REEFFIX: AN ICZM CORAL REEF RESTORATION, WATERSHED MANAGEMENT AND CAPACITY BUILDING DEMONSTRATION PROJECT FOR THE CARIBBEAN

-FINAL REPORT-

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Final Report

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In collaboration with the Ministry of Agriculture, Fisheries, Forestry, Environment and Sustainable Development of Belize, promote progress on ICZM / MPA / coral reef conservation. This OAS-Belize Audubon Society (BAS) project is to collaborate on coral reef health monitoring and outreach.

Submitted to Richard Huber, OAS Program Manager

Prepared by: Belize Audubon Society

October 10th, 2018

Contents

Project Background

Goal: Collaborate on coral reef health monitoring and outreach.

Objective: To integrate their existing biophysical monitoring data on coral reef ecosystem health into targeted communications for fishers, rangers, and participants of the Reef Protector program and other educational efforts. This builds on priority needs recently identified by BAS in the GCFI/NOAA MPA management capacity assessment.

Tasks:

1. Hold a series of internal working sessions to determine information needs of the enforcement program, the community liaison program and Reef Protectors, and match those with available monitoring information or possible data to gather in future.
2. Formulate and implement a data gathering step to actually pull together numbers and analyze findings to generate information needed as may be possible (with other NGOs, academia and the Fisheries Department's MPA program). Design and complete in both print and on-line digital information in different communications formats that can be easily used for enforcement, community work and the education program.

This report focuses on accomplishments of the following activities:

I. Give update on Marine Protected Area System Plan for Belize

II. Estimated Economic productivity /ha/yr for Lighthouse Reef Atoll (LHRA) with a focus on Half Moon Caye Natural Monument.

III. Sample Info-graphics for use as environmental education and outreach tools to communicate science information site specific to Half Moon Caye Natural Monument (HMCNM) and Blue Hole Natural Monument (BHNM) as well at the entire Lighthouse Reef Atoll.

I. Task (vi) Give update on Marine Protected Area System Plan of most representative marine ecosystems to meet Caribbean Challenge to put 25 percent of near-shore marine and 25 percent of terrestrial natural resources under effective conservation by 2020.

Disclaimer: For the purpose of the TOR dated September 25th, 2017 for the project REEFFIX: AN ICZM CORAL REEF RESTORATION, WATERSHED MANAGEMENT AND CAPACITY BUILDING DEMONSTRATION PROJECT FOR THE CARIBBEAN- Belize Audubon Society as Consultant, we take this opportunity to clarify that Belize is not a party to the "**Caribbean Challenge** *to put 25 percent of near-shore marine and 25 percent of terrestrial natural resources under effective conservation by 2020."*

Nonetheless, in an effort to describe status of MPA's in Belize this summary report was compiled for the completion of **Task (vi).**

1. Overview of Belize's MPA System

1.1 Background

The Belize Audubon Society is the co-manager of Blue Hole and Half Moon Caye Natural Monuments (established by the Forest Department) which are marine based and located with the Lighthouse Reef Atoll. These two sites along with five other marine protected areas, make-up the Belize Barrier Reef Reserve System World Heritage Site (BBRRS-WHS). Unlike marine reserves which were designated for the management of fishery, these are non-extractive protected areas designated for the protection of physical/biological features of national significance, key species (manatees), and tourism resources (Marine Protected Areas Atlas, Wildtracks). As a responsible co-manager, BAS actively works towards the protection and sustainable use of marine and coastal resources of the BBRRS-WHS. A written management plan guides the onsite management of the two protected areas, and the site objectives are achieved via the implementation of various program activities including, environmental education and community outreach, biodiversity research and monitoring, protected areas management inclusive of visitor management (for tourism) and fisheries management.

Belize is often referred to as leader in the region when it comes to protected areas management and design. This is so because of a combination of strategies (legislative, collaborative and biodiversity conservation based) embraced by the Government of Belize to facilitate the effective management of the National Protected Areas System. The system facilitates 103 protected areas of which the Marine Protected Areas (MPAs) network includes seven (7) marine protected areas forming Belize's World Heritage Site, eleven (11) protected spawning aggregation sites, and largest MPA, Turneffe Atoll, a stronghold for fisheries viability. These MPAs range from being entirely atoll ecosystems such as Glovers Reef/Lighthouse Reef, patch reef and barrier reef areas such as Gladden Spit and Silk Cayes Marine Reserve, to more coastal/estuarine systems as is the case of Port Honduras Marine Reserve. MPAs have a wide range of controlled and permitted

uses depending on the specific designation and management. Half Moon Caye Natural Monument, for example, is a protected area where no extractive use is permitted; fishing therefore is prohibited. In contrast, MPAs such as South Water Caye Marine Reserve are divided into zones where various levels of use and protection are provided to resources. This includes an area of "total protection" referred to as no-take zones (or replenishment zone) where fishing is not allowed and a general use zone where licensed fishers are permitted to conduct fishing activities (Economic Alternatives and Fishers Diversification Plan, 2012).

The evolution of the National Protected Areas System in Belize continues today, and it is our opinion that the accomplishment of several legislative and in-situ conservation actions over the past ten years have moved Belize into a position of leader in this arena. Belize is small but a biologically rich and diverse country and through continued collaborative efforts, hopes to continue serve as a model for other Caribbean countries.

Table 1. Timeline of accomplishments towards the sustainable management of marine and coastal resources of Belize.

Year	Action	Achievement
2012	**The established Turneffe Atoll Marine Reserve spans over 325,000 acres and now becomes the largest Marine Reserve in Belize and is considered one of the largest and most biologically diverse atolls in the Caribbean.**	Belize moves from 13% (in 2005) to 20% of its marine environs under protected status.
2012	**GOB endorsed exercise to assess the status and viability of marine replenishment zones with a plan for expansion to protect and sustain greater than 10% of most representative marine ecosystems.**	Assessment completed with accompanying plan and recommendations for implementation
2015	**The revision of the National Parks Systems Act (1981) to a comprehensive National Protected Areas System Act**	A comprehensive Act with accompanying action plan
2015	**Formalization of co-management agreement between GOB and CBOs and NGO partners for the shared management of Protected Areas**	Legal co-management agreement between Government of Belize and co-management partners

2016	**National Roll-out of Managed Access**	Catch share fisheries management tool piloted and implemented nationally. The goal is to implement a territorial user rights fishery management to end overfishing by empowering fishers to become stewards of their fishing areas and improving their livelihoods
2016	**Institutional restructuring and realignment of the Protected Areas Conservation Trust (PACT) to better carry out its legal mandate.**	Resulted in targeted financing for high value and high biodiversity protected areas in Belize.
2018	**Mangrove Protection Act revised and enacted.**	Allow for more stringent measures and restrictions on cleaning of mangroves.
2016	**Enactment of the Integrated Coastal Zone Management Act and Plan**	A plan for implementation was simultaneously developed.
2018	**Enactment of a moratorium on Off shore Oil**	Further secures integrity of BBRRS-WHS
2018	**The removal of Belize Barrier Reef Reserve System World Heritage Site (BBRRS-WHS) off UNESCO's List of World Heritage Sites In Danger**	As of June 2018, Belize's BBRRS-WHS off UNESCO's List of World Heritage Sites Ii Danger
2018	**Government of Belize officially commitments to the Phase-out of single use plastic grocery bags, food utensils, and Styrofoam take out containers by April 2019.**	This is a positive action by GOB to combat marine pollution.

2. Current Situation of Belize's MPAs

2.1 Summary of the Marine Protected Areas of Belize

Marine and terrestrial protected areas are key repositories of vital ecosystems and natural resources for sustainable development (National Protected Areas Policy and System Plan, 2005). Protected areas, both extractive and non-extractive, represent approximately 36% of Belize's terrestrial areas and 21.74% of its marine area (Technical Report, National Replenishment Zone Expansion Project, TNC). Along the Belize Barrier Reef the largest reef system in the western hemisphere, and second only to the great barrier reef of Australia, there is a high level of biodiversity including extensive mangrove forests, coral reefs, sea grass and sand cayes that supports a thriving population of conch, lobster and fin fish. These ecosystems together are highly valued by Belizeans for their economic and socio-cultural values.

Table 2: Listing of MPAs and area of territorial seas under protection

PROTECTED AREA	MANAGEMENT / CO-MANAGEMENT AGENCY	YEAR ESTABLISHED	AREA (ACRES)
Bacalar Chico Marine Reserve	Fisheries Department	1996	15,529
Blue Hole Natural Monument	Forest Department / Belize Audubon Society	1996	1,023
Caye Caulker Marine Reserve	Fisheries Department	1998	9,670
Corozal Bay Wildlife Sanctuary	Forest Department / Sarteneja Alliance for Conservation and Development	1998	178,000
Gladden Spit and Silk Cayes Marine Reserve	Fisheries Department / Southern Environmental Association	2000	25,978
Glover's Reef Marine Reserve	Fisheries Department	1993	86,653
Half Moon Caye Natural Monument	Forest Department / Belize Audubon Society	1982	9,771
Hol Chan Marine Reserve	Fisheries Department	1987 / 2014	102,400
Laughing Bird National Park	Forest Department / Southern Environmental Association	1996	10,119
Port Honduras Marine Reserve	Fisheries Department / Toledo Institute for Development and Environment	2000	100,000
Sapodilla Cayes Marine Reserve	Fisheries Department	1996	38,594
South Water Caye Marine Reserve	Fisheries Department	1996	117,875
Swallow Caye Wildlife Sanctuary	Forest Department / Friends of Swallow Caye	2002	8,972
Turneffe Atoll Marine Reserve	Fisheries Department / Turneffe Atoll Sustainability Association	2012	325,412

Prior to 2012, only 13% of Belize's territorial waters was under protection (through established marine reserves). Consequently, the largest of the three atolls found in Belize, Turneffe Atoll, was declared a marine reserve in 2012 and brought the total area under protection to just over 20% and allowed Belize to achieve its target of at least 20% of territorial seas under protected status. This is noteworthy and signals Government's commitment to the sustainable management of marine resources in Belize. While the United Nations Convention on Biological Diversity

(CBD) Aichi Target 11, set in 2010, only calls for 10% of marine areas to be conserved. Belize has long surpassed this goal and is making progressive steps towards another target set by the IUCN World Parks Congress in 2014, that recommends a representative network of MPAs should include strictly protected areas that amount to at least 30% of each marine habitat (Technical Report, National Replenishment Zone Expansion Project, 2012). To demonstrate this, the Fisheries Department collaborated with The Nature Conservancy in Belize, to undertake a study with the objective to further increase the managed "no-take zones" from approximately 3% to 10% of most representative marine ecosystems. While the exercise has been completed, there is also an ongoing effort by the Fisheries Department and other MPA managers towards rebranding "no-take zones" within MPAs to "replenishment zones" in hopes of better communicating their benefits to fisheries management, conservation of target species (such as conch, lobster, grouper/snapper complex) and ecosystems functions. (Economic Alternatives and Fishers Diversification Plan, 2012)

In an effort to improve the management of its marine resources Belize has been progressive in the use of the ecosystem-based approaches to management; including the use of marine protected areas (MPAs), protection of fish spawning aggregations, open and close season for commercially important species such as conch and lobster, a ban on trawling, protection of herbivorous reef fish and a rights-based approach to fisheries management called managed access. Together managed access and replenishment zones are created to help secure viable population and protecting vital habitats.

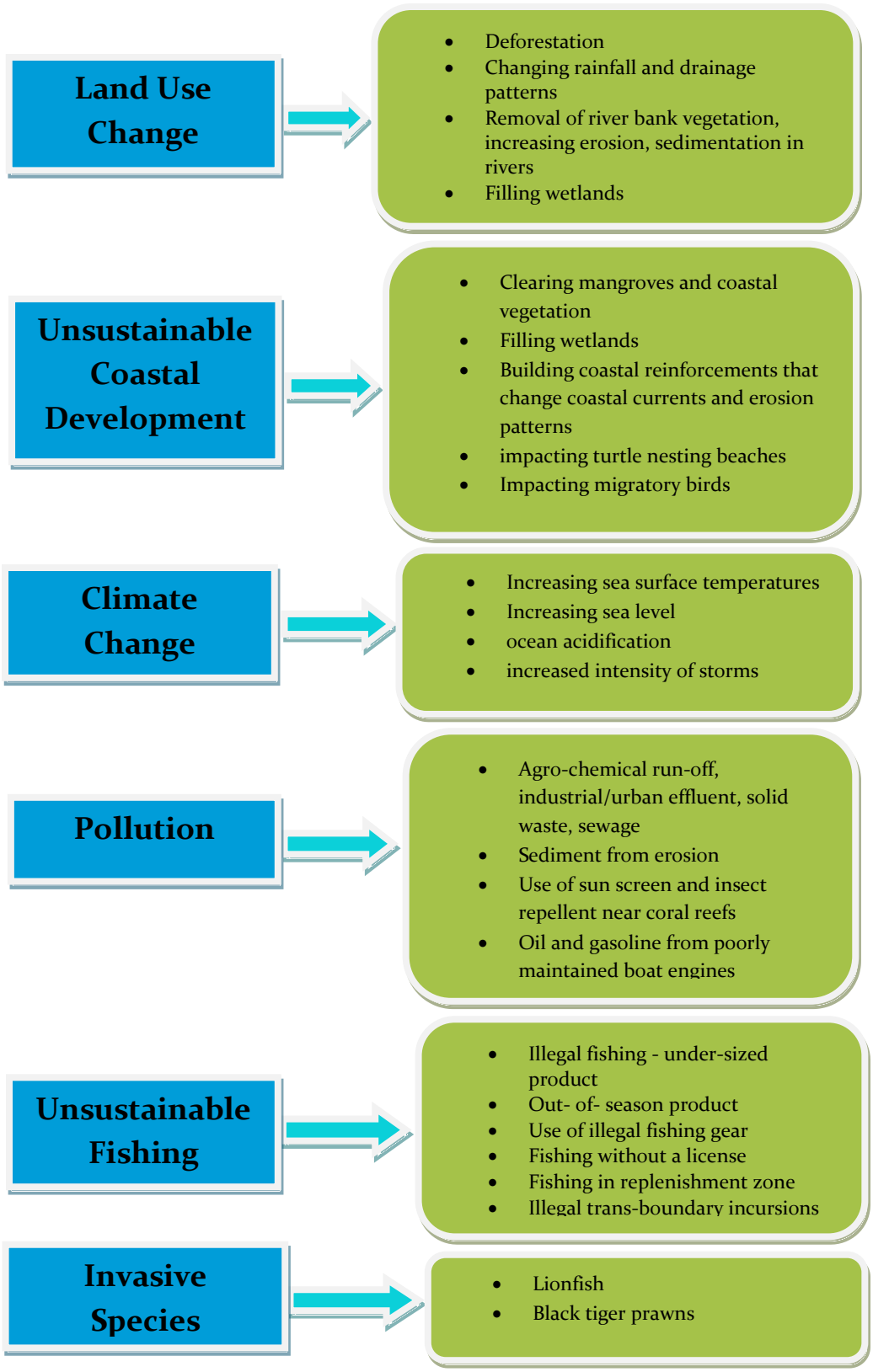
2.2 Threats

Threats to marine and coastal ecosystems in Belize range from overfishing, to agricultural run-off and unsustainable coastal development. A recent study conducted in 2016 by Wildtracks for the compilation of the Marine Protected Areas Atlas of Belize, showed the remarkably high number of threats to be tracked.

While the threat of climate change stares us in the face, others like land use change, and unsustainable fishing continue to mount with each passing year. According to the Healthy Reefs for Healthy People, reef report card 2018, one key finding states that, new management regimes are being implemented in the Mesoamerican Reef region to restore herbivore, nonetheless, strong efforts are needed to reduce nutrient pollution to combat microalgae proliferation. These threats can only be managed through continuous collaborative spirit, political will and regional action.

Graphic 1 below, summaries major threats to Belize's marine and coastal regions.

Graphic 1. Threats to Marine and Coastal Areas in Belize



Source: MPA Atlas Belize, Wildtracks

3. The Future of Belize's MPAs and other Protected Areas

The future of marine protected areas in Belize is looking positive in all respects. Nonetheless, the Government of Belize must continue to foster an enabling environment of collaboration and lead the way in creating comprehensive legislative and regulatory frameworks for sustainable management of marine and coastal resources. It has been demonstrated through resent successes, that a broad sector partnership approach strengthens the ability for future environmental sustainability in the marine environment.

In reference to written national development agendas and commitments, Belize is in no way delinquent. The Government has conceded to the invaluable benefits of the marine environment of Belize through its Growth and Sustainable Development Strategy and its accompanying Belize National Development Plan- a component of The Horizon 2030 Strategy. This strategy, speaks directly to the urgency and need for priority management actions. In Action 3.1.5., Marine and Aquatic resources states: Belize's marine and aquatic resources are among its most valuable assets, both for tourism and for provision of fish and other economic benefits. Actions to protect, sustain and sustainably use these resources are of the highest priority.

In addition, international comments to various Multi-lateral Environmental Agreements (MEAs) has led to the development of various strategic plans designed to protect biodiversity and ecosystems. One such case is the development of a National Biodiversity Strategy and Action Plan (NBSAP) as a commitment to the CBD. Goal B of the NBSAP states: "*Direct and indirect pressure on Belize's marine and freshwater and terrestrial ecosystems are reduced to sustain and enhance national biodiversity and ecosystem services"*. Likewise, Target B1 states, "*By 2020 primary extractive natural resource use in terrestrial, freshwater and marine environments is guided by sustainable management plans, with improved biodiversity sustainability"* (Marine Protected Areas Atlas of Belize, Wildtracks).

Our present position and successes in MPA management, is largely due to the Government's recognition of the significant contribution of advocacy groups, community-based management organizations, conservation organizations, co-management partners, fishers, tourism stakeholders and funding organizations towards the long term sustainability of our marine environment. As we move forward this is key to note. Together, these diverse stakeholder groups have inspired and continuous to lead various management regimes such as Managed Access as a rights based fisheries management tool, the moratorium on Off-shore Oil exploration, the national ban on fishing parrotfish and maintaining a healthy ridge to reef connectivity through an established network of high value and high biodiversity protected areas.

II. Estimated Economic productivity /ha/yr for Lighthouse Reef Atoll with a focus on Half Moon Caye.

4. Overview of LHRA

4.1 Lighthouse Reef Atoll

Lighthouse Reef Atoll is considered one of the best-developed coral atolls in Caribbean and two of Belize's best managed protected areas lie within. A well-developed coral barrier and interior lagoon patch reefs provide habitat for a diverse assemblage of about 289 species reef fish, commercially important lobster, conch, and sportfish (bonefish and permit) from which the tourism industry benefits. Open oceanic influences contribute to fish diversity and presence of pelagic species as well as two key fish spawning aggregation sites. With its distance from the mainland, Lighthouse Reef Atoll has been recognized in the past for having some of the least impacted reef areas in the region; however, still faces threats such as rising sea temperatures, coral disease, increased macroalgal cover, unsustainable fishing practices and invasive lionfish. Through the development of the last Management Plan for HMCNM and BHNM 2017-2021, the four most critical threats highlighted for these protected areas are:

1. Unsustainable fishing on the Atoll (including recreational / sport fishing)
2. Tourism impacts - Diving and Snorkeling, Boat impacts
3. Introduced Species (Coconuts, rats and lionfish)
4. Development impacts from adjacent cayes

4.2 Half Moon Caye Natural Monument and Blue Hole Natural Monument

As noted in the recent Management Plan, Half Moon Caye Natural Monument designated in 1982 provides important representation of both deep water and littoral forest ecosystems, and as such is an important component of the National Protected Areas System (NPAS). The Blue Hole Natural Monument designated in 1996 provides representation of unique geologic features and habitat for sharks and possible unique assemblage of endemic and cryptic species. The white-lined toadfish, a rare and cryptic fish, has been observed here. Together these protected areas being managed as "no-take" replenishment zones, Half Moon Caye and Blue Hole Natural Monuments provides an invaluable ecosystem services.

The Half Moon Caye itself was first declared as a protected area in 1928 in recognition of its importance for the nesting colony of white-phase red-footed boobies, along with a large number of magnificent frigatebirds. The caye is also important for representation of littoral forest, one of the most threatened ecosystems in Belize. The south-east facing beach on Half Moon Caye is important for sea turtles - loggerhead, green and hawksbill turtles have all been recorded nesting there. The reef, including the spectacular Half Moon Caye wall (where the Atoll walls drop away into the deeper water), is highlighted for the density and diversity of both corals and fish, leading

to its identification as one of Belize's most highly valued dive sites. Eight miles to the north, Blue Hole Natural Monument protects the geological formations found within the sinkhole – the Blue Hole attracts divers from all over the world to Belize for the opportunity to explore the unique features. Both Half Moon Caye and Blue Hole Natural Monuments have been designated as components of the Belize Barrier Reef Reserve System - World Heritage Site, in recognition of the uniqueness of their contribution to Belize's reef system, the largest, and possibly the least impacted reef complex in the Atlantic–Caribbean area.

Also highlighted is the remarkable biodiversity and beauty of the two protected areas, and their value as a scientific resource, importance in protecting threatened species, and in providing a management tool for ensuring the continued viability of commercial marine fisheries (Wildtracks, 2016 cited in WWF, 2002).

The other islands within the atoll Sandbore and Northern in the north along with Long Caye and Hat Caye in the south add additional value and unique features to the LHRA. These islands account for all the mangrove forests found within the atoll as none is found on Half Moon Caye. Together they add up to 690.43 hectares.

5. Environmental Services of the Protected Areas

5.1 Environmental Services of LHRA

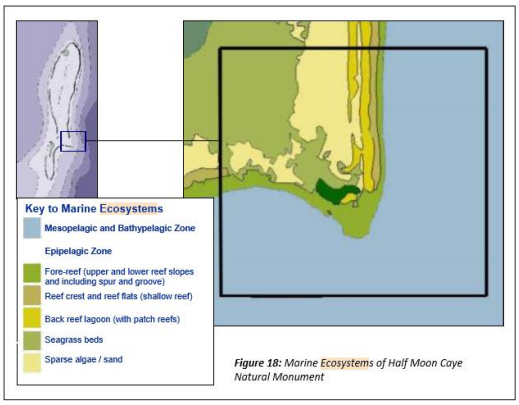
Whilst the two protected areas themselves are small in size, and therefore limited in the environmental services they provide, they are part of the larger Lighthouse Reef Atoll, with mangrove cayes, coral reefs and seagrass providing key interconnected ecosystems critical to the long term viability of marine resources of the area. The close connectivity of mangroves, whilst not within the protected areas themselves, is vital to maintaining the productivity of the coral reefs and seagrass beds of the central lagoon and Atoll wall. The Atoll provides a number of environmental services, supporting livelihoods and protecting lives. The environmental services include---regulation of storm impacts, recruitment of key commercial species, cultural and socio-economic benefits and support for marine life (Wildtracks, 2016).

6. Ecosystems in LHRA

Lighthouse Reef Atoll is dominated by marine ecosystems – coral reef, seagrass, sparse algae / sand and open sea. Five cayes are dotted throughout the Atoll, supporting terrestrial ecosystems with varying levels of human impact. Within the boundaries of the two protected areas, marine ecosystems dominate, with Half Moon Caye being the only representation of terrestrial ecosystems.

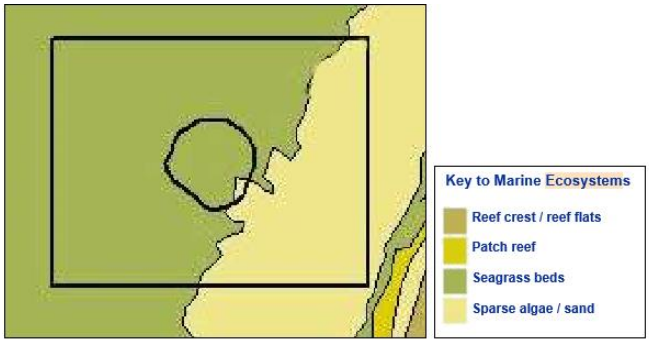
Map 1: Marine ecosystems of Lighthouse Reef Atoll

The marine environment of Half Moon Caye Natural Monument spans the range from the Epipelagic to Bathypelagic zones, including not only a part of the Atoll lagoon, but extending beyond the reef crest, best formed on the eastern wall of the lagoon, north of Half Moon Caye. This wall plunges steeply down to the east into the deep, Caribbean waters. A similar profile also occurs to the south of the caye, and is exemplified by the Half Moon Caye Wall, one of the premier reef sites in the World (Wildtracks, 2016)



Map 2: Marine ecosystems of HMCNM

Blue Hole Natural Monument lies entirely within the Epipelagic Zone, being within the Atoll lagoon and not extending beyond the Atoll wall. Almost perfectly circular, with a diameter of approximately 320m at the upper rim, and hourglass shape in cross section, and an estimated 124m deep the Blue Hole tells a geological history of eustatic changes in sea level, and inundation cycles of both salt and freshwater (Wildtracks, 2016 cited in Jones et. al. 2000). The sink hole is surrounded by an almost complete coral rim, which breaks the surface in places. Within the Blue Hole itself the collapsed cave system supports only a limited amount of marine life in comparison to the coral rim- with filamentous algae, boring sponges, cornflake algae and isolated gorgonians. (Wildtracks, 2016).



Map 3: Marine ecosystems of BHNM

6.1 Status of Ecosystems in LHRA

6.1.1 Corals

Percentage live coral cover at LHRA has declined dramatically, with live coral cover on the fore-reef declining from an average of 43.6% to 30.7% between 1997 and 2004 (Wildtracks, 2016 cited in McField, 2001; Graham et al, 2004), and an average of between 25 and 30% in 2015. By 2004, algae was more prevalent on the fore-reef than live coral cover (Wildtracks, 2016 cited in Graham et al, 2004). This was particularly true of the vulnerable patch reefs within the Atoll lagoon which experience higher water temperatures, less flushing, less larval transport, greater fishing pressure and a greater range of environmental conditions than the fore-reef. Macroalgal cover on Lighthouse Reef Atoll was shown to have increased from 9.4% in 1997 to 24.68% in 2004 on the fore-reef, and to an average of 68.5% macroalgae coverage on the patch reefs (Wildtracks, 2016 cited in Graham et. al., 2004). In 2016, macro-algal cover on the BAS survey sites averaged increased from 10-15% in 2015 to 20% in 2016 (HRI, 2018). A coverage of 59% of Belize's coral reefs are currently rated as Poor or Critical health, but this is improvement from 2015. There was an increase from 4% to 12% of our reefs considered in Good health, and still 0% in Very Good health, based on a survey of 94 sites across the country, including Lighthouse Reef Atoll (HRI, 2018). In 2016, Lighthouse Reef rated as Fair, with a Reef Health Index (RHI) of 3.3 which was an improvement from 2015 at Poor and 2.3 RHI respectively.

6.1.2 Mangroves & Littoral Forests

Two terrestrial ecosystems are recorded for Half Moon Caye (Meerman et al., 2004):

1. Tropical coastal vegetation on recent sediments (including both littoral forest and herbaceous beach vegetation)
2. Woody perennial crops (in the form of the coconut plantation)

Historically, anecdotal reports suggest that a further two ecosystems once occurred on Half Moon Caye (Coastal fringe Rhizophora mangle - dominated vegetation and Mixed mangrove scrub (Wildtracks, 2016 -Verde J. pers. com.)), both of which were eradicated by human activity. These ecosystems do occur elsewhere on the Atoll, associated with other cayes of the area, and are critically important for maintaining the health of the marine ecosystems and species of the Atoll. Littoral forest and herbaceous beach communities (Tropical coastal vegetation on recent sediments) are significantly under-represented within Belize's National Protected Areas System (Wildtracks, 2016 cited in Meerman, 2005; Walker et al., 2013). Of the estimated 16,820 ha of national coverage, only 8.5% lies within protected areas (below the national target of 10%), of which 2.7% is protected by Half Moon Caye Natural Monument. This presents a very significant shortfall in view of the Tropical coastal vegetation on recent sediments importance of this ecosystem in maintenance of cayes, with caye vegetation playing a critical role in stabilization of the caye beaches, prevention of erosion, in providing habitat for endangered species, anchoring of turtle nesting beaches, supporting refueling in migratory birds, and in the maintenance of island specialist species such as the Allison's anole and the island leaf-toed gecko.

Red mangrove (*Rhizophora mangle* occurred historically on the northern shore of the western half of Half Moon Caye (J. Verde, pers. com.), but was extirpated prior to the 1960's. Historically, coastal fringe red mangrove may have occurred along much of the north and northwest beaches of the Caye, and probably also along significant portions of the more exposed southeast and easterly beaches. Despite the key role played by this ecosystem in terms of erosion control and as a critical fisheries nursery area, these coastal fringe mangroves would have been targeted for clearance by the earlier settlers on the caye. By 1962, only red mangrove seedlings were reported, with no established mature stands (Wildtracks, 2016 cited in Stoddart, 1962). Surprisingly, whilst red mangrove propagules are seen relatively commonly floating along the sheltered northwest coast (thought to originate from Long Caye), very few have become established, with mangrove propagules being removed by wave action associated with storm events.

Mangroves are, however, present on other cayes on the Atoll. Long Caye has a policy of not removing mangroves. Both Hat Caye and Northern 2 Cayes have some small mangrove removal – Hat Caye generally as a result of the establishment of fishing camps, and Northern 2 Cayes as a result of development interests. Sandbore Caye once supported mangroves, but recent development interests have resulted in their removal.

7. Estimating the Economic Productivity/ha/yr for LHRA with a focus on HMC

As noted above, HMCNM and BHNM are composite sites within Belize's World Heritage Site. These two sites that lie within the LHRA contribute to the outstanding universal value our WHS provides to the world. The rich biodiversity of LHRA makes it a key location and highlights the fact that the protected areas act as the cornerstones that deliver a broad range of social and economic benefits (WWF, 2017). A study completed by WWF in 2017, showed that four of the 7 protected areas that are a part of the WHS provide up to US$19M/yr. in economic benefits from tourism recreation of which HMCNM and BHNM provide US$5.8M/yr.

The contribution of coral reefs and mangroves to Belize's fishing industry, through the provision of habitats for almost all commercially caught species, is estimated at US$14-16 million/year. In an effort to estimate the benefits that corals and mangroves provide as well as estimating the benefits from other ecosystem services from HMCNM and BHNM, the World Resource Institute's (WRI) economic valuation methodology was used to look at direct economic benefits provided by the coral reef and mangroves, but does not attempt to calculate Total Economic Value (TEV) (Weiner, 2013). Rather, the Ecosystem Value Transfer (EVT)/Benefit Transfer Method (BTM) was used to calculate the estimates for HMCNM and BHNM. These estimates range from hundreds to trillion of dollars.

For this activity a median value developed by Richard Huber of the Organization of American States of $550,000 USD ($/ha/yr) was used as rate for mangroves, and $60,000 USD ($/ha/yr) rate for coral reefs is used based on a conservation mid-range average of a low/high of

$200,000/$900,000 USD ($/ha/yr) for mangroves and $20,000/$100,000 USD ($/ha/yr) for coral reefs. The BTM values which have already been estimated for similar ecosystems were just extrapolated for these sites and modeled from those developed by Richard Huber (Weiner, 2013).

The values used for mangroves and coral reefs ecosystem services were ranked against each other using ecosystem services vs. condition of resources (values in US Dollars (USD)). The rank of the condition of these ecosystems was derived from the 2017 assessment of LHRA via the Conservation Action Planning Process for the development of the Half Moon Caye Natural Monument & Blue Hole Natural Monument's Management Plan 2017-2021. The data on the extent of each ecosystem type was sourced from the abovementioned management plan and mapping calculations from GIS.

	Ecosystem Type	
Condition	**Mangroves ($)**	**Coral Reef ($)**
Poor	200,000	20,000
Fair	400,000	40,000
Good	600,000	60,000
Excellent	900,000	100,000
Source: Huber, R.,OAS,2013		

The total value of the ecosystem services by site (mangroves and coral reefs) within the LHRA and more specifically for Half Moon Caye Natural Monument is noted in the table below. The value of the ecosystem services within the entire LHRA for Mangroves is over US$379 million with listed condition as good; Coral Reef is over US$204 million considering that the condition is currently listed as fair while the value of the beaches on the islands is over a million USD with good condition. Highlighting only Half Moon Caye Natural Monument, the value of the ecosystem services the coral reef within the protected area is valued at is over US$13 million while the beach is valued at almost a million USD. It is interesting to note that Half Moon Caye historically did have mangroves, but they no longer exist on the island thus not factored into the ecosystem services calculations.

Table 3: Total value of ecosystem services by site for LHRA

Entire LHRA		Using Average Value (Huber, R. OAS 2013); #s are subjective/conservative to a certain extent		Condition of resources based on viability rank for these conservation targets as per Conservation Action Plan for HMC 2017
Ecosystem	**Total Area**	**$/ha/yr rate**	**Total**	**Condition**
Mangrove- Sandbore, Northern, Long Caye, Hat	690.43	550,000	379,736,500.00	Good
Coral	3414	60,000	204,840,000.00	Fair
Beach	20.85	88,000	1,834,800.00	Good

T**able 4:** Total value of ecosystem services by site for HMCNM

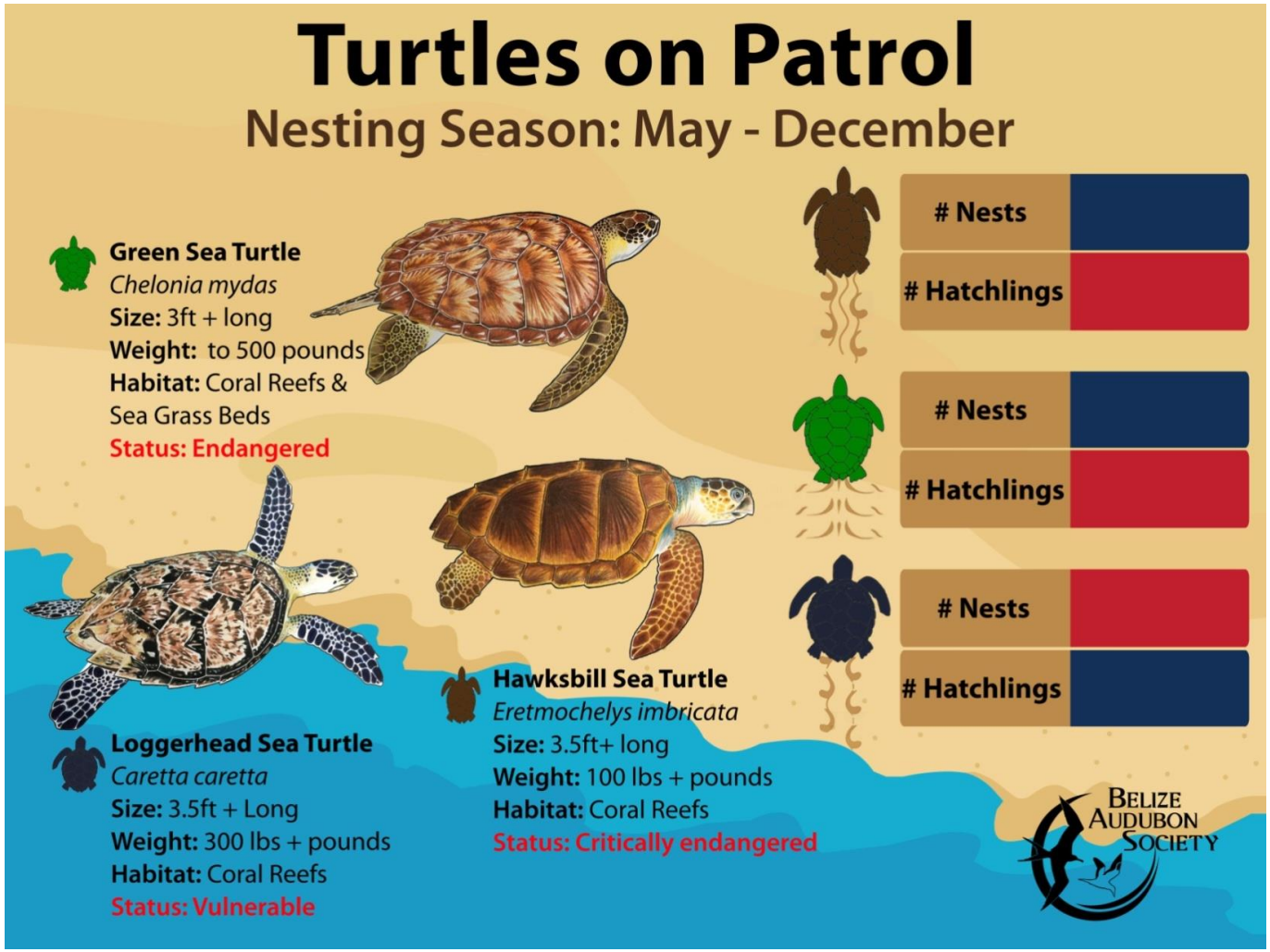
HMC only		Using Average Bound Value (Huber,R. OAS 2013); #s are subjective/conservative to a certain extent		Condition of resources based on viability rank for these conservation targets as per Conservation Action Plan for HMC 2017
Ecosystem	**Total Area (ha)**	**$/ha/yr rate**	**Total**	**Condition**
Mangrove- Half Moon Caye	0	550,000	-	-
Coral	226	60,000	13,560,000.00	Fair
Beach	10.52	88,000	925,760.00	Good

III. Infographics

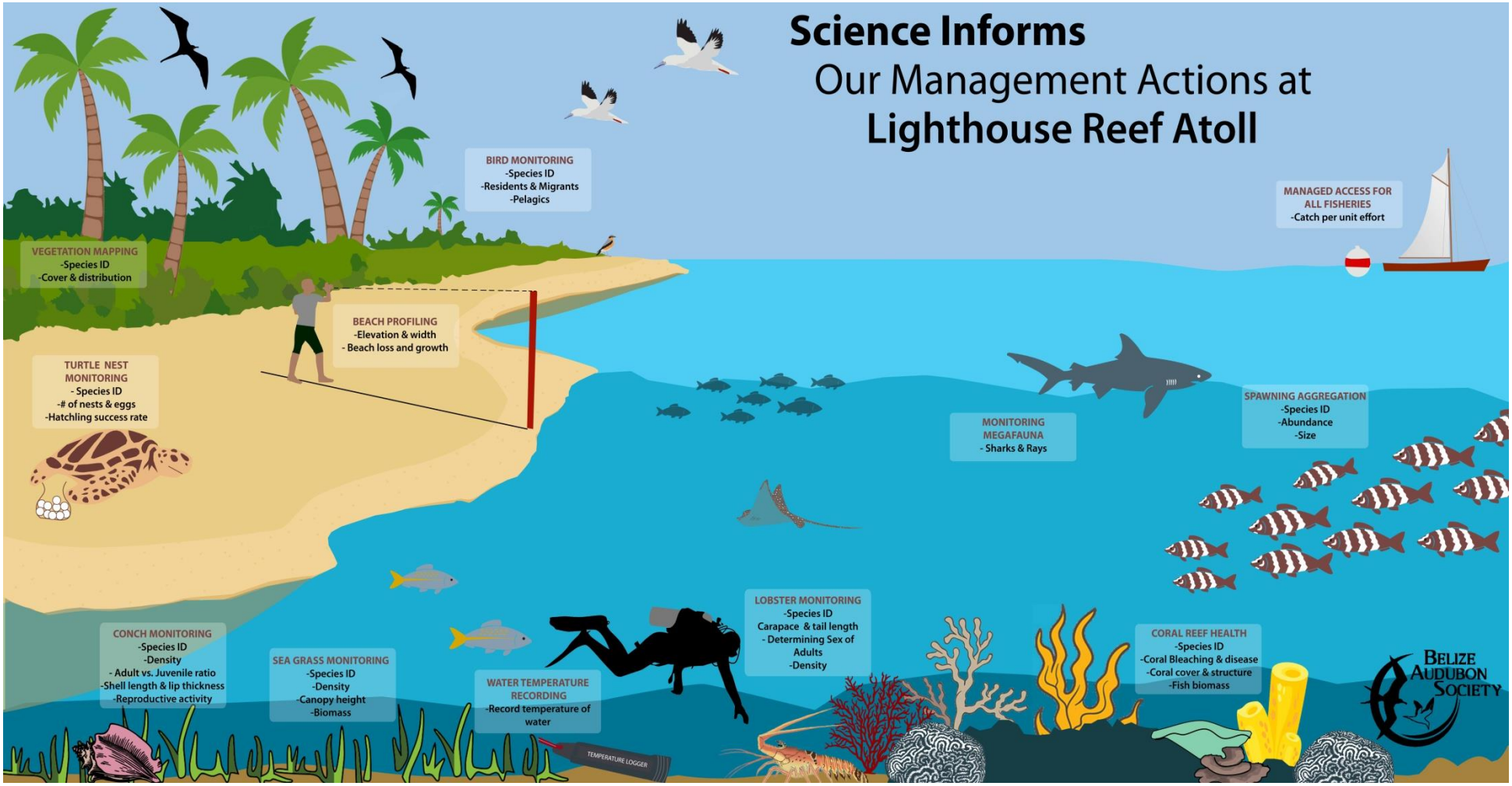
8. Info graphics

1- Turtle nesting data and educational sign for visitors of HMC

This sign will be printed on a 3 feet by 4 feet metal sheeting in full color and erected at HMC. The marine biologist will update the numbers to ensure site staff and visitors have information on turtle nesting season. **Please note this is a draft**



2- Summary of biophysical monitoring at Lighthouse Reef Atoll. This info graphic will be printed as a sign and erected next to the "gazebo" at HMC. This gazebo is used for lectures and educational talks with students and visitors to the island. This info graphic will aid staff/rangers to effectively communicate and summarize the biophysical monitoring activities at HMC. In addition, the info graphic will also be printed as a poster/banner for the education and outreach team to use at open days, Reef Protector Program and Boat to Boat Outreach Program targeting fishers. **Please note this is a draft**



Pending info-graphics

1.) Spawning Aggregations (SPAGS) in Belize (fishers and students)

2.) Common Birds of HMC (staff and visitors to HMC)

3.) Life history: conch and lobster (target fishers and students)

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