HOL CHAN MARINE RESERVE

2019-2024 MANAGEMENT PLAN

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ACKNOWLEDGEMENTS

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The Hol Chan Marine Reserve Board of Trustees is especially thankful to the Protected Areas Conservation Trust (PACT) for financial support used in the preparation of this updated management plan.

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Acronyms, Symbols & Abbreviations

BCNPMR	Bacalar Chico National Park and Marine Reserve
BTB	Belize Tourism Board
CBWS	Corozal Bay Wildlife Sanctuary
CZMAI	Coastal Zone Management Authority & Institute
ERZ	Exclusive Recreational Zone
FD	Fisheries Department
HCMR	Hol Chan Marine Reserve
HRI	Healthy Reef Initiative
IMF	International Monetary Fund
IUCN	International Union for the Conservation of Nature
LAC	Limits of Acceptable Change
MAR	Mesoamerican Reef
METT	Management Effectiveness Tracking Tool
NBCC	Northern Belize Coastal Complex
NCCPSAP	National Climate Change Policy, Strategy and Action Plan
NE	Northeast
NPAS	National Protected Areas System
^{0}F	Degrees Fahrenheit
ppt	Parts per Thousand
Q	Quadrat
RHI	Reef Health Index
SACD	Sarteneja Alliance for Conservation and Development
SI	Statutory Instrument
SMART	Spatial Monitoring and Reporting Tool
SMP	Synoptic Monitoring Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
WCS	World Conservation Society

Section A. Introduction

The Hol Chan Marine Reserve (HCMR) is an IUCN Category VI Reserve, originally located four miles southeast of San Pedro, Ambergris Caye, and was the first marine reserve to be declared in Belize as a multi-use protected area (Figure 1). Declaration was made in July 1987 in accordance with *Section 7 of the Fisheries (Amendment Act) of 1983*, in response to concerns over destructive fishing and diving at the site. The particular geomorphology of the channel in the area, coupled to the abundant fishery resources and interconnected coral reef, seagrass beds and mangrove ecosystems provided additional justification and persuasion for the designation of the site as a marine reserve. Consistent with the Fisheries Act, the HCMR was established "to *ensure, increase and sustain the productive service and integrity of the marine resources for the benefit of all Belizeans of present and future generations".*

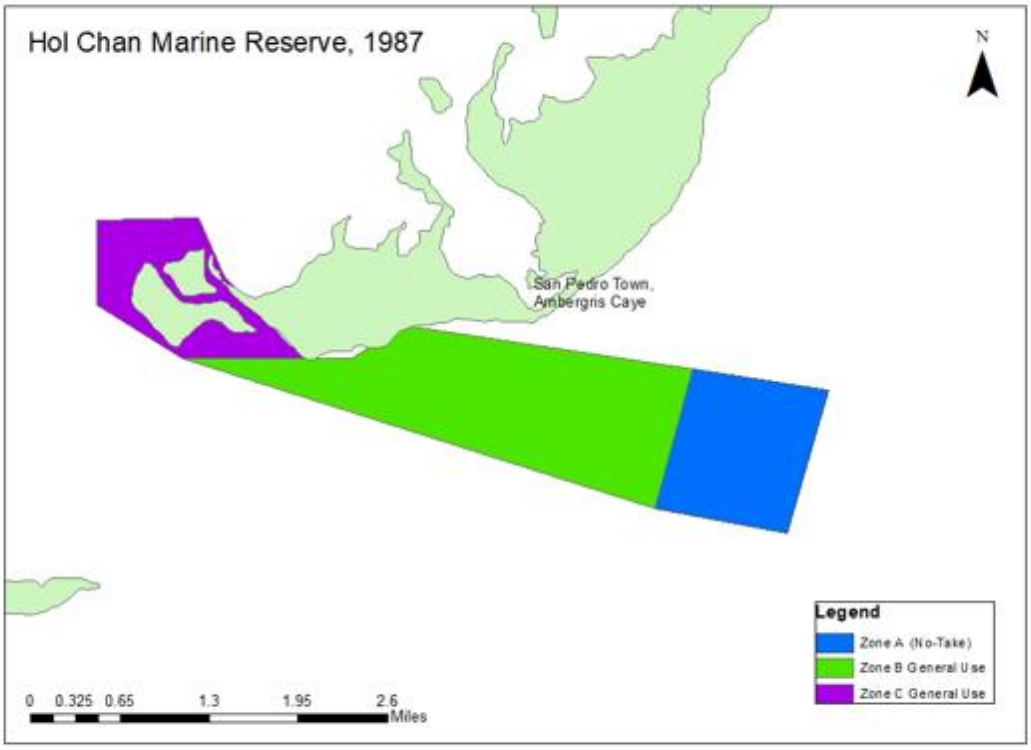

Figure 1. The HCMR as declared in 1987

In 1999 the HCMR saw the addition of a General Use Area and two Exclusive Recreation Areas, the latter two being Shark Ray Alley and Amigos del Mar Dive Wreck. In an effort to increase protection of critical coral reef habitats in the buffer zone of the reserve, the Government of Belize expanded the Hol Chan Marine Reserve on February 17, 2016 to include three new areas: Mexico Rocks

snorkel and dive site area; the mangrove wetland area including the Mata and Frances Lagoon; and the shoals that include Los Bajos and Los Salones (Figures 2). This recent expansion has made the reserve about 25 times bigger than its original size at time of declaration in 1987, and reconfirms the strategic position of the HCMR in consolidating marine conservation and ecosystem protection efforts in the Northern Belize Barrier Reef complex. The HCMR is now 103,058 acres or 41,706 hectares (Wildtracks, 2019).

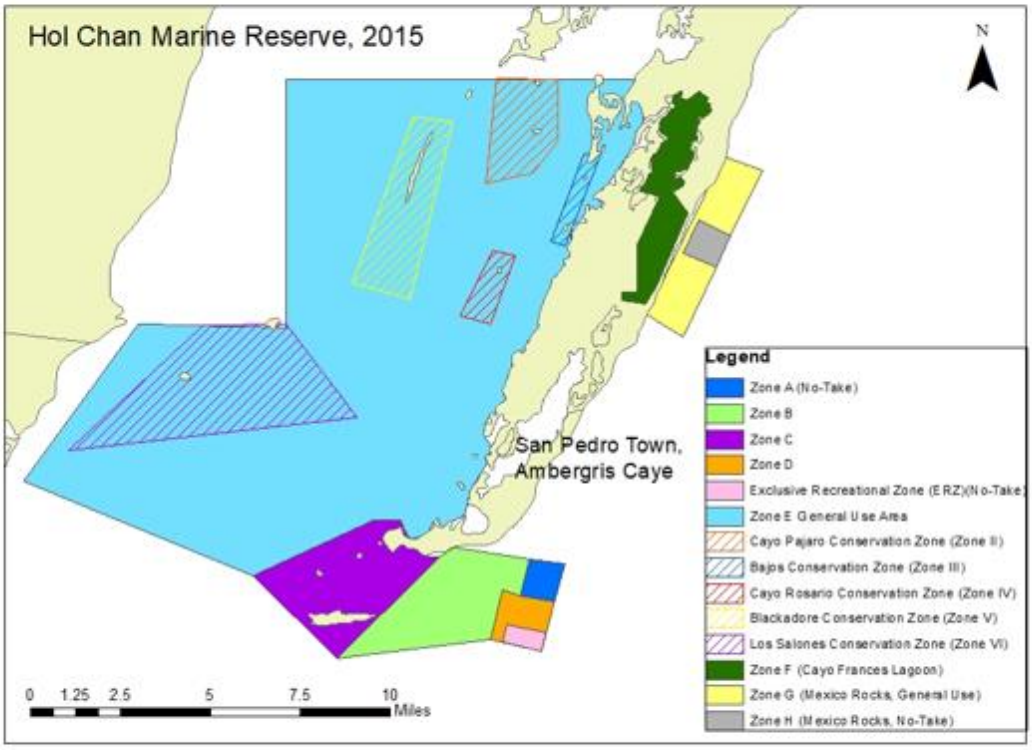

Figure 2. Expanded HCMR at 2105

The abundance and diversity of marine species at the HCMR, coupled to the convenience of only being 4 miles from San Pedro have been able to sustain a steady increase in visitation to the reserve by tourists, with over 85,000 visitors in 2017 (HCMR, 2019), allowing it to keep its reputation as one of the two most visited protected areas in the country, along with the Nohoch Che'en Archaeological Reserve at Caves Branch. However, the HCMR continues to be the most visited marine reserve by overnight tourists, thus consolidating its rightful place as an important element of the Belize brand and most certainly of the San Pedro Ambergris Caye identity and Brand.

Section B. Objectives of the HCMR Management Plan

The Hol Chan Marine Reserve Management Plan provides an enabling framework for the protection, enhancement, restoration and sustainable use of the natural resources within the reserve, within the context of the broader Northern Belize Barrier Reef Complex. It is meant to guide the HCMR over the next five (5) years in the implementation of its primary mandate to serve as a fisheries management tool, through interventions geared at maintaining critical ecosystem functions and integrity, resilience, community engagement, and sustainable use, while improving the overall management effectiveness of the reserve.

The HCMR forms part of the National Protected Areas System (NPAS), and as such, it is responsive to national protected areas policies and plans, and contributes to system-level conservation priorities and management objectives. In this regard, management interventions and results must be measurable and comparable to those of other reserves, while addressing the management needs that are specific to the existence and sustainability of the HCMR.

The HCMR Management Plan addresses the current status of the reserve, including the legal context in light of the expanded reserve, location, the regional and national contexts, the biological and physical environment, cultural and stakeholder use, socio-economic importance, threats, climate change considerations, community engagement, management planning, management structure and capacity, monitoring and evaluation, and management effectiveness. Additionally, this HCMR Management Plan is meant to be more '***actionable***' and a bit less descriptive, as is customary in other protected areas management plans. In this regard, it is aligned with the HCMR Strategic Plan and facilitates the elaboration of Annual Operational Plans to ensure proper implementation and allow for systematic monitoring and evaluation, which is absolutely necessary to inform adaptive management interventions.

Section C. Current Status of the HCMR

Location & Legal Context

The Hol Chan Marine Reserve was declared in July through Statutory Instrument (SI) 57 of 1987, in accordance with *Section 7 of the Fisheries (Amendment Act) of 1983;* is located at the south-eastern tip of San Pedro, Ambergris Caye, and its boundaries are contiguous with those of Corozal Bay Wildlife Sanctuary, to the north, extending to the shoals in west and to the reef drop-off just outside the channel to the east (Figure 3).

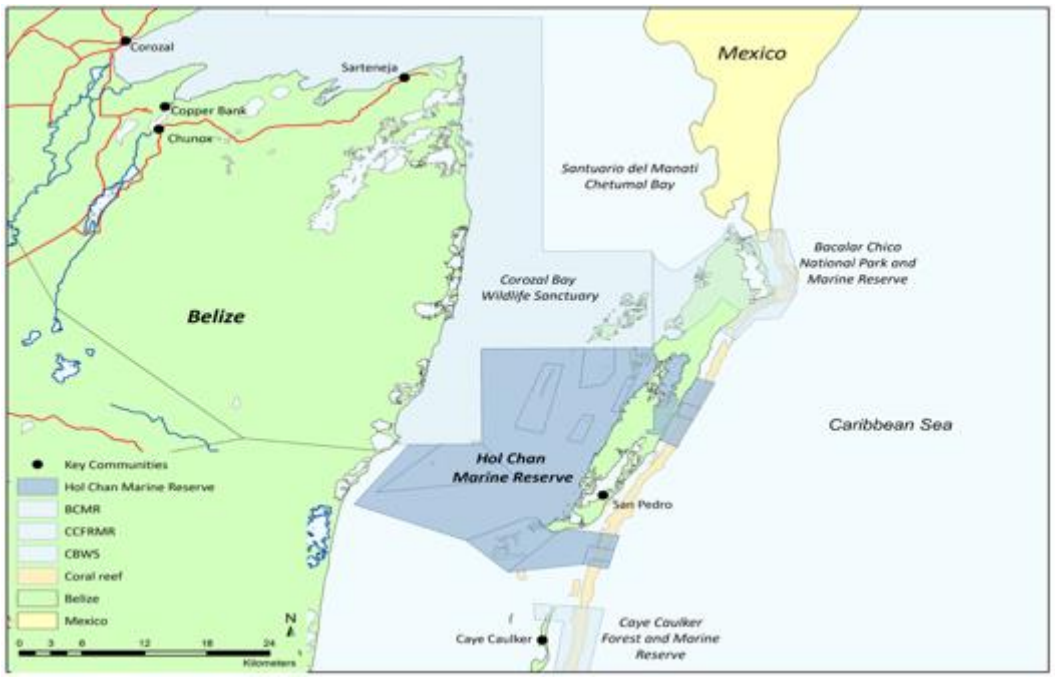

Figure 3. Location of the Hol Chan Marine Reserve (Wild Tracks, 2019)

Three management zones were initially defined within the reserve: Zone A (the reef), measuring 2.29km² where recreational (non-extractive) activities such as diving and snorkelling can occur; Zone B (Seagrass beds) the largest zone encompassing an area of 7.77km² and Zone C (Mangroves), an area measuring 2.59km². Both Zones B & C accommodate Sports and Commercial fishing under a special license from the Fisheries Administrator (Launchpad Consulting, 2005). The Hol Chan channel, the major focus of the reserve, is located approximately four miles southeast of San Pedro, Ambergris Caye. It encompasses 18.13 km^2 of coral reefs, seagrass beds and mangrove swamps.

As per the *HCMR (Amendment) Regulations of August 31st, 1999*, and as indicated above, Zone D (Shark Ray Alley) was also designated as part of Hol Chan, adding a General Use Area and two Exclusive Recreation Areas, the latter two being Shark Ray Alley and Amigos del Mar Dive Wreck. In an effort to increase protection of critical coral reef habitats in the buffer zone of the Reserve, the Government of Belize expanded the Hol Chan Marine Reserve to include three new areas: Mexico Rocks snorkel and dive site area; the mangrove wetland area including the Mata and Frances Lagoon; and the shoals that include Los Bajos and Los Salones. Since its declaration in 1987, the HCMR has seen at least eight (8) other pieces of legislation in support of its management and expansion passed in the form of S.I.s., the last being Statutory Instrument 18 of 2015. The sequence of S.I.s covering the period since declaration to current status of the HCMR is listed below:

- Statutory Instrument No. 57 of 1987
- Statutory Instrument No. 107 of 1988
- Statutory Instrument No. 113 of 1989
- Statutory Instrument No. 100 of 1999

- Statutory Instrument No. 101 of 1999
- Statutory Instrument No. 114 of 2008
- Statutory Instrument No. 116 of 2018
- Statutory Instrument No. 17 of 2015
- Statutory Instrument No. 18 of 2015

Regional Context

The HCMR is considered by many both nationally and internationally, to be one of the most successful marine reserves in the Central America and Caribbean Region, with exceptional ecological features and a long-established record of 'self-sustainability', and a model for other marine reserves in the region.

The Hol Chan Marine Reserve is part, and a faithful representation of the Mesoamerican Barrier Reef System, now more commonly referred to as the Mesoamerican Reef or MAR. It extends more than 1,000 km from the Yucatan Peninsula to the Bay Islands of Honduras, and includes the Belize Barrier Reef System, the second longest barrier reef in the world. This reef system is unique in the Western hemisphere on account of its size, its array of reef types, and the luxuriance of corals it contains. The MAR stabilizes and protects coastal landscapes; maintains coastal water quality; sustains species of commercial importance; serves as breeding and feeding grounds for marine mammals, reptiles, fish and invertebrates; and offers employment alternatives and incomes to over one million people living in coastal zones adjacent to the reefs. Associated with the coral reefs of the MAR are extensive areas of relatively pristine coastal wetlands, lagoons, seagrass beds and mangrove forests; these sustain exceptionally high biodiversity and provide critical habitat for threatened species. At least two sites along the MAR have been declared World Heritage sites (World Bank, 2001), including the Bacalar Chico National Park and Marine Reserve (BCNPMR), adjacent to the HCMR.

Hol Chan Marine Reserve is part of the Northern Belize Coastal Complex (NBCC), a river to reef seascape that stretches from the Rio Hondo and New River through the largest estuarine system of the Mesoamerican Reef and flows onto the reef at Hol Chan and Bacalar Chico. The NBCC is, itself, part of a larger, transboundary seascape - it is contiguous with the Sanctuario del Manati and Parque Nacional Arrecifes de Xcalak, in Mexico (Wild Tracks, 2019).

National Context

The Hol Chan Marine Reserve is an iconic and significant contributor to the National Protected Areas System and to Belize's natural heritage. It supports the protection of genetic diversity by maintaining critical ecosystems and species in a healthy and viable form, while providing breeding and nursery areas for juveniles of many species. It also serves as seeding ground for areas that have been depleted from overfishing, and is a major attraction for recreational and tourism activities. The HCMR

is synonymous to the identity and branding of San Pedro, Ambergris Caye as the primary coastal tourism destination of Belize, but is also known for cultural and traditional uses, including Beach Trap Fishing and Fly Fishing.

As described by Wild Tracks (2019), Hol Chan Marine Reserve is an important component of the Northern Belize Coastal Complex, a river-to-reef seascape of connected protected areas in northern Belize. Water flows from the Rio Hondo, New River and coastal lagoons of the Belize and Mexico mainland into the Corozal Bay/Chetumal estuary, and on to the reefs of Hol Chan, Bacalar Chico and Caye Caulker Marine Reserves. The shallow estuary acts as an important filter for water from the rivers. With the lack of flushing or strong currents, it also acts as a catchment for accumulating contaminants, settling out sediments and contaminants before the water reaches the reef at Hol Chan, Bacalar Chico (a component of Belize's World Heritage Site), and Caye Caulker, reducing potential stress from land-based pollutants on these ecologically and economically important reef areas. The key characteristics of national importance of the HCMR were described by Wild Tracks (2019) as follows:

- Protects part of the largest estuary emptying into the Mesoamerican Reef
- Hol Chan channel and Shark Ray Alley are two of Belize's primary tourism destinations, critical to the health of Belize's economy
- Protects Bulkhead Shoals, an important mud bank that prevents sediment and pollution from leaving the Corozal Bay estuary, protecting the reef
- Bulkhead Shoals is also important for shallow water sites for the sport fishing industry
- Includes important mangrove cayes and coastal mangroves – fish nursery areas and bird nesting sites
- High connectivity between reef, seagrass and mangrove

Physical and Biological Characteristics

The geomorphology and the physical and biological characteristics of the Hol Chan Marine Reserve were described by Young and Bilgre (2002), much of which are still relevant today. This original description is presented here, with updates where appropriate and as allowed by recent publications and other relevant literature.

Geology and Substrates Types

The Belize submarine shelf is 240 km long and its reefs represent the largest reef complex in the Atlantic-Caribbean area. With its three different offshore atolls, it also rivals the Great Barrier Reef in the complexity of coral reefs and variety of sediment types. The Belize shelf is divided into distinct northern and southern halves. Its edge is characterized by a series of five discontinuous ridges that trend northeast and which are thought to be fault-controlled, and lies on an escarpment formed as a result of uplifting caused by movement of the Caribbean plate against the North American plate along a SW-NE fault line in the Tertiary-Recent, approximately 1.8 million years ago (Wild Tracks, 2019). The least defined ridge lies along the northern edge of the barrier reef and Ambergris Caye,

encompassing the Hol Chan reef area. Here, the lagoon depths average three meters and are not greater than 5.5 meters. The reef facies occupy a narrow strip on the seaward edge of the shelf. Leeward of this zone, debris accumulates in the reef lagoon as coarse, slightly muddy skeletal sand which is stabilized by beds of *Thalassia* seagrass and the algae *Halimeda*.

The Boca Chica area is part of the Cangrejo shoals area. Its channels are comprised of organic-rich lime mud. The southern tip of Ambergris Caye is in the process of extending southward, assisted by the growth of mangroves.

Bathymetry

As reported by Wild Tracks (2019), bathymetry mapping has not been completed for the reef front, but some mapping has been conducted by the Sarteneja Alliance for Conservation and Development (SACD) in the adjacent Corozal / Chetumal estuary to the north and extends southwards to include part of the western extension of HCMR. A central canal drains southward, reaching depths of 5 meters in places, and cuts though Bulkhead Shoals or 'Bajos'. The wide, shallow estuary acts as a settling pool, with sediment from the watersheds and coastal erosion settling out as the current slowly moves southwards. To the south of the estuary, where it passes through HCMR, the large mud bank – Bulkhead Shoals or 'Bajos' – extends from west to east. This shallow bank of deposited sediment acts as a barrier to sediment transport, slowing water movement and resulting in sedimentation of remaining particles before the water reaches the reef at Hol Chan. This feature is also important in supporting the flats sport fishing industry out of San Pedro.

In the Cangrejo Cayes area, the "Boca Chica" Channel is approximately 3 meters deep, tapering up to about 1.5 meters along the mangrove borders, and represents the southernmost point of Ambergris Caye. To the east, the reef lagoon stretches to the reef crest, broken by the Hol Chan Channel, with a width of 23m and near vertical sides that drop to a depth of 10m. Beyond this is the reef drop off – the edge of the escarpment that supports the barrier reef and Ambergris Caye. HCMR (2016) described synoptic monitoring of spur and groove corals at depths ranging from 25 ft to 40 ft (7.62m to 12.19m) near the Hol Chan Cut, and monitoring sites in the back reef of the HCMR with depths ranging from 2 ft to 6 ft (0.30m to 1.83m), confirming somewhat of a gradual increase in depth from the back reef to the fore reef, and change in substrate type from muddy to sandy in west to east direction.

Tides and Water Movement

Wildtracks (2019) has described the tides and water movement for the HCMR. Said description is the most recent description available at this time, and presented as follows. Maximum tidal range is 37 - 45 cm on the exposed reef facing shores of Ambergris Caye, reaching a maximum of 55cm. The prevailing current inside the barrier reef is southerly; currents at reef entrances show a westerly flow, but the current in the "cut" reverses most days in response to tides, and is strongest during outgoing tides and near the cut itself. Strong currents of up to 7 knots flow through these reef channels, especially during low tides. HCMR is also influenced by the Caribbean Current, which provides ocean connectivity, determining the transport of larvae, nutrients and pollutants. This flows westwards from the Lesser Antilles then northwards, past HCMR and through the Yucatan Channel, with an average flow rate

of between 38 to 43 cm (15 to 17 inches) per second, and with localized gyres and counter-currents. On the leeward coast, tidal range is lower, ranging from 0 to 15 cm (Ebanks, 1975 in Wildtracks 2019).

The prevailing direction of the surface current within the Corozal/Chetumal Bay estuary is southerly, from the rivers to the coastal waters south of Ambergris Caye. Variations in sea level in the enclosed estuary to the west, however, are controlled primarily by wind direction. During the norther season, strong winds from the north push water southward, out of the estuary, decreasing the water level and reducing the salinity and temperature. In the dry season, the north winds are replaced by strong south-easterly winds, pushing water into the estuary, increasing water depth. This is exacerbated by heavy rainfall during storm events, which increases sheet flow off the mangrove savannas and river flow into the estuary.

Climate

Temperature, Salinity and Dissolved Oxygen

The surface water temperature of the HCMR near the barrier reef in July and August is 29 °C. The water is well mixed with normal seawater salinities of 35-37ppt (Young and Bilgre, 2002). Data published in 2017, however, revealed mean daily minimum temperature for Ambergris Caye as 27 ^{0}C during the day and 22 ^{0}C during the night, and corresponding primarily to the months of December to February (Figure 4). Similarly, mean daily maximum temperature for Ambergris Caye was reported as 30 ^{0}C during the day and 25 ^{0}C during the night, corresponding to the months of June to September (Figure 4 & 5) (www.meteoblue.com, 2017). Unvalidated temperature data for the Coral Gardens area near the HCMR logged between June 2016 to March 2018 recorded an average daytime temperature of 85.06 ^{0}F and 85.18 ^{0}F at night time. However, a higher night time than day time average is unlikely or abnormal, and thus more analysis of this information is necessary. Similarly, monitoring in of seagrass at the HCMR between 2010 and 2011 reported salinities between 15 ppt and 26 ppt, with an average salinity of 22.5 ppt. This salinity may be explained by the fact that seagrass is monitored in the lagoon area of the reserve, which is continuously subject to freshwater inflows from land and mixing, thus resulting in a salinity well below the regular sea water which should normally be around 35 ppt.

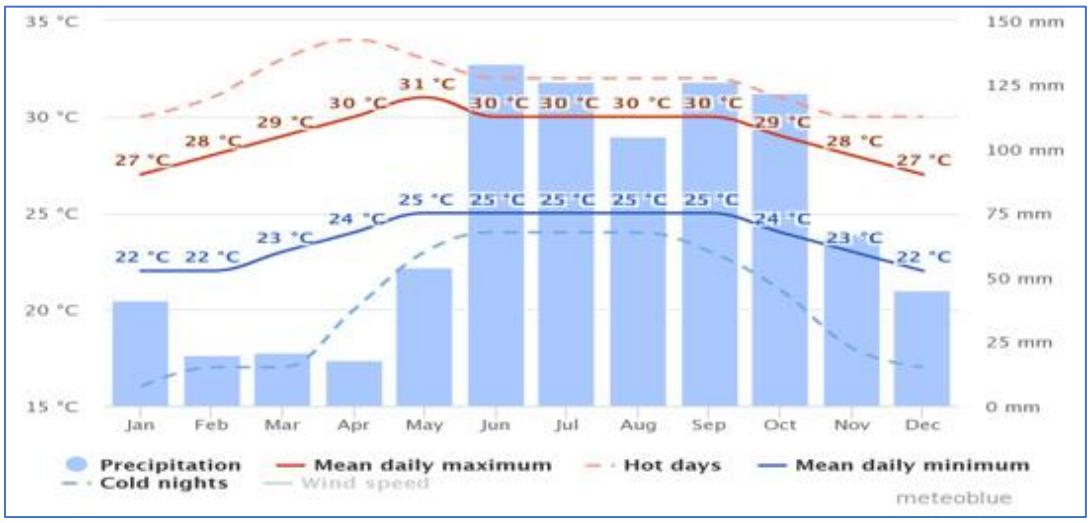

Figure 4. Minimum, Maximum and Mean Temperature for Ambergris Caye (Taken from www.meteoblue.com, 2017)

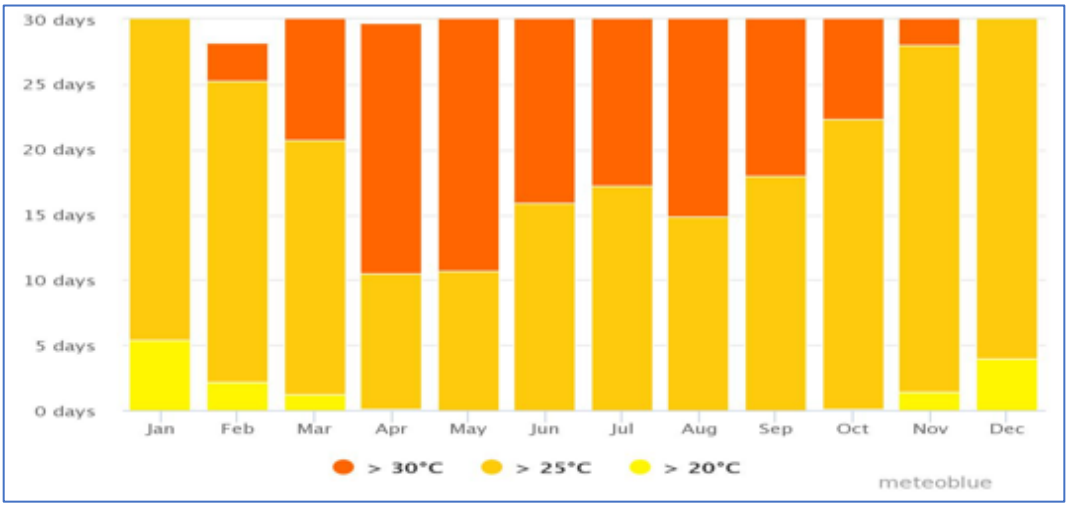

Figure 5. Maximum Monthly Temperature for Ambergris Caye (Taken from www.meteoblue.com, 2017)

Based on results of water quality monitoring currently conducted by SACD for the Corozal Bay Wildlife Sanctuary, and including the north western most areas of the HCMR, Wildtracks (2019) has described surface water temperatures in the reef lagoon as ranging from 26.4°C in January / February to 29.7°C in September, averaging 28°C. Water temperatures in the estuary show greater variation, both seasonally and across years, from an average of 24.5°C in the Norther Season to 30.6°C in the dry season, extreme weather events causing greater fluctuation. In the Bulkhead Shoals area or 'Bajos', water temperature is influenced by both the south flowing estuarine water, by the warmer reef lagoon water entering from the south as a result of the strong south east winds, and direct heating of the shallow water of the shoals. This can result in higher temperatures ranging from 31 to 35°C, particularly in the waters on the leeward side of Ambergris Caye.

Similarly, Dissolved oxygen (DO_2) levels in the reef lagoon are relatively high, and being at their highest during the dry season. In the estuarine system, dissolved oxygen levels are highest during the norther season with an average DO_2 level of 7.72 mg/l (ranging from a high of 9.37mg/l and low 6.02 mg/l) (Wildtracks, 2019).

Wind

Off Ambergris Caye, NE winds predominate at 5-15 knots, with seasonal "northers" between November-March, which are characterized by squall lines and high gusts. The NE winds are trade winds, and are the prevailing pattern of surface winds that typically blow from east and north-east towards the west. The HCMR also is subject to tropical storms between June and November each year, which can produce winds of up to 64 knots (118 km/h, 74 mph), and to hurricanes which can produce winds of up to 137 knots (252 km/h, 157 mph). Figure 6 illustrates the maximum wind speed per month in 5-day intervals for Ambergris Caye.

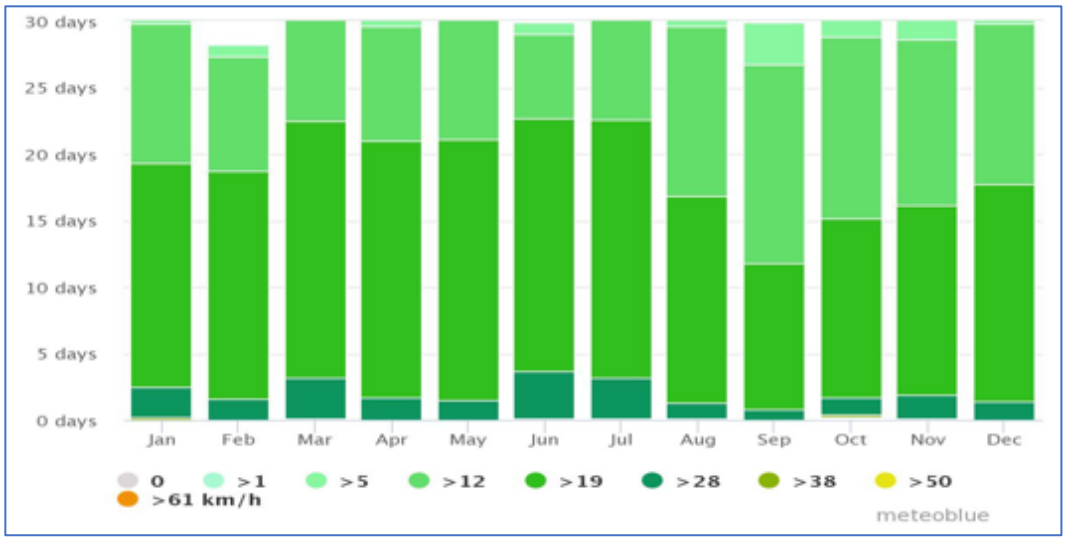

Figure 6. Max Wind Speed per Month in 5-Day Intervals for Ambergris Caye (www.meteoblue.com, 2017)

Rainfall

The average rainfall for the Ambergris Caye area is 133cm/year, with the season defined as being from June to November. The wettest month (with the highest rainfall) is October (245mm). The driest month (with the lowest rainfall) is March (37mm). Months with the highest number of rainy days are July, September and October (16 days). The month with the lowest number of rainy days is April, with only 4 days of rain (www.weather-atlas.com, 2019). Figure 7 illustrates monthly precipitation amounts in 5-Day intervals for Ambergris Caye (www.meteblue.com, 2017).

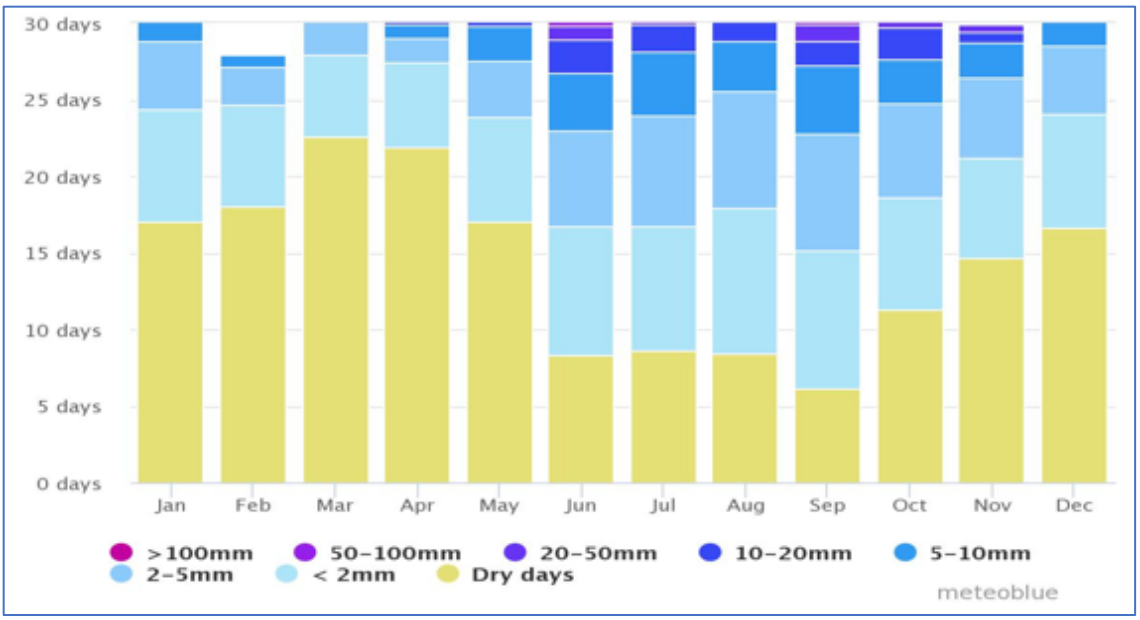

Figure 7. Monthly Precipitation Amounts in 5-Day Intervals for Ambergris Caye (www.meteoblue.com, 2017)

Tropical Storms & Hurricanes

The hurricane season in Belize is from June to November, with tropical storms affecting the country every year during this period. As stated above, tropical storms can produce winds of up to 64 knots (118 km/h, 74 mph), and to hurricanes which can produce winds of up to 137 knots (252 km/h, 157 mph). As reported by Wildtracks (2019), the HCMR has been affected on an almost annual basis by tropical storms, some of these reaching hurricane strength. Tropical storm impacts include mechanical damage to the reef and siltation of the corals, affecting habitat quality for reef organisms. The storm surge, a local rise in sea level of several feet that washes over the coastline, has the potential to remove vegetation cover, with salt contamination of ground water and soils. The severity of the impacts from tidal surges depends on the strength of the surge, and the duration of inundation under water. The strong winds and extreme rainfall can result in high sediment loads, particularly in the shallow Bajos in the HCMR extension, and being carried through to the reef front (Figure 8).

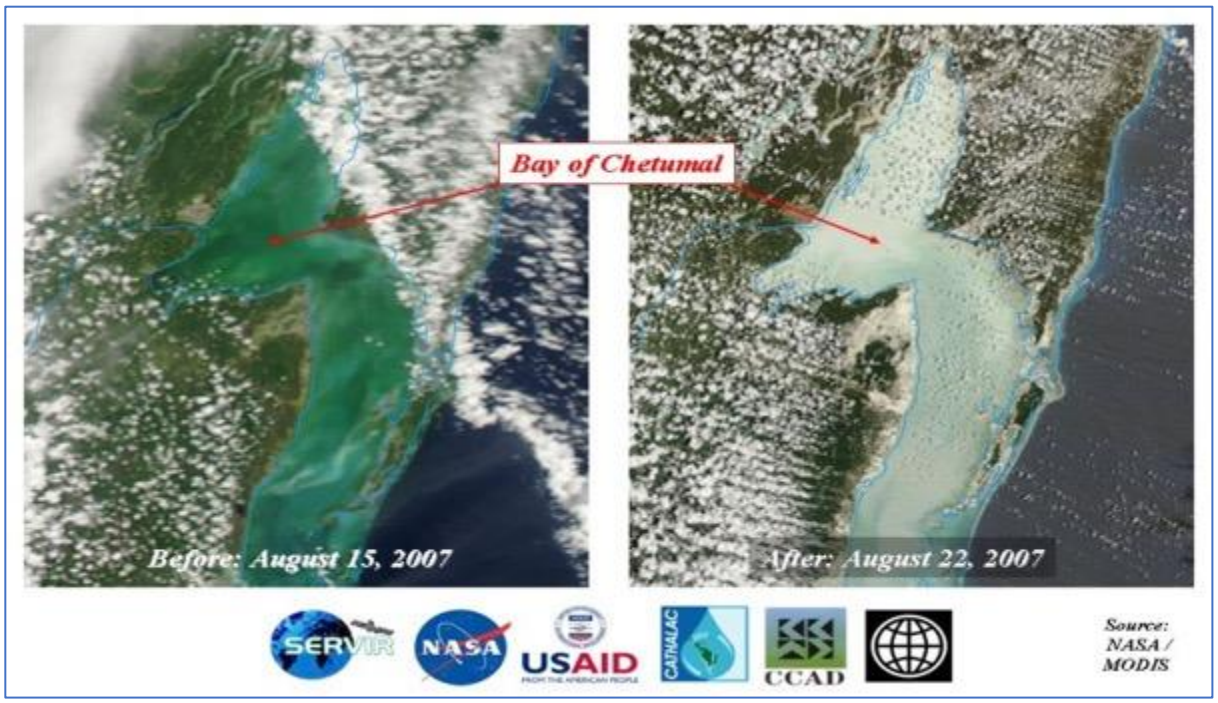

Figure 8. Hol Chan Marine Reserve, Corozal Bay Wildlife Sanctuary and Chetumal Bay, before and after Hurricane Dean in 2007, demonstrating the level of turbidity caused by the Category 5 hurricane (Taken from Wildtracks 2019).

Historical records identify 23 tropical storms / hurricanes that have impacted HCMR between 1864 and 2014, either passing directly across the Marine Reserve, or coming within a 50 km radius of the area. This includes 18 tropical storms, 3 Category One hurricanes, 1 Category Two, and 1 Category Four. Four additional major hurricanes (Hurricane Dean (H5, 2007), Carmen (H4, 1974), Janet (H5, 1955) and an unnamed storm (H4, 1933), passed beyond the 50km used to define storm influence, but were still strong enough to impact the area (Table 1).

Name	Cat.	Date Passed <50km of HCMR	Name	Cat.	Date Passed <50km of HCMR
Alex	TS	Jun 27, 2010	Not named	H4	Sept 10, 1931
Arthur	TS	May 31, 2008	Not named	TS	June 18, 1924
Chantal	TS	Aug 21, 2001	Not named	TS	June 17, 1921
Keith	TS	Oct 2, 2000	Not named	TS	Sept 1, 1916
Gert	TS	Sept 18, 1993	Not named	TS	Oct 15, 1906
Hermine	TS	Sept 22, 1980	Not named	TS	Oct 3, 1904
Edith	TS	Sept 11, 1971	Not named	TS	Nov 3, 1898
Not named	TS	Aug 31, 1945	Not named	TS	Sept 16, 1898
Not named	TS	Oct 23, 1943	Not named	H1	July 7, 1893
Not named	H2	Nov 9, 1942	Not named	H1	Nov 1, 1870
Not named	TS	Oct 11, 1938	Not named	H1	Aug 31, 1864
Not named	TS	Oct 10, 1932			
Other large storms > 50km					

Dean	H5	Aug 21, 2007	Janet	H5	Sep 28,1955
Carmen	H4	Sept 2, 1974	Not named	H4	Sep 10, 1931

Table 1. Historical Records of Storm Events passing within 50 Km of HCMR (Taken from Wildtracks, 2019)

Ecosystems of the HCMR

Assessments conducted as part of the action planning process to improve management effectiveness in the Northern Belize Coastal Complex included detailed descriptions of the ecosystems and representative fauna of the HCMR, which was subsequently included in the Draft Hol Chan Marine Reserve Management Plan 2019-2024 by Wildtracks (2019), and which has now been inserted here. The marine ecosystems of Hol Chan Marine Reserve range from the shallow epipelagic waters of the continental shelf, with scattered patch reef in a reef lagoon, to the fore reef, reef crest and back reef, and the bathypelagic zone of the open seas. It also encompasses the shallow waters of the Corozal Bay / Chetumal estuarine system and creeks and lagoons of the Cayo Franco area.

Epipelagic Zone (0m – 200m)

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

- Brackish Lagoon of the Caribbean Plain
- Sparse algae / sand
- Seagrass
- Coral Reef

Brackish lake of the Caribbean plain *(UNESCO Ecosystem Code: SA1b(5))* is represented by the Cayo Frances wetlands area, a series of interconnected lagoons and creeks with a benthic environment compose principally of fine organic sediment above a limestone bedrock. The area has many sink holes that lead into an extensive array of underwater caverns that are yet to be explored.

This ecosystem also includes the Bulkhead Shoals extension in the west of the Marine Reserve, the southern-most part of the extensive Corozal Bay / Chetumal estuarine system. This relatively shallow expanse of coastal waters supports few habitat types. The bottom is mainly limestone rock covered in some areas by a thin layer of sandy mud that supports inter-mixed patches of the alga *Batophora oerstedii* and turtle Grass (*Thalassia testudinum*). The Bulkhead Shoals themselves are composed of deposited sediment, and act as an important barrier at the mouth of the estuary. This shoal runs

from north west to south east across the wide estuary mouth, and is stabilized by extensive seagrass beds.

Mud and Sparse Algae: Where seagrass and reef patches are scarce or absent in the brackish lagoons systems, the benthic vegetation composition is predominantly mud, sand and / or sparse algae. Benthic components recorded by HCMR (2019) included gorgonians 2.7%, sponges 3.1%, bare rock and sand 11.8%, and encrusting coraline algae 4.15%. The percentages for these benthic components clearly illustrates that turf and macroalgae and turf algae are the dominant benthic cover inside the Reserve.

Seagrass *(UNESCO Ecosystem Code: VIIIA)**:*** The most important component of marine flora in the Marine Reserve is seagrass, a flowering plant growing in large, *Thalassia*-dominated patches on the shallow seabed, in the reef lagoon and to the west in the Bulkhead Shoals extension. They are also a critical ecosystem for many fish and invertebrate species. The dominant seagrass species in HCMR are turtle grass and manatee grass (*Thalassia testudinum* and *Syringodium filiforme*). Overall, seagrass coverage in the HCMR is interspersed with algae such as *Udotea spp., Penicillus spp.,* sponges, and some small hard corals such as *Manicina areolata* and *Favia fragum*.

Representative biodiversity in the seagrass habitat includes the Queen conch, bottlenose dolphin, the Antillean manatee, and many juvenile reef fish including commercial species such as tarpon, hogfish, yellowtail snapper and great barracuda. An area known as "Neptune's Garden" is located at the shallow southwestern end of this zone, extending beyond the border of the reserve. There is little seagrass in the area, but the fine sediment thin layer over the bedrock supports an unusual mix of sponge/algal beds, with approximately fifteen known species of sponge and several not yet identified, and provides a sheltered habitat for numerous juvenile fish and invertebrates, including lobsters.

Coral Reef *(UNESCO Ecosystem Code: SA1d (2))***:** North of the Hol Chan cut, the ***back reef*** is characterized by large formations of Elkhorn coral (Acropora palmata) which grow out in finger-like projections perpendicular to the reef crest. There is a high degree of bioerosion of these corals, particularly those closer to the reef crest, but a variety of other encrusting corals and sponges have attached to the dead sections, increasing their strength and rugosity. The large surface area of sheltered overhangs formed by these large elkhorn corals form the main habitat for Hol Chan's impressive lobster population. Patch reefs dot the floor of the shallow reef lagoon. Boulder coral formations (*Montastrea spp.*) are found here, as are brain corals (*Diploria spp*.), starlet corals (*Siderastrea spp.*), some patches of staghorn coral (*Acropora cervicornis*), and numerous sea fans (*Gorgonia spp.*) and other soft corals.

South of the Hol Chan cut, the back reef is characterized by large formations of finger corals (*Porites spp.*) and lettuce corals (*Agaricia spp.*) which cover large areas perpendicular to the reef crest. Near the southern border is a shallow region of coral rubble and sand covered with *Dictoyta spp*. algae. Large schools of blue tangs and grunts are common, as are triggerfish, hogfish, parrotfish, barracuda

and nurse sharks. Black tipped reef sharks are occasionally seen and the frequency of in water sightings of sea turtles has increased over the years.

In HCMR 2017 surveys, average coral cover was 8.5% at Zone A backreef, and 11% at Zone D backreef. The average coral cover at backreef sites was 9.75%. The most common species encountered during backreef site surveys in 2016 were *Acropora sp.* followed by *Siderstrea siderea,* and *Montastraea sp.*. In 2017 this shifted to *Diploria sp.* being the most common, followed by *Siderastrea* and then *Montastrea Sp..* Turf algae cover on backreef sites are relatively high compared to macroalgal and coral cover. Mean macroalgae cover was 8.7% and turf algae 50.6%, with Turf algae being dominant at both backreef sites. The average height of coral colonies in the backreef is 20.6cm. Zone D backreef continues to be the site with the bigger and wider coral colonies, with the average for the site being 40.5cm height and 51.2cm in width (Figure 9.). Coral colonies at Zone A backreef are short and wider. This site is also the shallowest of the backreef sites with depth averaging 3.5ft. The colonies have reached their maximum height due to water depth, but they have continued to grow horizontally. The site at Zone D backreef has an average depth of 4.5ft. The coral colonies at this site have more vertical growth compared to Zone A backreef, and horizontally they are a few centimetres above Zone A backreef (HCMR, 2017).

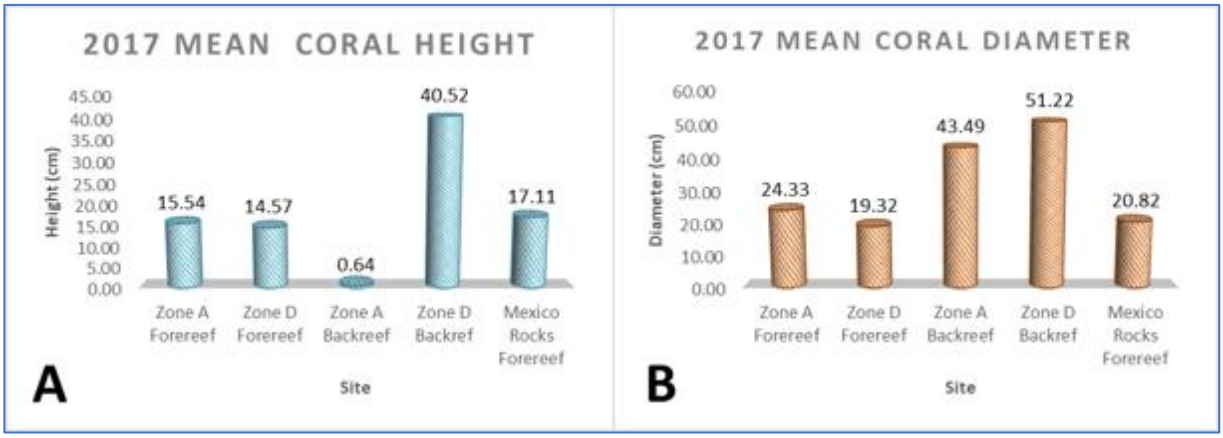

Figure 9. Coral Height and Diameter for a sample of 50 coral colonies

The ***reef crest*** foundation consists primarily of dead Elkhorn and boulder corals covered with turf algae and fire coral (*Millepora spp.*). The depth of this area is between 0 to 0.4 meters, with numerous dead Elkhorn coral tips breaking the water's surface during low tides. There are several deeper areas which allow further water exchange and passage across the reef for some schools of fish.

The ***Hol Chan Channel*** is one of the most visited area in Marine Reserve, with its deeper water (10 meters) and near vertical sides partially covered with live corals and interspersed with caverns. The leeward channel opening contains a patch reef complex dominated by boulder coral (*M. annularis*), brain corals (*Diploria spp.*) and starlet corals (*Siderastrea spp.*). This area is between 1 and 2 meters in depth, sloping downward to the 10-meter depth of the sandy channel to the east. The leeward area, with mooring points for tour boats, attracts schools of snappers (yellow-tail, dog, grey, and

schoolmaster), numerous grunts, and normally several large black or Nassau groupers. The channel itself is often visited by large schools of blue-stripped grunts, schoolmasters and horse-eye jacks, along with southern stingrays, eagle rays, sand divers, Atlantic spadefish and permit. There are even occasional sightings of tarpon, hammerhead sharks and Antillean manatee.

While the upper 2 meters of the channel walls are covered with live corals (*Porites, Agaricia, Diploria, Montastrea*) the lower ledges are composed of primarily dead, algae-covered coral. Large resident green moray eels have taken up residence inside eroded caves in these lower walls. On the seaward end of the channel, the depth decreases to approximately 6 meters and the channel walls level off, resulting in a low relief dispersal of hard and soft corals, gently sloping into the fore reef.

The Hol Chan ***fore reef*** is representative of the Northern Belize Shelf habitat. Sparse low-relief coral coverage (including soft corals) can be found beyond the outer reef crest from approximately 5 to 13 meters, where the characteristic spur and groove formations begin. These coral assemblages form typical spur and groove cliffs of coral with valleys of sand running perpendicular to the reef crest. At depths of approximately 20 meters these formations become well developed, with average heights of approximately 7 - 8 meters. The fore reef has the highest diversity of coral species including large tracts of lettuce corals (*Agaricia spp.*) which dominate the tops of the spurs. One unusually large assemblage of pillar corals (*Dendrogyra cylindrus*) is located about mid-way along the linear mile of fore reef at a depth of about 15 meters. Numerous sponges are interspersed along the spur sides. In addition to the characteristic reef fish species, spotted dolphins, green and loggerhead sea turtles have also been reported on the fore reef.

In monitoring conducted in the reserve, HCMR (2019) reported that the forereef site at Mexico Rocks had the highest coral cover of 13.8%, and all forereef sites were higher in coral cover compared to the backreef sites. Zone A backreef had the lowest coral cover 8.5% (Figure 10); backreef areas are generally characterized by patchy coral and sandy areas. Total mean coral cover was 11.7%.

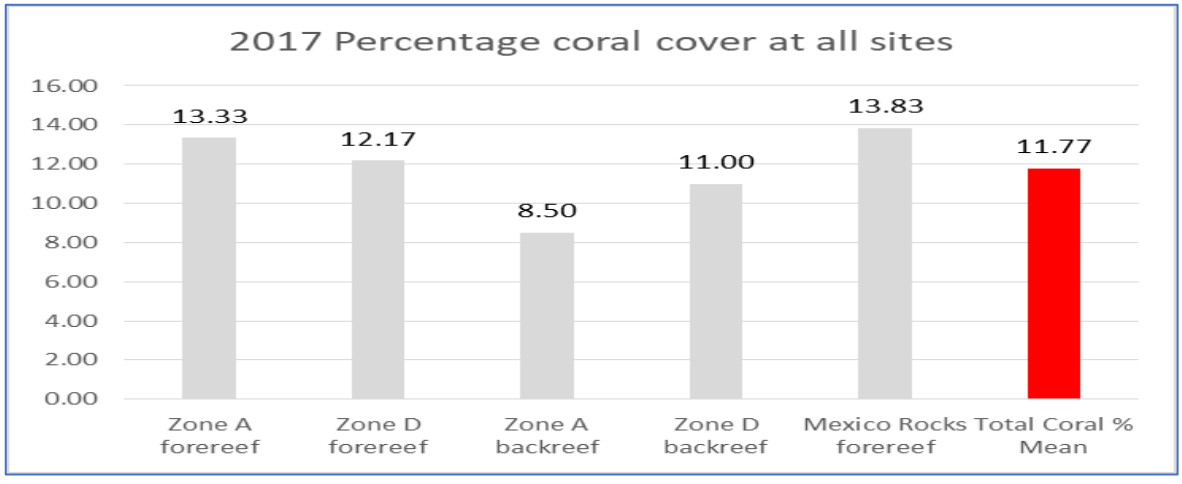

Figure 10. 2017 coral cover by site compared to the percent mean (HCMR, 2019)

Mangroves

Mangrove protection by Hol Chan Marine Reserve stretches across seven mangrove cayes separated by navigable channels, including the "Boca Chica" channel which borders the southern tip of Ambergris Caye (also the southernmost point on the Yucatan Peninsula), Siete Canales and the Cangrejo Islands. The mangroves here are frequently inundated and are predicted to become permanently so with climate change. The vegetation is predominantly inundated dwarf red mangrove (*Rhizophora mangle*) - significantly under-represented within the National Protected Areas System (<10% under protection). Fringing red mangrove lines the channels and islands Fringing red mangrove with arching roots that host a variety of sessile sponges, tunicates and molluscs and provide shelter for large numbers of invertebrates and juvenile fish - including angelfish, grunts, snapper, seahorses, crabs and other, smaller crustaceans.

Several of the islands also include dry land with some **littoral forest** elements, including other mangrove species such as white mangrove (*Laguncularia racemosa*), black mangrove (*Avicennia germinans*), and buttonwood (*Conocarpus erectus*). The more sheltered cayes of Bulkhead Shoals provides ideal conditions for colony nesting birds - for roseate spoonbills, white ibis, reddish egrets, great egrets, boat-billed herons and other species. Littoral forest is one of the most threatened ecosystems in Belize, with only 4.1% of the national extent protected within the National Protected Areas System.

In HCMR, the majority of the littoral forest is located on private cayes such as Blackadore and Cayo Rosario. Here, the littoral forest elements are located on the higher coastal ridges, usually a minimum of 0.3m above sea level, where soil salinity is reduced. Species distribution is based on the varying salt tolerances, with higher less saline areas supporting black poisonwood *(Metopium brownei*), coastal dwarf bullet tree (*Bucida spinosa*), bay cedar (*Suriana maritima*), sea grape (*Coccoloba uvifer*), chit or palmetto palm (*Thrinax radiata*), seaoxeye (*Borrichia frutescens*), romero (*Suriana maritima*), (*Ernodea littoralis*) ink plant (*Erithalis fruticosa*), the introduced coconut (*Cocos nucifera*) and invasive casuarina (*Casuarina equisetifolia*). Some cayes, such as Blackadore, also support grassland composed primarily of two species (*Spartina spartinae*) and (*Eragrostis sp.*), with small patches of sawgrass (*Cladium jamaicense*).

Other Representative Fauna

Mammals

Four species of marine mammals have been recorded in HCMR – the Antillean manatee, bottle-nosed and spotted dolphins. Northern raccoons use the mangroves, coastlines and cayes. Occasional records of whales entering the reef lagoon are generally associated with injured or ill animals or dead strandings. This includes pygmy sperm whale (*Kogia sp.*) and melon-headed whale (*Peponocephala electra*). On 30 July 2014, a juvenile melon-headed whale was observed disoriented and injured in the shallow waters of San Pedro, Ambergris Caye; it died the following day. Clymene Dolphin (*Stenella clymene*) a single animal was reported as a stranding on Ambergris Caye in 1991.

The Corozal Bay / Chetumal estuarine system has consistently been highlighted as a priority area for manatees. The estuary is very shallow with numerous coastal lagoons and inlets, localized areas of seagrass beds, and scattered deeper 'holes' with cold-water upwellings in the seabed. These particular habitats make the area important for feeding and resting of manatees. One of these important manatee resting holes is located on the Bulkhead Shoals, with its extensive seagrass, with aerial surveys consistently demonstrating the presence of groups of manatees using the area. During the 2015 norther season (February) surveys by SACD, a total of 178 manatees were seen over three survey replicates (one covering the entire NBCC, two covering CBWS / HCMR / BCMR, with an average of 59.3 individuals per survey, and a maximum count of 77 (CBWS / HCMR / BCMR), with the majority of the sightings being around three known manatee resting holes in the CBWS, and one in HCMR. Bottlenose dolphins (*Tursiops truncatus*) are often also seen in the Bulkhead Shoals area on the aerial surveys, in groups of up to 7 or 8. Young have also been seen, as have large congregations of 30 or more, travelling through the estuary.

Fish

As reported by HCMR (2019), the 2017 research and monitoring data for the HCMR revealed the four most abundant fish families to be Grunts (Haemulidae); Surgeonfish (Acanthuridae); Parrotfish (Scaridae); and Snappers (Lutjanidae). Grazers such as the Surgeonfish and Parrotfish were more abundant on the forereef (Figure 11).

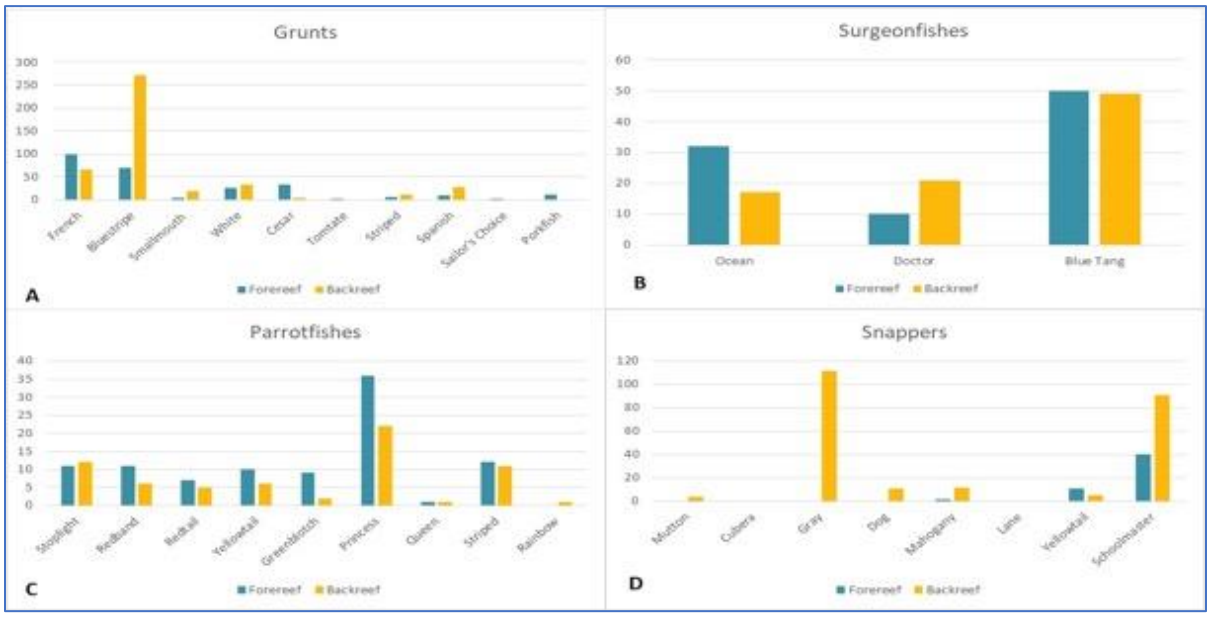

Figure 11. Four most abundant fish families in the HCMR in 2017 (HCMR, 2017)

Fish abundance surveys of 2017 recorded numerous other fish species including Lionfish, Bermuda Chub, Yellowtail Damsel, Jacks, Hogfish, Filefish, Triggerfish, Great Barracuda, multiple species of Grouper, Parrotfish (Princess, Striped, Stoplight and Redband), Snapper, Grunt, Angelfish, Butterfly

Fish and Surgeon Fish. Grunts were the most abundant overall, and particularly abundant in Zone A, while Parrotfish was more abundant at the forereef (Figure 12).

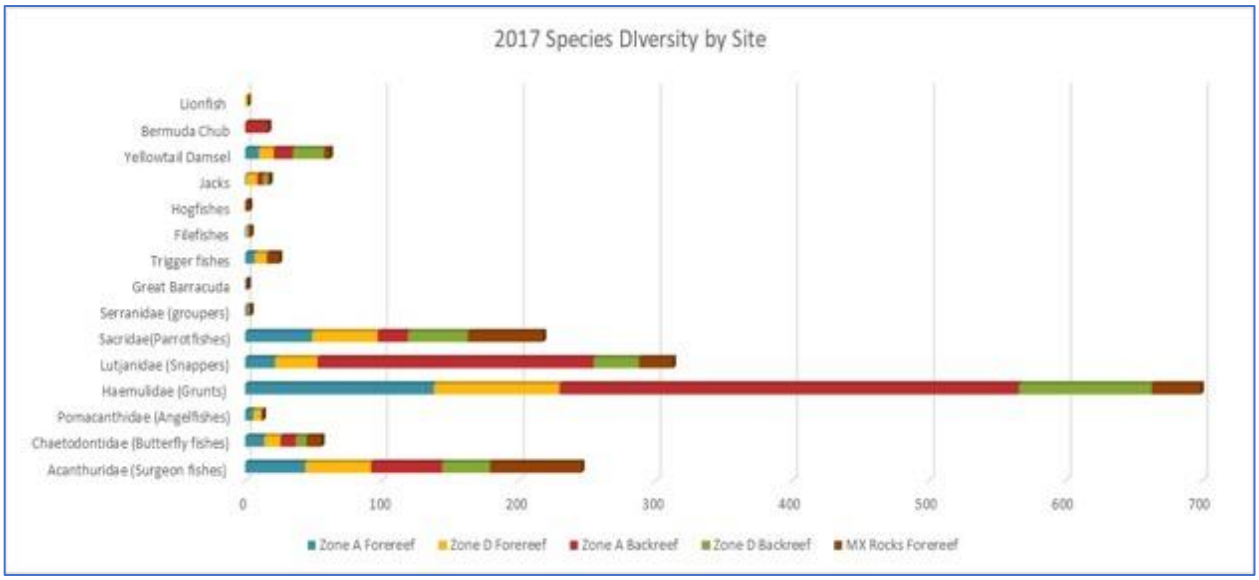

Figure 12. Fish abundance by zone as per the 2017 HCMR Research & Monitoring Report (HCMR, 2017)

Wild Tracks (2019) reported bull, blacktip, nurse and bonnethead sharks (*Carcharhinus leucas*, *C. limbatus*, *Ginglymostoma cirratum* and *Sphyrna tiburon*) from the Bulkhead Shoals area. The channels in this area are thought to be an important nursery area for these Elasmobranchs, and recent surveys have highlighted the presence of the only documented bull shark nursery in Belize.

Monitoring of Commercial Species

Conch

The HCMR Research & Monitoring Survey Report for 2017 (HCMR, 2019), suggests a decline in Conch population since 2014, with an overall decline in the population from 2013. This trend continues into 2017 (Figure 13), with a small increase in the backreef from 2016. Densities in Zone A backreef had small decrease, and there was an increase in density at the backreef outside site (Outside1(BR)) which is adjacent to Zone A (Figure 14). Most backreef areas increased in density from 2016, however, Zone A seagrass has continued to see decline in conch. The highest densities in 2017 was recorded in Zone D backreef with 0.37 conch per m^2 and the Zone D seagrass site with 0.33 conch per m^2. The backreef in general had higher densities of conch. The general population trend however, is downward indicating a decline in abundance. Most of the conch being observed at all sites even after the formation of the flared lip do not reach the legal-size limit. The data suggests that the conch inside Hol Chan are reaching maturity at a much smaller shell size; i.e., at approximately 150 mm.

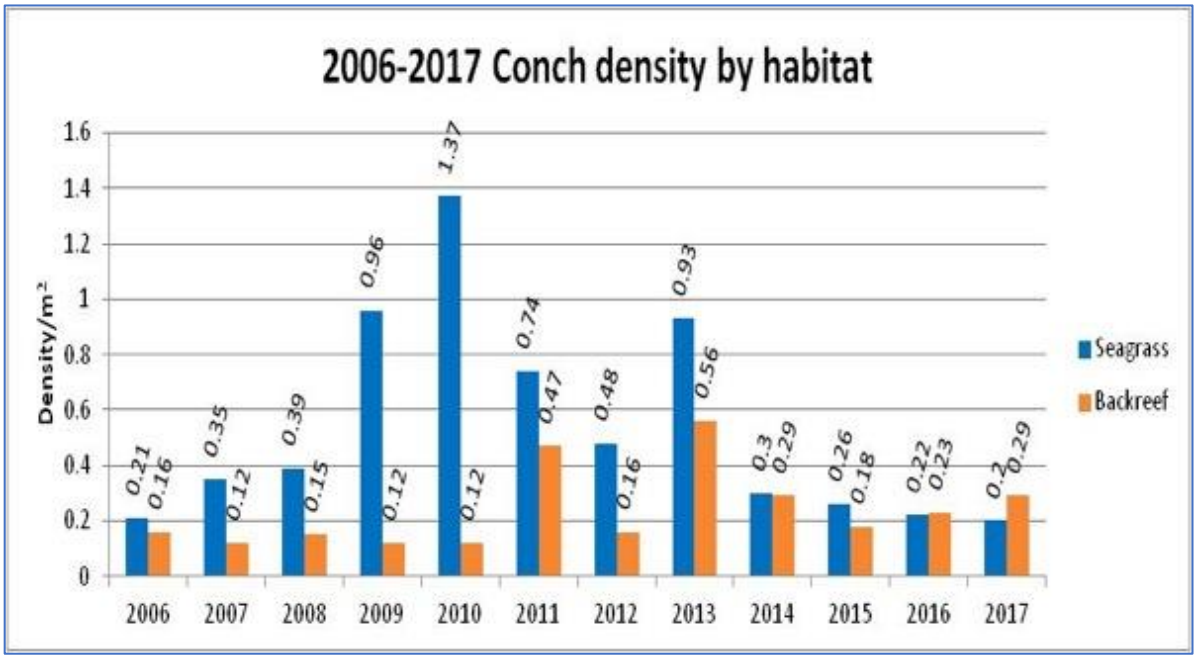

Figure13. Queen conch densities between 2006-2017. 2017 excluding Mexico Rocks (HCMR, 2019)

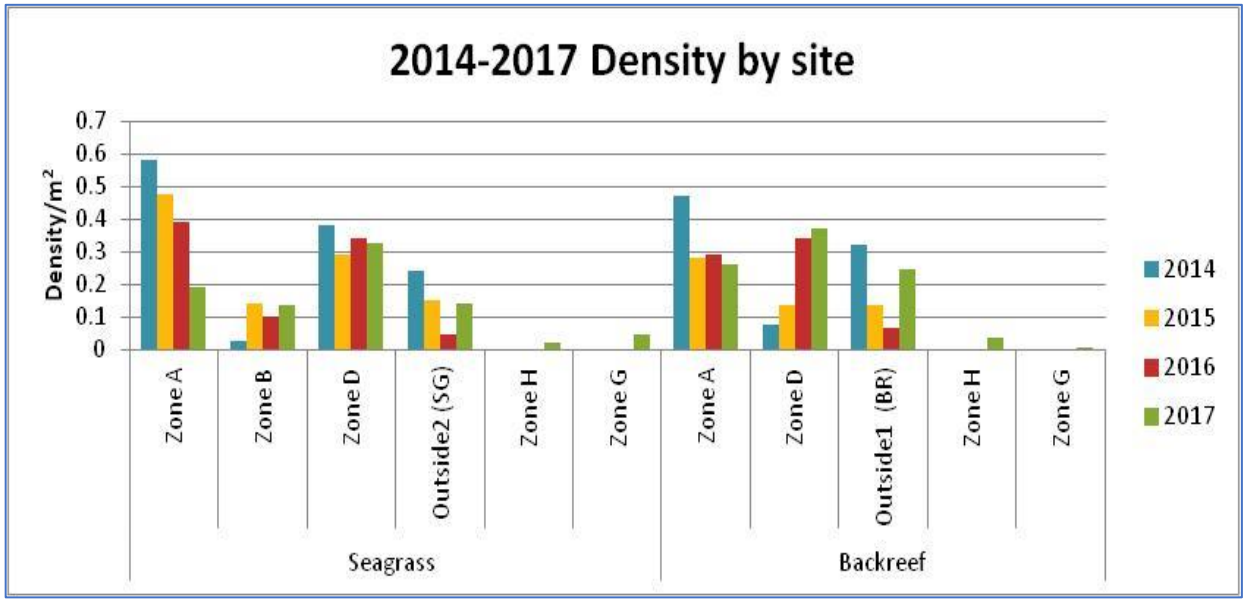

Figure14. Conch density by site (HCMR, 2019)

Figure 15. Conch Monitoring in the HCMR

Lobster

The HCMR conducted Lobster surveys during the months of February, March and June 2017, using 50m x 50m quadrats (Q). Q1, Q2, and Q3 are inside Zone A no-take area, which has been closed to fishing since the establishment of the reserve in 1987. Q4 is inside the exclusive recreational zone (ERZ) inside Zone D (closed to fishing in 2008). Q5 and Q6 are in the no-take areas of the Mexico Rocks area of the Reserve. Q1 and Q2 had the most lobsters counted during surveys (Figure 15), with a survey population size of N=46 for 2017, a 44.6% decrease from 2016. However, Lobster were observed in all quadrates at all sites during 2017.

The density of lobster observed inside Zone A (Q1-Q3) is estimated to be 0.002/m^2; density for Q4 (Zone D) was 0.001/m^2; and Mexico Rocks no-take (Q5 and Q6) was 0.0015/m^2 for both sample periods combined in 2017(Figure 16). Overall, there is a decline in the number of lobsters observed with the quadrats; this however, could have been the result of the fact that the 2017 surveys were conducted immediately after a northerly, and it is commonly believed that Lobsters are sensitive to barometric pressure.

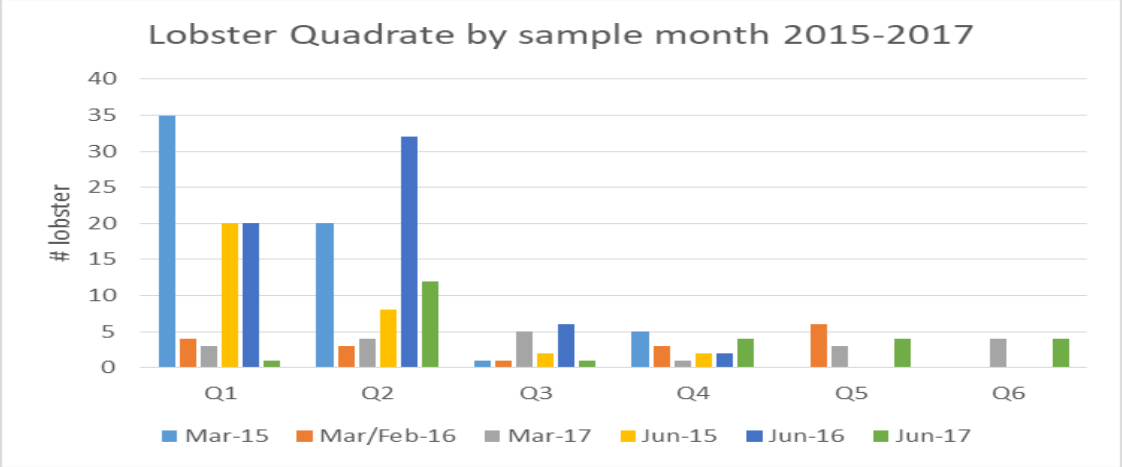

Figure 16. Number of Lobster per quadrate by survey period (HCMR, 2019)

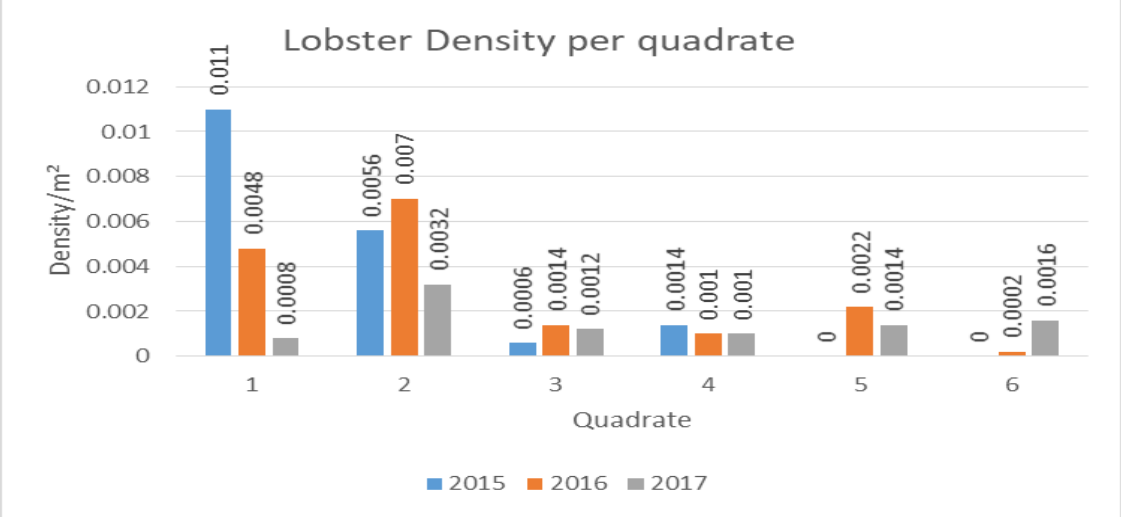

Figure 17. Lobster Density at HCMR for 2015-2017 (HCMR, 2019)

Herpetofauna

The conservation priorities for the herpetofauna of the Hol Chan Marine Reserve relate to the three species of sea turtle known to use the area: the critically endangered hawksbill (*Eretmochelys imbricata*), the endangered green (*Chelonia mydas)* turtles, and the vulnerable loggerhead (*Caretta caretta)*. 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 (Wildtracks, 2019).

The HCMR has been engaged in systematic monitoring of turtle nests since 2009. There was a total of 115 nests observed in 2017, a 29% increase from 2016. Robles beach had 81nest, Rocky point 22, Punta Azul 8, and Basil Jones 4. Emergent and hatching success was higher at Rocky Point and Robles, being 76% and 70%, respectively. In the 2017 surveys there were 49 *C. caretta* (Loggerhead turtle) nests, 58 *C. mydas* (Green turtle), 5 *E. imbricata* (Hawksbill turtle) nests, and 3 unknown nests. Survey data for 2017 revealed that 11,708 eggs incubated, of which 74% hatched successfully, and most of those 70% (8,216 eggs) emerged from the nest unaided. The overall average clutch size was 107 eggs per clutch; and 20% of the eggs (2,346 eggs) were undeveloped.

Figure 18. Monitoring of Turtle Nests by HCMR Staff

A small percentage (1%) of eggs were found dead in the nest after hatching; 346 (3%) were found alive in the nests and were taken to the drop off for release, Between 2010-2017 there has been a

fluctuating trend in the observation of turtle nests from year to year (Figure 20); however, 2017 has recorded the highest number of nests since 2010 with Robles Point clearly a major contributor to that statistic. Figure 20 illustrates the turtle species distribution at the HCMR between 2010-2017, and Figure 21 illustrates the total count of all turtle species for period 2010-2017.

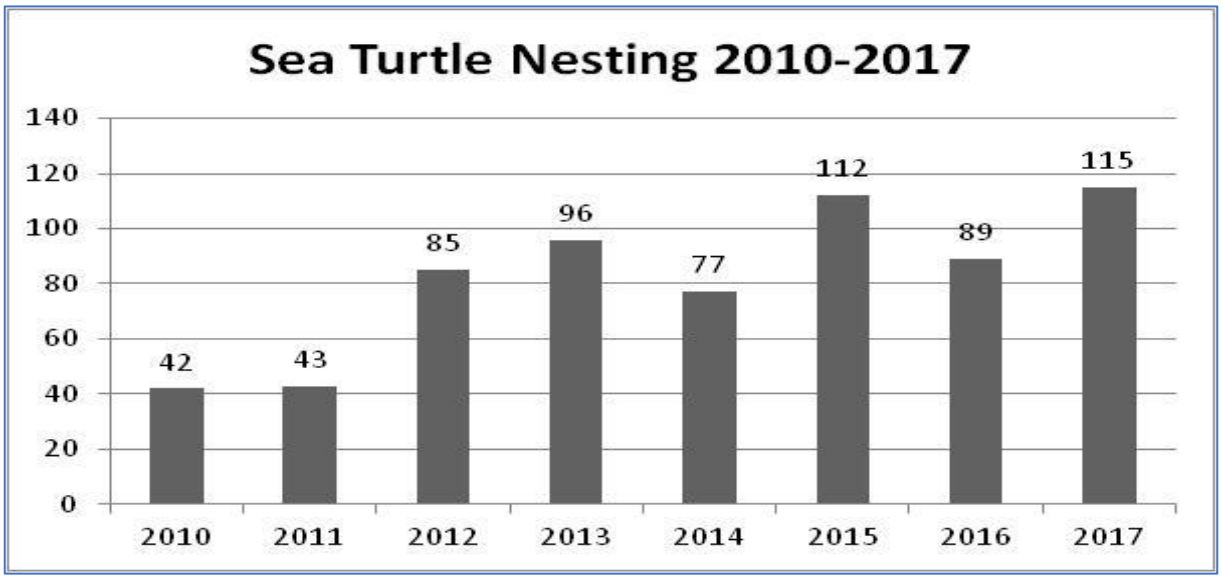

Figure 19. Bar graph showing number of sea turtle nest between 2010 and 2017 (HCMR, 2019)

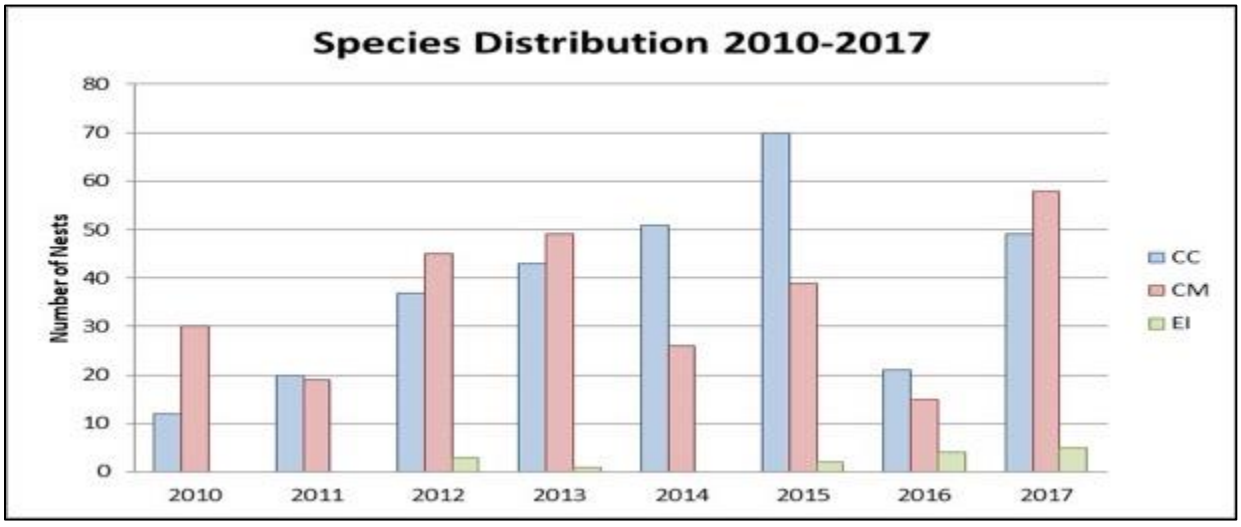

Figure 20. Species Distribution of Turtles at HCMR for 2010-2017 (HCMR, 2019)

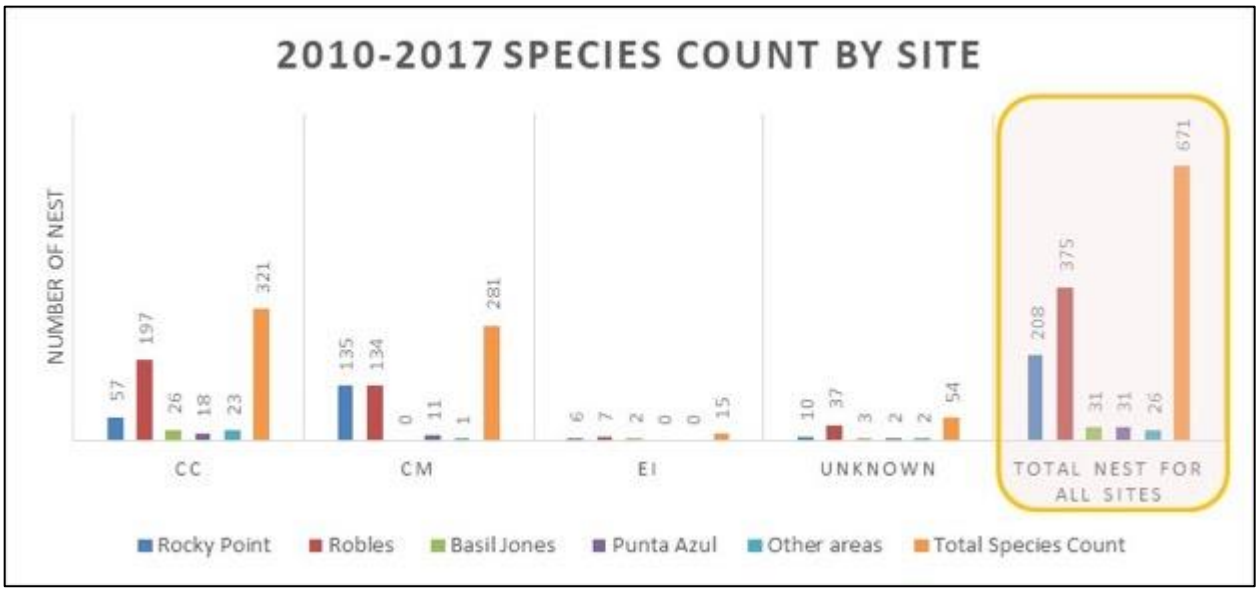

Figure 21. Total Count for all Turtle Species at the HCMR for 2010-2017 (HCMR, 2019)

Avifauna

While data bird data specific to the HCMR is not readily available, Wildtracks (2019) described the situation of birds for the HCMR as appears below, leveraging data available for the adjacent BCNPMR. It is estimated that 194 species of birds have been observed at the Bacalar Chico Marine Reserve and National Park, and can be expected to occur in Hol Chan Marine Reserve. Representative species include the Yucatan endemics, such as the black catbird (*Melanoptila glabrirostris*), Yucatan Woodpecker (*Centurus pygmaeus*), Yucatan Jay (*Cyanocorax yucatanicus*) and Yucatan Vireo (*Vireosylva magister*). The area's wetlands and lagoons are also very important to both resident and migrant wetland birds, including the reddish egret (*Egretta rufescens*), boat-billed heron (*Cochlearius cochlearius*), roseate spoonbill (*Platalea ajaja*), and wood stork (*Mycteria americana*).

The cayes of Bulkhead Shoals provides ideal conditions for colony nesting birds – such as roseate spoonbills, white ibis, reddish egrets, great egrets, boat-billed herons and other species.

The Cayo Franco wetlands area of the HCMR is known to be an important resting location or even overwintering ground for several species of Neotropical migratory species. Sixty-three species of migratory land birds were recorded at Wildtracks, near Rocky Point, including a number of species of concern in the United States - the prothonotary warbler (*Protonotaria citrea*), willow warbler (*Empidonax traillii*), and small numbers of wood thrush (*Hylocichla mustelina*), bay-breasted warbler (*Dendroica castanea*), Kentucky warbler (*Oporornis formosus*) and Canada warbler (*Wilsonia canadensis*).

Socio-economic and Cultural Importance of the HCMR

Hol Chan Marine Reserve provides recreational and ecosystem services which have consolidated its importance at the local, national and international levels. It is the most visited tourism destination in Belize. The reserve is easily accessible by air and by sea from the Philip Goldson Inteernational Airport, the Municipal Airports in Belize City and the rest of the country, and the Water Taxi Terminals in Belize City, Caye Caulker, and Chetumal, Mexico. The HCMR is the most visited snorkelling and dive site in Belize, due primarily to abundance, size and diversity of fish, turtles, and the spectacular overhangs and coral formation.

Figure 22. Catamarans, Dive Boats and Snorkelers at the HCMR Channel – 15th April 2019

Visitation to the HCMR has ranged from 40,000 in 1994 to over 85,000 in 2017, with peaks in 2004 and 2005, but with a steady increase between 2015 and 2018. Like all tourist attractions in Belize, visitation to the HCMR is seasonal, with one peak in February and March and another in July and August, corresponding to peak arrivals of tourists from North America and Europe, respectively. This steady increase in visitation has resulted in 'crowding' at the two primary sites visited in the reserve, and is a current management challenge to be addressed.

Figure 23. Beach Relaxation and Paddle Boarding at Secret Beach/HCMR – 15th April 2019

Most people living on Ambergris Caye are either directly or indirectly dependent on the tourism industry, and many resorts, dive shops and tour operating companies rely heavily on the HCMR to provide the products and services they offer to tourists. The shallow 'flats' in the lagoon side of the reserve supports a lucrative world-class sport fishing industry with substantial input to the local and national economy. Mangrove cayes serve as critical nursery and feeding areas for a variety of species of both national and international importance, including commercially important Caribbean spiny lobster and queen conch, and globally threatened charismatic species such as the Goliath grouper, hawksbill turtle and Antillean Manatee. Fishing outside the no-take zones and buffer areas is an important and constant source of protein and revenue stream for local and traditional fishers, and a reliable fish supply to resturants on Ambergris Caye.

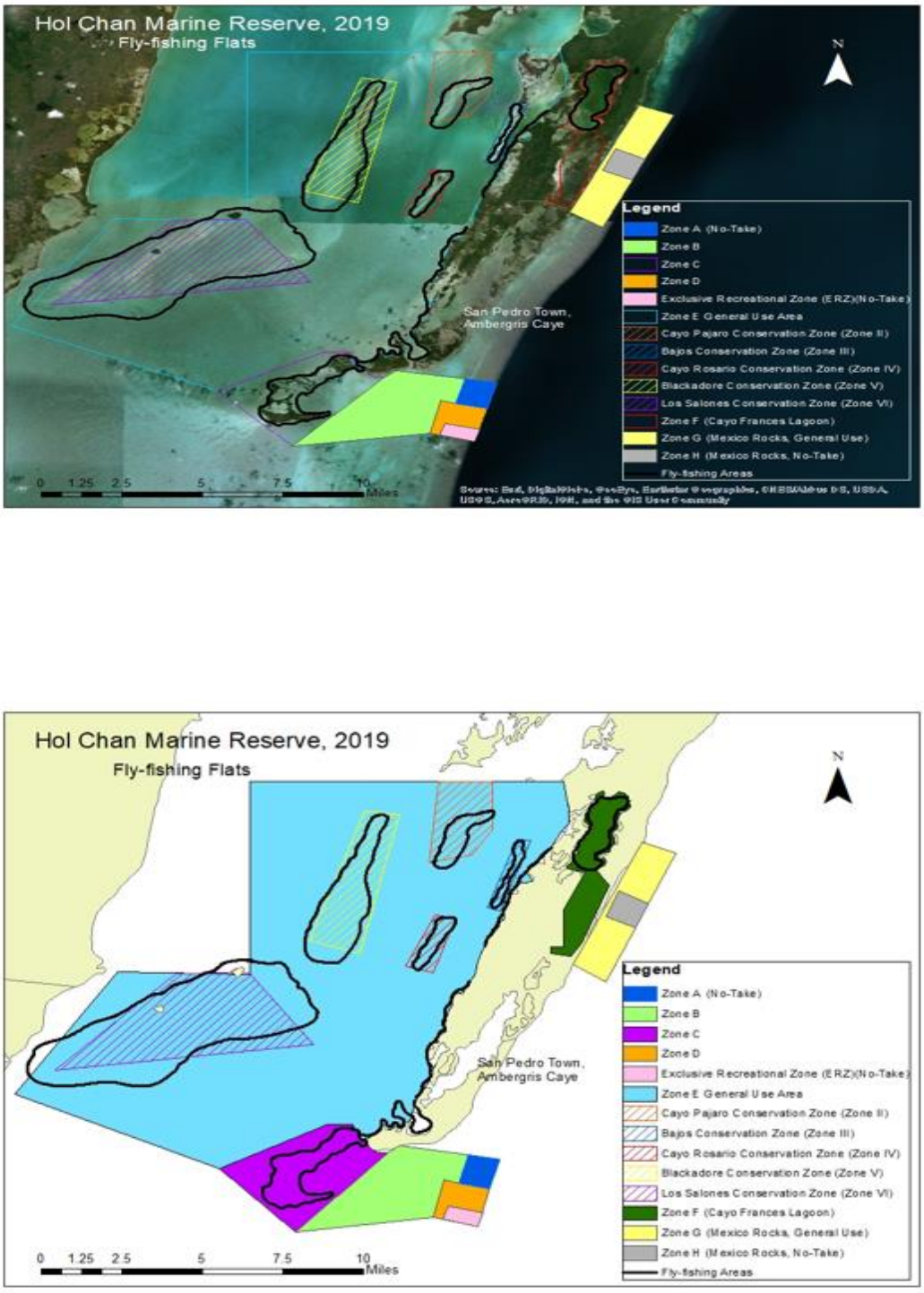

Figure 24. Maps of Fly Fishing Areas of the HCMR

Figure 25. Fly Fishing and Fish Traps on Flats at the HCMR – 15th April 2019.

As suggested by McField (2017), coral reefs and mangrove ecosystems provide vitally important goods and services (such as those provided by the HCMR), including critical protection against erosion and wave- induced damages from tropical storms and hurricanes, and the protection of property and lives. It was estimated in 2007 that the value of reef- and mangrove-related fisheries, tourism, and shoreline protection services in Belize was US$395-559 million per year, being approximately one third of the country's GED of US$1.3 billion. The HCMR is a major contributor to these numbers.

Threats to the HCMR and Overall Health

The marine ecosystems of Ambergris Caye and the HCMR over the years have been exposed to threats such as coral bleaching, hurricanes, and anthropogenic threats from heavy use through over exploitation of fishing resources, mangrove destruction, tourism development, recreational uses (snorkel, diving, and fishing), dredge and fill operations, and storm and waste water run-off. Coastal development is the main threat to the integrity of the marine ecosystems surrounding Ambergris Caye (HCMR, 2016).

Of major concern and thus the most documented is probably the threat from bleaching caused by climate change and other stressors. Belize has a relatively good amount of reef data available, including a field study describing the first coral bleaching event in 1995 (McField, 1999). The record has shown that there is some level of variability in bleaching events, with the most severe observed in 1998, a decrease in 2005, followed by a relatively constant 'moderate' bleaching since 2008 through to 2016, as illustrated below in Box 1 by McField (2017).

- 1995 – first documented coral bleaching event, caused widespread bleaching (~50% corals bleached), with coral mortality (~10% mortality in Belize)
- 1998 -the most significant known coral bleaching event causing significant coral mortality in the MAR combined with a catastrophic hurricane
- 2005 - low level bleaching with minimal mortality
- 2008 - moderate coral bleaching event with little coral mortality
- 2010 - moderate coral bleaching event with little coral mortality
- 2015 - moderate bleaching with little coral mortality
- 2016 - moderate bleaching with isolated partial mortality

Box 1: National-scale variability of coral bleaching in Belize

In field monitoring conducted in 2017, HCMR (2019) reported on key indicators of coral health within the HCMR. Coral cover decreased slightly from 12.7%, while Algal cover has continued to be significantly higher than coral cover. Coral cover was 11.7% compared to total algal cover of 65.8%. Algal cover included both turf and macro-algae (Figures 26 & 27). However, overall recent mortality was below 1% at all sites. Monitoring of bleaching conducted in the HCMR during the summer of 2017 revealed that 26.7% of the coral on the forereef paled, and 1.5% on the backreef, thus the backreef did not show much sign of paling or bleaching.

Fish data which can also be used to inform on the overall health of the HCMR was also conducted in 2017. Many of the larger species of parrot fish that would contribute most to the reef health in their role as grazers were as in previous years not observed, and if present their numbers were very low and insignificant. Only one rainbow parrotfish was observed on the transects. Rainbow parrotfishes can grow to a maximum of 5ft, they are very important to the health of the system, but have been known to be locally extinct in some areas of Belize. This finding is consistent with data on fish populations comparing 2002 and 2008 observations on the main Belize reef, which

indicated a decline in populations and sizes of larger reef fish such as grouper, snapper, and triggerfish (Mumby, 2009). Surgeonfish are also important grazers and often prey on algae that parrotfish do not eat. Surgeonfish were slightly more abundant than parrotfish. Also, the average size of fish observed along transects have decreased, and the average size of the fish being caught by fishers has also decreased. There was a small decrease in the number of *Diadema* between 2016 and 2017. Of note is the fact that Lionfish were encountered in less than 1% of the observations conducted during the survey.

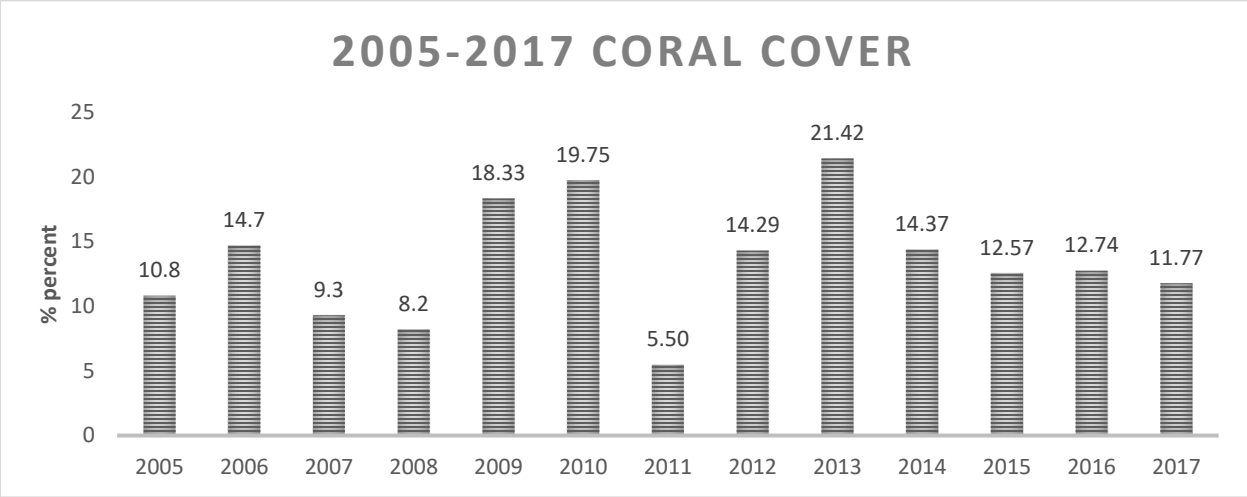

Figure 26. 2005-2017 percent coral cover (HCMR, 2019)

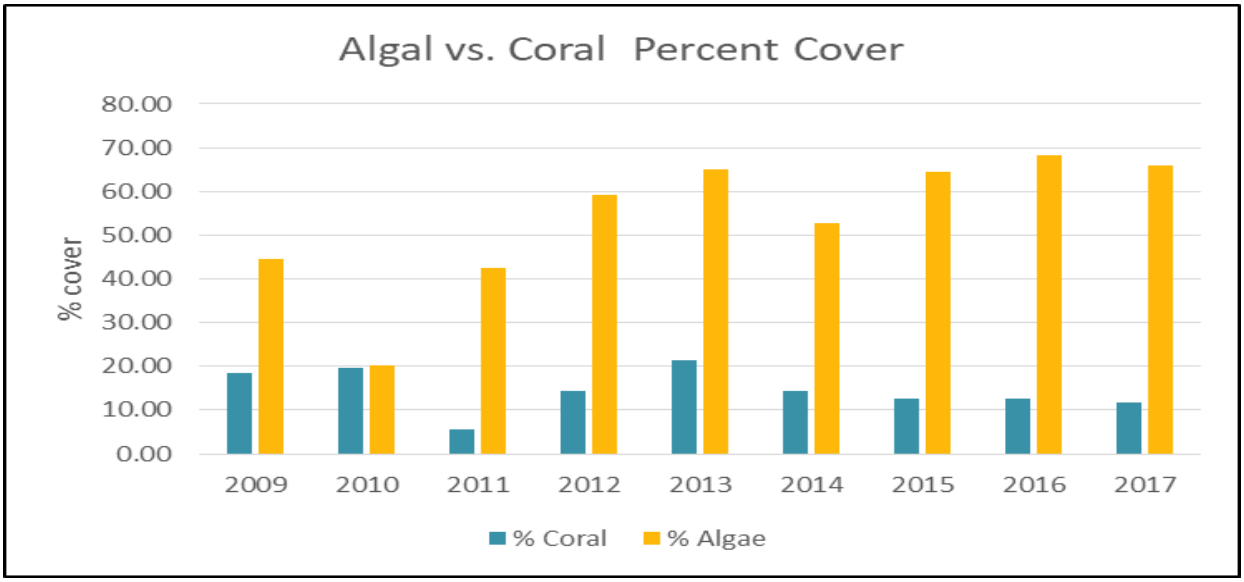

Figure 27. Percent algal vs. coral cover (HCMR, 2019)

The findings described above seem consistent with the findings of HRI (2018) which indicated an overall reef health in Belize to be 2.8, with a 16% live coral cover and a 21% fleshy macroalgae cover, thus ranking reef health nationally as 'Fair'. The 2017 HCMR report and the HRI 2018 report both reflect a minor improvement from the following statement from HRI (2015) "*Overall reef health in Belize remains in 'poor' condition with a Reef Health Index (RHI) score of 2.5. Coral cover in Belize is scored 'fair' (15%) but has declined slightly since the last Report Card (18%) likely related to increases in macroalgal cover and declining water clarity*".

Coastal development linked to tourism is a major threat to the HCMR. This may be due to physical damage to habitats and ecosystems from mangrove clearance, dredging and pollution, or threats directly linked to the tourism activity itself. Turtle nesting sites may be damaged from beach traffic by tourists and locals alike, but may also be from the physical deposit and accumulation of solid waste; i.e., garbage (Figure 28). Three nests were lost at Robles during the 2017 monitoring season due to people and the use of golf carts along the beach, directly threatening the continued use of these beaches as sea turtle nesting areas.

Figure 28. Damage to Turtle Nesting Site by Garbage

Turtle nesting areas and other beach habitat and intertidal habitats such as mangroves and littoral forests are threatened by the constant increase in the construction of permanent concrete and

wooden buildings on the westward side of the reserve. The transport of sand, cements, cinder blocks and other construction materials by boat and barge inevitably causes substantial damage to the shallow flats that are so critical for the sport fishing industry. It is not unusual to see construction material being accumulated along the shore in the reserve, a clear sign that construction of permanent structures is imminent (Figure 29). While the HCMR recognizes access by traditional fishermen, some beach traps in the reserve have been abandoned and left in the water to rust and deteriorate creating not only an *in-situ* source of pollution, but also an eye soar and physical obstruction to fly fishers, who run the risk if expensive fishing gear getting tangled and destroyed in an abandoned beach trap (Figure 30).

Figure 29. Sand and Cinder Blocks for Imminent Construction in the HCMR – April 2019

Figure 30. Abandoned and Deteriorating Beach Trap in the HCMR – April 2019

Over-water structures (Figure 31), both for private and public use, significantly affect the aesthetic appeal of the reserve and create irreversible damage to the benthic ecosystem at the site of installation and nearby, not just during the installation process, but from the human, boat and jet-ski traffic to be generated from the use of these structures. A bad precedence has been set in the Secret Beach area of the HCMR, where in addition to over-water structures, tourism activities have now led to the installation of ‘in-water’ structures such as wooden picnic tables and umbrellas

(Figure 32). These generate the same impacts as over-water structures, but probably worse, since there is constant feet movement by people occupying the said structures, constantly stirring the sediments which remain suspended for extended periods of time and drift to other areas, as well as physically trampling the seagrass bed.

Figure 31. Over-water Structure on Westward Side of the HCMR – April 2019

Figure 32. In-water Structures at Secret Beach, HCMR – April 2019

One last threat to be flagged is the use of jet-skis in the Secret Beach area. There has been widespread concern raised by stakeholders consulted in April 2019, regarding the use of these machines. Observations made at Secret Beach on 15th April 2015 showed jet-ski use in between and among snorkelers, swimmers and paddle boarders, including among children, with what seems to be an imminent accident, and possibly serious bodily harm or death. Such an incident would not only create problems for the business owners and tour operators possibly involved, but also will inevitably include liability issues for the management of HCMR, as the trustees of the reserve.

In addition to the possibility of noise, the smell of fuel and smoke, and the chances of physical injury, jet-skis are a major threat to the integrity and functionality of the flats and seagrass beds

on the westward side of the HCMR. These shallow habitats are the primary fishing grounds for the Bone Fish, Tarpon and Permit used by fly-fishing guides and sport-fishing tourists. The economic importance of the fly-fishing industry which relies heavily on the HCMR to provide these ecosystems services should not be compromised by a recreational activity such as jet-ski use.

Figure 33. Recreational Use of Jet-Ski at Secret Beach, HCMR – April 2019

Of note is the excess transport and deposit of Sargassum within the HCMR, Ambergris Caye and the entire coastline of the country. As reported by www.cep.unep.org, the impacts of excessive landings of Sargassum may be economic (tourism, fishery, nautical activities), environmental (perturbation of marine species, beach erosion) and health aspects (decomposition of algae and release of Hydrogen Sulfide). There is a specific concern about the stagnancy of large amounts of sargassum within the wetlands (mangrove, corals and sea grass) because of the potential anoxia caused to the environment. Also, there have been reports of sea turtles and fish having been found dead in the sargassum landings. Furthermore, the coastal population and beach goers may suffer from the release of Hydrogen Sulfide from sargassum rotting. Cases of nausea, headaches, skin rash and breathing difficulties have been reported. The tourism sector in the Caribbean has experienced cancellations in hotels and desertion of restaurants close to landings areas because of the smell; damages have also been recorded among electronic appliances of coastal hotels (air-conditioning units, TVs, computer) due to the prolonged exposure to high concentrations of hydrogen sulfide. Disturbance for the nautical activities such as diving, kite surfing or even windsurfing have been noted and fishers have expressed difficulties in launching and maneuvering their boats due to sargassum entanglement in the gear.

Section D. Conservation Planning

This section is based on a Management Action Planning (MAP) process conducted for the Northern Belize Coastal Complex (Wild Tracks, 2019), and which includes necessary conservation planning considerations for the HCMR. The original information has been adjusted

where necessary and where available information allows, to reflect additional HCMR-specific considerations and priorities, based on the sections described above, and based on stakeholder contributions received during consultations held in April and May 2019. Where only generic information is available at the level of the NBCC, this has remained as is. Some information deemed not relevant for the HCMR at this time may also have been removed.

Management Targets

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

Identification of Management Targets

Targets were identified at the seascape level, as part of the Northern Belize Coastal Complex Management Action Planning process, and are considered relevant and applicable for the HCMR.

Identification of Management Targets

Seven Management Targets were chosen to represent and encompass the biodiversity values of the Northern Belize Coastal Complex, six of which are relevant for the HCMR, to provide a basis for setting goals, developing strategies and actions, and monitoring success:

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

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

- **Targets should represent the biodiversity of the site.** The focal targets should represent or capture the array of ecological systems, communities, and species of importance at the project area and the multiple spatial scales at which they occur.
- **Targets reflect ecoregion or other existing conservation goals.** Focal targets should reflect conservation efforts at the regional and national level where they exist, such as TNC and CI Ecoregional Assessments, the National Protected Areas System Plan, the NPAPSP Rationalization recommendations, and the National Biodiversity Action Plan.

Focal targets are grounded in the reasons for the project area's current status of protection, and the identification of the Belize Barrier Reef as one of the regions key marine areas of ecological, biological and social importance.

- **Targets are viable or at least feasibly restorable.** Viability (or integrity) indicates the ability of a conservation target to persist for many generations. If a target is on the threshold of collapse, or conserving a proposed target requires extraordinary human intervention, it may not represent the best use of limited conservation resources.
- **Targets are highly threatened.** All else being equal, focusing on highly threatened targets will help ensure that critical threats are identified and addressed through conservation actions.

Assessing Biodiversity Viability

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

- A means for determining changes in the status of each focal target over time, to measure success of conservation strategies, compare the status of a specific conservation target with future conditions, and with other projects in Belize / Central America that focus on that target

- A basis for the identification of current and potential threats to a target and identification of past impacts that require mitigation actions

- A basis for strategy design and the foundation for monitoring

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

Viability Assessment for Management Targets

The overall viability rating for the conservation area is **FAIR**, with six targets rating as **FAIR**, and one target rating as **GOOD**. No target rates as **VERY GOOD** (Box 2)**.**

Coastal Ecosystems: Nested Targets	
Littoral Forest	Migratory bird species
Sandy Beach	Nesting Sea Turtles
	Hawksbill Turtle
	Loggerhead
	Green Turtle
	Nesting Crocodiles
	American Crocodile
Mangrove	Nesting Birds
	Magnificent frigatebird
	Brown pelican
	Roseate spoonbill
	Reddish egret
	White-winged dove
	Black catbird
	Juvenile fish species
	Juvenile lobster
Coastal Lagoons	Snapper, grouper
	Mojarra
	Wood stork (Bulkhead)
	Stingrays
	Southern stingray
	Long-nosed stingray
	Caribbean whiptail
	Blue swimming crab

Conservation Target	Landscape Context	Condition	Size	Viability Rank
Coastal Ecosystems	Good	Good	Fair	**Fair**
Seagrass	Fair	Good	Good	**Good**
Coral Reef	Fair	Poor	Fair	**Fair**
Commercial /Recreational Species	Good	Poor	Poor	**Fair**
Charismatic Marine Megafauna	Poor	Fair	Good	**Fair**
Physio-chemical Environment	Fair	Fair	Good	**Fair**
Project Biodiversity Health Rank				**Fair**

Very Good	Ecologically desirable status. Requires little or no intervention for maintenance
Good	Within acceptable range of variation. Some human intervention required for maintenance
Fair	Outside acceptable range of variation. Requires human intervention
Poor	May result in local extinction. Restoration difficult / impossible

Box 2. Viability Assessment of HCMR Management Targets

TARGET 1: COASTAL ECOSYSTEMS

This target, ***Coastal Ecosystems,*** encompasses four ecosystems ***– Littoral Forest, Sandy Beach, Mangrove*** and ***Coastal Lagoon*** (Box 3*)*.

Littoral forests and the herbaceous beach communities of ***Sandy Beaches*** are classified under the Belize Ecosystem Mapping report as ***Tropical coastal vegetation on recent sediments*** (Meerman and Sabido, 2001). This vegetation type, found on the coastline, and on the cayes, is very resilient to hurricane damage, and can become established on small, isolated cayes, with long distances between patches. In HCMR, littoral forest and other coastal ecosystem elements are located on cayes. Many of these, however, are under private ownership and under threat of removal for development.

Coastal Ecosystems: Nested Targets	
Littoral Forest	Migratory bird species
Sandy Beach	Nesting Sea Turtles
	Hawksbill Turtle
	Loggerhead
	Green Turtle
	Nesting Crocodiles
	American Crocodile
Mangrove	Nesting Birds
	Magnificent frigatebird
	Brown pelican
	Roseate spoonbill
	Reddish egret
	White-winged dove
	Black catbird
	Juvenile fish species
	Juvenile lobster
Coastal Lagoons	Snapper, grouper
	Mojarra
	Wood stork (Bulkhead)
	Stingrays
	Southern stingray
	Long-nosed stingray
	Caribbean whiptail
	Blue swimming crab

Potential Indicators

- **Extent of littoral forest system**
- **% of area in natural condition**
- **Number of turtle nests per species**
- **Abundance of crocodile nests per species**
- **% of Total area of 2004 littoral forest / sandy beaches that is now developed**
- **Number of bird colony nesting cayes within the NBCC**

Box 3. Ecosystems of Target 1 and Potential Indicators

This ecosystem is highlighted under Belize's National Protected Areas System Plan as being significantly under-represented within the current protected area system, with only 8.6% of the national coverage for this ecosystem being under protection, as compared with the national target of 60% (Walker et al., 2012; NPAPSP, 2005). Only 4.1% of the littoral forest on Belize's cayes

lies within protected areas. Protection of littoral forest is an important contribution to Belize's commitments of ecosystem representation under the Convention on Biological Diversity, but still a significant shortfall considering the importance of this ecosystem for migratory birds. The herbaceous beach community is also included within this target, and is considered very important for the stabilization of the turtle and crocodile nesting beaches. As with the littoral forest, this ecosystem is found in areas targeted for residential and tourism development, and is therefore at risk of extensive clearance to expose the sandy beaches.

Coastal lagoons and ***mangroves*** are important in their role as fish nursery areas. Extensive lagoon systems lie in the Cayo Franco wetland area. These are highly vulnerable ecosystems, frequently inundated and are predicted to become permanently so with climate change. Much of the mangrove within the MAP scope is dwarf mangrove - significantly under-represented (<10% under protection), within the National Protected Areas System. Fringing mangrove, which lines many of the cayes within the Marine Reserve, is also significantly under-represented (12.5%) within the NPAS. Despite these low coastal areas having low development potential, they are, never-the-less, at high risk, with the significant global interest in coastal development for both residential and tourism purposes. The current rating for Conservation Target 1 is presented below in Box 4.

Conservation Target	Category	Key Attribute	Indicator	Current Rating
Coastal Ecosystem	Landscape Context	Connectivity among communities and ecosystems	Regional extent of littoral forest	FAIR
		Connectivity among communities and ecosystems	Regional extent of mangrove	GOOD
	Condition	Population structure & recruitment	Availability of crocodile nesting beaches	POOR
		Population structure & recruitment	Availability of sea turtle nesting beaches	FAIR
		Population structure & recruitment	Condition of littoral forest	FAIR
		Primary productivity	Primary productivity of mangrove	GOOD
	Size	Size / Extent of characteristic communities / ecosystems	Extent of littoral forest in NBCC	POOR
		Size / Extent of characteristic communities / ecosystems	Extent of mangrove in NBCC	GOOD

Box 4. The current rating for Conservation Target 1

TARGET 2. SEAGRASS

Seagrass meadows form an important, highly productive ecosystem essential for maintaining the ecological health of the shallow marine ecosystems, with an important role in nutrient cycling and sediment stabilization. They support the traditional fishing industry, providing nurseries, shelter, and food for a variety of commercially, recreationally, and ecologically important species, including manatee, fish, sea turtles, and invertebrate species (including conch and crustaceans). Seagrass types and nested targets are presented in Box 5 and the current rating for Conservation Target 2 is presented in Box 6.

Seagrass: Nested Targets	
Seagrass species	Turtle Grass
	Manatee Grass
	Shoal Grass
	Widgeongrass
Juvenile fish	
Crustaceans	
Algae	
Represented under other targets	*West Indian manatee*
	Queen conch

Box 5. Seagrass Types and Nested Targets

Conservation Target	Category	Key Attribute	Indicator	Current Rating
Seagrass	Landscape Context	Connectivity among communities and ecosystems	Regional extent of seagrass	**VERY GOOD**
		Water quality	Water quality	**FAIR**
	Condition	Species composition / dominance	% cover of seagrass	**GOOD**
	Size	Size / Extent of characteristic communities / ecosystems	Extent of seagrass in NBCC	**GOOD**

Box 6. Current Rating for Conservation Target 2

TARGET 3: CORAL REEFS

Reef building corals of the HCMR are critical to the maintenance of marine biodiversity in the reef lagoon and on the barrier reef, and are considered a conservation priority. Coral reefs are one of the most diverse ecosystems on Earth, essential to the viability of the majority of fish and marine invertebrates living on the reef, and providing basic structure for shelter, foraging, and reproduction. Coral reefs are essential to the maintenance of the artisanal and commercial fishing industries, particularly for spiny lobster and finfish populations. It is one of the most important tourism resources Belize has to offer, and supports a significant percentage of employment in San Pedro and Caye Caulker, as well as contributing to incomes in Belize City, Sarteneja, and Corozal. The diversity and health status of HCMR reefs are described above under the section 'Current Status'. Nested targets for coral reefs are presented in Box 7 and the Current rating for Conservation Target 3 is presented in Box 8.

Coral Reef: Nested Targets	
Corals	
Reef fish	Fish with touristic appeal
	Snapper
	Grouper
	Spawning aggregation Species
Reef invertebrates	
Herbivores	*Diadema*
	Parrotfish
	Rainbow parrotfish
	Midnight parrotfish
	Redtail Parrotfish
	Spotlight parrotfish
Represented under other targets	*Commercial fish species*
	Spiny lobster

Box 7. Nester Targets for Coral Reefs

Conservation Target	Category	Key Attribute	Indicator	Current Rating
Coral Reefs	Landscape Context	Connectivity among communities and ecosystems	Area of coral reef with critical connectivity	**FAIR**
	Condition	Community architecture	Rugosity	**GOOD**
		Population structure & recruitment	Number of SPAGs (relative to baseline)	**FAIR**
		Presence / abundance of key functional guilds	Parrotfish Species Richness	**FAIR**
		Presence / abundance of keystone species	Diadema abundance	**POOR**

		Reef Health	Coral Bleaching (Frequency and Extent)	**FAIR**
		Reef Health	SIRHI Score	**FAIR**
		Species composition / dominance	Coral diversity	**FAIR**
	Size	Size / Extent of characteristic communities / ecosystems	Extent of coral cover in NBCC	**FAIR**

Box 8. Current Rating for Conservation Target 3

TARGET 4: COMMERCIAL MARINE SPECIES

This target includes both the species caught for the local and export markets, and the sport fishing species. The HCMR commercial fishery is focused primarily on conch and lobster, with some finfish. The abundance and diversity of Lobster, Conch and fish in the HCMR were described above under the section 'Current Status'. The estuarine system is reported to have at least four shark species within the general area, with bull, blacktip, nurse and bonnethead sharks (*Carcharhinus leucas, C. limbatus, Ginglymostoma cirratum* and *Sphyrna tiburo*) reported from the Bulkhead Shoals area to the southern end of the Wildlife Sanctuary, southeast of Deer Caye. Shark and ray species diversity increases to the east in the reef lagoon and along the reef drop off, with the number of species increasing to 9 species of shark and 5 species of stingray (Graham, pers. com.). As described above, sport fishing is an important industry for HCMR, with the key targeted species being bonefish (*Albula vulpes*), tarpon (*Megalops atlanticus*) and permit (*Trachinotus falcatus*). Common snook (*Centropomus undecimalis*) and great barracuda (*Sphyraena barracuda*) are also considered important. Sea Cucumber (*Holothuria mexicana* and *Isostichopus badionotus)* are also targeted commercial species. The current rating for Conservation Target 4 is listed in Box 9.

Conservation Target	Category	Key Attribute	Indicator	Current Rating
Commercial Marine Species	Landscape Context	Connectivity among communities and ecosystems	Presence of juveniles of commercial species	GOOD
	Condition	Population structure & recruitment	Commercial species juvenile population size	FAIR
		Species composition / dominance	Elasmobranch species diversity	POOR
	Size	Population size and dynamics	Catch per unit effort	GOOD
		Population size and dynamics	Commercial species population size	POOR
		Population size and dynamics	Shark population size per species	POOR

Box 9. Current Rating for Conservation Target 4

TARGET 5: CHARISMATIC MARINE MEGAFAUNA

The target "Charismatic Marine Megafauna" covers the larger vertebrates that use the NBCC – primarily Antillean manatee and dolphins (crocodiles are covered under Coastal Ecosystems, as the primary threat is considered to be to their nesting habitat; sharks are covered under Commercial Marine Species, as their primary threat is fishing).

Belize's Antillean manatee (*Trichechus manatus manatus*), a subspecies of the West Indian manatee, is listed as globally 'Endangered' with approximately 2,500 mature individuals in the wild, and a predicted 20% decline in population size over the next ~40 years unless effective conservation plans are implemented. The Belize population is estimated at between 700 and 1,000, with a maximum count of 507 in the 2012 national survey. There has been an increase in the number of strandings over the years, with watercraft collision as the primary cause of identified death, primarily in the Belize City / Belize River area. The current rating for Conservation Target 5 is presented in Box 10.

Conservation Target	Category	Key Attribute	Indicator	Current Rating
Charismatic Marine Megafauna	Landscape Context	Connectivity among communities and ecosystems	Barriers to connectivity	**VERY GOOD**
		Water quality	Water quality	**FAIR**
	Condition	Species composition / dominance	% manatee calves	**GOOD**
		Species composition / dominance	Manatee population structure	**GOOD**
	Size	Population size and dynamics	Population size of manatees	**GOOD**
		Population size and dynamics	Population size of sea turtles	**GOOD**

Box 10. Current Rating for Conservation Target 4

TAREGET 6: PHYSIO-CHEMICAL ENVIRONMENT

The target **"Physio-chemical environment"** covers the waters of the reserve and includes the primary lagoon, seagrass and reef habitats. The primary parameters targeted are water temperature, salinity and dissolved oxygen. These water parameters drive the temporal and spatial distribution and movements of species through the reserve. The basic water parameters are assessed as within the normal range; however, better temperature, salinity, and dissolved oxygen data are needed for the HCMR. There are concerns that water temperatures are increasing in the shallow estuary, with the potential for increasing fish kills as available dissolved oxygen is reduced. In HCMR, this increasing water temperature is also of concern for the health of the coral reef, with an increase in consecutive hot water days above 33°C.

Decreasing pH is also a cause for concern, with the predicted impacts of ocean acidification identified as one of the key changes being seen in the oceans, and a key impact on calcium dependent species such as corals. Less information is available, however, on contaminants – particularly agrochemical pollution, including sewage. Faecal contamination studies have also been conducted on Ambergris Caye. *Enterococci* levels for a series of sampling points on the east coast of Ambergris Caye were indicative of faecal contamination, with concerns for water quality in the reef lagoon in front of San Pedro and some of the larger resorts, particular approaching Rocky Point and beyond, where the reef is close to the land. Heavy metal and pesticide residue contamination should also be given due consideration, and the bio-accumulation of heavy metals in conch, sea cucumber, and lobster should be targeted. The current rating for Conservation Target 6 is presented in Box 11.

Conservation Target	Category	Key Attribute	Indicator	Current Rating
Physio-chemical Environment	Landscape Context	Landscape pattern (mosaic) & structure	Coastline erosion - accretion	**FAIR**
		Landscape pattern (mosaic) & structure	Sea level	**GOOD**
		Water quality	Nutrients	**FAIR**
		Water quality	Pollutants	**FAIR**
	Condition	Water quality	Water quality	**FAIR**

Box 11. Current Rating for Conservation Target 6

Threat Assessment of Conservation Targets

The MAP process also included a baseline threat assessment, which focused on the assessment of stresses and threats affecting the key ecological attributes and the targets, and providing each focal target with a threat status rating. Outputs prioritized the most critical threats and targets with the highest level of impacts. Threat ratings are presented in Table 1.

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

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

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

- **Seagrass**

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

- **Charismatic Marine Megafauna**

Table 1. Threat Ratings of the HCMR, based on NBCC Assessment

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

Rating of Threats

The critical threats to the HCMR are assessed by Area, Severity and Urgency, using the following criteria developed by WCS, and are presented below:

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

Proportion of Area Affected		
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		
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		
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	Won't happen in > 10 years

Threats to Hol Chan Marine Reserve (Wildtracks, 2019)			
Threat: Climate Change			***Overall Threat Rank: Very High***
Status:	***Historical***	***Active***	***Potential***
Conservation Target(s): All			
Threats (*Direct*)*:* ▪ Reduced live coral cover ▪ Erosion of beach ▪ Reduction in extent of littoral forest, beach vegetation and mangrove ▪ Ecological shifts in benthic communities ▪ Reduced biodiversity ▪ Reduced coral growth rates and live coral cover			
Source (Indirect Threat)***:*** ▪ Increased water temperatures ▪ Increased storm events / hurricanes ▪ Sea level rise ▪ Increased wave action – potentially as outer barrier reef loses some of its functionality – and changes in currents ▪ Ocean acidification			
Area	***4***	Climate change is a global phenomenon, and is affecting biodiversity throughout HCMR	
Severity	***3***	The impacts of climate change are currently being felt at HCMR through increased bleaching and storm events, and increased drought conditions. It is predicted that the severity and frequency of these events will increase over the coming years, with significant impact on live coral cover and reef health.	
Urgency	***3***	Although the impacts of climate change are occurring over an extended time period, the cumulative effects of this stressor pose significant risk to a wide range of species and ecosystems	

Threats to Hol Chan Marine Reserve (Wildtracks, 2019)			
Threat: Unsustainable coastal development			***Overall Threat Rank: Very High***
Status:	***Historical***	***Active***	***Potential***
Conservation Target(s): All			
Threats (*Direct*)*:* ▪ Reduced extent of littoral forest, mangroves and herbaceous beach vegetation ▪ Erosion of sandy beaches ▪ Reduced viability of nesting turtles populations ▪ Reduced viability of nesting bird populations ▪ Reduced viability of coral reef ▪ Reduced populations of commercial and non-commercial marine species ▪ Increased nutrients, sediment and pollutants in marine environment ▪ Potential destruction of seagrass beds			
Source (Indirect Threat)***:*** ▪ Clearance of littoral vegetation ▪ Infrastructure development (residential tourism, research, etc.) ▪ Inadequate / unplanned water management practices ▪ Increased pollutants (fertilizer, herbicide, insecticides, sewage etc.) ▪ Dredging			

- Sedimentation
- Financial and political incentives

Area	***3***	Much of the coastline is private property, with the projections for increased development during the five years of the management plan.
Severity	***3***	Increased development will result in removal of coastal vegetation, remove littoral forest and mangrove, and have the potential to significantly contaminate the reef, estuarine and lagoon environments if best practices aren't followed.
Urgency	***2***	Poor access has prevented extensive development of the coastline to date.

Threats to Hol Chan Marine Reserve (Wildtracks, 2019)

Threat: Land-based pollution			***Overall Threat Rank: High***
Status:	***Historical***	***Active***	***Potential***

Conservation Target(s): Coral Reefs, Physio-chemical environment, Ancient formations, Seagrass, Marine Mammals

Threats (*Direct*)*:*

- Reduced water quality – oxygen availability
- Water contamination

Source (Indirect Threat)***:***

- Increased pollutants (fertilizer, herbicide, insecticides, sewage etc.)
- Inadequate / unplanned water management practices
- Clearance of riparian vegetation and associated erosion
- Financial and political incentives

Area	***4***	Water quality is of concern throughout the NBCC, originating from mainland Belize watersheds, San Pedro and Mexico
Severity	***2***	Declining water quality from land-based pollution is identified as one of the factors in reduced resilience of reefs to climate change
Urgency	***3***	This threat is ongoing and will only increase in the future

Threats to Hol Chan Marine Reserve (Wildtracks, 2019)

Threat: Unsustainable / Illegal Fishing			***Overall Threat Rank: High***
Status:	***Historical***	***Active***	***Potential***

Conservation Target(s): Commercial Marine Species, Coral Reefs, Seagrass, Marine Mammals

Stresses (*Direct*)*:*

- Reduced commercial species populations
- Trophic shifts in marine ecological communities

Sources of Stress (Indirect)***:***

- Limited management presence for size of area
- Low income in fishing communities
- Traditional occupation
- Market demand from fishing coops and export market

▪ Increased local and tourism demand for local fresh marine product ▪ Demand for marine products from Mexico		
Area	***4***	Unsustainable and illegal fishing occur throughout the Marine Reserve
Severity	***2***	Unsustainable and illegal fishing is having a measurable impact on marine species, though will not result in local eradication
Urgency	***3***	Illegal fishing (transboundary, within zones, undersized / out of season product) is ongoing

Managing for Climate Change

Belize faces hurricanes, flooding, sea level rise, coastal erosion, coral bleaching, and droughts, with impacts likely to intensify given expected increases in weather volatility and sea temperature. With the tourism sector estimated to employ around 28% of Belize's workforce, and responsible for 21% of its GDP in 2014; and fisheries employ around 15% of the population, the economic impacts of climate change could be significant (IMF, 2018). Consistent with this recognized level of importance, fisheries and coastal management have been identified as priority sectors under the National Climate Change Policy, Strategy and Action Plan (NCCPSAP), with defined objectives geared towards enhancing the resilience of Belize's coral reef to climate change by reducing pollution and overfishing and implement maximum carrying capacity limits for areas impacted negatively by excessive human activity (IMF, 2018).

Site Resilience Assessment

Obura and Grimsdith (2009) define and differentiate between resistance and resilience in coral reefs as follows:

> *Resistance* – when exposed to high temperature and other mitigating factors, the ability of individual corals to resist bleaching, and if bleached to survive.
>
> *Resilience* – following mortality of corals, the ability of the reef community to maintain or restore structure and function and remain in an equivalent 'phase' as before the coral mortality.

A Site *Resilience* Assessment was conducted for the HCMR (Wildtracks, 2019), based on the conservation targets and environmental services of the reserve, and on Belize's "*Guidelines for Integrating Climate Change Adaptation Strategies into Protected Areas Management Plans"* management planning framework, and provides a mechanism for assessing the implications of climate change through a series of steps as described below:

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

Primary Climate Change Elements and General Predictions

The primary climate change elements associated with the HCMR are identified below, and are consistent with those identified for Belize on a national level (IMF, 2018):

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

Climate predictions for Belize from the literature are indicative of those for the HCMR and have been summarized in Table 2.

Table 2. Climate Change Predictions for the HCMR (Adapted from Wildtracks, 2019)

Climate Change Predictions for the HCMR			
Climate Change Impacts	**Current Status**	**25 - 50 years**	**100 years**
Sea level rise	Increased global average sea level rise rate of 1.8mm per year from 1961 – 2003 (IPCC, 2007). Current average increase in sea level rise in the Mesoamerican region is estimated at 3.1mm per year (IPCC, 2007).	The Hadley Centre's Unified Global Climate Model (GCM), HadGEM2-ES provides additional data to the IPCC reports (IPCC 2007, 2013) for the three Representative Pathways Projection scenarios[1]. In all three, the coastal sea level is projected to exceed 10 cm by the 2030s; 22, 23, and 38 cm respectively are projected for the low, medium and high emission	By the end of the Century, the Hadley Centre's Unified GCM, HadGEM2-ES projects coastal seal level to rise by 34, 56, 120 cm respectively for the low, medium and high emission scenarios (NCCPSAP 2015).

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

		scenarios by 2050 (NCCPSAP 2015).	
Sea surface temperature rise	Water temperature has increased by 0.74˚C between 1906 and 2005 Current levels of increase are estimated at 0.4˚C per decade (Simpson et al., 2009)	Belize is expected to be warmer by up to 20C by the 2030s, and up to 40C by the end of the century; with sea surface temperatures in the Caribbean projected to go up by as much as 2 degrees Celsius by the end of the century (IMF, 2018)	Predicted regional increase of temperature by up to 5˚C by 2080, with the greatest warming being experienced in the north-west Caribbean (including Belize) (WWF, 2009).
Increased intensity and frequency of storms	Increased storms from 1999 onwards, with annual fluctuations. More storms during El Nina, fewer during El Nino. Stronger storms >Cat 4 / 5	Extreme precipitation events over most of the mid-latitude land masses and over wet tropical regions predicted to become more intense and more frequent.	Extreme precipitation events over most of the mid-latitude land masses and over wet tropical regions predicted to become more intense and more frequent.
Increased Air Temperature	Mean annual temperature has increased in Belize by 0.45°C since 1960, an average rate of 0.10°C per decade. Average number of 'hot' days per year in Belize (days exceeding 10% of current average temperature) has increased by 18.3% between 1960 and 2003 (NCSP/UNDP).	Warming is occurring throughout Central America; up to 1°C since the mid-1970s (IPCC, 2014). Both seasonal and annual air temperatures are predicted to increase by approximately 2°C.	Temperatures are expected to increase between 1.6°C to 4.0°C by 2100 (IPCC, 2014).
Changes in rainfall regime	Mean annual rainfall over Belize has decreased at an average rate of 3.1mm per month per decade since 1960 (NCSP/UNDP)	Predictions suggest that 2020/2030 may show a slight increase in the early and late parts of the wet season (May and Oct-Nov). The dry season and the mid-wet season decreases in rainfall (June), on the other hand, will be characterized by further decreases. Between 2030/2040, the entire country will be characterized by reduced precipitation, with exceptions only in early and late parts of the wet season (May and Nov). 2050/2060 projections are for an enhancement of the 2030s pattern of reduced rainfall (-1 to -4 mm/day) in the dry season (December – April). Increased precipitation of 2-7 mm/day is projected during the early and late (Oct May - Nov) parts of the	During the 2070s and 2090s predictions suggest that the Belize landscape is marked by reduced rainfall from December through to September. The largest reduction of up to -7 mm/day is projected in the Stann Creek District during the mid-wet season dip in June. The end of the wet season (Oct - Nov) maintains increased rainfall of 2 – 5 mm/day in the western Toledo, Stann Creek, Orange Walk and Corozal Districts (NCCPSAP 2015)

		wet season (NCCPSAP 2015). These predictions are based on predictions for the mainland – Stann Creek District. Predicted ecological shifts may alter the catchment functionality important for maintaining rivers in dry season in the south of Belize, and providing nutrients to the reef environment. Increased concentration and seasonality of agrochemical delivery	
Ocean acidification (molluscs and crustaceans)	Atmospheric CO_2 concentration has increased from 280 parts per million (ppm) in 1880 to 385 ppm in 2008 - 35% increase in hydrogen (Simpson et al., 2009). 48% of all atmospheric CO2 resulting from burning of fossil fuels has been taken up by the ocean (Hartley, 2010)	Predicted atmospheric CO_2 levels of 450 by 2040 (Simpson et al., 2009). Predicted 30% decrease in pH. Predicted decrease in calcification rate by 20 - 50% by 2050	Some experts predict a 35% reduction in coral growth by 2100 (Simpson et al., 2009) Decrease of between 0.3 and 0.5 units by 2100 (Hartley et. al. 2010).

Climate Change Assessment Outputs

Anticipated climate change impacts for each primary element are presented for the major *ecosystems* (coral reefs, coastal ecosystems, seagrass and mangroves) of the HCMR (Table 3), followed by the anticipated impacts of each primary element for the key *resources* (commercial species, manatees and sea turtles, colony nesting birds, and the physio-chemical environment) of the HCMR (Table 4).

For each of the conservation targets identified above, the impacts of the identified primary climate change elements (sea level rise, increased sea surface temperature, increased intensity of storms, ocean acidification, decreased precipitation, increased air temperature), were rated on a scale of 1 to 4 using the guide presented in Table 5. The proposed r*atings for prioritization of conservation targets* based on the climate change assessment are presented in Table 6, with coral reef, manatee/sea turtles, coastal ecosystems/mangroves, and commercial species having been identified as having the highest priority.

Table 3. Anticipated Climate Change Impacts for HCMR Ecosystems (Wildtracks, 2019)

Climate Change Impacts	Ecosystems			
	Coral Reefs	Coastal Ecosystems	Seagrass	Mangrove
Sea level rise	Coral reefs may be able to keep up with sea level rise, barring other impacts and dependent on rate of sea level rise. Change in dispersal / recruitment routes / sources. Potential loss of deeper corals, shift in distribution, as light availability decreases. Increased sedimentation and reduced light availability due to shore erosion.	Inundation of cayes and low-lying coastline, with loss of vegetation. In the short term, the increasing salinity of the groundwater will lead to a shift in species composition to those that are more salt tolerant. In the longer term, these ridges will be inundated by sea level rise, with littoral forest gradually being replaced by mangroves.	Temperature stress on seagrass will result in distribution shifts, changes in patterns of sexual reproduction, altered seagrass growth rates, metabolism, and changes in carbon balance. Over the medium term, seagrass should be able to survive in increased water depth, and may do better in the shallow estuarine area. In the deeper waters, increases in water depths above present meadows will reduce light availability Changes in currents may cause erosion and increased turbidity of water column	Mangrove ecosystems face inundation, habitat loss, and shifts in distribution. Inundation of fringing mangroves lenticels in aerial roots can cause the oxygen concentrations in the mangrove to decrease, and resulting in death. Inland migration will occur, as saline savannahs become inundated and ground water becomes more saline from saltwater intrusion. Changes in dispersal patterns for mangrove propagules
Sea surface temperature rise	Increased coral bleaching and eventual loss of ecosystem functionality. Increased coral disease. Possible impacts from new invasive species and algal blooms. A shift towards more tolerant species and symbiont types, and more opportunistic species, with reduced diversity. May alter localized current patterns and therefore coral larval dispersion.		Temperature stress on seagrass will result in distribution shifts, changes in patterns of sexual reproduction, altered seagrass growth rates, metabolism, and changes in carbon balance. When temperatures reach the upper thermal limit for individual species, the reduced productivity will cause plants to die (above 35˚C for *T. testudinum*). Higher temperatures may	Reduced oxygen content in water in mangrove areas. Loss of reef may reduce protection from erosion and storm events, increasing risk to mangroves.

	Impact on tourism as a result of reduced coral health		increase epiphytic algal growth, reducing available sunlight.	
Increased frequency and intensity of storms	Increased mechanical damage to corals. Increased sedimentation, particularly from watersheds following high rainfall and storm damage to riparian belts. Removal of macro algae, resulting in more available substrate for recruitment. Fragmentation of coral – dispersal and colonization	Removal of some or all natural vegetation with less time for regeneration between storms, lower scrubbier vegetation, change in forest structure / reduced species diversity. Increased erosion of coast, changes in beaches. Arrival of opportunistic species. Impacts on ability to provide structural support for bird colonies (nesting / roosting) and provisioning of migratory species	Massive sediment movements that can uproot or bury seagrass. It may also become harder for seagrasses to become re-established. Would be exacerbated by anthropogenic impacts – primarily dredging and landfill	Destruction, inundation, changes in sediment dynamics. Possible increase in nutrients / growth. Large storm impacts result in mass mortality. Projected increases in the frequency of high water events could affect mangrove health and composition due to changes in salinity, and inundation. More frequent inundation is also projected to decrease the ability of mangroves to photosynthesize.
Ocean acidification (corals, lobster / conch)	Decreases in coral calcification rates, growth rates and structural strength. Also impacts other invertebrates. Weakening of reef matrix. If there are areas of localised calcification, acidification will have a drastic impact on the localized environment. Change in ratio of accretion / dissolution	Reduced sand production for replenishment of beaches	Possible direct positive effect on photosynthesis and growth, as in some situations, seagrass is carbon limited. Higher CO_2 levels may also increase the production and biomass of epiphytic algae on seagrass leaves, which adversely impact seagrasses by causing shading. The acidification of seawater could counter the high pH formed by photosynthesis in dense seagrass stands, thus increasing seagrass photosynthesis and productivity.	Positive increase in growth. However, damage to coral reefs may adversely impact mangrove systems that depend on the reefs to provide shelter from wave action. May affect mangrove root communities – especially invertebrates, such as molluscs.

Decreased Precipitation	There is a hypothesis that increased algal blooms may be attributed to reduced precipitation, resulting in decreased visibility – with potential to be positive, by shading corals from intense UV, or negative by blocking sunlight, depending on light penetration	Reduction of freshwater lens, affecting carbon uptake and photosynthesis. Potential change in species composition favouring more heat / saline tolerant species Drier conditions, leading to a shift in species composition, to lower diversity, and more drought-tolerant plants species. Reduced value for migratory birds. Effects on carbon uptake, photosynthesis and productivity	Potential increase in extent of seagrass beds in the Corozal Bay / Chetumal estuary as the freshwater influence decreases	Reduction of freshwater lens, effect on carbon uptake and photosynthesis. Decreased precipitation results in a decrease in mangrove productivity, growth, and seedling survival, and may change species composition favouring more salt tolerant species and shrubby growth forms.
Increased Air Temperature		Higher air temperature could cause more arid conditions – drier soils Potential change in species composition favouring more heat tolerant species.		May alter phenological patterns - timing of flowering and fruiting. At temperatures above 25°C, some species show a declining leaf formation rate. Above 35°C have led to thermal stress affecting mangrove root structures and establishment of mangrove seedlings. At leaf temperatures of 38-40°C, almost no photosynthesis occurs (IUCN, 2006). Possible localized changes in distribution.

Table 4. Anticipated Climate Change Impacts for Key HCMR Resources (Wildtracks, 2019)

Climate Change Impacts	Resources			
	Commercial Species	Antillean manatees / Sea Turtles	Colony Nesting Birds	Physio-chemical Environment
Sea level rise	Conch / sea cucumber: May experience shift in range or habitat loss linked to changes in critical habitat. Snapper / grouper / lobster: Shift in range / habitat loss of both adult and juvenile finfish and lobster – linked to inundation of mangrove, shift in seagrass distribution, changes in coral reef. Tarpon / bonefish / permit: Shift in range / habitat loss of both adult and juvenile sport fish	Potential for improved habitat for manatees in NBCC, supported by improved seagrass productivity. Deeper water buffering against reduced temperature ranges Turtle and crocodile nesting beaches may become inundated	The nesting cayes may become inundated, Salt incursion of water table altering terrestrial vegetation cover, with changes in species presence / diversity, reducing structural support of nesting colony and availability of nesting sites.	Deeper, more stable water in estuary - reduced wind impact stirring up sediments. More stable water temperatures – reduced fluctuation. Improved seagrass conditions, improving filtration of water, reducing turbidity. Reduced efficiency of Bulkhead Shoals, with increased water flow through estuary and sediment
Sea surface temperature rise	Reduction in accessibility to commercial marine resources – lobster, conch, snapper move into deeper cooler water. Associated reduction in income for commercial fishing industry Conch: Temperature may negatively affect spawning Lobster: Loss of critical habitat May affect physiological processes, and disease may become more prevalent. Possible impacts from new invasive species and algal blooms. Reduced capacity for holding oxygen - Increased potential for fish kills	Temperatures exceeding 33˚C may result in manatees moving out of the estuary to seek cooler waters, but may be buffered by increased water depth. Temperatures exceeding 35˚C will result in decreased productivity of seagrass Shifts / habitat loss of critical ecosystems Turtles: Increased potential for disease in eggs and low hatching success	Potential impacts on food sources	Potential for reduced oxygen content, reducing support for fish and other species in high temperature peaks – however, offset by increased water depth

	in high temperature peaks in shallow lagoon and estuarine waters. Changes in currents larval dispersal			
Increased frequency and intensity of storms	Reef, seagrass and mangrove destruction, increased sedimentation - reduced availability of habitats Possible impacts on larval dispersal / survival (potential for wider dispersal of larvae) Increased frequency of damage / destruction of fishing infrastructure (boats, beach traps) negatively impacting the fishing industry Increased mechanical damage to sport fish habitats, reducing tourism potential Increased sedimentation and associated agrochemical contamination impacts on reef, reducing reef health Increased frequency of damage / destruction of tourism infrastructure (hotels, mooring buoys, signage etc.) and boats, negatively impacting sport fishing incomes	Manatees are able move away from storm areas, but can be impacted if caught up in the storms Small number of manatee deaths / strandings have been reported after large hurricanes Increased potential for inundation of turtle and crocodile nests during storm events Removal or erosion of turtle and crocodile nesting beaches, deposition of corals and boulders over existing beaches, by storm events Impacts on dispersal / survival of both adults and nestling turtles	Destruction of nesting structure, removal of nesting colonies. High mortality in birds	Damage / destruction of coastal vegetation with increased erosion of coast and cayes, increasing sediment load in water. Stirring up of sediments laid down at the river mouths, releasing stored contaminants into the estuary. Increased agro-chemical contamination following storm events, with agrochemicals washing into the rivers, then flowing into the estuary (both Rio Hondo and New River). Increase pollution from communities, with overflowing septic systems washing into the rivers and estuary.

Ocean acidification	Habitat loss (impacts on reef). Impacts on larval viability and adult growth rates Weakening shell structures - a decrease in the calcification process by species that build an exoskeleton of $CaCO_3$ (e.g. conch) Impacts on larval viability and adult growth rates Changes in larval fish behaviour, based on reduced ability to distinguish chemical cues	Sea turtle olfaction may be impacted reducing their ability to locate food and nesting sites,	Possible impacts on food sources	Increased pH of water
Decreased Precipitation	Possible changes in salinity impacting larval dispersal. Lobster migration patterns and times will change. More frequent, higher salinity pulses before equalization with main seawater body. There is a hypothesis that increased algal bloom may be attributed to reduced precipitation Impacts on larval viability and adult growth rates. Possible changes in salinity impacting larval dispersal	Manatees require access to relatively freshwater (< 10ppt) every 10 days or so… decreased precipitation may encourage their use of river mouths increasing risk of injury / mortality from boat collisions Improved seagrass productivity.	Possible changes in littoral forest species composition to more drought tolerant species may impact structural suitability of littoral forest for supporting nesting colony	Increased salinity
Increased Air Temperature	Potential impacts on mangroves as a nursery habitat	Turtles may have a female biased sex ratio >31˚C females; 29 -- 30˚C 50:50; <29˚C males. Warming of turtle and crocodile nesting beaches,	Potential impact on hatch success	

		resulting in increased egg mortality, shorter hatching time with smaller average hatching size, reducing survival potential. Increased disease risk to eggs		

Table 5. Conservation Targets Prioritization Rating Guide

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

Table 6. Ratings of Key Climate Change Elements on Conservation Targets (Wildtracks, 2019)

Predicted climate change element	*Conservation Targets*					
	Coral Reef	*Seagrass*	*Coastal Ecosystems / Mangroves*	*Commercial Species*	*Antillean Manatee / Sea Turtle*	*Colony Nesting Birds*
Increased sea level	High (3)	Positive (0)	High (3)	Low (1)	High (3)*	High (3)
Increased sea temperature	Very High (4)	High (2)	Low (1)	High (3)	Medium (2)	Low (1)
Decreased Precipitation	Low (1)	Positive (0)	Medium (2)	Low (1)	Medium (2)	Low (1)
Increased frequency of storms	Medium (2)	High (3)	High (3)	Medium (2)	Medium (2)	High (3)
Ocean acidification	Very High (4)	Positive (0)	Low (1)	High (3)	Low (1)	Low (1)
Increased air temperature	-	-	Medium (2)	-	High (3)	Low (1)
Averaged Rating	**2.80**	**1.00**	**2.00**	**2.00**	**2.17**	**1.67**
	Selected		**Selected**	**Selected**	**Selected**	

Management Planning

Management Goal and Objectives

The goals of the HCMR Management Plan must be consistent with the overarching purpose for which the reserve was created: "to *ensure, increase and sustain the productive service and integrity of the marine resources for the benefit of all Belizeans of present and future generations".* This purpose was further articulated and developed in the goals and objectives of the first HCMR Management Plan of 2002. While fidelity to purpose must be maintained, the five-year timeline for the implementation of this management plan requires that the activities in support of goals and objectives also be actionable within the established timeline, be reflective of current management challenges, be measurable and comparable to management metrics used in the National Protected Areas System, and must contribute to building an evolving baseline for continuous assessment of management effectiveness within the HCMR.

The **Overall Goal** of the 2019-2014 Hol Chan Marine Reserve Management Plan:

'The integrity, functionality and genetic diversity of the HCMR ecosystems are maintained through proactive and adaptive management'.

Objective I. Ensure the effective monitoring of ecosystem health, the restoration of critical habitats, and adaptation to climate change through the implementation of a management-responsive technical program with robust data collection, analysis and interpretation.

Objective II: Ensure the contribution of the HCMR to the consolidation of the Northern Belize Coastal Complex through results-oriented enforcement, community outreach and engagement, good governance, and enhanced management effectiveness.

Objective III: Maintain tangible benefits to local stakeholders, the country, and the global community, while identifying new opportunities for sustainable ecosystem services.

Institutional & Organizational Arrangements of the HCMR

The governance framework is synonymous to the 'institutional framework' of the HCMR, and is that which is defined in the Hol Chan Area Marine Order of the Fisheries Act and the Fisheries (Hol Chan Marine Reserve) Regulations, 2015. Therefore from an overarching institutional and policy perspective, the HCMR and its enabling regulations (Order/S.I.s) were established for the purposes of the Fisheries Act, and are thus subject to the provisions and powers of the Fisheries Act. Consistent with the Fisheries Act, the following interpretation is relevant in explaining the overall institutional and management roles applicable to the HCMR:

i. The HCMR gets it legal identity from the Fisheries Act and was established for the purposes of the Fisheries Act, thus the relevance and necessary role of the Fisheries Department in the oversight and management of the HCMR has been established by law;
ii. The Fisheries Department is legally mandated and responsible for the management and well-being of *all* marine reserves at a national level, beyond the management of any single marine reserve, and also at the international level in terms of compliance with obligations under international conventions and agreements;
iii. All marine reserves declared under the Fisheries Act, are legally required to align their management effectiveness, monitoring, operations and financial management reporting as per the requirements of the National Protected Areas System;
iv. The Fisheries Department is institutionally liable to the National Protected Areas System for the non-compliance of any marine reserve declared under the Fisheries Act;

v. The HCMR forms part of a broader system of marine reserves and responds to a broader National Protected Areas System, and is thus subject to overarching national policies and international obligations that go beyond the mandate and purview of the immediate HCMR institutional framework; and

vi. The fact that the HCMR Regulations provide for oversight and management through the Board of Trustees, these provisions do not free the Fisheries Department of its obligations and overall responsibility for all marine reserves at the national level including the HCMR, and they do not free the HCMR of its obligations to the National Protected Areas System, for which the Fisheries Department is institutionally responsible, in accordance with its legal mandate.

The Hol Chan Area Marine Order of the Fisheries Act and the Fisheries (Hol Chan Marine Reserve) Regulations, 2015 provide a general indication as to purpose, permitted uses, and limitations of the HCMR. Strategic direction, policies and standards by which the ultimate objectives of the HCMR are to be achieved are defined by the Board of Trustees, as per the functions and powers provided for in the Fisheries (Hol Chan Marine Reserve) Regulations, 2015, and specifically by the Constitution of the Board of Trustees, consistent with Schedule I of said regulations. In accordance with this enabling legal framework, all policies, procedures and manuals approved by the Board of Trustees to govern the daily operations and management of the HCMR automatically become part and parcel of the HCMR institutional framework.

The Organizational Framework of the HCMR is hierarchically subordinate to the institution and derives its identity, strategic direction, operational mandate and organizational boundaries from the institution. The organization is the management and operational arm of the institution, and is therefore accountable to the institution through the Executive Director who reports directly to the Board of Trustees. To this end, the organization operates and functions as per the policies, norms, guidelines and standards as defined by the institution and mandated through its Board of Trustees. The organizational framework consists of the Executive Director, Technical Manager, all staff positions, all programs, and all processes which fall below the institution.

Management Capacity Needs

This section summarizes the key capacity needs identified in an HCMR Institutional Assessment conducted in 2018, observations and recommendations obtained during stakeholder consultations held in April and May 2019, and recognizes adjustments made to date.

I. Need for a formal capacity building program, inclusive of a training plan and/or staff development plan for the HCMR;

II. Need for additional technical skills to effectively implement a management-responsive technical program addressing the monitoring of HCMR ecosystems, commercial species, habitat restoration, climate change adaptation, and the quantification of the value of the reserve in the replenishment of buffer zones;
III. Need for technical capacity to specifically and systematically monitor and correlate HCMR ecosystem health with visitation, carrying capacity, economic returns, and financial sustainability;
IV. Enforcement capacity has to be continuously assessed and adjusted to meet both daytime and nocturnal surveillance needs of the reserve;
V. Need to train rangers in evidence-gathering, case file preparation, and prosecution techniques;
VI. Need to build and secure operations management capacity to improve operational efficiency and management of the HCMR assets;
VII. Need to build capacity to pursue financial sustainability in a structured and persistent manner;
VIII. Need to enhance outreach and community engagement capacity;
IX. The capacity to identify, secure and sustain meaningful inter-institutional alliances and partnerships in support of HCMR management objectives must be given priority;
X. Capacity for a performance and results-driven approach to management must be strengthened; and
XI. Need to continuously strengthen executive management capacity in response to evolving management needs.

Management Strategies & Policies

There is a general perception by stakeholders and the community that the HCMR has been successful in contributing to the restoration of depleted fishing areas, and has allowed for both fisheries species and their related habitats within the reserve to re-generate, providing invaluable ecosystem services as is evidenced by the stable visitation rates by tourists and the overall non-extractive use in recreational zones. However, this evident growth and perceived success do not come without challenges in operations, human resources, MPA management effectiveness, possible sub-optimal development of the full potential of the reserve, and overall challenges in organizational output and efficiency. Additionally, the recent expansion requires strategic interventions and considerable investment to ensure that proper management is undertaken through-out the entire expanded reserve, and thus allows HCMR to maintain its biological integrity and ecosystem services, while providing tangible economic benefits to buffer communities.

Established Management Strategies

The management strategies available to the HCMR are described below, they are meant to be responsive to the threats identified above, and are guided by the enabling regulatory and policy framework of the HCMR, and consistent with those available at the national level under the NPAS.

Fisheries Regulations

The Fisheries Regulations for species, size and seasons are implemented in the General Use Zone, where fishing is permitted for traditional users under the Managed Access Framework. Extraction of marine resources is not permitted in the Conservation Zones, and the overall Fisheries Regulations are applicable to the HCMR.

The general HCMR regulations state that no person within the boundaries of the Reserve:

> Shall have in his possession any flora or fauna without special license from the Administrator;
> Shall deposit any materials in or on the waters of the Reserve except by special license from the Administrator;
> Shall erect any structure, whether temporary or permanent;
> Shall discharge or deposit any waste material into the water or land areas;
> Shall mark or tamper with any sing, buoy or notice installed by the Administrator;

Sharks, rays, turtles and manatees are protected under Hol Chan regulations and *"no touching of flora or fauna shall be allowed in the exclusive recreation areas."* Consistent with such regulations, Box 12 below present visitation best practices for sharks and rays within the HCMR which must be observed as a formal management policy.

Sharks and Rays Visitation Best Practice

- Respect sharks and rays - this is their home
- Choose a tour company that promotes best practices
- Let the sharks and rays come to you - don't chase them
- Never poke, prod, or ride the sharks and rays
- Don't hold the sharks and rays or restrict their movements in any way

Box 12. Adapted from Wildtracks (2019)

A summary of the Fisheries Regulations applicable to the HCMR and specific rules and regulations of the different general zones of the HCMR are presented below in Box 13.

Fisheries Regulations

GENERAL
No person shall set traps outside the reef or within 300 feet of the Barrier Reef
No spear fishing within marine reserves
No fishing without a valid fisher folk or fishing vessel license
No one should fish using compressed air or scuba gear
No fishing shall be conducted using explosives or chemicals

CONCH (*Lobatus gigas* - once *Strombus gigas*)
Shell length should exceed 7 inches (17.8 cm)
Market clean weight and fillet weight should exceed 3 ounces (85 g) and 2.75 ounces (78 g) respectively
No person or establishment shall buy, sell or have in possession diced conch meat except under a special permit issued by the Fisheries Administrator.
Closed Season: July 1st to September 30th, or when the catch quota has been met

LOBSTER (*Panulirus argus*):
No person or establishment should have in possession fillet or diced lobster tail.
It is illegal to have in possession any soft shell (molting) lobster or females with eggs (berried)
It is illegal to remove from any female lobster any eggs or spawn or the setae or fibre to which any eggs or spawn are or have been attached.
Minimum carapace length is 3 inches
Minimum tail weight is 4 ounces
Closed season: 15th February to 14th June

FISH FILLET
Every fish, other than Nassau groupers and grazers, caught in Belizean waters and landed as fillet fish should have a skin patch of 2 inches by 1 inch

SEA CUCUMBER
No person shall engage or attempt to engage or assist a person to engage or attempt to engage in fishing, of any kind, for sea cucumber without a special license from the Fisheries Administrator
Individuals applying for special license for sea cucumber must have a valid fisherman's license
No person shall fish for, or harvest, at any time in the waters of Belize, or buy, sell, have in possession, export or attempt to export any sea cucumber between July 1st and Dec 31st (Special license required)

NASSAU GROUPER
No person shall take in the waters of Belize, buy, sell, or have in his possession any Nassau Grouper (Epinephelus striatus) between 1st December and 31st March
No person shall take, buy, sell, or have in his possession any Nassau Grouper which is less than 20 inches and greater than 30 inches
All Nassau Grouper are to be landed whole

SHARKS
No person shall take, buy, sell, possess, and export shark meat or fins during the period 1st August to 31st October
No person shall take or kill any shark of Nurse shark (Ginglymostoma cirratum) and Whale shark (Rhincodon typus) in the waters of Belize
No person shall engage in shark finning
Fishing for any other non-protected shark species requires a special license issued by the Fisheries Administrator
All sharks are to be landed with the fins attached

TARPON, BONEFISH, PERMIT
These species of fish are designated for the purpose of sport fishing
Bonefish commonly known as “macabi” Scientific name: *Albula vulpes*
Permit Scientific name: *Trachinotus falcatus*
Tarpon: Scientific name: *Megalops atlanticus*
No person shall have in possession any bonefish, permit fish or tarpon or any of its product forms, save and except in the act of catch and release.
No establishment shall have in its possession any bonefish, permit fish or tarpon or any of its product forms
NOTE: Catch and Release means the act of catching fish and then releasing them back immediately into the waters of Belize in the same state in which the fish was landed

GRAZERS:
No person shall take in the waters of Belize, buy, sell, or have in his possession any grazers. Grazers refer to any fish of the parrotfish, angel fish and tangs (Scaridae and Acanthuridae)

CORAL:
It is Illegal for any person to take, buy, sell or have in his possession any type of coral
An exception is made in the case of Black Coral - this may only be bought, sold or exported with a license from the Fisheries Administrator

MARINE TURTLES:
No person should interfere with any turtle nest
No person should take any species of marine turtle
No person shall buy, sell, or have in his possession any turtle or articles made of turtle parts

TRAWLING
No person shall engage in trawling

RESEARCH
Every person who applies for a research permit needs to submit a proposal for vetting and approval
Bio-prospecting also requires special permission

GEAR RESTRICTIONS

NETS AND LONG LINES

No gill net, or series of joined gill nets, can exceed 300m in length from any reef structure or reef habitat
Gill, seine and stop nets, and long lines cannot block a river, creek or stream. No net or long line can stretch more than a quarter of the distance across that river, creek or stream and must not exceed 200m in total length
No gill net, seine net, stop net, or long line can be set in a lagoon, that is more than one-tenth of the distance across the lagoon, and cannot exceed 200m in total length
No nets or beach traps can be set within half a mile of any city, town, or village

WITHIN A MARINE RESERVE

Valid licenses are required for commercial fishing, sport fishing and recreational fishing in a Marine Reserve
Fishing activities conducted in Marine Reserves can only be those permitted in accordance to the specific zone regulations.
The use of beach traps and fish traps is prohibited in Conservation and Preservation Zones
A license is required for the use of beach traps and fish traps in the General Use Zone.
Fishing in a Conservation Zone is prohibited without a license
Fishing, snorkelling and diving are prohibited in a Preservation Zone
Spearfishing is prohibited in Marine Reserves
Use of long lines, seine nets and gill nets is not permitted within Marine Reserves
It will be assumed that anyone with a spear gun, pole spear, Hawaiian sling, spearfishing mask or powered spear gun or sling is attempting to engage in spearfishing

Specific rules and regulations for the different zones of the HCMR:

ZONE A
The removal of flora and fauna is prohibited within Zone A.
The feeding of fish is prohibited.
All boats shall use the mooring buoys provided.
No person shall cast or drag anchor in such a way as to damage coral formations.

ZONE B
Commercial fishing is allowed for traditional fishermen under a special license from the Fisheries Administrator.
Spear Fishing is prohibited.
Trawling is prohibited.
The use of gill nets or any other type of nets are prohibited within this zone, except for cast nets.

ZONE C

Sport and commercial fishing are allowed under a special license from the Fisheries Administrator.
Setting of net across the mangrove channels is prohibited
Cutting down of mangrove is prohibited.
The use of gill nets or any type of nests is prohibited except for cast nets.
Spear fishing is prohibited.

ZONE D
Traditional commercial fishing is allowed within this zone except in the 'Exclusive Recreational Area'.
Touching of flora or fauna is prohibited within this zone.
Scuba diving in 'Shark Ray Alley" is prohibited.
Commercial recreational vessels are allowed to stay only for one hour in 'Shark Ray Alley'.

Box 13. Summary of Fisheries Regulations and Rules Applicable to HCMR Zones

HCMR Management Zones

As stated above, and as part of the overall management strategy designed for the HCMR, the Hol Chan Regulations describes in detail specific management zones (Figure 3), each with their particular set of rules.

GENERAL USE ZONE

Zones

This zone is open to fishing. However, unlike the waters outside the protected areas, there are more regulations about what gear you can use, and fishermen are more likely to see patrol boats enforcing the regulations (Wildtracks, 2019). In Hol Chan Marine Reserve, this allows for the sustainable management of existing/traditional uses of the HCMR by Managed Access Area 1 fishers. The key objectives of this zone are to provide opportunity for established uses and activities to be continued in a sustainable manner with effective surveillance and enforcement and monitoring to check for fisher compliance, specifically with respect to fishing gear, catch sizes etc. and to deter the potential for incursions into conservation and preservation zones.

Commercial fishing is permitted, with a Managed Access fishing license valid for Fishing Area 1.
Gear restrictions apply: No use of long lines, spear guns or gill nets. No traps made with seine, cast nets, gill nets, trammel nets or tangled nets Sport fishing is allowed with a permit.
Tourism and recreational use is allowed, following BTB and zone regulations.

CONSERVATION ZONE I
Replenishment zones / Exclusive Recreational Zone.
No commercial, subsistence or sport fishing of any kind.

No feeding of fish.
Tourism and recreational use is allowed, following BTB and MPA regulations.
Boats to be anchored at mooring buoys provided.

CONSERVATION ZONE II
No commercial or subsistence fishing of any kind.
Tourism and recreational use are allowed, following BTB and MPA regulations.
Sport fishing allowed with relevant permits.
Boats to be anchored at mooring buoys provided.

PRESERVATION ZONE
Key replenishment zones. No tourism, commercial, subsistence or sport fishing or tourism of any kind.

New Management Policies

To complement the strategies described above by regulation, a series of new policies are included in this HCMR Management Plan that are applicable to the operations and management of the HCMR, and are geared towards addressing identified threats, as well as concerns and issues raised during the consultations with stakeholders between April and May 2019. The following policies have the support of most stakeholders consulted.

I. There shall be a 500 feet 'no-wake' zone from the westward shore of the HCMR.
II. In order to ensure real time '*in-situ'* monitoring of visitor activities within the reserve, at least one HCMR Ranger shall be required from time-to-time to snorkel and/or dive during tourist visitation to observe and record visitor behaviour and compliance with the rules and regulations of the reserve.
III. The floating HCMR pontoons installed within the reserve for administrative and management purposes shall at all times be equipped with basic first aid and safety equipment, to complement the equipment Tour Operators are required by law to have on their boats at all times while executing a tour, and for which this policy is ***not*** a substitute.

Figure 34. HCMR Pontoon Installed at the Hol Chan Channel

IV. In order to provide appropriate funding for management activities and to support the financial sustainability of the HCMR, a User Fee for all visitors, including Belizeans, shall be instituted for the HCMR and the current yearly boat registration access fee to the HCMR shall be revised; both amounts to be determined by the HCMR Board of Trustees.

V. On the principle of equitable access and fairness, private vessels visiting the HCMR shall be required to pay a boat fee and all persons on said vessels shall also be required to pay an entrance fee; said boat fee to be determined by the HCMR Board of Trustees and the entrance fee for persons shall be as per that defined in the regulations.

VI. To ensure safe boat handling, the safety of visitors, and to minimize risks, tour boats and private boats in the HCMR shall be required to have at least a dedicated Boat Captain on board and a Tour Guide at all times, except in the case of Sport Fishing.

VII. Within the possibilities of the HCMR, and in the spirit of ensuring the welfare and safety of all visitors to the reserve, HCMR rangers on duty at the reserve may render assistance in times of distress. This policy is ***not*** a substitute to the primary responsibility of the Tour Operator and Tour Guides to ensure the safety of their guests at all times.

VIII. In an effort to minimize risks, the HCMR shall declare the reserve 'closed' whenever the HCMR's management believes that weather conditions may pose significant risks to human life and equipment, or in the presence of any other risks as may be defined by the management of the HCMR. In all such cases the HCMR management shall also declare the duration for which the reserve shall be closed.

IX. In an effort to minimize risks and place the safety of visitors first, the use of a swim/snorkel vest shall be mandatory for all visitors to the HCMR.

X. The respective use zones within the HCMR shall be demarcated.

XI. In an effort to protect the integrity of ecological processes and the quality of the visitor experience at the HCMR, reserve staff shall institute a conscious effort to control lionfish populations within the reserve, including but not limited to culling.

XII. All applications for use of over-water structures within the HCMR shall be assessed on a case by case basis, and the HCMR shall reserve the right to refuse all such applications if the proposed use is deemed to be incompatible with the management objectives of the reserve.

XIII. In an effort to reduce the perceived crowding at the current recreational areas (Channel and Shark & Ray Alley) within the HCMR, the area known 'Coral Gardens' shall be considered for inclusion in the reserve, and promoted by the management of the HCMR as an alternative site for visitation, and the same shall be subject to access based on time-slots and to all other rules, regulations, and policies of the reserve.

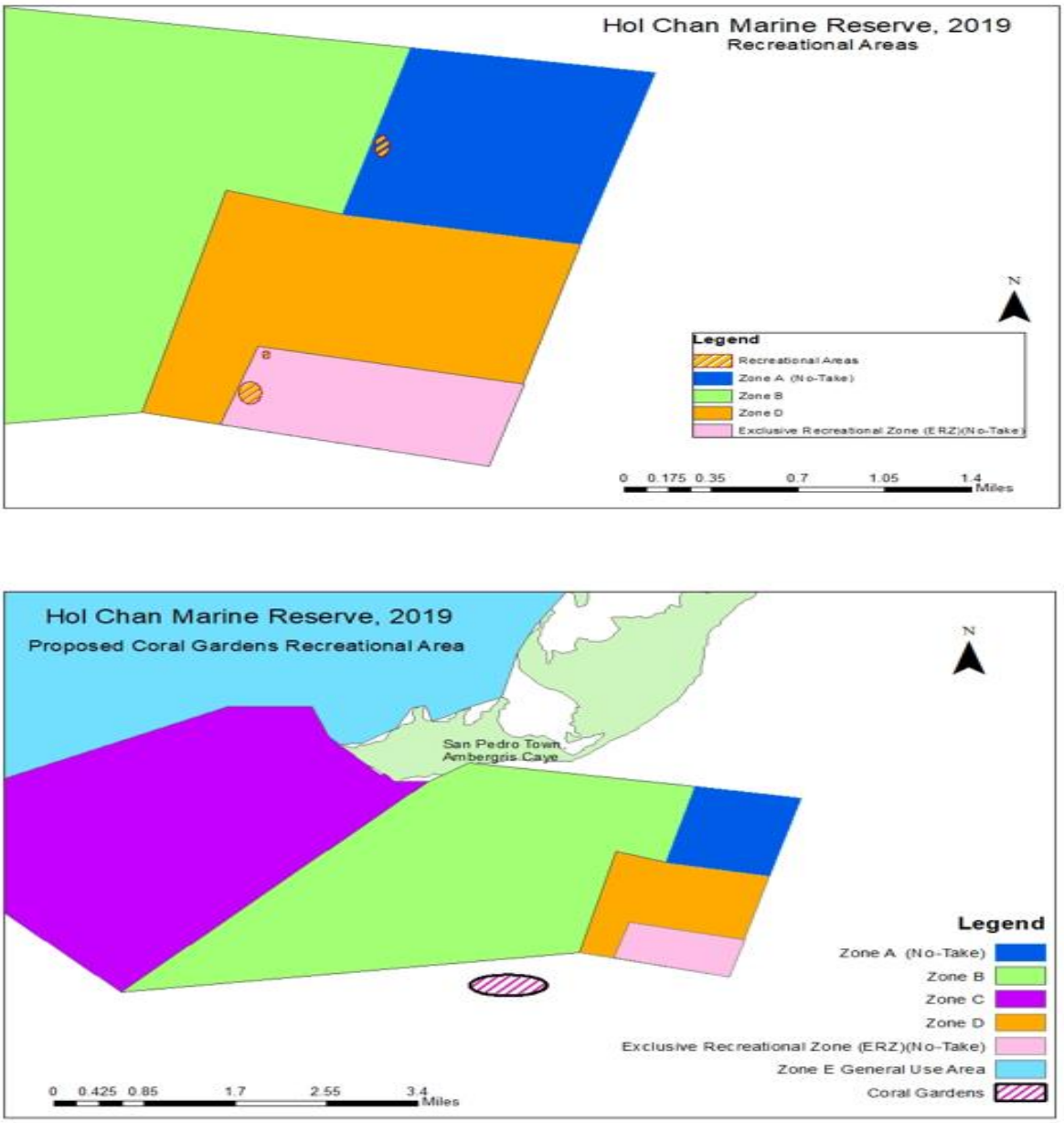

Figure 35. Current Recreational Areas (Top) and Proposed new Area (Bottom) at the HCMR

XIV. Feeding is permitted at Zone D and Mexico Rocks or as may be designated by the HCMR.

XV. The feeding of Nurse Sharks and Rays within the HCMR shall be allowed at the discretion of the Board of Trustees, and the type of feed to be used shall require the prior approval of the HCMR and may be provided by the HCMR.

XVI. In an effort to implement a ‘Green Policy”, the HCMR management shall actively advocate for and promote the use of 4-stroke engines, electric engines, and reusable containers for food and drink within the HCMR, and only biodegradable Sun Tan and Sunscreen lotions may be used in the HCMR.

XVII. The use of Jet Boards and Jet Skis shall be prohibited in the HCMR.

XVIII. All boats visiting the ERZs of the HCMR must place all fishing rods flat on the bottom of the boat.

XIX. Fishing gear such as hook sticks and spearguns are not allowed in the reserve.

XX. In an effort to improve the visitor experience at the HCMR, all Rangers shall be trained in Public Relations & Interpersonal Communications and in Risk & Safety Management.

XXI. Notwithstanding the Guest to Guide ratio defined by the Belize Tourism Board (BTB), the Board of Trustees of the HCMR has the legal authority to implement the Guest to Guide Ratio for visitors to the reserve, it believes are in the best interest of the management objectives of the HCMR.

XXII. In an effort to curb incidences of visitors (guides and tourists) not obeying the rules of the reserve, the HCMR shall devise and implement a system of fines and penalties to address this situation.

XXIII. It shall be prohibited for any visitor to the reserve to touch or remove any organism from the reserve.

XXIV. As a matter of fairness and equitable access, the HCMR shall implement a policy to limit ‘traditional fishing’ rights within the HCMR to the generation currently fishing in the reserve, with no possibility of inter-generational transfer of fishing rights; i.e., traditional fishing rights cannot be sold, inherited or transferred.

XXV. HCMR will establish landing sites and all permit holders are required to report catch data for each landing.

XXVI. HCMR will require all Sport Fishing Guide to report catch data.

XXVII. The HCMR shall monitor and report on the health and performance of the HCMR at least once per year.

XXVIII. Consistent with the Fisheries Act and the Hol Chan Regulations, the HCMR Board of Trustees and the Fisheries Administrator have the mandate and reserve the right, to implement any policy they believe are in the best interest of the management objectives of the reserve, and these shall be complementary to any other applicable regulations or policy under any other law or agency.

Management Programmes

The Management Programmes of the HCMR Management Plan provide structure to the overall plan implementation process, and is designed to reflect and capture the conservation priorities, climate change considerations, and threats defined through-out this document. It is also meant to be consistent with the HCMR 2019-2022 Strategic Plan, and considers the current implementation capacity of the HCMR, and the likeliness of the necessary additional capacity being in place to effectively implement the plan within the stipulated timeline (2019-2024). Considerations were also given to the recent organizational restructuring of the HCMR, and efforts were made to best align management programmes with the organizational structure of the HCMR.

Four management programmes have been identified to deliver the results needed to meet the management objectives of the HCMR, none of which are mutually exclusive and are intimately linked:

1. **Technical Programme**
2. **Public Use & Visitor Management Programme**
3. **Stakeholder Engagement Programme**
4. **Administration Programme**

Technical Programme

The **Technical Programme** supports activities to strengthen science-based management, monitoring, and reporting on the conservation and management performance of the HCMR. This programme is critical for providing technical information on all elements of reef ecosystems health, and their correlation with a series of stressors of both anthropogenic and natural causes. In order for the HCMR to maintain its relevance, high quality information must be systematically generated, analyzed and interpreted, with the resulting findings vetted and shared with stakeholders, the reserve's buffer communities, local and international partners, and the global community. More specifically, the Technical Programme must be able to inform management decisions on overall reserve management, including physical and chemical parameters of the reserve, climate change adaptation, the status of reef health, herbivorous fish, algal cover, diversity and abundance of reef fish including apex predators such as barracuda, snapper and grouper, seagrass health, mangrove ecosystems health, sea turtles, manatees, abundance of commercially important species (lobster, conch, sea cucumber), and generate recommendations on Limits of Acceptable Change (LAC), guided by information on reef health correlated to visitation numbers.

The delivery of the Technical Programme as described above will require that the programme focuses on scientific research, biological and water quality monitoring, the monitoring of the impacts of climate change, data management and dissemination. The technical skills and financial resources needed to address all requirements of the programme cannot be sourced sole at the HCMR, and as such, technical alliances and partnerships will be crucial for the success of the programme. This latter requirement will have to coordinated closely with the Administration Programme, which will

have direct responsibility for the formalization and institutionalization of alliances and partnerships, including all due diligence requirements with the Board of Trustees.

Technical Programme Objectives	Specific management actions to meet the overall management objectives	Key Resource Needs
1. Implement a Comprehensive Reserve Monitoring Program, including biological, physical and chemical parameters, and the impacts of climate change	1. Adjust the current biological monitoring programme to include coral recruitment, temperature, salinity, Dissolved Oxygen, and pH as mandatory parameters to be measured along with biological parameters. 2. Re-institute the HCMR Water Quality programme and include other parameters such as Nitrates, Phosphates, Chlorophyll A., E. coli, pesticide residues, and sediments. 3. Develop specific parameters and baseline to allow for the monitoring of the impacts of climate change, and incorporate into Action No. 1 above. 4. Adjust the biological monitoring programme to include specific targeted monitoring of apex reef predators to provide data on abundance of adults and juveniles, including inter and intra-population dynamics. 5. Select a set of reef health parameters to be correlated with visitation numbers and collect, analyse and report on correlations, with recommendations for management. 6. Implement a Bird Monitoring Program for the HCMR, with morning and evening observations at least twice per year.	**Staff:** ○ Reef Biologist ○ Reef Technician ○ Water Quality Technician ○ Fisheries Technician ○ Bird Technician **Equipment:** ○ Dive gear ○ Temperature, Salinity and O_2 probe ○ Nitrate and Phosphate kit ○ Spectrophotometer ○ Monitoring accessories **Training**: Supplementary training in various monitoring techniques, data analysis, and coral restoration. **Other:** Collaboration with other agencies in technical program implementation, data analysis, and training.
2. Conduct Fisheries Management-Specific Research on a systematic basis	1. Expand and or integrate the current monitoring of commercial species in the HCMR to better reflect data for abundance and distribution of Sea Cucumbers in the north of the country. 2. Design and implement a monitoring program for key sport-fishing species: Bone Fish, Permit, and Tarpon, focusing on spawning, juvenile and adult abundance and distribution within the reserve, with linkages to the health of critical habitat. 3. HCMR will establish landing sites and all permit holders are required to report catch data for each landing. 4. HCMR will require all Sport Fishing Guide to report catch data.	
3. Develop and implement Coral Restoration as permanent activity	1. Consult and coordinate with fragments of Hope on a possible collaboration and technical support for the design and implementation of a coral reef restoration program for the HCMR. 2. Implement the restoration program as a permanent activity and report successes in annual monitoring reports.	
4. Data management, validation, and dissemination	1. Organize and implement an Annual Research & Monitoring Technical Meeting to review and validate the data produced for the HCMR.	

	2. Publish HCMR research/monitoring data in a peer-reviewed magazine or online publication at least every 2 years and annually on HCMR website.	

Table 7. Objectives, Management Actions and Resource Needs of the Technical Programme

Public Use & Visitor Programme

Visitor management and safety are the direct responsibility of tour guides and tour operators, consistent with several BTB regulations. However, and consistent with the Fisheries Act and the Hol Chan Regulations, the HCMR Board of Trustees and the Fisheries Administrator have the mandate and reserve the right, to implement any policy they believe are in the best interest of the management objectives of the reserve, and these shall be complementary to any other applicable regulations or policy under any other law or agency. In this regard, the **Public Use and Visitor Management Programme** is dedicated primarily to the safety and quality of experience to be had by the HCMR visitor, and seeks to protect the critical habitats and key offerings of the reserve through the management of visitor numbers, access, and behaviour.

Public Use & Visitor Management Programme Objectives	Specific management actions to meet the overall management objectives	Key Resource Needs
1. Ensure that visitors to the HCMR are safe and receive a quality experience	1. Define and implement system for access to the HCMR according to authorized time-slots based on user history, equitable access, fairness, and carrying capacity 2. Install emergency equipment on the HCMR pontoons 3. Implement policy to required that all boats visiting the reserve must have at least a dedicated Boat Captain and a Tour Guide at all times. 4. Produce and update the HCMR Visitation Plan inclusive of future infrastructure needs. 5. Conduct an Annual Visitor Satisfaction Survey. 6. Develop and implement a Disaster Management Plan for the HCMR, addressing preparation, post-event interventions, and restoration. 7. Implement policy requiring that a floating device be mandatory for all visitors to the HCMR. 8. Implement policy requiring that all HCMR Rangers be trained in Risk and Safety Management relevant	**Staff:** ○ At least 24 rangers ○ Technical Trainers **Equipment**: ○ Ranger Boats ○ Patrol Boats **Training:** SCUBA for some rangers Training of rangers in enforcement of BTB regulations

	for the day-to-day operations of the reserve 9. Implement the policy prohibiting the feeding of any Barracuda or Eel within the HCMR 10. Implement policy requiring that only biodegradable Sun Tan and Sunscreen lotions may be used in the HCMR 11. Implement policy for an age restriction requirement, both minimum and maximum age, for snorkelers and divers visiting the HCMR.	Training to Rangers in Public Relations and Inter-Personal Communications Training to Rangers in use of emergency equipment on pontoons Training to Rangers in administration of Visitor Satisfaction Survey **Other:** Collaboration agreement with the BTB Collaboration agreement with WCS
2. Enforcement and ranger activities to enforce regulations and management rules follow protocols and guidelines established by the HCMR and SMART	1. Develop and implement protocols, guidelines, and standards on how the enforcement and ranger activities should be conducted. 2. Implement the SMART protocol in collaboration with WCS. 3. Enforce the HCMR's regulations and management rules	
3. Protect the critical habitats that are the basis for the tourism and sport-fishing products offered by the HCMR	1. Implement management policies to restrict use of jet-skis as defined in this management plan. 2. In an effort to implement a 'Green Policy", the HCMR shall actively advocate for and promote the use of 4-stroke engines, electric engines, and reusable containers for food and drink within the HCMR	
4. To develop standards for and implement Limits of Acceptable Change in the HCMR	1. Conduct Carrying Capacity Assessments for the ERZs of the HCMR as basis for the definition and implementation of Limits of Acceptable Change (LAC) 2. Implement a dedicated LAC monitoring programme	

Table 8. Objectives, Management Actions and Resource Needs of the Public Use & Visitor Management Programme

Stakeholder Engagement Programme

Ownership and the creation of long-term champions to advocate for and promote the objectives of the HCMR will not be achieved without targeted and sustained community engagement and feedback.

The HCMR as an institution has two primary roles: (i) safeguard critical species and ecosystems for future generations; (ii) promote awareness and understanding in support of species and ecosystems

protection and ensure that the natural and cultural values of the reserve are not compromised by development and visitation. A public that fully understands the interrelationships between the resources of the HCMR, the economy, and Belize's ecosystems will offer the best possible protection for the reserve. This awareness and understanding may be best communicated through structured and targeted education initiatives, and is a very powerful tool to truly engage with HCMR stakeholders and the broader public, in the long-term process of changing perceptions, behaviours, and securing support for the reserve. This programme seeks to inform and educate HCMR stakeholders about the importance and roles of the HCMR and promote the values of the reserve in an ecosystem context, while enhancing the involvement of the community and building the reserve's constituency base. This programme will additionally seek to communicate the successes and conservation benefits of the HCMR in a non-technical, credible, and neutral format, targeting a broad cross section of society at local and national levels. Consistent with the above, the **Stakeholder Engagement Programme** will support the Technical Programme in the dissemination of scientific and research information, and will support the Public Use & Visitor Management Programme with interpretation materials.

Stakeholder Engagement Programme Objectives	Specific management actions to meet the overall management objectives	Resource Needs
1. To foster general interest in and knowledge of the HCMR assets and value through education, interpretative programs, and stakeholder participation.	1. Conduct an HCMR Stakeholder Mapping & Classification Exercise 2. Develop & Implement an HCMR Stakeholder Engagement based on the results of the mapping exercise, followed by a Public Education & Awareness Campaign structured according to targeted audiences. 3. Promote best tourism practices for resorts, companies, tour operators, tour guides, using the HCMR 4. Encourage participation by HCMR stakeholders by extending 'broad and wide' invitations to all HCMR events. 5. Implement a 'Touch Pond' for its education and stakeholder engagement efforts.	**Staff:** Public Education Manager **Equipment:** Graphic design software High resolution printer Computer Audio-visual equipment **Training**: Graphic design Video and audio production **Other:** Collaboration with all other programmes
2. To engage the HCMR stakeholders and the broader San Pedro Community in frequent informative one-on-one exchanges	1. Develop and Implement Institutionalized Stakeholder Engagement Forum at least quarterly using the local media.	
3. To specifically engage land owners and developers in the education and awareness campaign.	1. Develop and disseminate informative materials specifically targeting land owners and developers. 2. Dedicate at least one Engagement Forum per year to discuss the impacts of development on HCMR ecosystems	

4. To monitor & evaluate the impact of the HCMR Stakeholder Education and Engagement efforts through Behavioural Change of stakeholders and users of the reserve	1. Develop and implement a behavioural change survey at least every 2 years	Collaboration with local media.

Table 9. Objectives, Management Actions and Resource Needs of the Stakeholder Engagement Programme

Administration Programme

The **Administration Programme** will seek to build sustained capacity necessary for proper succession, develop tools for performance and results-driven approaches to operations and management, structurally strengthen the HCMR, will pursue increased access to innovative technology for management, and will seek to strengthen overall HCMR governance at the institutional level. This programme will set goals for departments, stations, and units in order to carry out the vision of HCMR, and will engage the Board of Trustees to communicate organizational successes and failures as well as suggest alternative strategies to achieve HCMR management goals. The Administration Programme will ensure that all operations at HCMR abide by maximum transparency, efficiency, and compliance with fiduciary standards and best practice, and shall be responsible for all human resources, procurement, financial and fiscal management aspects of HCMR operations, and will provide leadership and coordination in the administrative, business planning, procurement planning, accounting and budgeting efforts of the HCMR.

The Administration Programme is also tasked with the financial sustainability of the HCMR. The success of the HCMR as an institution and as a marine reserve is contingent on its ability to identify innovative financing beyond current visitation fees. Sustainability must be embraced from the perspective of resource needs, in which 'resources' encompasses financial, human, technical, technological, social, and institutional. The HCMR must be structured and organized to position itself to access all resources needed from a variety of sources, both internal and external to the institution. While financial strategies are a natural consideration in dealing with sustainability, serious attention also must be given to mutually beneficial inter-institutional linkages and partnerships. This is extremely important in the case of partnerships with agencies having shared objectives and goals in protected areas management, coral reef and fisheries monitoring, socio-economic benefits of marine reserves, and overall reef health. Added to this, is the consideration for partnerships with the private sector, academia and the broader community. Inter-institutional relationships with counterpart agencies in other countries and regions of the world can bring substantial benefits in terms of strategic positioning, the insertion of the HCMR into national and regional networks, information exchange, access to expertise, and opportunities for joint program development.

Administration Programme Objectives	Specific management actions to meet the overall management objectives	Key Resource Needs
1. Ensure all management and operational best practices are implemented at all times at the HCMR	1. Implement Board of Directors Manual, HR Policy Manual, Procurement & Financial Manual, Ranger Protocol, and all visitation best practice tools.	**Staff**: Dedicated sustainability staff **Equipment**: N/A **Training**: Fund Raising Negotiations **Other**: Collaboration with like-minded partners at the national and international level.
2. To secure long-term resource needs and strategic positioning through institutional partnerships and memberships at the national and international level	1. Secure at least 2 strategic partnerships secured per year and explicitly targeting specific resource needs of the HCMR (technical expertise, data, joint monitoring, co-financing, training to HCMR staff, etc.) 2. Identify and secure at least 2 strategic international memberships every other year	
3. To strategically engage corporate partners and citizens in targeted sustainability initiatives for the HCMR	1. Pursue the engagement of at least 2 corporate citizens per year for sponsorship agreements with the HCMR	
4. To optimize fee collection and management through continuous assessment of carrying capacity during peak and non-peak periods, willingness to pay, and revenue generation and reserve ecosystem health linked to visitation	1. Conduct a willingness to Pay Assessment every other year 2. Conduct a comprehensive Review of the HCMR Fee System 3. Pursue the development and implementation of HCMR cause related marketing products	
5. Institute structural adjustments required for the institutionalization of sustainability initiatives	1. Secure the services of staff dedicated specifically to the pursuit of sustainability initiatives for the HCMR.	

Table 10. Objectives, Management Actions and Resource Needs of the Administration Programme

Monitoring & Evaluation of Plan Implementation

In the process of monitoring the implementation of the HCMR Management Plan, it is recommended that the tool developed for other marine reserves be used, in order to allow for comparative analyses. In the tool each programme is expanded to form an implementation matrix, including present and desired status, responsible parties, a timeline based on the 5-year implementation period, and highlighting any limitations or context conditions that would need to

be taken into consideration for successful implementation. The Monitoring & Evaluation Matrix for the HCMR Management Plan is presented in Annex 1A-D.

Management Effectiveness of the HCMR

The evaluation of management effectiveness is generally achieved by the assessment of series of criteria (represented by carefully selected indicators) against agreed objectives or standards. Management effectiveness evaluation is defined as the assessment of how well protected areas are being managed – primarily the extent to which management is protecting values and achieving goals and objectives. The term management effectiveness reflects three main 'themes' in protected area management:

- design issues relating to both individual sites and protected area systems;
- adequacy and appropriateness of management systems and processes;
- and delivery of protected area objectives including conservation of values.

(www.cbd.int, sourced July 2019)

Wildtracks (2019) reported on the results of the last management effectiveness assessment conducted for the HCMR. In that assessment, the indicators were selected from the national Monitoring Package for Assessing Management Effectiveness. A score of 1 to 4 is allocated to each indicator, and is then expressed as a percentage to facilitate comparison with other assessments. Table 11 highlights the overall ratings for the HCMR in 2016.

HCMR Outputs of Indicator Categories			
Indicator Category	**Score out of 4**	**Average Score (as a %)**	**Rating**
1. Resource Information	**3.27**	**81.7**	Very Good
2. Resource Administration, Management and Protection	**3.44**	**86.0**	Very Good
3. Participation, Education and Socio-Economic Benefit	**2.85**	**71.3**	Good
4. Management Planning	**2.08**	**52.0**	Good
5. Governance	**3.40**	**85.0**	Very Good
6. Human Resources	**3.07**	**76.8**	Very Good
7. Financial and Capital Management	**3.44**	**85.9**	Very Good
Overall	**3.03**	**75.7%**	Very Good

Table 11. ***HCMR Results for Indicator Categories (2016)***

The management effectiveness of Hol Chan Marine Reserve was rated as **VERY GOOD,** with an overall Management Effectiveness score of **75.7%** (3.03 out of 4.00) – a decrease from the 2009 rating of 92.2% (though both rates as **VERY GOOD**). Indicator categories rate from **VERY GOOD** to **GOOD**, with Financial and Capital Management being the strongest, achieving a rating of 85.9%. Management Planning is identified as the weakest area, rating at the lower end of **GOOD**, with

52.0%, which reflects the absence of an up to date management plan. All Indicator Categories have decreased ratings since the 2009 assessment, which reflects the expansion of HCMR and increasing management needs for the marine reserve, not having the strategic management framework that is provided by an up to date management plan and an increasing understanding of the indicators used.

The HCMR is currently undergoing an organizational restructuring with new policies and systems in place, new units and departments, expanded staff, new strategic plan, new management strategies and policies, and very soon a new Management Plan. Upon the finalization and approval of this new management plan, it will be indispensable to conduct an updated management effectiveness assessment. In that process, all efforts should be made to seek alignment and compatibility with the methodology and interpretation used for management effectiveness conducted for Corozal Bay Wildlife Sanctuary and Southwater Caye Marine Reserve by Mojica (2015).

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ANNEX 1- Monitoring & Evaluation Matrix of the HCMR 2019-2024 Management Plan

-Annex 1A –

TECHNICAL PROGRAMME					
Objective 1: Implement a Comprehensive Reserve Monitoring Program, including biological, physical and chemical parameters, and the impacts of climate change					
Management Actions	Present Status (2019)	Desired Status	Year	Resources	Context Notes
1. Adjust the current biological monitoring programme to include coral recruitment, temperature, salinity, Dissolved Oxygen, and pH as mandatory parameters to be measured along with biological parameters.	Current physical and chemical data sporadic and incomplete	Completely adjusted and under implementation	End of 2019	**Staff:** ○ Reef Biologist ○ Reef Technician ○ Water Quality Technician ○ Fisheries Technician ○ Bird Technician **Equipment:** ○ Dive gear ○ Temperature, Salinity and O_2 probe ○ Nitrate and Phosphate kit ○ Spectrophotometer ○ Monitoring accessories **Training**:	Technical skills required and supplementary budget May require additional staff
2. Institute the HCMR Water Quality programme and include other parameters such as Nitrates, Phosphates, Chlorophyll A., E. coli, pesticide residues, and sediments.	Water Quality Monitoring Program non-functional	Instituted and include other parameters such as Nitrates, Phosphates, Chlorophyll A., E. coli, pesticide residues, and sediments.	April 2020		Technical skills required and supplementary budget May require additional staff
3. Develop specific parameters and baseline to allow for the monitoring of the impacts of climate change, and incorporate into Action No. 1 above	Climate Change-specific parameters not monitored	Climate Change-specific parameters being monitored as part of regular reef health.	April 2020		Technical skills required and supplementary budget May require additional staff
4. Adjust the biological monitoring programme to include specific targeted	Apex reef predators not specifically monitored as part of reef health	Apex reef predators monitored systematically in reef fish monitoring efforts.	April 2020		Technical skills required and supplementary budget

	monitoring of apex reef predators to provide data on abundance of adults and juveniles, including inter and intra-population dynamics.				Supplementary training in various monitoring techniques, data analysis, and coral restoration. **Other:** Collaboration with other agencies in technical program implementation, data analysis, and training.	May require additional staff
5.	Select a set of reef health parameters to be correlated with visitation numbers and collect, analyse and report on correlations, with recommendations for management.	No correlation currently done between visitation and reef health	Management requires that ecosystems health data in the HCMR be correlated with visitation data to inform policy decisions on permissible visitation numbers.	End of 2019		Technical skills required and supplementary budget; correlation with Public Use & Visitor Management Programme
6.	Implement a Bird Monitoring Program for the HCMR, with morning and evening observations at least twice per year.	Bird observations are based on those of Bacalar Chico.	HCMR-specific bird inventory and population dynamics need to be established.	Starting January 2021		Birding staff or secured through volunteer services
Objective 2: Conduct Fisheries Management-Specific Research on a systematic basis						
1.	Expand the current monitoring of commercial species to include abundance and distribution of Sea Cucumbers	Only lobster and conch monitored at this time	Fisheries species monitored expanded or integrated to better reflect data for sea cucumber of commercial interest in the north of the country.	September 2019	IDEM	Additional staff time needed
2.	Design and implement a monitoring program for key sport-fishing species: Bone Fish, Permit, and Tarpon, focusing on spawning, juvenile and adult abundance and distribution within the reserve, with linkages to the health of critical habitat	Not currently monitored; no data on abundance of key species	Baseline on Abundance established, with systematic monitoring thereafter.	Starting June 2020		Technical skills required and supplementary budget Additional staff time needed

3. Establish landing sites and collect catch data from all permit holders for each landing, as well as catch data from Sport Fishing Guides.	Not currently monitored; no data on abundance of key species	Baseline on Abundance established, with systematic monitoring thereafter.	Starting June 2020		Technical skills required and supplementary budget Additional staff time needed
Objective 3: Develop and implement Coral Restoration as permanent activity					
1. Consult and coordinate with fragments of Hope on a possible collaboration and technical support for the design and implementation of a coral reef restoration program for the HCMR.	Coral restoration not currently done	Restoration program designed; staff trained.	September 2021	IDEM	Fragments of Hope available and willing to assist. Supplementary budget needed
2. Implement the restoration program as a permanent activity and report successes in annual monitoring reports	Restoration program initiated	Implementation of restoration program initiated	December 2021		Supplementary budget needed
Objective 4: Data management, validation, and dissemination					
1. Organize and implement an Annual Research & Monitoring Technical Meeting to review and validate the data produced for the HCMR.	Data and reports not currently reviewed and validated by peer group.	Technically robust and peer validated report on the HCMR available, and can be used as a reliable source to inform management	Starting 2021	IDEM	Usefulness of data and reports must be upgraded. Collaborative partnerships needed with other technical organizations
2. Publish HCMR research/monitoring data in a peer-reviewed magazine or online publication at least every 2 years	Current HCMR Reports not peer reviewed or published, minimizing the opportunity for exposure of the reserve to the internationally community	Peer reviewed reports published at least every 2 years.	Starting 2021		Currently limited use of HCMR data and limited exposure.

and annually on HCMR website					

-Annex 1B-

PUBLIC USE & VISITOR MANAGEMENT PROGRAMME					
Objective 1: Ensure that visitors to the HCMR are safe and receive a quality experience					
Management Actions	Present Status (2019)	Desired Status	Year	Resources	Context Notes
1. Define and implement system for access to the HCMR according to authorized time-slots based on user history, equitable access, fairness, and carrying capacity	Not implemented with crowding consequences during visitation	Better management of access and crowding in the reserve	2020	**Staff:** o At least 24 rangers o Technical Trainers **Equipment**: o Ranger Boats o Patrol Boats **Training:** SCUBA for some rangers Training of rangers in enforcement of BTB regulations	Crowding must be addressed
2. Install emergency equipment on the HCMR pontoons	None existent.	HCMR rangers better able to assist in the event of emergency	2019		HCMR rangers not able to assist
3. Implement policy to required that all boats visiting the reserve must have at least a dedicated Boat Captain and a Tour Guide at all times.	Not implemented with neglect of tourist	Tour Operator follows the rules and safety of tourist is secured	2019		There should be no tolerance for non-compliance
4. Produce and update the HCMR Visitation Plan inclusive of future infrastructure needs.	None existent with sub-optimal management of visitation	Structured visitation plan developed and being followed.	2020		External technical support may need to be sourced.
5. Conduct an Annual Visitor Satisfaction Survey.	Not currently done for the reserve	First hand data on quality of the visitor experience available to inform management decisions	Starting 2019		Should be easily implemented by staff or external person

6. Develop and implement a Disaster Management Plan for the HCMR, addressing preparation, post-event interventions, and restoration.	No such plan exists and response to natural disaster is 'reactive'.	Coordinated and structures preparation, response and restoration linked to disaster (natural and human)	2020	Training to Rangers in Public Relations and Inter-Personal Communications Training to Rangers in use of emergency equipment on pontoons Training to Rangers in administration of Visitor Satisfaction Survey **Other:** Collaboration agreement with the BTB Collaboration agreement with WCS	External technical support may need to be sourced.
7. Implement policy requiring that a floating device be mandatory for all visitors to the HCMR	No such policy exists at this time for the HCMR	Floating device mandatory as a safety measure, consistent with the rules implemented in several neighbouring countries	2020		HCMR Board of Trustees to lead this charge
8. Implement policy requiring that all HCMR Rangers be trained in Risk and Safety Management relevant for the day-to-day operations of the reserve	Rangers may not be at the level required and do not possess a standardized certification training for this purpose	Ranger trained as per a common standard and able to better manage	2021		HCMR Board of Trustees to lead this charge
9. Implement the policy prohibiting the feeding of any Barracuda or Eel within the HCMR	Policy not implemented; This dangerous and high-risk practice currently done by some guides	This practice completely stopped and risk of tourist being bitten reduced	2019		HCMR Board of Trustees to lead this charge
10. Implement policy requiring that only biodegradable Sun Tan and Sunscreen lotions may be used in the HCMR	Chemical-based currently used with potential damage to corals	No chemical-based lotions or sunscreen used in the HCMR	2020		HCMR Board of Trustees to lead this charge
11. Implement policy for an age restriction requirement, both minimum and maximum age, for snorkelers and divers visiting the HCMR.	Some divers may be too old or too young for diving, increasing risk of a medical emergency	Age-related medical risk reduced, and liability to the HCMR is reduced.	2021		HCMR Board of Trustees to lead this charge
Objective 2: Enforcement and ranger activities to enforce regulations and management rules follow protocols and guidelines established by the HCMR and SMART					

1. Develop and implement protocols, guidelines, and standards on how the enforcement and ranger activities should be conducted.	Enforcement protocols can be improved to increase efficiency and impact	Efficiency of enforcement improved	2020	IDEM	Existing protocol to be revised and updated
2. Implement the SMART protocol in collaboration with WCS.	Discussions for SMART underway, but not implemented yet	HCMR needs to consistent with other reserves and implement the SMART protocol	2020		Process with WCS to be accelerated
3. Enforce the HCMR's regulations and management rules	Currently done within the capacity of staff and equipment.	Sustained and continuously improved.	Starting 2019		Public Use & Visitor Management Programme to lead this charge
Objective 3: Protect the critical habitats that are the basis for the tourism and sport-fishing products offered by the HCMR					
1. Implement management policies to restrict use of jet-skis as defined in this management plan.	No policies exist with consequences on sport-fishing activity	Policy implemented and habitats for sport-fishing species protected	2020	IDEM	HCMR Board of Trustees to lead this charge
2. In an effort to implement a 'Green Policy", the HCMR shall actively advocate for and promote the use of 4-stroke engines, electric engines, and reusable containers for food and drink within the HCMR	Regular engines and disposal containers used by visitors to the reserve	Green Policy implemented and HCMR demonstrates leadership in greening visitation.	2019		HCMR Board of Trustees to lead this charge
Objective 4: To develop standards for and implement Limits of Acceptable Change in the HCMR					
1. Conduct Carrying Capacity Assessments for the ERZs of the HCMR as basis for the definition and implementation of Limits of Acceptable Change (LAC)	Carrying Capacity data does not exist.	Information available to inform LAC programme	2021	IDEM	External technical capacity may need to be sourced and staff trained

2.	Implement a dedicated LAC monitoring programme	No LAC programme or monitoring exist	LAC programme under implementation and monitoring started	2022		External technical capacity may need to be sourced and staff trained

-Annex 1C-

STAKEHOLDER ENGAGEMENT PROGRAMME					
Objective 1: To foster general interest in and knowledge of the HCMR assets and value through education, interpretative programs, and stakeholder participation.					
Management Actions	Present Status (2019)	Desired Status	Year	Resources	Context Notes
1. Conduct an HCMR Stakeholder Mapping & Classification Exercise	Preliminary mapping exist, classification and ranking necessary	HCMR stakeholders identified, grouped and ranked.	2019	**Staff:** Public Education Manager **Equipment:** Graphic design software High resolution printer Computer Audio-visual equipment **Training**: Graphic design Video and audio production	The context requires that this be treated with some level of priority
2. Develop & Implement an HCMR Stakeholder Engagement Strategy based on the results of the mapping exercise, followed by a Public Education & Awareness Campaign structured according to targeted audiences, and including implementation of a Touch Pond as a tool..	Non-structured public awareness and education program exist	Audiences targeted by specific messages relevant to their circumstances and relationship with the HCMR	2020		The context requires that this be treated with some level of priority
3. Promote best tourism practices for resorts, companies, tour operators, and tour guides, using the HCMR	Best practices not sufficiently addressed in HCMR campaigns	Purpose-driven messaged developed and delivered to resorts, companies, tour operators, and tour guides,	2020		The context requires that this be treated with some level of priority

4. Encourage participation by HCMR stakeholders by extending 'broad and wide' invitations to all HCMR events	Selective invitations is the current norm	'broad and wide' invitations to all HCMR events is the new standard	2019	**Other:** Collaboration with all other programmes Collaboration with local media.	The context requires that this be treated with some level of priority
Objective 2: To engage the HCMR stakeholders and the broader San Pedro Community in frequent informative one-on-one exchanges					
1. Develop and Implement Institutionalized Stakeholder Engagement Forum at least quarterly using the local media.	Such for a do not exist where stakeholders can 'face' the HCMR	HCMR Board, management and staff totally accessible to stakeholders though local media.	2019	IDEM	To be led by Executive Director, assisted by the Board
Objective 3: To specifically engage land owners and developers in the education and awareness campaign.					
1. Develop and disseminate informative materials specifically targeting land owners and developers.	Land owners and developers not specifically targeted in current campaigns	Message clearly targeting land owners and developers prepared and disseminated	2020	IDEM	The context requires that this be treated with some level of priority
2. Dedicate at least one Engagement Forum per year to discuss the impacts of development on HCMR ecosystems	Land owners and developers not currently considered as a specific group to be targeted in a HCMR engagement forum	Land owners and developers invited to join the HCMR engagement forum and contribute to the discussions on HCMR management	2020		The context requires that this be treated with some level of priority
Objective 4: To monitor & evaluate the impact of the HCMR Stakeholder Education and Engagement efforts through behavioural Change of stakeholders and users of the reserve					
Develop and implement a behavioural change survey at least every 2 years	Not currently used as a tool, but is programmed in the current HCMR Strategic Plan	First-hand data on behavioural change available to inform success and or adjustments to the Stakeholder Engagement Strategy	Starting 2020	IDEM	Training in use of tool may be necessary

-ANNEX 1D-

ADMINISTRATION PROGRAMME					
Objective 1: Ensure all management and operational best practices are implemented at all times at the HCMR					
Management Actions	Present Status (2019)	Desired Status	Year	Resources	Context Notes
1. Implement Board of Directors Manual, HR Policy Manual, Procurement & Financial Manual, Ranger Protocol, and all visitation best practice tools.	Manuals and policies developed; implementation is recent	Continue implementation and assess against overall organizational performance and public perception	Starting 2019	**Staff**: Dedicated sustainability staff **Equipment**: N/A **Training**: Fund Raising Negotiations **Othe**r: Collaboration with like-minded partners at the national and international level.	Led by Executive Director and Board of Trustees

Objective 2: To secure long-term resource needs and strategic positioning through institutional partnerships and memberships at the national and international level					
1. Secure at least 2 strategic partnerships per year and explicitly targeting specific resource needs of the HCMR (technical expertise, data, joint monitoring, co-financing, training to HCMR staff, etc.)	Partnerships not systematically pursued	At least partnerships established and are of mutual benefit to the HCMR	Starting 2020	IDEM	Led by Executive Director and Board of Trustees
2. Identify and secure at least 2 strategic international memberships every other year	Not currently pursued as something of strategic importance	Memberships secured and used to better position the HCMR abroad and open doors for more beneficial partnerships	2021		Led by Executive Director and Board of Trustees
Objective 3: To strategically engage corporate partners and citizens in targeted sustainability initiatives for the HCMR					
1. Pursue the engagement of at least 2 corporate citizens per year for sponsorship agreements with the HCMR	Corporate citizens not seen as potential collaborators on an individual level	HCMR sustainability benefitting from individual corporate sponsorship	Starting 2020	IDEM	Led by Executive Director and Board of Trustees
Objective 4: To optimize fee collection and management through continuous assessment of carrying capacity during peak and non-peak periods, willingness to pay, and revenue generation and reserve ecosystem health linked to visitation					
1. Conduct a willingness to Pay Assessment every other year	The existing baseline is over 10 years old and no longer relevant	Updated baseline available to inform on fee revision possibilities	Starting 2019	IDEM	External technical expertise may be required
2. Conduct a comprehensive Review of the HCMR Fee System	No structured analysis exist which highlights deficiencies and opportunities in the HCMR fee structure	Baseline available to inform on fee revision opportunities	2020		External technical expertise may be required
3. Pursue the development and implementation of HCMR cause related marketing products	Cause related marketing products not currently used at the HCMR and is a lost opportunity for revenue	Cause related marketing products established as a formal option among revenue options for the HCMR	2021		External technical expertise may be required

Objective 5: Institute structural adjustments required for the institutionalization of sustainability initiatives					
1. Secure the services of staff dedicated specifically to the pursuit of sustainability initiatives for the HCMR.	No such staff currently exist at the HCMR; thus sustainability initiatives do not receive dedicated attention.	sustainability initiatives for the HCMR institutionalized through the hiring of dedicated staff for this purpose.	2021	IDEM	Led by Executive Director and Board of Trustees