor facilities within the Gladden Spit and Silk Cayes Marine Reserve and remains under-utilized for educational purposes. Though SEA recognizes the importance of hands-on experience in creating environmental awareness, SEA's Education Programme hosts school trips to the reef – predominantly in the Laughing Bird Caye area, with its easier access and a larger caye than on the Silk Cayes. Educational activities, which has been ongoing throughout the history of the current organization and its predecessor, Friends of Nature, continues under SEA.

3. CONSERVATION PLANNING

Conservation action planning is a structured process that identifies and assesses the species and ecosystems of concern, the threats that impact them, and the strategies that can be used within the management of the area to mitigate these threats.

3.1. Identification of Conservation Targets

Conservation targets are species, species assemblages or ecosystems that have been selected as representing the biodiversity of a protected area – such that strategic actions, taken to ensure their continued viability and reduce the pressures impacting them, will adequately address the needs of the system as a whole. An initial list of potential conservation targets was generated, to represent and encompass the biodiversity values of the area, and to provide a basis for setting goals, developing strategies and actions, and monitoring success. These potential targets were then reviewed, combined or nested into a list of five conservation targets, each representing or capturing the array of ecological systems, communities and species of the GSSCMR (Table 18).

Table 18: Conservation Targets for GSSCMR

Conservation Target	Justification for Target	Species, Communities or Ecological Systems represented by Conservation Target
Bird Nesting and Turtle Nesting/Silk Cayes	Bird nesting on North Silk Caye , this can serve as a tourist attraction with proper regulation; sea bird colony on North Silk Caye is perhaps one of the last remnants in Belize; threats include erosion, crowd control, loss of vegetation; Middle Silk Cayes may be developed which will lead to further loss of habitat; sea turtles are threatened with the hawksbill being listed as critically endangered	Laughing Bird, Osprey, Brown Pelicans, hawksbill, loggerhead and green turtles, sandy beaches
Commercial Species	Threatened by lionfish; angel fish and grazers being fished; existing fishing zones depleted; possibly extend no take zone; possibly implement catch and size limits	Angel fish and grazers, Queen Conch, lobster
Spawning Aggregations/ Whale Sharks	Number of whale sharks sighted during season has declined	Nassau grouper Whale Sharks

Conservation Target	Justification for Target	Species, Communities or Ecological Systems represented by Conservation Target
	significantly (according to SEA ranger and PTGA reps). Nassau grouper pop. decreasing (2005-2017)	Mutton, dog and cubera snappers
Coral reef communities	Lionfish (threat); Impacted by global warming; bleaching; basis of the commercial fishery (reef species)	Coral Reef communities and all associated reef species (reef fish, gorgonians, sponges etc)
Seagrass communities	Feeding and nursery habitat for juvenile fish and invertebrate species; filters sediment from water. Currently unaware of the status due to absence of monitoring; ecological importance; over 90% considered intact 5 years ago	Seagrass beds, juvenile fish and invertebrate species, manatees and turtles

3.2. Assessment of Conservation Target Viability

The Viability Assessment, as conducted under the Conservation Action Planning (CAP) process, provides:

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

Each Conservation Target was assessed using the following viability ratings:

Very Good		The Indicator is considered to have an ecologically desirable status, requiring little or no intervention for maintenance.
Good		The indicator lies within the acceptable range of variation, though some intervention is required for maintenance.

Fair		The indicator lies outside the acceptable range of variation, and human intervention is required if the viability of the target is to be maintained.
Poor		Restoration of the conservation target is increasingly difficult, and impacts may result in extirpation from the conservation area.

The results of the Viability Assessment are included in Table 19.

Note: The current status of some of these indicators could not be determined during the CAP process, given the unavailability of data and anecdotal information. These are indicated as “UNK” (for “unknown”) in the table below.

Table 19: Viability Assessment of Conservation Targets				
Assessing the Health of the Conservation Target				
Indicator	Current Status			
	Poor	Fair	Good	Very Good
BIRD AND TURTLE NESTING/SILK CAYES				
a) Number of birds nesting			Good	
b) Total area of littoral forest	Poor			
c) % littoral forest in natural condition			Good	
d) Number of turtle nests		Fair		
e) Number of successful hatches			Good	
f) Condition of nesting beaches	Poor			
g) Abundance of sea turtles per annum per caye		Fair?		
COMMERCIAL SPECIES				
a) Water quality		UNK		
b) Commercial fish biomass	Poor			
c) Conch density		UNK		
d) Lobster density		UNK		
CORAL REEF COMMUNITIES				
a) Current IRHI of resilient site		UNK		

Assessing the Health of the Conservation Target

Indicator	Current Status			
	Poor	Fair	Good	Very Good
b) Water quality	UNK			
c) % average live coral cover	UNK			
d) % recent coral mortality	UNK			
e) Level of coral recruitment	UNK			
f) Commercial fish biomass	UNK			
g) Parrot fish biomass	UNK			
h) % macroalgal cover		UNK		
i) % survey sites/coral bleaching per annum		UNK		
SEAGRASS COMMUNITIES				
a) Extent of seagrass			UNK	
b) % seagrass cover			UNK	
c) Water quality			UNK	
d) Coverage of seagrass not impacted				UNK
e) Seagrass density			UNK	
SPAGS/WHALE SHARKS				
a) Number of whale sharks	UNK			
b) Density and size class of cubera snapper		UNK		
c) Density and size class of mutton snapper		UNK		
d) Density and size class of dog snapper		UNK		
e) Density and size class of Nassau grouper	UNK			

3.3. Threats to Biodiversity

3.3.1 Identified Threats

The threats affecting the conservation targets as identified by the CAP process include:

- Erosion of sandy beaches
- Erosion of natural beach vegetation
- Human impacts related to tourism/recreational use
- Coral bleaching
- Illegal fishing and incursions
- Overfishing
- Pollution (garbage)
- Boat impacts (anchor damage)
- Sedimentation to coral and seagrass communities
- Invasive species (lionfish)
- Pollution (wastewater and sewage)

Outputs from the threat assessment are presented in Table 20. Threats to the conservation targets included:

Table 20: Threats to Conservation Targets of GSSCMR

Conservation Target	Threats
Bird Nesting and Turtle Nesting/Silk Cayes	<ul style="list-style-type: none"> ▪ Loss of vegetation ▪ Human impacts (tourism related) ▪ Erosion ▪ Pollution
Commercial Species	<ul style="list-style-type: none"> ▪ Illegal fishing and incursions ▪ Overfishing (grazers) ▪ Overfishing (other species) ▪ Lionfish (Invasive species)
Coral reef communities	<ul style="list-style-type: none"> ▪ Human impacts (tourism related) ▪ Bleaching ▪ Boat impacts (anchor damage) ▪ Wastewater/sewage
Seagrass communities	<ul style="list-style-type: none"> ▪ Boat impacts (anchor damage) ▪ Sedimentation (and nutrient-rich waters)
Spawning Aggregations/ Whale Sharks	<ul style="list-style-type: none"> ▪ Human impacts (tourism related) ▪ Overfishing

These were prioritized using three criteria to direct resources toward mitigation of the most critical threats (Table 21).

This assessment rated:

- The area affected by the threat

- The severity of the threat
- The urgency of actions needed to mitigate the threat

Rating Critical Threats

The critical threats are assessed by Area, Severity and Urgency, using the following criteria:

Area: The area of the threat (how much of the conservation target area it affects).

Proportion of Area Affected (adapted)		
Criteria	Score	
Area	4	Will affect throughout >50% of the area
	3	Widespread impact, affecting 26 – 50% of the area
	2	Localized impact, affecting 11 – 25% of the area
	1	Very localized impact, affecting 1 – 10% of the area

Severity: The severity of the threat – how intense or great the impact is.

Severity Ranking (adapted)		
Criteria	Score	
Severity	3	Local eradication of target possible
	2	Substantial effect but local eradication unlikely
	1	Measurable effect on density or distribution
	0	None or positive

Urgency: The likelihood of the threat occurring over the next five years.

Urgency Ranking (adapted)		
Criteria	Score	
Urgency	3	The threat is occurring now and requires action
	2	The threat could or will happen between 1 – 3 years
	1	The threat could happen between 3 – 10 years
	0	Will not happen in > 10 years

Table 21: Threats to Conservation Targets of GSSCMR

DIRECT THREAT/INDIRECT THREAT	AREA	SEVERITY	URGENCY	A*S*U
BIRD AND TURTLE NESTING/SILK CAYES				
<ul style="list-style-type: none"> ▪ Loss of vegetation <ul style="list-style-type: none"> ▪ Raking of beach sand, erosion, sea level rise, weather pattern changes 	4	3	3	36
<ul style="list-style-type: none"> ▪ Human impacts (tourism related) <ul style="list-style-type: none"> ▪ Not applying carrying capacity limits 	4	3	3	36
<ul style="list-style-type: none"> ▪ Erosion <ul style="list-style-type: none"> ▪ Raking of beach sand, sea level rise, weather pattern changes 	4	3	3	36
<ul style="list-style-type: none"> ▪ Pollution <ul style="list-style-type: none"> ▪ Improper disposal of garbage 	3	1	3	9
COMMERCIAL SPECIES				
<ul style="list-style-type: none"> ▪ Illegal fishing and incursions <ul style="list-style-type: none"> ▪ Demand for fish from neighbouring countries, ineffective patrols (not strategic, insufficient number), penalties too small, corrupt practices, lack of interagency support 	4	3	3	36
<ul style="list-style-type: none"> ▪ Overfishing (grazers) <ul style="list-style-type: none"> ▪ Poor and corrupt practices of issuing of fishing licenses; lack of interagency support; lack of size and quota regulations and type of fish that can be extracted, ineffective patrols (not strategic) 	4	3	3	36
<ul style="list-style-type: none"> ▪ Overfishing (other species) <ul style="list-style-type: none"> ▪ Poor and corrupt practices of issuing fishing licenses, lack of interagency support, Managed Access may cause increased fishing pressure in some areas 	4	3	3	36
<ul style="list-style-type: none"> ▪ Lionfish <ul style="list-style-type: none"> ▪ Invasive 	3	3	3	27
CORAL REEF COMMUNITIES				
<ul style="list-style-type: none"> ▪ Human impacts/tourism (diving, snorkelling, swimming) <ul style="list-style-type: none"> ▪ Carrying capacity issues 	2	3	3	18
<ul style="list-style-type: none"> ▪ Bleaching <ul style="list-style-type: none"> ▪ Climate Change 	4	3	3	36
<ul style="list-style-type: none"> ▪ Boat anchor damage 	2	3	3	18

DIRECT THREAT/INDIRECT THREAT	AREA	SEVERITY	URGENCY	A*S*U
<ul style="list-style-type: none"> ▪ Improperly monitored Charter boats, Captains (foreigners) who lack knowledge of the area 				
<ul style="list-style-type: none"> ▪ Pollution - wastewater/sewage ▪ Inappropriate technology, inadequate facilities on Silk Caye to accommodate the number of visitors; no adequate wastewater facilities on the coast, inadequate regulations 	3	3	3	27
<ul style="list-style-type: none"> ▪ Sedimentation (and nutrient-rich waters) 	3	3	3	27
SEAGRASS COMMUNITIES				
<ul style="list-style-type: none"> ▪ Boat anchor damage ▪ Lack of moorings 	2	3	3	
<ul style="list-style-type: none"> ▪ Sedimentation (and nutrient-rich waters) ▪ Unmonitored development 	4	3	3	
SPAWNING AGGREGATIONS/WHALE SHARKS				
<ul style="list-style-type: none"> ▪ Human impacts (tourism related) ▪ Lack of resources for effective monitoring, irresponsible or illegal tour guiding practices 	4	3	3	36
<ul style="list-style-type: none"> ▪ Illegal fishing and incursions ▪ Demand for fish from neighbouring countries, ineffective patrols (not strategic, insufficient number), penalties too small, corrupt practices, lack of interagency support 	3	3	3	27
<ul style="list-style-type: none"> ▪ Overfishing ▪ Issuing of fishing licenses - poor and corrupt practices, lack of interagency support 	3	3	3	27

3.3.2 Prioritizing Threats

Once the threat assessment has been completed, the threats are prioritized, to effectively focus financial and human resources. This occurs through a standard prioritization process, with the threat scores being transferred from the threat assessment. The threat with the highest total threat score is ranked as the highest threat (Table 22).

As shown in Table 22, the threats which ranked as the highest priority of active threats included: **Human Impacts (tourism related), loss of vegetation,**

erosion, illegal fishing and incursions, overfishing, sedimentation and bleaching.

Table 22: Results of Threat Assessment

Threat	Score
Human Impacts (Tourism related) (SPAG/WS) (Bird and Turtle Nesting/Silk Cayes)	36
Loss of vegetation (Bird and Turtle Nesting/Silk Cayes)	36
Erosion (Bird and Turtle Nesting/Silk Cayes)	36
Illegal fishing and incursions (Commercial Species)	36
Overfishing (Commercial Species – grazers and other species)	36
Sedimentation (Seagrass communities)	36
Bleaching (Coral Reef communities)	36
Illegal fishing and incursions (SPAG/Whale Sharks)	27
Overfishing (SPAG/Whale Sharks)	27
Lionfish (Commercial Species)	27
Pollution - Wastewater/sewage (Coral Reef communities)	27
Sedimentation (Coral Reef communities)	27
Human impacts/tourism (Coral Reef communities)	18
Anchor damage (Coral Reef communities) (Seagrass communities)	18
Pollution - Garbage (Bird and Turtle Nesting/Silk Cayes)	9

3.4. Planning for Climate Change

Belize is considered to be highly vulnerable to the impacts of Climate Change related impacts such as sea level rise, sea surface temperature rise, increased intensity of storms and ocean acidification. Protected Areas play a critical role in the maintenance of ecosystem services and will become even more important as climate change impacts increase in the future. When developing management plans it is important to understand and integrate climate change adaptation into protected areas planning. The management strategies identified should help to ensure that the protected area continues to mitigate the predicted impacts of climate change. The methodology for identifying the Climate Change related management strategies is based on the **Guidelines for Integrating Climate Change Adaptation Strategies into Management Plans** (Wildtracks, 2012) which is an addendum to Management Plan Framework developed under the National Protected Areas Policy and System Plan (NPAPSP, 2005).

A Climate Change (CC) Analysis Workshop was held with stakeholders to look at how climate change can impact the GSSCMR. The management plan for the LBCNP, also co-managed by SEA, is currently being updated and given the close

proximity of the two PAs and the similar CC impacts they would face, they were considered as one unit for the Climate Change Analysis exercise. The results of the CC Analysis reflect potential impacts and related management strategies for both GSSCMR and LBCNP.

Situation Analysis

To achieve conservation, the impacts of climate change must be mitigated. This can be achieved through an understanding of the changes that will come about at the national and site level as a result of these forces, and identifying conditions that may lead to solutions. The potential climate change impacts for Belize are described in Table 23.

Table 23: Predicted Climate Change Elements for Belize

Climate Change Impacts	Current Status	25-50 years	100 years
Sea level rise	In 2014, global sea level was 6.6 cm above the 1993 average—the highest annual average in the satellite record (1993-2014). Sea level currently rises at a rate of about 0.3 cm per year. While this does not sound like much, sea level rose by 19 cm since Stoddart did his assessment of the Belize cayes. The Silk Cayes are at risk of disappearing soon, with their 2017 sizes reduced between 60%-79% compared to their sizes in 1960/61.	Predicted increase of between 0.38 m to 0.47 m	Predicted increase of between 0.47 m and 0.91 m over next 100 years
Sea surface temperature rise	Water temperature has increased by 0.75°C between 1906 and 2005		Predicted regional increase of temperature by up to 5°C by 2080, with the greatest warming being experienced in the north-west Caribbean
Increased frequency of Storms	Increased storms from 1999 onwards, with annual fluctuations. More storms during El Nina, fewer El Nino. Stronger storms >Cat 4 / 5		
Ocean acidification (corals, lobster/ conch)	Atmospheric CO ₂ concentration has increased from 280 parts per million (ppm) in 1880 to nearly 380 ppm in 2005; – 30% of all atmospheric CO ₂ resulting from burning of fossil fuels has been taken up by the ocean (IPCC 2007).	Predicted 30% decrease in pH Predicted decrease in calcification rate by 20 – 50% by 2050	Decrease of 0.5 unit pH for 100 years (UNDP, 2009)
Decreased Precipitation	Mean annual rainfall over Belize has decreased at an average rate of 3.1mm per month per decade since 1960 (UNDP)	Predicted ecological shifts up the altitudinal gradient of the Maya Mountains Massif may remove the cloud forest, and the catchment functionality important for maintaining rivers in dry season in the south of Belize, and providing nutrients to the reef environment.	Predicted decrease in precipitation of 9% by 2099 (IPCC, 2007), with significant fluctuations, attributed to El Niño

Climate Change Impacts	Current Status	25-50 years	100 years
Air Temperature	Mean annual temperature has increased in Belize by 0.45°C since 1960, an average rate of 0.10°C per decade. Average number of 'hot' days per year in Belize (days exceeding 10% of current average temperature) has increased by 18.3% between 1960 and 2003 (NCSP/UNDP).		Predicted mean annual temperature increase is 3.5° by 2099 (UNDP, 2009)

3.4.1 Priority Climate Change Adaptation Focal Targets

A series of Focal Targets on which to base Climate Change Adaptation planning was identified to ensure that the financial and human resource investments for adaptation strategies are prioritized for maximum effectiveness. The four Focal Targets included:

- Conservation Targets identified during Conservation Action Planning Workshop
- Ecosystem Services provided by the PAs
- Socio-economic Activities dependent on the natural resources of the PA
- Stakeholder Communities (Community Resource Users) of the PA

The key questions asked to determine the Priority Focal Targets were:

- Which of the Conservation Targets identified during Conservation Planning would be most affected by climate change?
- What key ecosystem services provided by the protected area will be significantly impacted by climate change?
- Which community resource users would be most affected by climate change impacts on the protected area?
- How vulnerable / resilient are those communities?
- What socio-economic activities dependent on the natural resources of the protected area will be most affected by climate change?

Results of the Climate Change Analysis Workshop

Priority Conservation Targets

Which of the Conservation Targets identified during Conservation Planning would be most affected by climate change?

Of the conservation targets identified during the conservation planning sessions for GSSCMR (Table 24), four of these were selected as priority conservation targets that would be most affected by climate change.

Table 24: Conservation Targets identified for GSSCMR

Conservation Targets - GSSCMR
Bird and Turtle Nesting/Silk Cayes
Commercial Species
SPAGS/Whale Sharks
Coral reef communities
Seagrass communities

These were selected through a prioritization process based on a rating (on a scale of 1 to 4) of the impacts of the relevant predicted climate change elements for Belize (Table 25). They include:

- Turtle/Bird Nesting
- Commercial Species
- Coral Reef Communities
- Seagrass Communities

The Potential Climate Change impacts on each of the four priority conservation targets are described in Table 26.

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

Table 25: Priority conservation targets²¹

Predicted Climate Change Elements		Conservation Targets			
		Turtle/Bird Nesting	Commercial Species	Coral Reef Communities	Seagrass Communities
1	Sea Level Rise	Very High	High	High	High
2	Sea Temperature Rise	Very High	Very High	Very High	Very High
3	Increased Intensity of Storms	Very High	High	High	High
4	Ocean Acidification	Very High	Very High	Very High	Very High
5	Decreased Precipitation	Medium	Medium	Low	Low
6	Increased Air Temperature	High	High	Low	Low
	Average Score	3.5	3.2	2.7	2.7

Table 26: Potential Climate Change impacts on priority conservation targets

CC Impacts	Turtle/Bird Nesting	Coral Reef Communities
Sea level rise	<ul style="list-style-type: none"> Inundation of nesting beaches - as moisture content increases, successful hatches decrease. Due to the diminishing of the islands, the bird nesting sites may ultimately disappear 	<ul style="list-style-type: none"> Should be able to keep up with sea level rise, barring other impacts (bleaching/mortality and erosion). Decrease in light availability may lead to a loss of deeper corals, shift in distribution Increased sedimentation and reduced light availability due to shore erosion
Sea surface temperature rise	<ul style="list-style-type: none"> Extended nesting season, with earlier onset of nesting 	<ul style="list-style-type: none"> Increased coral bleaching Increased prevalence of coral disease Reduced biodiversity due to a shift towards more tolerant, opportunistic species
Increased frequency of Storms	<ul style="list-style-type: none"> Inundation of nests from higher groundwater Habitat destruction 	<ul style="list-style-type: none"> Increased damage of corals Increased sedimentation Reduced ability of colonies to re-establish after storm events

²¹ Selected based on predicted Climate Change elements

Ocean acidification		<ul style="list-style-type: none"> ▪ Decreases in coral calcification rates ▪ Decreased growth rates and structural strength
Air Temperature	<ul style="list-style-type: none"> ▪ Warming of beaches, resulting in changes in reproductive patterns, increased egg mortality, shorter hatching time, reducing survival potential 	
CC Impacts	Seagrass Communities	Commercial Species
Sea level rise	<ul style="list-style-type: none"> ▪ Will reduce light availability ▪ Changes in currents may cause erosion and increased turbidity of water column ▪ Shifts in distribution of seagrass beds 	<ul style="list-style-type: none"> ▪ Shift in range / habitat loss of both adult and juvenile fish and lobster ▪ Shift in seagrass distribution ▪ Changes in coral reef ▪ Potential changes in water currents affecting viability of spawning aggregation sites
Sea surface temperature rise	<ul style="list-style-type: none"> ▪ Shifts in distributions of seagrass beds ▪ Changes in growth rates 	<ul style="list-style-type: none"> ▪ Habitat loss (impacts on reef) ▪ Reproduction in seagrass is temperature driven, so may be affected ▪ Possible impacts from new invasive species and algal blooms ▪ Disease may become more
Increased frequency of Storms	<ul style="list-style-type: none"> ▪ Massive sediment movements can uproot or bury seagrass ▪ Increase annual turbidity may reduce light availability for deeper water sea grasses 	<ul style="list-style-type: none"> ▪ Habitat destruction - seagrass and mangroves ▪ Sedimentation ▪ Possible impacts on larval dispersion / survival
Ocean acidification (corals, lobster/ conch)	<ul style="list-style-type: none"> ▪ Possible direct positive effect on photosynthesis and growth ▪ Higher CO₂ levels may increase the production and biomass of epiphytic algae on seagrass leaves leading to shading 	<ul style="list-style-type: none"> ▪ Habitat loss (impacts on reef). ▪ Impacts on larval viability and adult growth rates ▪ Possible increase in seagrass productivity
Decreased Precipitation		<ul style="list-style-type: none"> ▪ Possible changes in salinity impacting larval dispersal
Air Temperature		<ul style="list-style-type: none"> ▪ Potential impact on mangroves as a nursery habitat

Key Ecosystem Services

What key ecosystem services provided by the protected area will be significantly impacted by climate change?

The group initially listed seven ecosystem services provided by the PAs. These included: coastal protection, climate regulation, recreation, nursery habitat, food production, waste assimilation and research and education. Through group consensus, three of the seven ecosystem services were considered to be at greatest risk from climate change. These included:

- **Coastal Protection**
- **Climate Regulation**
- **Nursery Habitat**

Priority Stakeholder Communities

Which community resource users would be most affected by climate change impacts on the protected area?

The initial list of seven stakeholder communities was selected from those identified in the LBCNP and GSSCMR stakeholder analysis. The communities were evaluated based on 3 vulnerability factors:

1. **Exposure:** The extent to which a community comes into contact with climate events or specific climate impacts
2. **Sensitivity:** The degree to which a community is negatively affected by changes in climate
3. **Adaptive Capacity:** The potential or capability of a community to adjust to impacts of changing climate, and to minimize, cope with and recover from the consequences of changes

Three priority stakeholder communities were chosen:

- Placencia Village
- Monkey River Village
- Sarteneja Village

How vulnerable / resilient are those communities?

All communities were considered to have a high exposure and sensitivity to Climate Change and low adaptive capacity.

Key Socio-Economic Activities

What socio-economic activities dependent on the natural resources of the protected area will be most affected by climate change?

The stakeholder analysis of LBCNP and GSSCMR showed that the main socio-economic activities of the PAs are tourism and fishing.

Potential climate change impacts on the tourism sector include loss of beaches, coastal infrastructure and property due to sea level rise and loss of coral reefs due to temperature induced bleaching events and ocean acidification.

Potential impacts on the fisheries sector include loss of key habitats such as coral reefs, mangroves and sea grasses. Rising sea levels could lead to partial or complete disappearance of these habitats through inundation and increased sea surface water temperature and increased ocean acidification may cause severe bleaching events and loss of coral reefs.

Developing Adaptation Strategies

General adaptation strategies were identified for integration into the GSSCMR management program (Table 27). The strategies aim to reduce anthropogenic threats which may exacerbate the impacts of climate change.

Table 27: General Adaptation Strategies for Climate Change Impact

Climate Change Impact Themes	Strategies
Reduction in fish catch	<ul style="list-style-type: none"> ▪ Prohibit fishing in SPAG areas ▪ Increase/improve enforcement of regulations
Degradation in tourism destination	<ul style="list-style-type: none"> ▪ Implement hard adventure carrying capacity measures
Reduction of terrestrial habitat	<ul style="list-style-type: none"> ▪ Increase vegetation coverage by prohibiting access to certain areas ▪ Reforestation ▪ Implement sea level rise vulnerability studies to inform management decisions
Reduction of underwater habitat	<ul style="list-style-type: none"> ▪ Install mooring buoys around sensitive areas ▪ Implement no-wake zones ▪ Expansion of coral restoration activities ▪ Increase monitoring of tourism development activities around the MPAs ▪ Monitor impact of tourism activities in MPAs

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APPENDICES

Appendix 1 – Fisheries (GSSCMR) Regulations

CHAPTER 210

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CHAPTER 210

(GLADDEN SPIT AND SILK CAYES MARINE RESERVE) REGULATIONS

(Section 13)

[5th July, 2003.]

PART I

PRELIMINARY

1. These Regulations maybe cited as the FISHERIES (GLADDEN SPIT AND SILK CAYES MARINE RESERVE) REGULATIONS

2. In these Regulations, unless the context otherwise requires:

“Advisory Committee” means the committee established under regulation 3;

“committee member” means any person appointed under regulation 3 to assist in the management of the Reserve;

“fish” includes all the varieties of marine or fresh water animals or plant life;

“fishing” means fishing for, capturing, taking or killing fish, or attempting to do any of the above by any method;

“Fisheries Administrator” means the Fisheries Administrator appointed under section 107 of the Belize Constitution for the purpose of the Fisheries Act and the regulations made thereunder;

“Fisheries Officer” means any technician, conservation officer, assistant fisheries officer or fisheries officer employed by the Reserve;

“recreational fishing” means fishing for the fun with the intention to eat the fish caught but not for the purpose of selling;

“Reserve” means the Gladden Spit Marine Reserve declared under the Fisheries (Gladden Spit and Silk Cayes Marine Reserve) Order;

“Reserve Manager” means an officer appointed for the purpose of managing the Reserve;

“Schedule” means the schedule to these Regulations;

“sport fishing” means catch and release.

PART II

ESTABLISHMENT OF AN ADVISORY COMMITTEE

3. (1) The Fisheries Administrator shall establish an Advisory Committee for the purpose of assisting in the management of the Reserve.

(2) The committee members shall be appointed by the post they hold in their organization.

(3) The committee members shall consist of representatives from the following organizations:

- (a) Fisheries Department;
- (b) Forest Department;
- (c) Coastal Zone Management Authority and Institute;
- (d) Placencia BTIA;
- (e) Placencia Village Council;
- (f) Friends of Nature;
- (g) Belize Fishermen Cooperative Association;
- (h) Northern Fishermen Cooperative;
- (i) Monkey River Fishermen; and
- (j) Placencia Tour Guide Association.

PART III

ESTABLISHMENT OF ZONES AND RULES FOR ZONES

4. (1) For the purposes of the regulation and control of the Reserve, there shall be established three zones within the Reserve as follows:

- (a) the General Use Zone;
- (b) the Conservation Zone 1; and
- (c) the Conservation Zone 11 (Restoration Area and Spawning Area).

(2) The description of the above Zones shall be as set out in the Schedule hereto.

5. (1) The General Use Zone shall be restricted to those with the appropriate fishing licence for commercial, sport or recreational fishing. Fishermen shall apply for a licence to fish in accordance with these regulations.

(2) No person shall be permitted to use long lines, trawlers or gill nets in the Reserve unless authorized by the Fisheries Administrator.

(3) No person shall, within the General Use Zone, cast or drag any anchor in any manner that may damage coral reef formation.

(4) Fishermen catching lobster shall possess lobster with its carapace, tailed but not as fillet while in the Reserve.

(5) Fishermen catching conch shall possess conch whole or market clean but not as fillet or diced while in the Reserve.

6. (1) No person shall engage in commercial fishing, sport fishing or recreational fishing within the Conservation Zone I.

(2) No person shall engage in water-skiing and jet- skiing.

(3) No person shall secure a boat to the seabed of the Conservation Zones except by means of a mooring that is officially designated for this purpose, (save in the case of an emergency where life and property are endangered), or with the prior written permission of the Reserve Manager.

7. (1) Restoration Area and Spawning Area-

(a) No person shall engage in commercial, sports and recreational fishing;

(b) No person shall engage in trawling, setting nets, long-lines and traps; and

(c) No person shall engage in water-skiing and jet skiing.

(2) No person shall secure a boat to the seabed of the Conservation Zones except by means of a mooring that is officially designated for this purpose, (save in the case of an emergency where life and property are endangered), or with the prior written permission of the Reserve Manager.

(3) Spawning area-

(a) no touching, chasing or molesting of whale sharks will be permitted;

(b) divers and snorkelers should remain at least 15 feet away in any direction from any whale shark;

(c) maximum depth for divers of any certification is 80 feet to avoid disturbing fish aggregations;

(d) boats shall remain at least 50 feet away from any whale shark;

(e) dive and snorkel boats should maintain a distance of at least 200 feet away from each other;

(f) all divers and snorkelers should be out of the water by 5:30p.m;

(g) six (6) dive and snorkel tours will be limited to two hours from March 1 to July 31 of any year inclusive;

(h) a maximum of two boats per day per tour operator will be allowed;

(i) all boats will be allowed to carry a maximum of 12 visitors at any one time;

(j) no vessel larger than 48 feet will be allowed within this area; and

(k) the Fisheries Department reserves the right to close the Spawning Area because of inclement weather conditions or for any other reason it deems necessary.

8. (1) Divers shall register with the Reserve Manager prior to entering the Conservation Zones.

(2) Charter dives shall first obtain a licence in the prescribed form set out as Form VI of the Schedule hereto before operating in the Conservation Zones and all dive boats shall fly the “divers down flag” when they have divers in the water.

(3) Only certified scuba divers, or divers undergoing a training course conducted by a recognized instructor shall be allowed to use scuba equipment in areas of the Reserve where diving is permitted.

(4) Dive guides shall be required to explain the rules of the Reserve to all divers within the Reserve.

(5) All boats which need to operate in this zone shall first obtain registration from the Fisheries Administrator in accordance with these Regulations.

(6) For the purpose of this Regulation “divers down flag” means a flag with a white diagonal stripe upon a red background.

(7) All motorboats are to observe the low wake boat way when approaching snorkelers or divers.

(8) For SCUBA tours a maximum of eight divers per licensed dive master will be permitted.

(9) For snorkel tours a maximum of eight snorkelers per licensed tour guide will be permitted.

PART IV

COMMERCIAL FISHING, RESEARCH, SPORT FISHING LICENCES AND REGISTRATION OF DIVE BOATS

9. (1) Any person who is desirous of fishing within the Reserve shall apply to the Fisheries Administrator for a commercial fishing licence in the prescribed form set out as Form I of the Schedule

(2) The Fisheries Administrator may within fourteen (14) days of the receipt of an application under this regulation grant a fishing licence in the prescribed form set out as Form II of the Schedule after consultation with the advisory committee.

(3) Upon the expiry of a fishing licence granted under these

Regulations, the license holder may apply to the Fisheries Administrator for a renewal of the same in prescribed form set out as Form I of the Schedule.

(4) A fee of (\$25.00) shall be payable upon the receipt of a fishing licence or for the renewal of the same.

10. (1) Any person who is desirous of conducting research shall apply to the Fisheries Administrator for a licence to do so in the prescribed form set out as Form III of the Schedule.

(2) The Fisheries Administrator may within fourteen (14) days of the receipt of an application under this regulation issue or grant a licence in writing to conduct research.

(3) The Fisheries Administrator shall set conditions for research licences issued under these regulations.

(4) (a) A fee of \$500.00BZ shall be payable upon the receipt of a research licence or for the renewal of same.

(b) The Fisheries Administrator may in his discretion, waive or vary the fee payable for a research licence.

11. (1) Any person who is desirous of conducting sport/recreational fishing within the Reserve shall apply to the Fisheries Administrator or the Reserve Manager for a fishing licence in the prescribed form set up as Form IV of the Schedule.

(2) The Fisheries Administrator or the Reserve Manager, as the case may be, may grant a fishing license in the prescribed form set up as Form V of the Schedule.

(3) A fee of \$100.00BZ shall be payable upon receipt of a sports fishing licence.

(4) The licensee shall not kill any fish caught under a sport fishing license.

12. (1) Any boat operator who is desirous of conducting SCUBA diving/snorkeling within the Reserve shall apply to the Fisheries Administrator for registration in the prescribed form set up as Form VI of the Schedule.

(2) A fee of \$100.00BZ shall be payable upon registration of the boat.

(3) Boat registration under this section shall expire on the 31st December of any year inclusive.

13. Licences issued under these regulations shall not be transferable.

14. Licences issued under these regulations, unless otherwise stated, shall be valid until December 31 of any year and maybe renewed for like period upon payment of the fees specified in these regulations.

15. The Fisheries Administrator may cancel any licence granted under these regulations if the license holder breaches any conditions of the licence or contravenes any provision of these regulations or the Fisheries Regulations.

16. In issuing a licence under these regulations, the Fisheries Administrator may attach conditions to such licences, as the case may be, having due regard to the nature of the licence and the need to protect the environment and natural resources.

PART V

GENERAL

17. Any person in an accident which involves personal injury or damage to property or the environment within the Reserve shall report such accident to the person in charge of the Reserve or to any officer of the Reserve or the Fisheries Administrator as soon as possible or at least within twelve (12) hours of the occurrence of the accident.

18. The Government shall not be liable for any personal injury or damage to property occurring within the Reserve.

19. Notwithstanding the provisions of these regulations, the Fisheries Regulations shall apply within the Reserve.

20. The Reserve Office shall be open daily to the public between the hours of 6:00 a.m. to 6:00 p.m.

21. (1) For all water recreational activities, excluding sports and recreational fishing, fees shall be as follows:

(a) Swimmers/Snorkelers \$ 10.00 per person per day in the General Use Area.

(b) Scuba \$30.00 per person per week in the General Use Area.

(c) Scuba \$ 100.00 per person in the Spawning Area.

(d) Snorkel \$50.00 per person in the Spawning Area.

(e) Belizeans will pay \$15.00 per person in the Spawning Area.

(2) No fees shall be payable by Belizeans and foreign children below twelve years of age.

22. Without prejudice to the activities prohibited by the Fisheries Act and the Penalties prescribed therein, no person shall-

(a) Remove, damage or have in his possession any flora, fauna or part thereof except under a license issued by the Fisheries Administrator;

(b) Deposit any material in or on the waters of the Reserve, except in the case where a license to do so has been issued by the Fisheries Administrator;

(c) Deface or tamper with any sign, buoy or notice which is installed in the Reserve.

23. (1) The Fisheries Administrator may designate certain areas as special development areas.

(2) No person shall within the Reserve engage in water activities outside of the designated areas.

24. All commercial, recreational and sport fishermen shall render the weight of fish caught within the Reserve to the Reserve Rangers upon request.

25. Any person employed (technician, conservation officer, Assistant Fisheries Officer or Fisheries Officer) by the Reserve for the purpose of management of the Reserve, shall be a Fisheries Officer to uphold the Reserve Regulations as well as the Fisheries Regulations.

26. (1) Any person who contravenes any of the provisions of and these regulations is guilty of an offence and liable on summary conviction to a fine not exceeding five hundred dollars or to imprisonment for a period not exceeding six months, or to both such fine and imprisonment.

(2) Notwithstanding sub-regulation (1) any person who damages corals shall pay a penalty of five hundred dollars and an additional penalty may be imposed based on the assessed damage but such penalty shall not exceed five hundred dollars.

MADE by the Minister of Agriculture and Fisheries this 30th day of June, 2003.

(SERVULO BAEZA)

Minister of Agriculture and Fisheries

Appendix 2 – Fish Species of GSSCMR

Fish Species of Gladden Spit and Silk Cayes Marine Reserve			
Family	Species	Common name	IUCN
Acanthuridae	<i>Acanthurus bahianus</i>	Ocean surgeonfish	
	<i>Acanthurus chirurgicus</i>	Doctorfish	
	<i>Acanthurus coeruleus</i>	Blue tang	
Albulidae	<i>Albula vlupes</i>	Bonefish	
Apogonidae	<i>Apogon bintatus</i>	Barred Cardinalfish	
	<i>Apogon lachneri</i>	Whitestar cardinalfish	
	<i>Apogon maculatus</i>	Flamefish	
	<i>Apogon townsendi</i>	Twospot cardinalfish	
	<i>Apogon robinsi</i>	Roughlip Cardinalfish	
	<i>Apogon stellatus</i>	Conchfish	
Aulostomidae	<i>Aulostomus maculatus</i>	Trumpetfish	
Balistidae	<i>Aluterus schoepfi</i>	Orange filefish	
	<i>Balistes capriscus</i>	Gray triggerfish	
	<i>Balistes vetula</i>	Queen triggerfish	NT
	<i>Cantherdermis sufflamen</i>	Ocean triggerfish	
	<i>Cantherhines macrocerus</i>	Whitespotted filefish	
	<i>Cantherhines pullus</i>	Orangespotted filefish	
	<i>Melichthys niger</i>	Black durgon	
	<i>Monocanthus tuckeri</i>	Slender filefish	
	<i>Xanthichthys ringens</i>	Sargassum triggerfish	
Batrachoides	<i>Batrachoides gilberti</i>	Large eye toadfish	
	<i>Sanopus barbatus</i>	Bearded toadfish	
	<i>Sanopus greenfieldorum</i>	Whitelined toadfish	VU
	<i>Sanopus splendidus</i>	Splendid toadfish	EN
Belonidae	<i>Ablennes hiannes</i>	Flat needlefish	
	<i>Strongylura notata</i>	Redfin needlefish	
	<i>Tylosurus crocodilus</i>	Houndfish	
Bothidae	<i>Bothus lunatus</i>	Peacock flounder	
Carangidae	<i>Caranx batholomaei</i>	Yellow jack	
	<i>Caranx crysos</i>	Blue runner	
	<i>Caranx hippos</i>	Crevalle jack	
	<i>Caranx latus</i>	Horse-eye jack	
	<i>Caranx lugubris</i>	Black jack	
	<i>Caranx ruber</i>	Bar jack	
	<i>Decapterus macarellus</i>	Mackerel scad	
	<i>Elagatis bipinnulata</i>	Rainbow runner	

Fish Species of Gladden Spit and Silk Cayes Marine Reserve

Family	Species	Common name	IUCN
	<i>Trachinotus falcatus</i>	Permit	
	<i>Trachinotus goodei</i>	Palometa	
Carcharhinidae	<i>Carcharhinus leucas</i>	Bull shark	
	<i>Carcharhinus limbatus</i>	Blacktip shark	
	<i>Carcharhinus perezi</i>	Caribbean Reef Shark	
	<i>Carcharhinus falciformis</i>	Silky shark	
	<i>Carcharhinus acronotus</i>	Blacknose shark	
	<i>Galeocerdo cuvier</i>	Tiger Shark	
	<i>Negaprion brevirostris</i>	Lemon shark	
	<i>Rhizoprionodon porosus</i>	Caribbean Sharpnosed shark	
	<i>Carcharhinus brevipinna</i>	Spinner Shark	
	<i>Carcharhinus galapagensis</i>	Galapagos shark	
Centropomidae	<i>Centropomus undecimalis</i>	Common snook	
Chaenopsidae	<i>Emblemariopsis diana</i>	Orangeflag blenny	
Chaetodontidae	<i>Chaetodon aculeatus</i>	Longsnout butterflyfish	
	<i>Chaetodon capistratus</i>	Foureye butterflyfish	
	<i>Chaetodon ocellatus</i>	Spotfin butterflyfish	
	<i>Chaetodon sedentarius</i>	Reef butterflyfish	
	<i>Chaetodon striatus</i>	Banded butterflyfish	
Cirrhitidae	<i>Amblycirrhites pinos</i>	Red-spotted hawkfish	
Clinidae	<i>Acanthemblemaria spinosa</i>	Spinyhead blenny	
	<i>Chaenopsis ocellata</i>	Bluethroat pike blenny	
	<i>Emblemaria pandionis</i>	Sailfin blenny	
	<i>Lucayablennius zingaro</i>	Arrow blenny	
	<i>Malacoctenus boehlkei</i>	Diamond blenny	
	<i>Malacoctenus macropus</i>	Rosy blenny	
	<i>Malacoctenus triangulatus</i>	Saddled blenny	
	<i>Ophioblennius atlanticus</i>	Redlip blenny	
Congridae	<i>Heteroconger halis</i>	Garden eel	
Dasyatidae	<i>Dasyatis americana</i>	Southern stingray	
	<i>Dasyatis gutatta</i>	Longnose stingray	
	<i>Himantura schmarda</i>	Chupare stingray	
Diodontidae	<i>Diodon holocanthus</i>	Balloonfish	
	<i>Diodon hystrix</i>	Porcupinefish	
Echeneidae	<i>Echeneis neucratoides*</i>	Whitfin sharksucker	
Elopidae	<i>Megalops atlanticus</i>	Tarpon	
Ephippidae	<i>Chaetodipterus faber</i>	Atlantic spadefish	
Exocoetidae	<i>Hirundichthys speculiger</i>	Mirrorwing flyingfish	

Fish Species of Gladden Spit and Silk Cayes Marine Reserve				
Family	Species	Common name	IUCN	
Gerreidae	<i>Eucinostomus lefroyi</i>	Mottled mojarra		
	<i>Gerres cinereus</i>	Yellowfin mojarra		
Ginglymostomidae	<i>Ginglymostoma cirratum</i>	Nurse shark		
Gobiesocidae	<i>Tomicodon briggsi</i>			
	<i>Tomicodon clarkei</i>			
	<i>Tomicodon lavettsmithi</i>			
Gobiidae	<i>Ctenogobius saepapellans</i>	Dash goby		
	<i>Coryphopterus dicrus</i>	Colon goby		
	<i>Coryphopterus eidolon</i>	Pallid goby		
	<i>Coryphopterus galucofraenum</i>	Bridled goby		
	<i>Coryphopterus lipernes</i>	Peppermint goby		
	<i>Coryphopterus personatus</i>	Masked goby		
	<i>Gnatholepsis thompsoni</i>	Goldspot goby		
	<i>Gobionellus saepepallens</i>	Dash goby		
	<i>Gobiosoma dilepsis</i>	Orangesided goby		
	<i>Gobiosoma evelynae</i>	Sharknose goby		
	<i>Gobiosoma genie</i>	Cleaning goby		
	<i>Gobiosoma horsti</i>	Yellowline goby		
	<i>Gobiosoma illecebrosus</i>	Barsnout goby		
	<i>Gobiosoma prochilos</i>	Broadstripe goby		
	<i>Elacatinus colini</i>			
	<i>Elacatinus lobeli</i>			
	<i>Elacatinus lori</i>			
	<i>Lophogobius cyprinoides</i>	Crested goby		
	Grammistinidae	<i>Gramma loreto</i>	Fairy basslet	
		<i>Gramma melacara</i>	Blackcap basslet	
<i>Liopropoma rubre</i>		Peppermint basslet		
Haemulidae	<i>Anisotremus surinamensis</i>	Black margate		
	<i>Anisotremus virginicus</i>	Porkfish		
	<i>Haemulon album</i>	White margate		
	<i>Haemulon aurolineatum</i>	Tomtate		
	<i>Haemulon carbonarium</i>	Caesar grunt		
	<i>Haemulon chrysargyreum</i>	Smallmouth grunt		
	<i>Haemulon flavolineatum</i>	French grunt		
	<i>Haemulon macrostomum</i>	Spanish grunt		
	<i>Haemulon melanurum</i>	Cottonwick		
	<i>Haemulon parra</i>	Sailor's choice		
<i>Haemulon plumieri</i>	White grunt			

Fish Species of Gladden Spit and Silk Cayes Marine Reserve

Family	Species	Common name	IUCN
	<i>Haemulon sciurus</i>	Bluestriped grunt	
	<i>Haemulon striatum</i>	Striped grunt	
Hemiramphidae	<i>Hemiramphus brasiliensis</i>	Ballyhoo	
Holocentridae	<i>Holocentrus adscensionis</i>	Squirrelfish	
	<i>Holocentrus rufus</i>	Longspine squirrelfish	
	<i>Sargocentron coruscum</i>	Reef squirrelfish	
	<i>Sargocentron vexillarium</i>	Dusky squirrelfish	
	<i>Myripristis jacobus</i>	Blackbar soldierfish	
	<i>Neoniphon marianus</i>	Longjaw squirrelfish	
	<i>Priacanthus arenatus</i>	Bigeye	
Inermiidae	<i>Emmelichthys atlanticus</i>	Bonnetmouth	
	<i>Inermia vittata</i>	Boga	
Kyphosidae	<i>Kyphosus sectatrix</i>	Bermuda chub	
Labridae	<i>Bodianus pulchellus</i>	Spotfin hogfish	
	<i>Bodianus rufus</i>	Spanish hogfish	
	<i>Clepticus parrae</i>	Creole wrasse	
	<i>Doratonatus megalepis</i>	Dwarf wrasse	
	<i>Halichoeres bivittatus</i>	Slippery dick	
	<i>Halichoeres cyanocephalus</i>	Yellowcheek wrasse	
	<i>Halichoeres garnoti</i>	Yellowhead wrasse	
	<i>Halichoeres maculipinna</i>	Clown wrasse	
	<i>Halichoeres radiatus</i>	Puddingwife	
	<i>Hemipteronotus novacula</i>	Pearly razorfish	
	<i>Lachnolaimus maximus</i>	Hogfish	VU
	<i>Thalassoma bifasciatum</i>	Bluehead wrasse	
	<i>Xyrichtys martinicensis</i>	Rosy razorfish	
	<i>Xyrichtys spendens</i>	Green razorfish	
Labridomidae	<i>Malacoctenus triangulatus</i>	Saddled blenny	
Lutjanidae	<i>Lutjanus analis</i>	Mutton snapper	NT
	<i>Lutjanus apodus</i>	Schoolmaster	
	<i>Lutjanus cyanopterus</i>	Cubera snapper	VU
	<i>Lutjanus griseus</i>	Grey Snapper	
	<i>Lutjanus jocu</i>	Dog snapper	
	<i>Lutjanus mahogani</i>	Mahogany snapper	
	<i>Lutjanus synagris</i>	Lane Snapper	
	<i>Ocyurus chrysurus</i>	Yellowtail snapper	
Malacanthidae	<i>Malacanthus plumieri</i>	Sand tilefish	
Mobulidae	<i>Manta birostris</i>	Atlantic manta	

Fish Species of Gladden Spit and Silk Cayes Marine Reserve

Family	Species	Common name	IUCN
	<i>Mobula hypostoma</i>	Devil ray	
Monacanthidae	<i>Cantherhines pullus</i>		
	<i>Cantherhines macrocerus</i>	Whitespotted filefish	
	<i>Aluterus scriptus</i>	Scrawled Filefish	
Mugilidae	<i>Mugil curema</i>	White mullet	
Mullidae	<i>Mulloidichthys martinicus</i>	Yellow goatfish	
	<i>Pseudopeneus maculatus</i>	Spotted goatfish	
Muraenidae	<i>Enchelycore carychroa</i>	Chestnut moray	
	<i>Gymnothorax funebris</i>	Green moray	
	<i>Gymnothorax miliaris</i>	Goldentail moray	
	<i>Gymnothorax moringa</i>	Spotted moray	
	<i>Gymnothorax vicinus</i>	Purplemouth moray	
Myliobatidae	<i>Aetobatus narinari</i>	Spotted eagle ray	
Ogcocephalidae	<i>Ogcocephalus nasutus</i>	Shortnose batfish	
Ophichthidae	<i>Myrichthys breviceps</i>	Sharptail eel	
Opisthognatidae	<i>Opistognathus aurifrons</i>	Yellowhead jawfish	
	<i>Opistognathus macrognathus</i>	Banded jawfish	
	<i>Opistognathus whitehurstii</i>	Dusky jawfish	
Ostraciidae	<i>Acanthostracion polygonia</i>	Honeycomb cowfish	
	<i>Acanthostracion quadricornis</i>	Scrawled cowfish	
	<i>Lactophrys bicaudalis</i>	Spotted trunkfish	
	<i>Lactophrys trigonus</i>	Buffalo trunkfish	
	<i>Lactophrys triqueter</i>	Smooth trunkfish	
Pempheridae	<i>Pempheris schomburgki</i>	Glassy sweeper	
Pomacanthidae	<i>Holacanthus ciliaris</i>	Queen angelfish	
	<i>Holacanthus tricolor</i>	Rock beauty	
	<i>Pomacanthus arcuatus</i>	Grey angelfish	
	<i>Pomacanthus paru</i>	French angelfish	
	<i>Holacanthus ciliaris</i>	Queen angelfish	
Pomacentridae	<i>Abudefduf saxatilis</i>	Sergeant major	
	<i>Abudefduf taurus</i>	Night sergeant	
	<i>Chromis cyanea</i>	Blue chromis	
	<i>Chromis insolata</i>	Sunshinefish	
	<i>Chromis multilineata</i>	Brown chromis	
	<i>Microspathodon chrysurus</i>	Yellowtail damselfish	
	<i>Stegastes diencaeus</i>	Longfin damselfish	
	<i>Stegastes adustus</i>	Dusky damselfish	
	<i>Stegastes leucostictus</i>	Beaugregory	

Fish Species of Gladden Spit and Silk Cayes Marine Reserve

Family	Species	Common name	IUCN
	<i>Stegastes partitus</i>	Bicolor damselfish	
	<i>Stegastes planifrons</i>	Threespot damselfish	
	<i>Stegastes variabilis</i>	Cocoa damselfish	
Priacanthidae	<i>Priacanthus arenatus</i>	Bigeye	
	<i>Priacanthus cruentatus</i>	Glasseye snapper	
Rhincodontidae	<i>Rhincodon typus</i>	Whale shark	EN
Scaridae	<i>Scarus coelestinus</i>	Midnight parrotfish	
	<i>Scarus coeruleus</i>	Blue parrotfish	
	<i>Scarus guacamaia</i>	Rainbow parrotfish	NT
	<i>Scarus iserti</i>	Striped parrotfish	
	<i>Scarus taeniopterus</i>	Princess parrotfish	
	<i>Scarus vetula</i>	Queen parrotfish	
	<i>Sparisoma atomarium</i>	Greenblotch parrotfish	
	<i>Sparisoma aurofrenatum</i>	Redband parrotfish	
f	<i>Sparisoma chrysopteron</i>	Redtail parrotfish	
	<i>Sparisoma radians</i>	Bucktooth parrotfish	
	<i>Sparisoma rubripinne</i>	Yellowtail parrotfish	
	<i>Sparisoma viride</i>	Stoplight parrotfish	
	<i>Cryptotomus roseus</i>	Bluelip parrotfish	
Sciaenidae	<i>Equetus acuminatus</i>	Highhat	
	<i>Equetus punctatus</i>	Spotted drum	
	<i>Equetus umbrosus</i>	Cubbyu	
	<i>Odontoscion dentex</i>	Reef croaker	
Scombridae	<i>Scomberomorus regala</i>	Cero	
Scorpaenidae	<i>Scorpaena plumieri</i>	Spotted scorpionfish	
	<i>Pterois volitans</i>	Red Lionfish	INV
Serranidae	<i>Alphestes afer</i>	Mutton hamlet	
	<i>Cephalopholis fulvus</i>	Coney	
	<i>Cephalopholis cruentatus</i>	Graysby	
	<i>Epinephelus adscensionis</i>	Rock hind	
	<i>Epinephelus guttatus</i>	Red hind	
	<i>Epinephelus flavolimbatus</i>	White Grouper	VU
	<i>Epinephelus inermis</i>	Marbled grouper	NT
	<i>Epinephelus itajara</i>	Goliath grouper	CR
	<i>Epinephelus niveatus</i>	Snowy grouper	VU
	<i>Epinephelus morio</i>	Red grouper	
	<i>Epinephelus striatus</i>	Nassau grouper	EN
	<i>Hypoplectrus aberrans</i>	Yellowbelly hamlet	

Fish Species of Gladden Spit and Silk Cayes Marine Reserve

Family	Species	Common name	IUCN
	<i>Hypoplectrus chlorurus</i>	Yellowtail hamlet	
	<i>Hypoplectrus gemma</i>	Blue hamlet	
	<i>Hypoplectrus gummygatta</i>	Golden hamlet	
	<i>Hypoplectrus guttavarius</i>	Shy hamlet	
	<i>Hypoplectrus indigo</i>	Indigo hamlet	
	<i>Hypoplectrus nigricans</i>	Black hamlet	
	<i>Hypoplectrus puella</i>	Barred hamlet	
	<i>Hypoplectrus unicolor</i>	Butter hamlet	
	<i>Mycteroperca bonaci</i>	Black grouper	
	<i>Mycteroperca interstitialis</i>	Yellowmouth grouper	VU
	<i>Mycteroperca rubra</i>	Comb grouper	
	<i>Mycteroperca tigris</i>	Tiger grouper	
	<i>Mycteroperca venenosa</i>	Yellowfin grouper	
	<i>Paranthias furcifer</i>	Creole-fish	
	<i>Rypticus saponaceus</i>	Greater soapfish	
	<i>Serranus baldwini</i>	Lantern bass	
	<i>Serranus flaviventris</i>	Twinspot bass	
	<i>Serranus tabacarius</i>	Tobaccofish	
	<i>Serranus tigrinus</i>	Harlequin bass	
	<i>Serranus tortugarium</i>	Chalk bass	
Sparidae	<i>Calamus bajonado</i>	Jolthead progy	
	<i>Calamus calamus</i>	Saucereye porgy	
Sphyraenidae	<i>Sphyraena barracuda</i>	Barracuda	
	<i>Sphyraena picudilla</i>	Southern sennet	
Sphyrnidae	<i>Sphyrna mokarran</i>	Great Hammerhead	EN
	<i>Sphyrna lewini</i>	Scalloped hammerhead	EN
	<i>Sphyrna tiburo</i>	Bonnethead	
Sygnathidae	<i>Cosmocampus elucens</i>	Shorthorn pipefish	
	<i>Hippocampus erectus</i>	Northern seahorse	VU
Synbranchidae	<i>Ophisternon aenigmaticum</i>	Obscure swamp eel	
Synodontidae	<i>Synodus intermedius</i>	Sand diver	
	<i>Synodus saurus</i>	Bluestriped lizardfish	
Tetraodontidae	<i>Canthigaster rostrata</i>	Sharpnose puffer	
	<i>Chilomycterus antennatus</i>	Bridled burrfish	
	<i>Chilomycterus antillarum</i>	Web burrfish	
	<i>Diodon holocanthus</i>	Balloonfish	
	<i>Diodon hystrix</i>	Porcupinefish	
	<i>Sphoeroides spengleri</i>	Bandtail puffer	

Fish Species of Gladden Spit and Silk Cayes Marine Reserve			
Family	Species	Common name	IUCN
	<i>Sphoeroides testudineus</i>	Checkered pufferfish	
Triakidae	<i>Mustelus canis</i>	Dusky smooth hound	
Triglidae	<i>Prionotus ophryas</i>	Bandtail searobin	
Tripterygiidae	<i>Enneanectes altivelis</i>	Lofty tripletail	
	<i>Enneanectes atrorus</i>	Blackedge triplefin	
Urolophidae	<i>Urolophus jamaicensis</i>	Yellow stingray	

Appendix 3 – GSSCMR Management Effectiveness Assessment

Issue	Criteria	Score (out of 3)	Comment/Explanation
1. Legal status Does the protected area have legal status (or in the case of private reserves is covered by a covenant or similar)? <i>Context</i>	The protected area has been formally gazetted/covenanted	3	
2. Protected area regulations Are appropriate regulations in place to control resource use and activities (e.g. fishing)? <i>Planning</i>	Regulations for controlling resource use and activities in the protected area exist but there are some weaknesses or gaps	2	Some additional protections for some species such as black durgon and angel fish. Expand no-take zone. Set up demarcation buoys for no-take zone.
3. Law enforcement Can staff (i.e. those with responsibility for managing the site) enforce protected area rules well enough? <i>Input</i>	The staff have acceptable capacity/resources to enforce protected area legislation and regulations but some deficiencies remain	2	Limitation in human and financial resources.
4. Protected area objectives Is management undertaken according to agreed objectives? <i>Planning</i>	The protected area has agreed objectives, but is only partially managed according to these objectives The protected area has agreed objectives and is managed to meet these objectives	2.5	Limitation in human and financial resources.
5. Protected area design Is the protected area the right size and shape to protect species, habitats, ecological processes and water catchments of key conservation concern? <i>Planning</i>	Protected area design is not significantly constraining achievement of objectives, but could be improved (e.g. with respect to larger scale ecological processes)	2	Consider expanding NTZ and SPAGs sites
6. Protected area boundary demarcation Is the boundary known and demarcated? <i>Process</i>	The boundary of the protected area is known by both the management authority and local residents/neighbouring	2	Need to install demarcation buoys and should be regularly maintained

Issue	Criteria	Score (out of 3)	Comment/Explanation
	land users but is not appropriately demarcated		
7. Management plans Is there a management plan and is it being implemented? <i>Planning</i>	A management plan exists but it is only being partially implemented because of funding constraints or other problems	2	Resource constraints
Additional points: <i>Planning</i>			
7a. Planning process	The planning process allows adequate opportunity for key stakeholders to influence the management plan	1	
7b. Planning process	There is an established schedule and process for periodic review and updating of the management plan	0	
7c. Planning process	The results of monitoring, research and evaluation are routinely incorporated into planning	0	
8. Regular work plan Is there a regular work plan and is it being implemented? <i>Planning/Outputs</i>	A regular work plan exists and many activities are implemented	2	Some activities not carried out due to external factors, re-orientation of priorities and funding constraints. Mission critical focus
9. Resource inventory Do you have enough information to manage the area? <i>Input</i>	Information on the critical habitats, species, ecological processes and cultural values of the protected area is sufficient for most key areas of planning and decision making	2	Needs more data analysis in order to support management
10. Protection systems Are systems in place to control access/resource use in the protected area? <i>Process/Outcome</i>	Protection systems are moderately effective in controlling access/resource use	2	Limitations in staff. Local fishers and tour operators report on infractions

Issue	Criteria	Score (out of 3)	Comment/Explanation
11. Research Is there a programme of management-orientated survey and research work? <i>Process</i>	There is considerable survey and research work but it is partially directed towards the needs of protected area management	2	Need to recruit a marine biologist to coordinate research; Data analysis tools
12. Resource management Is active resource management being undertaken? <i>Process</i>	Many of the requirements for active management of critical habitats, species, ecological processes and, cultural values are being implemented but some key issues are not being addressed	2	Needs better demarcation, more cooperation from Fisheries Dept on info for special licenses for mutton snapper. No night capability to monitor fishers from Honduras
13. Staff numbers Are there enough people employed to manage the protected area? <i>Inputs</i>	Staff numbers are below optimum level for critical management activities	2	2 more Rangers needed (for tourism); 4 Rangers currently assigned including the Head ranger, 2 Science rangers, and 1 Enforcement ranger
14. Staff training Are staff adequately trained to fulfil management objectives? <i>Inputs/Process</i>	Staff training and skills are adequate, but could be further improved to fully achieve the objectives of management	2	More training needs to be done for rangers, customer service, fish ID, rules and regs, etc.
15. Current budget Is the current budget sufficient? <i>Inputs</i>	The available budget is acceptable but could be further improved to fully achieve effective management	2	Improve funding stability through the development of a resource mobilization strategy
16. Security of budget Is the budget secure? <i>Inputs</i>	There is very little secure budget and the protected area could not function adequately without outside funding	1	Self-generated fees covers only 30% of budget
17. Management of budget Is the budget managed to meet critical management needs? <i>Process</i>	Budget management is adequate but could be improved Budget management is excellent and meets management needs	2.5	Unrestricted funding would ease budget management
18. Equipment Is equipment sufficient for management needs? <i>Input</i>	There are equipment and facilities, but still some gaps that constrain management	2	Research equipment - BCD, scuba gear, waterproof camera, etc.; Weather monitoring at Little Water Caye, etc.; Firearms needed for night patrols

Issue	Criteria	Score (out of 3)	Comment/Explanation
19. Maintenance of equipment Is equipment adequately maintained? <i>Process</i>	There is basic maintenance of equipment and facilities Equipment and facilities are well maintained	2.5	Protocols need to be consolidated
20. Education and awareness Is there a planned education programme linked to the objectives and needs? <i>Process</i>	There is an education and awareness programme but it only partly meets needs and could be improved There is an appropriate and fully implemented education and awareness programme	2.5	Lacking in staff and funding to carry out plans. Feedback mechanism needs to be developed. Needs to be more strategic
21. Planning for land and water use (seascape) Does land and water use (seascape) planning recognise the protected area and aid the achievement of objectives? <i>Planning</i>	Adjacent seascape planning does not take into account the long term needs of the protected area, but activities are not detrimental to the area	1	Greater integration needs to be done with other MPAs in the SBRC
22. State and commercial neighbours Is there co-operation with adjacent land and water users? <i>Process</i>	There is contact between managers and neighboring official or corporate land and water users, but only some co-operation	2	Hatchet Caye very compliant with the regulations and one of the informants -- monitor and make reports
23. Indigenous people (traditional resource users) Do indigenous and traditional peoples resident or regularly using the protected area have input to management decisions? <i>Process</i>	Indigenous and traditional peoples directly contribute to some relevant decisions relating to management but their involvement could be improved	2	Can be improved by having an advisory committee. Composition must include IP interest
24. Local communities Do local communities resident or near the protected area have input to management decisions? <i>Process</i>	Local communities directly contribute to some relevant decisions relating to management but their involvement could be improved	2	Tourism consultation practice in place, managed access in place but local advisory committee needs to be reconstituted
Additional points <i>Local communities/indigenous people</i>			

Issue	Criteria	Score (out of 3)	Comment/Explanation
24 a. Impact on communities	There is open communication and trust between local and/or indigenous people, stakeholders and protected area managers	1	Improved relationship with communities and stakeholders
24b. Impact on communities	Programmes to enhance community welfare, while conserving protected area resources, are being implemented	0	Is it SEA's responsibility?
24c. Impact on communities	Local and/or indigenous people actively support the protected area	1	There is a sense of community stewardship
25. Economic benefit Is the protected area providing economic benefits to local communities, e.g. income, employment, payment for environmental services? <i>Outcomes</i>	There is a major flow of economic benefits to local communities from activities associated with the protected area	3	Benefits from commercial fishing and tourism
26. Monitoring and evaluation Are management activities monitored against performance? <i>Planning/Process</i>	There is some <i>ad hoc</i> monitoring and evaluation, but no overall strategy and/or no regular collection of results	1	Implement monitoring tracking tool
27. Visitor facilities Are visitor facilities adequate? <i>Outputs</i>	Visitor facilities and services are inappropriate for current levels of visitation	1	There is limited space and toilets sewer system needs to be improved.
28. Commercial tourism operators Do commercial tour operators contribute to protected area management? <i>Process</i>	There is limited co-operation between managers and tourism operators to enhance visitor experiences and maintain protected area values	2	More engagement needed
29. Fees If fees (i.e. entry fees or fines) are applied, do they help protected area management? <i>Inputs/Process</i>	Fees are collected, and make some contribution to the protected area and its environs	2	Higher costs for patrol, and a larger area to cover

Issue	Criteria	Score (out of 3)	Comment/Explanation
30. Condition of values What is the condition of the important values of the protected area as compared to when it was first designated? <i>Outcomes</i>	Some biodiversity, ecological or cultural values are being severely degraded	1.5	SPAGS have significantly declined; whale shark views have dramatically declined – no whale shark views from SEA in 2017. General decline in SPAGS across the country.
	Some biodiversity, ecological and cultural values are being partially degraded but the most important values have not been significantly impacted		
<i>Additional Points: Condition of values</i>			
30a: Condition of values	The assessment of the condition of values is based on research and/or monitoring	1	There is some monitoring data available
30b: Condition of values	Specific management programmes are being implemented to address threats to biodiversity, ecological and cultural values	0.5	Some measures taken to protect bird and turtle nesting
30c: Condition of values	Activities to maintain key biodiversity, ecological and cultural values are a routine part of park management	1	
TOTAL SCORE		65	
Total possible score = 90		72.2%	