Lighthouse Reef Atoll Coastal Zone Management Guidelines

Photo Credit: Julie Robinson

Coastal Zone Management Authority & Institute
2016

Cite as:
Coastal Zone Management Authority and Institute (CZMAI). 2016. *Lighthouse Reef Atoll Coastal Zone Management Guidelines.* Belize Integrated Coastal Zone Management Plan. CZMAI, Belize City.

ACKNOWLEDGEMENTS

The process for developing the original management guidelines for the region, the Lighthouse Reef Cayes Region Development Guidelines, which had a specific focus on development issues, was possible with assistance from the following agencies and individuals **during 2003-2004**:

Agencies:
Archives Department
Belize Audubon Society
Belize City Council
Belize Port Authority
Belize Tourist Board
Department of Environment
Fisheries Department
Geology and Petroleum Department
Lands and Surveys Department
Ministry of Economic Development

Individuals:

Malikah Cardona	Ministry of Natural Resources
Anthony Andrews	Housing and Planning Department
Hannibal Torres	Hat Caye Caretaker
Elijio Tzul	Fisherman
Ivan Young	Sandbore Lighthouse Keeper
Tomas Sharp	Northern (2) Caye
Sharon Ramclam	Belize Audubon Society
Jackson Edwards III	Long Caye Land Owner
Omar Vasquez	
Leo Bassel	
Billie Leslie	
Ralph Fisher	
Allan Burns	
Ian Augustine	
Ramon Trujillo	
Robert Tucker	

The Lighthouse Region Coastal Advisory Committee (LRACAC), and other important interested individuals of the region, is acknowledged for their time commitments in revising and updating the coastal zone management guidelines for the region. These individuals are namely:

*** Indicates LRACAC member 2010-2011**

1. *****Rachel Graham	Wildlife Conservation Society
2. Sarah Pacyna	Wildlife Conservation Society
3. *****Elissa Gibson	Belize Port Authority (Chairperson)
4. *****Jackson Edwards III	Long Caye Land Owner/Developer (Treasurer/Fundraiser)
5. Blake Ross	Long Caye Land Owner/Developer
6. *****Julie Robinson	The Nature Conservancy (Vice Chairperson)
7. Pedro Alvarez	Belize Fishermen Cooperative Association
8. *****Arreini Palacio-Morgan	Belize Audubon Society
9. Shane Young	Belize Audubon Society
10. *****Billy Leslie	San Pedro Tour Guide Association
11. *****Marcel Eck	Discovery Expeditions Belize (Belize Aggressor III/Sun Dancer II
12. *****Allan Bevans-Green	Belize Fishermen Cooperative Association
13. Dwight Neal	Belize Fishermen Cooperative Association

CZMAI held a series of consultation meetings that were open to the general public during the mandatory 60-day public review period following the completion of the first comprehensive draft of the Belize Integrated Coastal Zone Management Plan document. The meeting for the Lighthouse Reef Atoll Region was held in Belize City on May 16, 2013, and had participation from the following individuals:

Public consultations 2013:

Cornallly Canto	University of Belize Student
Matthew James	CONCH
Rochelle Reneau	Belize Coalition to Save Our Natural Heritage
Nadia Bood	World Wildlife Fund
John Oliver	Belize Sailing Association
Leandra Cho-Ricketts	ERI-University of Belize
Jamal Galvez	CZMAI/S2S
Angeline Valentine	OAK Foundation
Nataly Castelblanco	Oceanic Society
Jackson Edwards	Long Caye
Julio Maaz	Wildlife Conservation Society
Arreini Palacio-Morgan	Belize Audubon Society
Shane Young	Belize Audubon Society
Julie Robinson	The Nature Conservancy

A final round of consultations was held July 7th 2015-September 7th 2015 as-the re-constituted CZMA Board of 2014 directed a re-opening of the public comment period.

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CBA	Central Building Authority
CZAC	Coastal Zone Advisory Council
CZMAI	Coastal Zone Management Authority & Institute
DOE	Department of Environment
EIA	Environmental Impact Assessment
GOB	Government of Belize
HRA	Habitat Risk Assessment
LRACAC	Lighthouse Reef Atoll Coastal Advisory Committee
LUA	Land Utilization Authority
Marine InVEST	Marine Integrated Valuation of Ecosystem Services and Trade-off
NSTMP	National Sustainable Tourism Master Plan
SWMP	Solid Waste Management Plan

GLOSSARY OF TERMS

Certain technical terms have been used in the text of these guidelines. The following represents an explanation of such terms that were not provided within the text.

Artisanal/Subsistence Fishing *means traditional fisheries involving fishing households (as opposed to commercial companies), using relatively small amount of capital and energy, relatively small fishing vessels (if any), making short fishing trips, close to shore, mainly for local consumption.*

Building Height *means the recommended maximum building height that should be allowed for each building to be measured from ground level to roof*

Building Setback *means the recommended minimum distance that should be allowed between buildings or between buildings and site boundaries*

Commerce *means the storage and retail of consumer goods*

Commercial Development *means land use involving the construction of a building or buildings that are used solely for commerce and business activities by the owners or others to the exclusion of all other uses within the density requirements of these guidelines*

Commercial Fishing *means the harvesting of fish, either in whole or in part, for sale, barter or trade.*

Conservation *means the retention of the natural features but with allowance of limited non-disruptive development*

Conservation Area *means areas including the 66ft reserve and other reserves, canal buffers, water bodies, flood prone lands; areas with ecological significance such as mangrove wetlands,*

Community Facilities *means Spaces set aside in large residential or commercial subdivisions for public purposes. They may include facilities such as public parking lots, schools, cemeteries, churches, public sporting areas, youth centers, police stations or health facilities*

Coverage *any building, including balconies and verandas, and expressed as a percentage of total lot size*

Density *means a level of development within a site, as measured by the number of lots per acre, number of dwelling units per acre, or maximum site coverage*

Development *means any activity which involves mining, engineering or building operations or change of use of land or building in, under, over or on land1*

Dwelling Unit *means a living area consisting of contiguous rooms intended for convenient, long-term occupancy by one family and providing complete, independent facilities for living, eating, cooking, sleeping and sanitation*

Fish camp *means a building that is permanently or temporarily used for ancillary housing, trap-making and storage, boar repair and docking by full or part time commercial fishermen as licensed by the Fisheries Department,*

Habitable Room *means any room except that used for a kitchen or bathroom*

Land *means all incorporeal hereditaments of every tenure or description that are either permanently or temporarily above the surface of the sea, whether through natural or man-made activity. The seabed, while not 'physical' land, is defined as National Land*

Liquid Waste *means grey water from bath, basin and sink and sewage waste that consist mainly from discharge of body waste.*

Lots *acre should be subdivided and alienated*

Low-Density Development *means development of a site that does not exceed 20 dwelling units per acre, 6 lots per acre and a maximum site coverage of 50 percent*

Low-Impact Development *means an ecologically-friendly approach to site development and storm water management that mitigates development impacts to land, water and air; through conserving natural systems and hydrologic functions of the site. Site development includes residential dwelling units and community facilities and impervious surface cover is a maximum of 30 percent of total cover*

Marina *means a mooring facility for four or more recreational vessels*

Maximum Human Carrying Capacity *means the maximum population size of humans that the environment can sustain indefinitely, given the food, habitat, water and other necessities available in the environment.*

Maximum Number of Floors *means the recommended maximum number of floors a building should have, including attics or roof space designed for habitation*

Maximum Number of Lots *means the recommended maximum number of lots in which an acre of land can be subdivided and alienated*

Maximum Habitable Rooms *means the recommended maximum number of rooms to be allowed and measured per acre of land*

Maximum Building Coverage *means the recommended maximum ground coverage of any building including balconies and verandahs and expressed as a percentage of total lot size*

Maximum Site Clearance *means the recommended maximum amount of land that should be allowed to be cleared and expressed as a percentage of the total site area*

Medium-Density Development *means development of a site that does not exceed 40 dwelling units per acre, 8 lots per acre and a maximum site coverage of 66 percent*

Medium-Impact Development *means an ecologically-friendly approach to site development and storm water management that mitigates development impacts to land, water and air; through conserving natural systems and hydrologic functions of the site. Site development includes a combination of residential dwelling units, community facilities and commercial activities, and impervious surface cover is a maximum of 50 percent of total cover*

Minimum Lot Size *means the recommended smallest size a parcel of land should be allowed to be alienated*

National Land *means all lands, including cayes and parts thereof not already located or granted and also includes any lands which have been, or may hereafter become, escheated to, leased by, or otherwise acquired by the Government;*

Piers per Site *means the recommended number of piers that should be allowed to be constructed on any site*

Primary Land Use *means the recommended preferred use of the site*

Residential Development *means land use that involves the construction of a building or buildings that are used solely for permanent or temporary domiciles by the owners or others on a non-commercial basis to the exclusion of all other uses within the density requirements of these guidelines*

Resort *means a building, buildings or site which offers accommodation and general amenities to visitors with other uses such as bars, restaurants, general storage and repair facilities and docking*

Secondary land Use *means the recommended next preferred use to be applied to the site either in conjunction with the primary land use or as an alternative to the primary land use if that is not applicable*

Solid Waste *means any unwanted material that is useless, thrown away or discarded*

Swamp *means an area of very shallow lagoon with mud, savannah or very low vegetation*

Utility *means the service and infrastructure used for the supply of energy, water, communication and waste disposal*

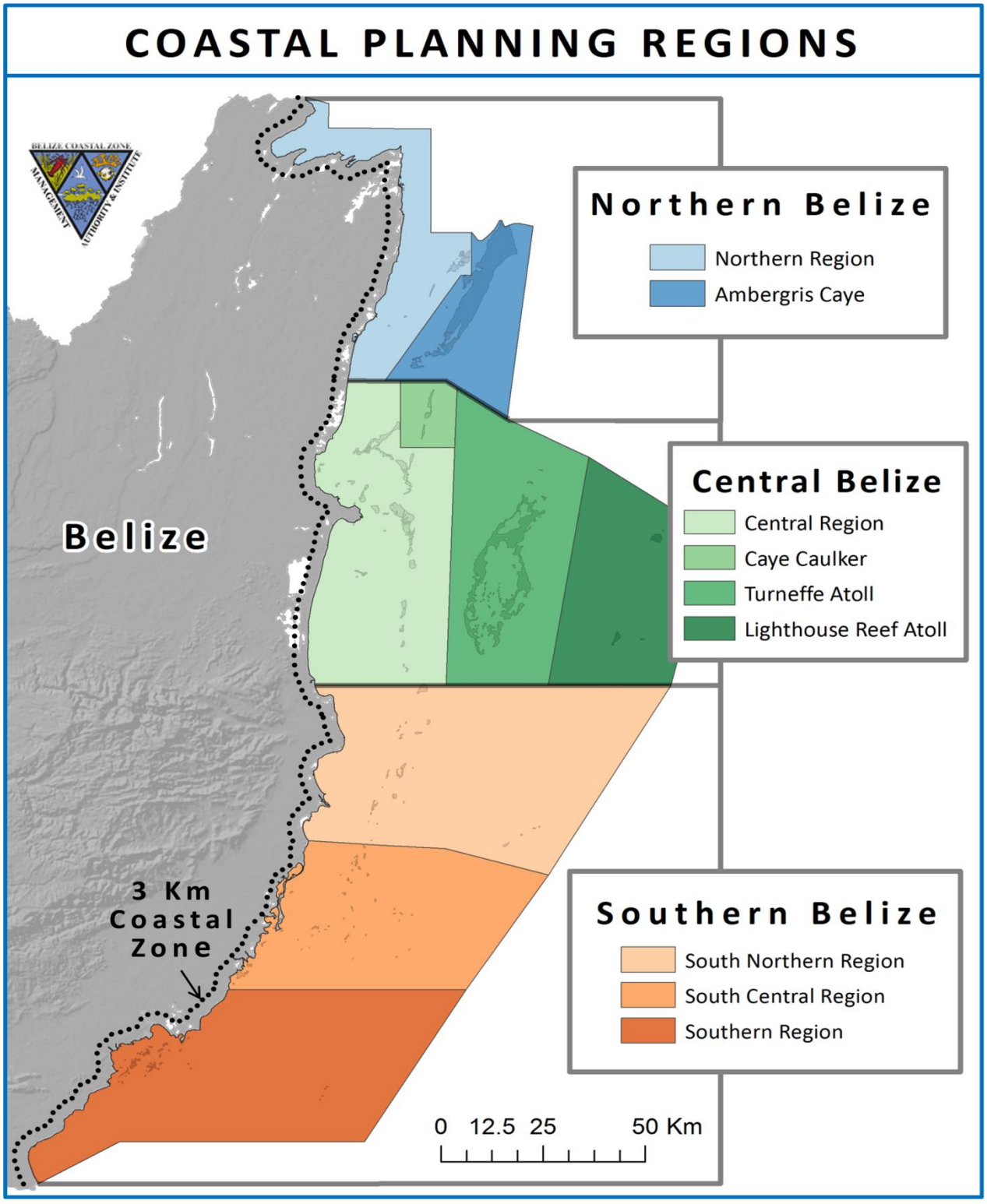
PREAMBLE

The Belize Coastal Zone Management Authority and Institute (CZMAI), a statutory body established by the Coastal Zone Management (CZM) Act of 1998, is tasked with the broad responsibility of assisting with the development of policies, strategies and guidelines for the improved management and sustainable use of the country's coastal resources at a national level.
In keeping with its mandate to prepare an integrated coastal zone management plan, the agency has developed regional coastal zone management guidelines to provide support for planned development and resource management along the coastline and offshore areas of the entire country. These guidelines have been prepared for nine (9) coastal planning regions (**Map 1**), which were demarcated based on commonalities, geographic definition and regional characteristics. The coastal zone management guidelines will help to integrate management efforts across the land-sea interface.

The Lighthouse Reef Atoll Region Coastal Zone Management Guidelines were developed in conjunction with the stakeholders of the communities within the Lighthouse Reef Atoll Region. The Lighthouse Reef Atoll is relatively undeveloped and known for its fishing and internationally known natural wonders. Using the expert subjective information from stakeholders in addition to the best available objective data, CZMAI was able to produce this guideline with the following goals:

1. Encourage and promote the sustainable development of areas within the Lighthouse Reef Atoll Region that will promote economic growth while simultaneously ensuring ecosystem stability and the efficient delivery of ecosystem services.
2. Protect and preserve the traditional way of life of the stakeholders within the Lighthouse Reef Atoll Region
3. Ensure sustainability of coastal resources by identifying areas in need of conservation and reducing user conflicts

These goals are culturally informed, and rooted, where possible, on sound science and local knowledge. These guidelines represent the views and recommendations of the stakeholders of the Lighthouse Reef Atoll Region. They are also a response towards addressing the management gaps identified by stakeholder communities through an extensive consultation process. The coastal zone management guidelines will ensure that human use of the coastal region occurs in consideration of the carrying capacity of the environment in addition to other ecological, cultural, social and economic development priorities of the region. These guidelines will aid policy development for integrated coastal zone management. They will be implemented by all those agencies that have legal mandates and/or permitting powers that impact resource utilization in the coastal zone of Belize, in partnership with this region's stakeholder groups.



Map 1: Coastal Planning Regions of Belize

1.0 INTRODUCTION

The Lighthouse Reef Atoll is made up of five (5) islands, strung in a north to south direction in a semicircular formation and comprising almost forty thousand acres of terrestrial and aquatic environment including flats and reefs. The cayes of the region can be seen in Table 1.

Table 1: Cayes within the Lighthouse Reef Atoll Planning Region

Cayes	
Northern (2) Caye	Sandbore Caye
Hat Caye	Long Caye
Half Moon Caye	

Development intensity varies within the region with Northern (2) Caye and Long Caye being the most developed and Half Moon Caye being the most utilized. The two other cayes are fairly undeveloped have little to no development and related structures on them. The region boasts rich biodiversity, both in the terrestrial and aquatic provinces. The species range from corals to fishes, conch to sea turtles, and birds to dolphins. Mangroves, sea grasses and palms are also found in this region. The main economic activities of the region are fishing and tourism, the latter focused on Northern Two Caye, Long Caye and Half Moon Caye.

While most of the land is elevated and its soil profile makes it suitable for development activity, the ecological sensitivity and vulnerability of the region and its national and international scientific significance, directs that future development of the region be more toward conservation and low intensity residential activity. The latter is intended to accommodate existing property rights. These coastal zone management guidelines will help to ensure the continued sustainable use and management of the region.

Undoubtedly, there are a number of users of the Central region, namely, fishermen, vacationers, tourists, tour Guides, developers, hoteliers, each pursuing differing purposes, some complimentary, while others conflicting. This is within a region that is characterized by varying geomorphic and physical characteristics, defined by a habitat that is ecologically vulnerable and one which supports a diverse population of species, some endangered. While there exist some form of legislative and institutional mechanisms to support implementation of these guidelines, these are undermined by legislative deficiencies and centralized and under resourced institutions.

2.0 REGION BOUNDARIES

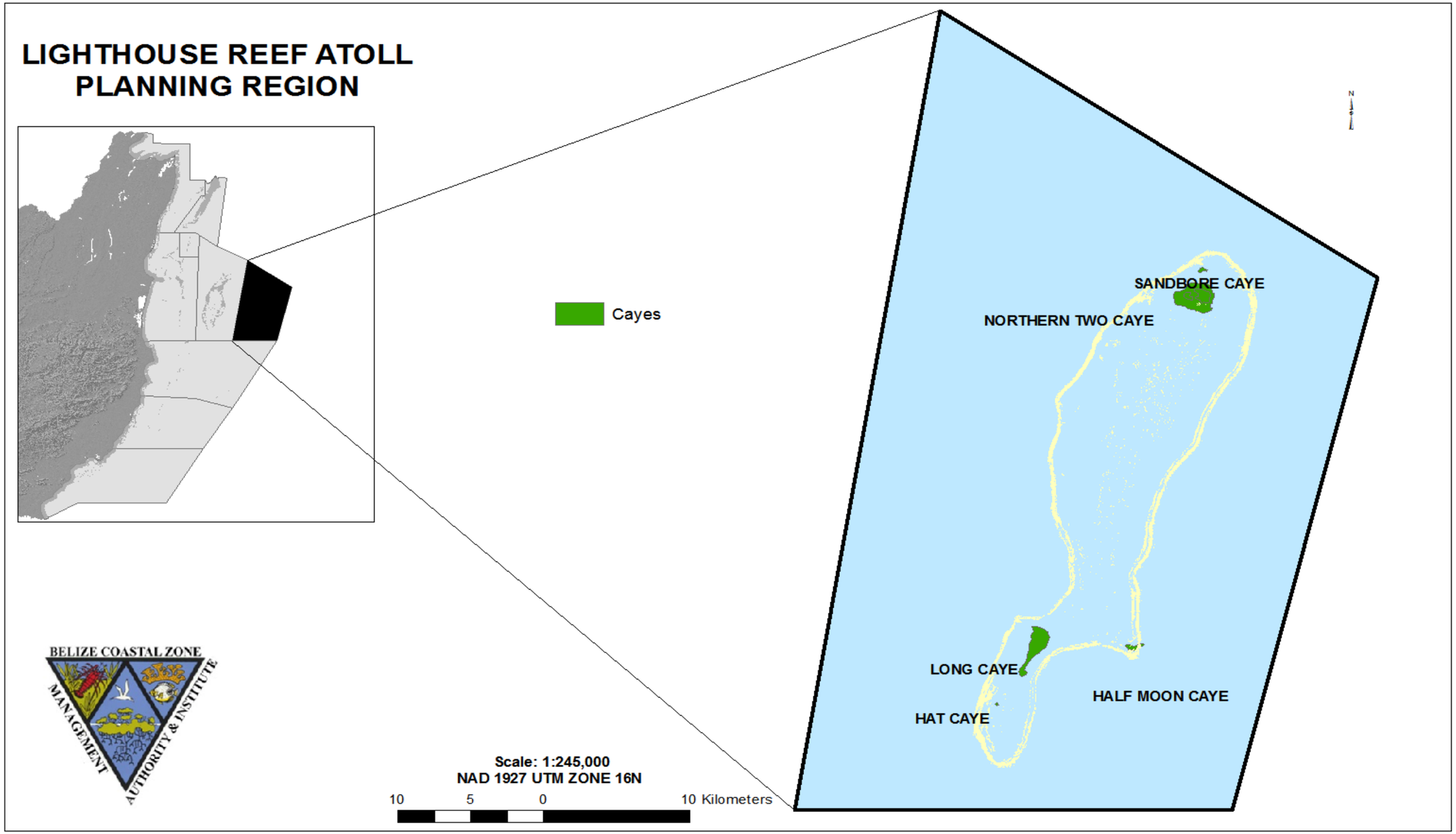
Location and Geographic Definition

The Lighthouse Reef Cayes Region for which these guidelines have been prepared is one of nine regions into which the coastal zone has been demarcated (**Map1**). It encompasses approximately 1600.5 sq. kilometres of land and sea and can be described as the area enclosed within the following UTM 16 coordinates. South East of the Ambergris Caye and Caye Caulker Regions, East of the Turneffe Cayes Region, and North of the Dangriga Cayes Region. **(See Maps 2, 3 and 4)**

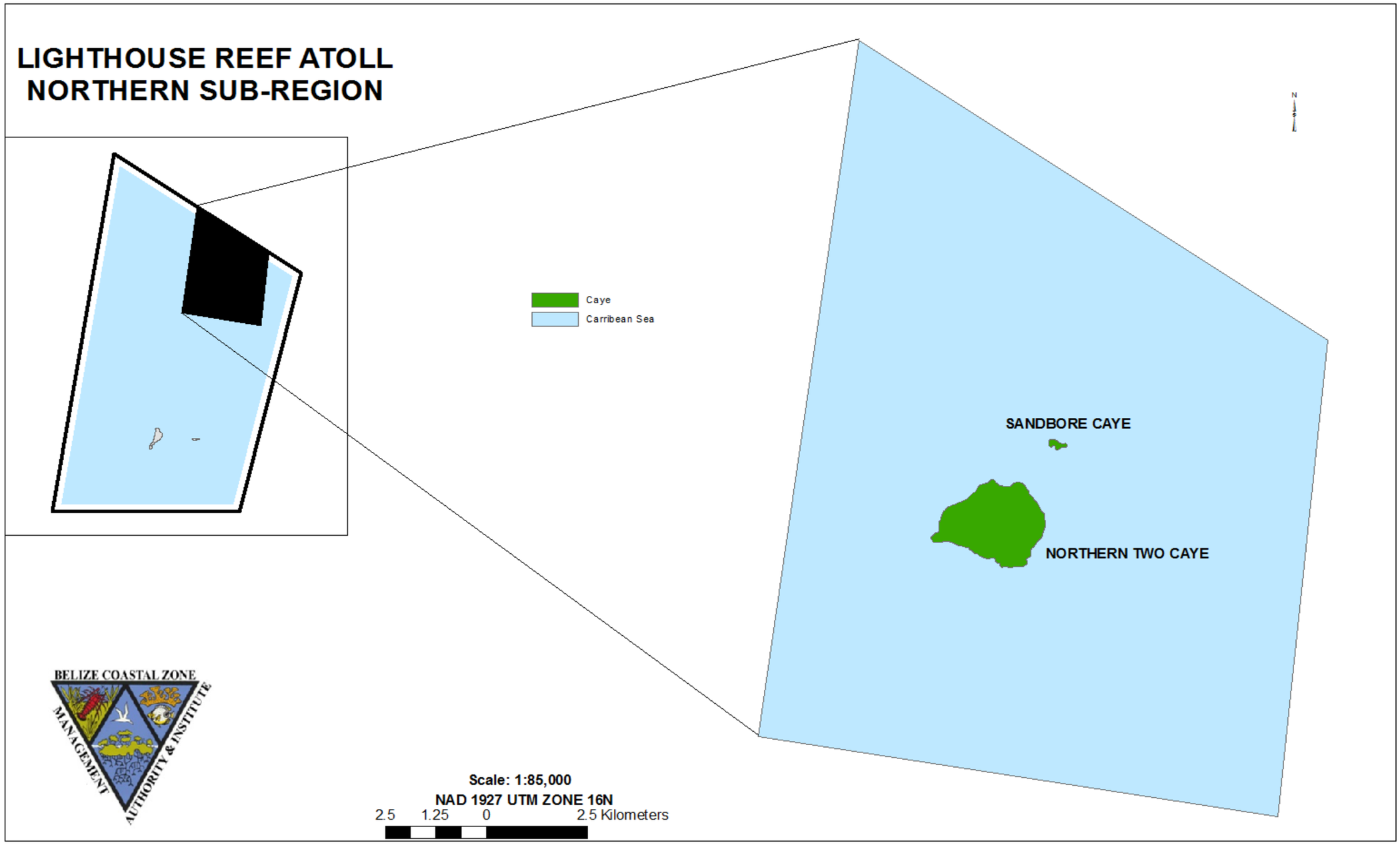
Point 1: (1949866 N, 430088 E)
Point 2: (1889858 N, 420034 E)
Point 3: (1889964 N, 450091 E)
Point 4: (1930075 N, 460145 E).

Regional Context

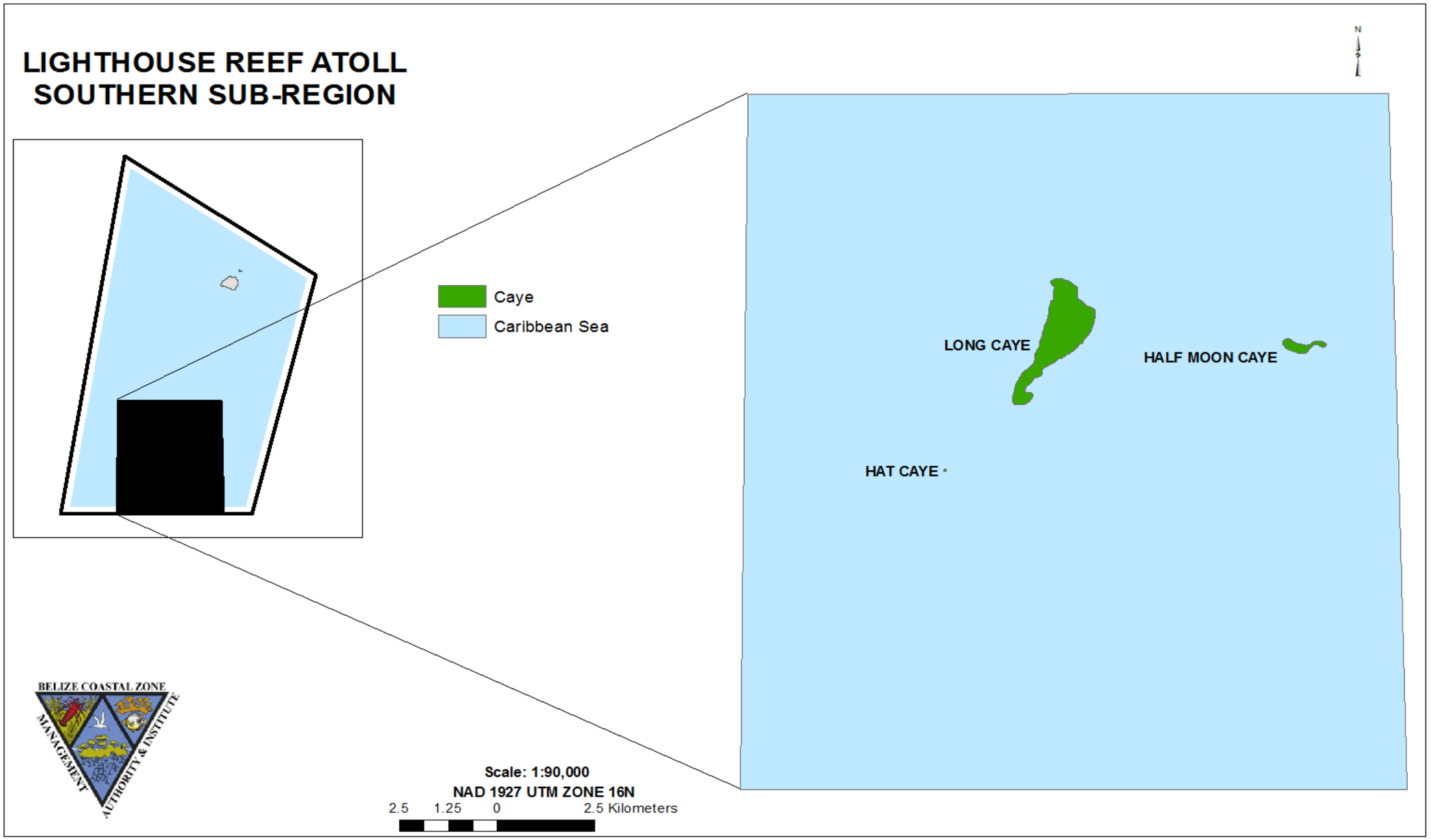
The Lighthouse Reef Cayes Region is made up of five (5) islands strung in a north southerly direction forming in a semi-circular and comprising approximately 1600.5 sq. kilometres of terrestrial and aquatic environment including flats and reefs of which 7.2 or 0.45 % is terrestrial and 1593.3 sq. kilometres or 99.55 00 % is aquatic. The cayes of the region are located approximately fifty five (55) miles east south east of Belize City and twenty five (25) miles east of the Turneffe Atoll. They are situated mainly on coral deposits and range in size from 1 acre (Hat Caye) to 1100 acres (Northern Two Caye). The coral deposit that makes up the lighthouse reef area is approximately 30 miles long and 6 miles wide (180 sq miles). Just 8 miles north of Half Moon Caye lay the famous Blue Hole, a World Heritage Site.



Map 2: Lighthouse Reef Atoll Coastal Zone Planning Region



Map 3: Lighthouse Reef Atoll Region Cayes (Northern Sub-region)



Map 4: Lighthouse Reef Atoll Region Cayes (Southern Sub-region)

3.0 OBJECTIVES

The management of the Lighthouse Reef Atoll region's coastal zone must be linked to the goals and aspirations of the people of Belize, particularly the stakeholders of the Lighthouse Reef Atoll. Consequently, it must be intrinsically tied to the socio-economic, cultural and other basic needs of the people of Belize, and their use and demand for land and marine resources. Thus the key objectives of the Lighthouse Reef Atoll region coastal zone management guidelines may be summarized as follows:

1. Protecting the fishing resources and traditional fishing rights, especially for the fisher folk that fish within the region.

2. Promoting orderly and sustainable development, based on suitable land use planning, and with effective development guidelines that will meet the needs of current and future generations

3. Maintaining and protecting on going and future conservation, recreational and tourism areas and uses

4. Preventing inappropriate high-impact, unsustainable developments that are incompatible with community needs

5. Protecting and preserving significant national and international natural features and ecological biodiversity of special interest or uniqueness that define the character and scientific importance of the Lighthouse Reef Atoll marine ecosystem.

6. Preserving the social and cultural values of the people and communities of the region that are connected to the environment

7. Fostering and supporting a continued partnership among stakeholders for managing the coastal resources

8. Establishing a framework for regulating the development and use of resource of the region through the continuation of CZMAI's coastal planning program activities and coastal advisory committee process

4.0 LEGISLATIVE AND INSTITUTIONAL FRAMEWORK FOR INTEGRATED COASTAL ZONE MANAGEMENT IN BELIZE

The Coastal Zone Management Act, hereinafter referred to as "the Act", was enacted in 1998 and has been described as reflective of the trend in legislation in Belize towards more accountability and transparency for government actions, and more direct participation by the public in decision making, particularly public resources. The intent of the Act is to promote the sustainable development of coastal and ocean areas through coordination of existing legislation affecting coastal resources and through building capacity and expertise to manage coastal resources. The main purpose of the Act is to:

- Provide for the improvement of coastal zone management in Belize through the establishment of a Coastal Zone Management Authority and a Coastal Zone Management Institute;

- Provide for the establishment of a Board of Directors to control and manage the affairs of the Authority;

- Provide for the preparation of a Coastal Zone Management (CZM) Plan;

- Provide for the establishment of mechanisms to improve monitoring of various activities within the coastal zone;

- Provide for the payment of fees and charges related to the use of the coastal zone and

- Provide for matters connected therewith and incidental thereto

The Coastal Zone Management Authority is the policy making and planning institution for coastal zone management. Its functions are primarily in the realm of planning, advising, cooperating, collaborating and monitoring. It is given no jurisdiction to permit or regulate activities which may affect the sustainable development of the coastal zone. The Coastal Zone Management Institute is the research and technical arm of the Authority. As is indicated above, the Coastal Zone Management Authority is mandated to develop a comprehensive Coastal Zone Management (CZM) Plan for Belize. The CZM Plan is to be developed by the Chief Executive Officer (CEO) of the Authority through consultation with all affected government agencies, non-governmental agencies, statutory bodies and the private sector. The Act mandates that the plan address certain areas. These include:

- Guidelines to be used in determining the suitability of particular development activities in the coastal zone;

- Guidelines for the general monitoring of the coastal zone, including its biological species, communities and habitats;

- Proposals, including existing proposals from Government agencies, relating to the coastal zone that deal with the following subjects:
    - Land use
    - Planning for the establishment of marine protected areas and for the conservation of threatened or potentially threatened or endangered species;
    - Preservation and management of the scenic, cultural and other natural resources;
    - Recreation and tourism;
    - Monitoring of the environment and natural resources, mineral extraction, living resources, human settlements, agriculture, aquaculture, and industry

- Proposals for the reservation of land or water in the coastal zone for certain uses, or for the prohibition of certain activities in certain areas of the coastal zone;

- Recommendation for the improvement of public education as well as public participation in the management of coastal resources;

- Recommendations for strengthening governmental policies and powers and the conduct of research for the purposes of coastal resources conservation and management

The process for approval of the CZM Plan is as follows: The Act requires the CEO of the Authority to submit the CZM Plan to the Board of the Authority, who has sixty days to make modifications. Thereafter, the Board is to notify the public of the availability of the CZM Plan by an order published in the Gazette. Any member of the public may submit comments within sixty days. Upon completion of the sixty days, the Board may approve the CZM Plan, subject to modifications, if they deem it fit in regard to the comments submitted, and then submit the same to the Minister for approval. The Minister, after approving the CZM Plan, shall table it in the House of Representatives for approval by the House by affirmative resolution. Subsequent to approval by the House, the CZM Plan must be published in three consecutive issues of the Gazette. The CZM Plan is to come into operation on the date of the last publication or such later date as may be specified therein. The Act requires the CZM Plan to be revised during the four year period after it comes into operation.

It was agreed by the CZMAI that the CZM Plan would be developed in phases, with the first phase being the development of an Integrated Coastal Zone Management Strategy

document, which underwent extensive public consultation. It was endorsed by the cabinet in 2003, and is an official policy document of CZMAI. The second phase involved the formulation of cayes development guidelines for eight of the nine coastal planning regions into which the coastal zone has been sub-divided by the CZMAI. This subdivision was based on geographical, biological, administrative and economic similarities. The Ambergris Caye Development Master Plan serves as a guide for regulating the use and development of land in the Ambergris Caye Planning Region. See Map 1 for the definition of the nine coastal planning regions.

The management guidelines were formulated using the Cayes Development Policy (2001) as a framework. During 2010-2012, the cayes development guidelines were updated to include new information on the cayes, but also to include human use of the coastline and marine waters. As such, the development guidelines have been renamed the coastal zone management guidelines. Thus, the Integrated Coastal Zone Management Strategy (2003), together with the coastal zone management guidelines for the nine coastal planning regions, contributes to the development of the comprehensive Integrated Coastal Zone Management Plan.

5.0 GUIDING PRINCIPLES

It is important that the coastal zone management guidelines for the region be formulated as a part of a sustainable plan geared towards contributing to national, regional and local development policies, goals and aspirations. They must therefore be holistic and pragmatic, yet underpinned by certain fundamental principles. These can be detailed as follows:

Principle 1:- *Recognition that the Lighthouse Reef Atoll needs special protection and management because of its physical, economic, scientific, cultural and aesthetic attributes*

Principle 2:- *Recognition of the need to avoid placing undue strain on the terrestrial and aquatic environment of the region by ensuring that proposed development activities do not exceed the carrying capacity of the region*

Principle 3:- *Recognition of the rights and interests of traditional users and stakeholders while acknowledging the national development policy which promotes tourism and job creation*

Principle 4:- *Recognition that environmental concerns are best handled with the participation of all concerned stakeholders at all levels and from all sectors*

Principle 5:- *Recognition that planning guidelines represent a preventative and precautionary approach to environmental degradation and a tool for pursuing sustainable development of the region*

6.0 SECTORAL ISSUES AND POLICIES

These policies are organized into ten sectors that address current and potential issues within the Lighthouse Reef Atoll Region coastal zone, and provide recommendations from stakeholders. They include: Fishing, Marine Tourism, Land-Use, Marine Dredging, Sensitive Habitats, Utilities, Pollution Control, Conservation, and Social Amenities. They were developed by the key people consulted from the Lighthouse Reef Atoll Region during all consultation efforts.

6.1 Fishing

Fishing has traditionally been an important component of the economy of Lighthouse Reef Atoll, providing a steady source of fishing for centuries supporting fisherfolk from Sarteneja, Copper Bank and Chunox villages. The waters and coral reef system act both as fishing and breeding grounds, augmented by the presence of deep waters and extensive flats between the cayes. The region is home to three protected spawning aggregation sites at Northern (2) Cayes, Sandbore Caye and South Point. There are spawning aggregation sites, however, that are not protected and which fall within traditional fishing areas. While the region is rich in fishing resources, illegal and inadequate regulatory enforcement mechanism may eventually affect fishing stocks. The present situation of undefined boundaries to separate spawning sites encourages illegal, unregulated and unreported fishing and exploitation of resources. As an alternative to wild-capture fishing in the region, and to reduce the pressures on the remaining stocks, stakeholders have recommended the exploration of conch, lobster and/or seaweed faming.

In addition to the threats to fishing resources, the issue of securing camping areas for use by traditional fishermen is a concern in this region. In the past, fishermen had several options for camping as less of the cayes in this region were privately-owned. However, as the ownership of traditional camp sites has become privatized it has become increasingly challenging for fishermen to find areas to camp. There is a high degree of uncertainty over the availability of areas that can continue to serve as fishermen's camps. The current uncertainty surrounding proposed development on Northern (2) Caye has exacerbated the shortage of camping availability for fishermen. Hat Caye is coming under increased pressure from fishermen as an unofficial camping site, and while camping access for fishermen may be desired there must be a clear and defined policy in place *before* permitting camping access.

As fishermen play a role as custodians of the cayes and waters of the region, the protection of their camps is critical to the effective management of the cayes. The owners of Long Caye and the Lighthouse Reef Conservation Institute have accommodated fishermen camping access in the past. However, the owners have expressly stated that due to "*inconsiderate waste & garbage creation, destruction of mangroves for fuel and unauthorized*

fill operations we will be forced to disallow such camping on site". The Long Caye Owners have indicated that they are willing to facilitate local fishermen's participation in the ongoing development process by leasing a portion of Long Caye for use by fishermen as a camp site. Such a lease would be of a short but renewable term and subject to agreed and defined boundaries of use and treatment of waste issues, non- destructive practices etc.

In this region, the total spiny lobster habitat area covers 157 km2. Using InVEST's ecosystem service model for Spiny Lobster, it was estimated that the total export of tail meat under the current zoning scheme amounts to 14,853 lbs., and generating revenue of approximately BZ $395 thousand (**Fig 4, Appendix**). In addition, model results suggest that a conservation zoning scheme could increase exports to 19,932 lbs.; and generate an annual revenue of BZ $530 thousand by 2025. However, a development zoning scheme would decrease the exports significantly to 1,993 lbs., and generating annual revenue of only BZ $52,999 by 2025. The model results indicate that the proposed zoning (Informed Management) scheme for this region could increase exports of tail meat in the amount of 15,463 lbs., generating annual revenue of BZ $411 thousand by 2025. This represents a 16.79% increase from 2010 returns.

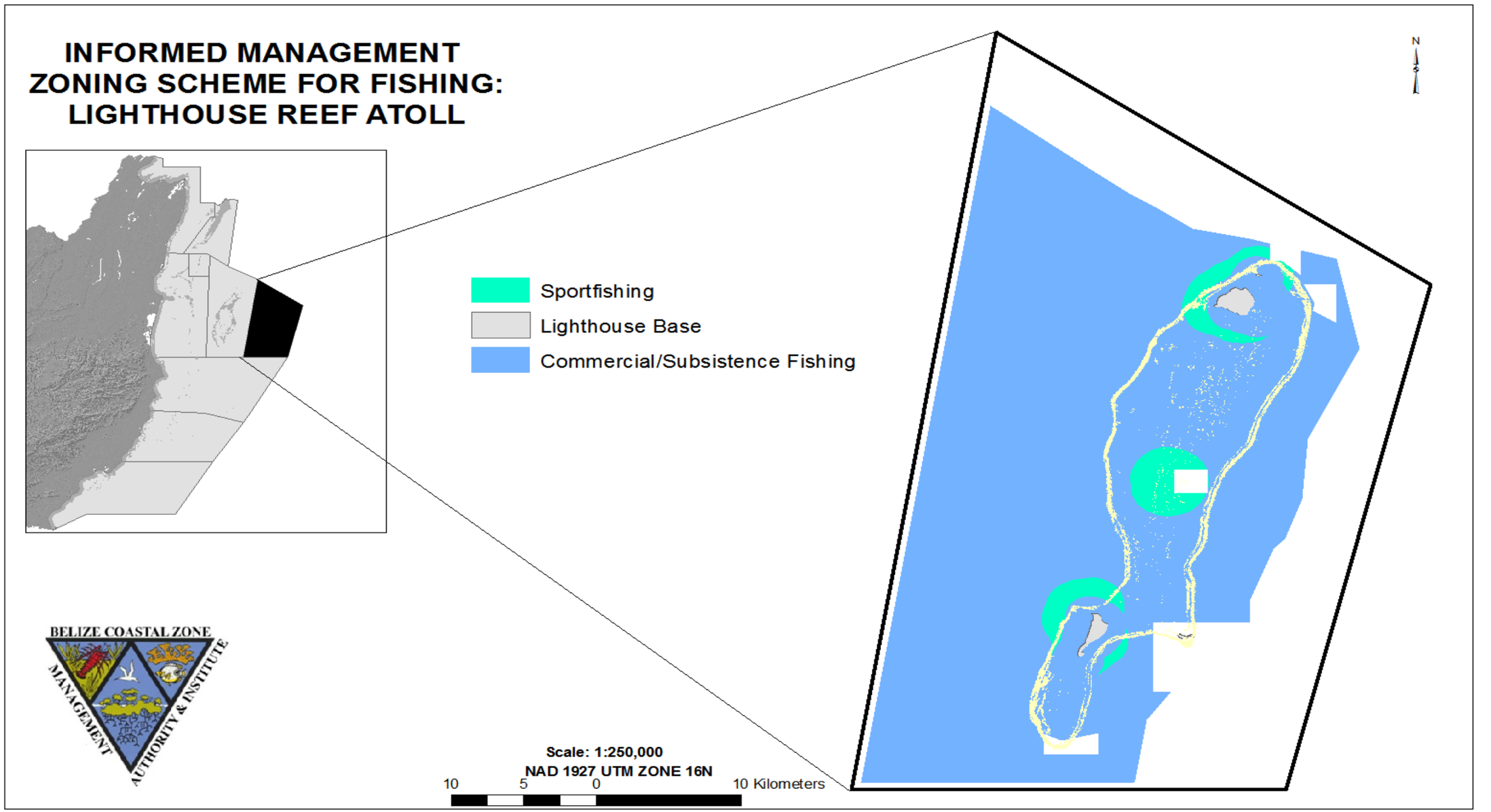
Compared to the Informed Management Zoning Scheme (**Map 5**), the Conservation Zoning Scheme is the better option for maintaining increased lobster catch and revenue through to 2025. This is mainly attributed to the fact that under the Conservation Zoning Scheme, habitats that support the lobster fishery are under relatively less stress from human activity than in the Informed Management scheme. However, while the zoning scheme under a Conservation Scenario is good for habitats and the provision of important ecosystem services, such as protein from lobster, significantly less human activities occur in this zoning scheme. Although there may be some loss to habitat quality and lobster production, the Informed Management zoning scheme represents a balance between managing the resources of the coastal zone and the continued allocation of areas for human use through to 2025. The framework for implementing the Informed Management zoning scheme can be seen in **Table 2.**

In discussing the results of the InVEST ecosystem models, and in particular the lobster fishery model, there is the need to consider limitations of the model, which are highlighted below:

- Population growth parameters are nationwide, not region-specific
- Habitat dependencies are obligatory (e.g., habitat substitutability is not explicit represented).
- The population responds to change in habitat quantity (i.e., areal extent of mangrove, seagrass, and coral reef), not quality of those habitats.
- The fishery is assumed to take place at the start of the year, before natural mortality
- The model assumes near knife-edge selectivity in harvest function
- Harvest selectivity (and catchabilitiy) is invariant, such that technological improvements to gear or changes in fishing practices are not modeled.
- Market operations are fixed, such that they do not vary in response to amount of harvest, shifts in market or consumer preference, or technological changes.

- Climate change impacts are not directly accounted for in model

Additional information on how this model works can be found in **Appendix B.4** of the Belize Integrated Coastal Zone Management Plan.



Map 5: Informed Management Zoning Scheme for Fishing in the Lighthouse Reef Atoll Region

Table 2: Framework for Implementing Informed Fisheries Management in the Lighthouse Reef Atoll Region

ZONE	CHARACTERISTICS OF ZONE	SCHEDULE OF PERMITTED USES			SCHEDULE OF RESTRICTED USES	SUPPORTING NATIONAL POLICIES	IMPLEMENTING AGENCY
		Dominant	Compatible	Regulated			
Fishing	Marine area defined for the extraction of fish for food and commercial trade, except for sport fishing which only involves the catch and release of fish	1.Sportfishing(bonefish, tarpon, permit); 2.Wild capture of commercial fish species using only permitted fishing gear 3. Subsistence fishing using traditional fishing gear 3. Wild capture of invasive species	Marine recreation and eco-tourism Passage/entry of fishing vessels Research and Education within marine reserves Establishment of fish pots and traps Seaweed culture	Sport fishing Commercial fishing Research and Education	1. Illegal extraction of catch and release species, endangered marine species and organisms under seasonal management regime; 2.Extraction within legally specified “no-take”/replenishment zones 3. Dredging 4. Use of prohibited fishing gear 5. Trawling 6. Shipping and navigation 7. Dumping of solid and liquid wastes 8. Oil exploration and extraction	Fisheries Act Coastal Zone Management Act	Fisheries Department Coastal Zone Management Authority

Conch harvest at Lighthouse Reef mirrors that of the lobster harvest, that is, a total denuding of each species by fishermen actively fishing Lighthouse Reef Atoll. The absence of stringent size & bag/quantity possession for lobster & conch any effort at harvest reduction & control is meaningless. Long Caye & Pleasure Island will support the introduction of such limits, however, it must be understood that fishermen must be active participants in the process and such legislation be supported by enforcement presence.

Encouraging adoption of live lobster production would entail the adoption of carapace measuring devices (much needed given the implementation of a new 5.5" carapace size); the measure would also require the use of bully nets & tickle sticks. This measure would save millions of lobster eggs as the current practice of using a hook stick causes fatal damage to harvested lobster (with each fecund lobster carrying an average of 1 million eggs even a 10% reduction in harvested females provides an exponential increase in viable egg laying females). Economic returns achieved in nearby Chinchorro preserve in Mexico using such methods described return an average of $28 U.S. per live lobster; far more lucrative than the $ per lb. revenue generated by 'wrung tails'.

Finfish throughout Belize are being dramatically affected by the use of gill nets; as such nets are recommended for removal or banned use from at Lighthouse Reef Atoll. Whelk harvest also raises significant issues as harvesting such shellfish encourages human/reef interaction to unacceptable levels as whelk harvesting involves 'walking' on the reef structure. The reef cannot tolerate such misuse & the nominal economic returns are far outweighed by the damage inflicted upon the reef & Atoll ecosystem.

The Fisheries Act, administered under the Fisheries Department, is the principal governing legislation to regulate the fishing industry (Table 2 above), and is directly concerned with maintaining sustainable fish stocks and protecting the marine and freshwater environments. In order to protect the fishing resources of the Lighthouse Reef Atoll Region and the user rights of the traditional fishing communities, the following action steps are recommended, to complement the existing Fisheries regulations and to enhance regional management of the fisheries resources.

Recommended Actions:

To ensure that fishing remains a viable industry and continues to contribute to the local economy for this region, the following are recommended:

1. Ensure that fishing remains a viable industry and continues to contribute to the economy of the region and country

2. Protect the spawning and traditional fishing grounds of the Lighthouse Reef Atoll as well as the interest of Belizean fishermen through implementation of the Managed Access Program.

3. Provide for more effective regulatory mechanisms for development activities, which can complement the initiatives of other agencies, and can significantly contribute to a sustainable fishing industry

4. Provide for partnerships between regulatory authorities and stakeholders of the region

5. Protect fishermen's user right of access camping areas

6. Install clear markers to indicate the location and boundaries of spawning aggregation sites, no-take zones within the protected areas as well as traditional fishing grounds

7. Encourage fisherfolk stakeholders to play an active role as custodians of the fishery resources, and active participants in enforcement process.

8. Discourage the use of gill nets at Lighthouse Reef Atoll

6.2 Marine Tourism & Recreation

Tourism is a vibrant economic activity in the Lighthouse Reef Atoll Region and opportunities abound within the sector. It is an alternative to fishing and other income generating activities and contributes substantially to the national economy. However, if not planned and managed correctly, tourism activities can result in destructive and devastating damage to the natural environment, which inevitably can have alarming impacts on the Subsistence of both the fishing and the tourism industries alike.

All the cayes in the region, with the exception of Hat and Sandbore Cayes, are being used for tourism purposes. These include short and long vacations as in the case of Northern (2) and Long Cayes, and for one day visits, as in the case of Half Moon Caye. Over the past two decades, the advent of cruise ship tourism has seen the visitation rates multiply tremendously. While ecotourism in this region is strongly encouraged, such activities must not be to the detriment of the environment or gains from existing conservation management. Any perceived negative impacts that may arise from unplanned tourism development, and which would conflict with the existing environment, must be minimized and mitigated against.

The Sustainable Tourism Master Plan recognizes the social, economic and cultural importance of the Lighthouse Reef Atoll Region and therefore does not recommend any new development for the cayes comprising the region. Only small extensions to already existing infrastructure are recommended in order to improve living conditions of marine reserve staff. Long Caye and Hat Caye, which are privately owned by Pleasure Island Limited, have legally binding and enforced eco guidelines that ensure sustainable development on Long Caye.

InVEST Recreation and Tourism ecosystem service model results suggest that currently, approximately 52 thousand people visit this region generating revenue of BZ $6.1 million annually (**Fig 5 Appendix**). In a conservation future scenario, InVEST Recreation model results indicate that there may be an increase in tourist visitation to approximately 118 thousand, generating annual revenue of BZ $13 million. In a development future scenario, there would also be an increase in the current tourist visitation to approximately 84 thousand, and generating annual revenue of BZ $9.3 million. In the proposed Informed Management scenario **(Map 6)**, InVEST Recreation model results indicate that there will also be an increase in tourist visitation to approximately 222 thousand and that tourist expenditure would generate an annual revenue of BZ $38 million. The supporting framework for implementing the Informed Management Zoning Scheme for marine recreation and tourism is outlined in **Table 3**. This perceived impacts associated with the projected increases in tourist arrival to the region will be controlled by the recommendations for land-use (Section 6.3) on the atoll.

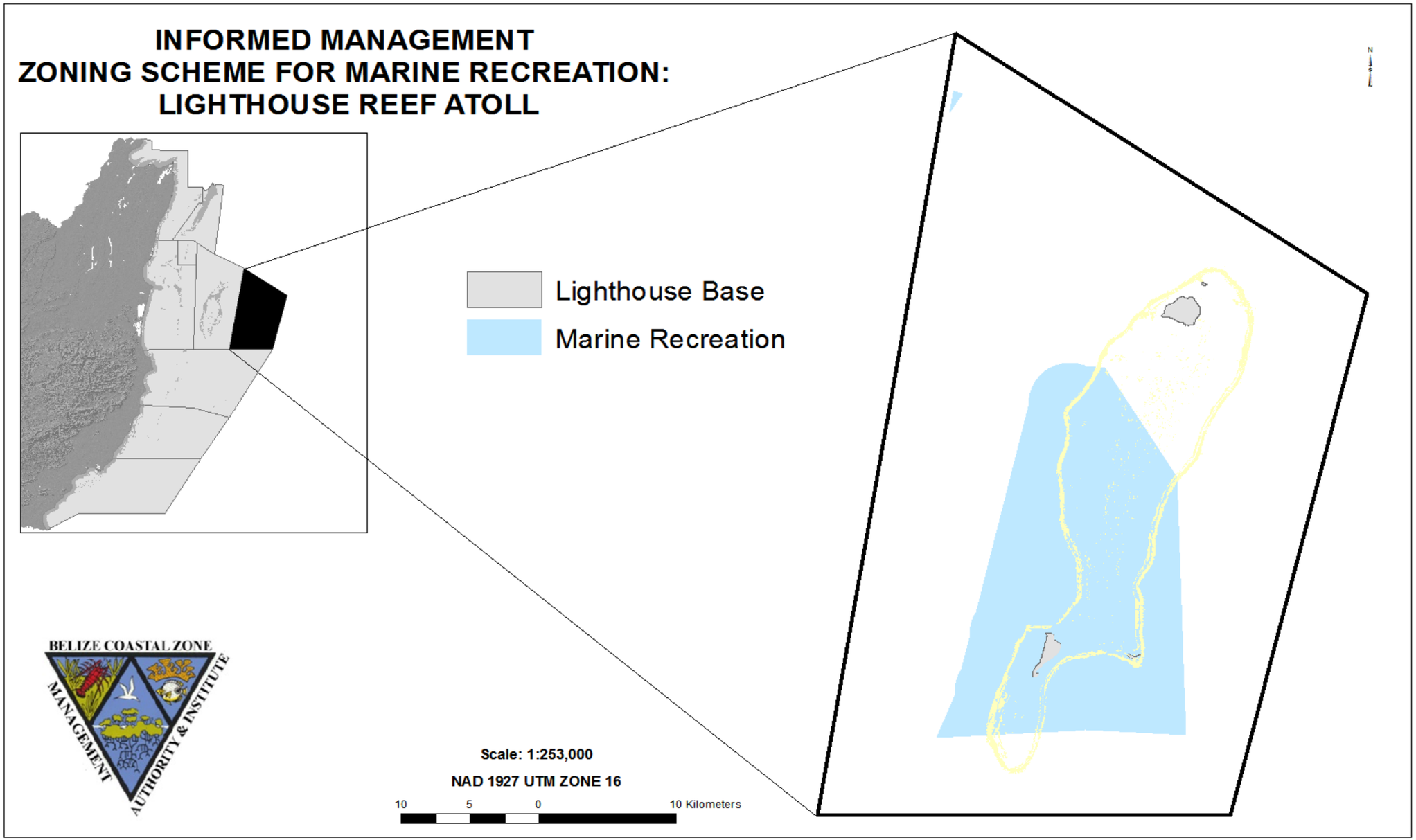
In discussing the results of the InVEST ecosystem models, and in particular the recreation model, there is the need to consider limitations of the model, which are highlighted below:

- The model assumes that people will respond similarly in the future to the attributes that serve as predictors in the model. In other words, the assumption is that people in the

future will continue to be drawn to or repelled by a given attributes to the same degree as currently.

- Some of the attributes that are used as predictors of visitation are representations of areas managed for particular human use (e.g. transportation). The model assumes that future management of the zones and the type of activities that they represent are similar to current.
- Since there are no fine-scale data on the distribution of visitors to Belize, we use photo-person-days as a proxy for the relative density of actual person-days of recreation across the coastal zone.
- Climate change impacts are not directly accounted for in model

Additional information on how this model works can be found in **Appendix B.3** of the Belize Integrated Coastal Zone Management Plan.



Map 6: Informed Management Zoning Scheme for Marine Recreation in the Lighthouse Reef Atoll Region

Table 3: Framework for Implementing Informed Management Marine Recreation Scheme

ZONE	CHARACTERISTICS OF ZONE	SCHEDULE OF PERMITTED USES			SCHEDULE OF RESTRICTED USES	SUPPORTING NATIONAL POLICIES	IMPLEMENTING AGENCY
		Dominant	**Compatible**	**Regulated**			
Marine Recreation	Marine areas especially suited to swimming, snorkeling, diving, kayaking, surfing, and other water sports	1. Swimming 2. Snorkeling 3. Diving 4.Kayaking 5. Surfing, 6. Jet skiing, 7. Kite boarding 8. Other water sports	Passage/entry of water taxis, tour boats, cruise vessels Research and education within marine protected areas Sport fishing	Research and Education Eco-tourism activities within marine protected areas Sport fishing	1. Commercial fishing 2. Establishment of fish pens/cages, mariculture 3. Oil exploration and extraction 4. Dredging 5. Passage of commercial fishing vessels 6. Shipping and navigation 7. Trawling 8. Dumping of solid and liquid wastes from ships and boats	Belize Tourism Board Act Fisheries Act Coastal Zone Management Act National Park System Act Wildlife Protection Act	Belize Tourism Board Fisheries Department Belize Forest Department Coastal Zone Management Authority

Recommended Actions:

1. Confine land use zoning assignment for resort type development to those areas where they already exist with limited scope for intensification or new development

2. Incorporate land use zoning assignment that takes into consideration maximum human carrying capacity for those areas which may be impacted negatively from excessive human activity,

3. Implement land use zoning assignment in compliance with existing protected area management plans

4. Combine ecological and nature tourism and non-damaging traditional economic generating activities with conservation policies in those ecologically sensitive, but potentially attractive natural environments which are also traditional fishing grounds

6.3 Land-Use

The majority of the land within the Lighthouse Reef Atoll Region is privately owned. Those lands which are nationally-owned should ideally remain as is as this state of affairs provides the opportunity for decision makers to have greater input in land management concerns. Where land is private property, the right to alienate and develop must be recognized but regulated to ensure that the subdivision of land subscribes to guidelines, which ensure that the parcels can sustain the type of permitted development activity.

In terms of the potential for developing the cayes for future development uses, the recommendations are on a case by case basis. For instance, given that Half Moon Caye is a natural monument and a part of the Belize's World Heritage Site, this caye should not be developed. Over time, Sandbore Caye has experienced a natural "shifting" phenomenon. If this caye is shifting, there needs to be a clear statement that given this circumstance this caye is not suitable for future development. Hat Caye, a very small caye, is mainly used as a camp for fishermen. There is a small portion of the island that has some potential for development. The northeastern part of Long Caye is the most suitable area on this caye that can sustain low-impact development. The developers/owners of this caye have prepared a plan for resort development that utilizes the model of eco-friendly architecture. The lagoon area, however, is absolutely unsuitable for development. On Northern (2) Caye, northeastern and northwestern fringes of the island are elevated and are suitable for low impact development, while the other areas contain lagoons and mangrove marshes. Thus only a small area of the island can be developed further.

All cayes within the Lighthouse Reef Atoll region are accessible by boat and an airstrip is situated on Northern (2) Caye. This provides accessibility to the region by air. There are 7 piers in the region. Half Moon Caye presently has 3 piers, 2 of which are operational. The other was damaged during Hurricane Richard in 2010. The Belize Audubon Society does not intend to repair this pier and there are plans to remove it completely from the island. Long Caye has 2 functional piers, 1 on the west side of the island, the other on the east side. Northern (2) Caye and Sandbore Caye each have 1 pier but they are both in deplorable condition. The pier and dock at Hat Caye no longer exist as they were destroyed during Hurricane Richard. With the exception of Hat Caye, the coastal advisory committee for this region recommends that no additional piers be constructed in this region. The construction and proliferation of piers can cause destruction of the beach, sea grass bed and seabed and sedimentation, particularly if they are positioned on the windward side. Furthermore, the movement of debris during storms from buildings constructed on piers can be dangerous.

In the case of privately held undeveloped lands, the development standards presented within these guidelines presents the most sustainable and appropriate future land use. Although the CZMAI recognizes the right of the landowner to develop their land in any matter they see fit there must be measures in place to steer future development in order to ensure sustained ecosystem services. Therefore, in the case of these lands, if there is no development activity within the first five (5) years of the passage of this planning document then all future

development activities, after the time period, **MUST** follow development standards as outlined within this coastal development guideline.

6.3.1 Development Standards

The existing standards for subdivision of land (Land Utilization Act, Chapter 188 of the Substantive Laws of Belize, Revised Edition 2000) did not anticipate the magnitude of urban expansion, tourism and other development that Belize has experienced over the past decade. In 2010, the National Guidelines for Subdivision and Consolidation of Land in Belize was revised to address such issues and provide transparency and equitability to the process of subdividing and developing land. Although revised, the amendments made were general in scope and lacked the specificity needed for sensitive areas such as the cayes and atolls.

Development on cayes and atolls require specific building standards since these areas are closer in proximity to important sensitive habitats such as sea grass beds, mangroves and coral reefs. Ad hoc or uncontrolled development in these areas can have severe negative effects on surrounding ecosystems. For example the construction and proliferation of piers can cause destruction of the beach, sea grass bed and seabed and sedimentation, particularly if they are positioned on the windward side. Furthermore, the movement of debris during storms from buildings constructed on piers can be dangerous.

In 2004, CZMAI produced a set of development guidelines for the cayes within each planning region. These development guidelines were produced in consultation with stakeholders from each planning region along with technical input from government relevant agencies. Within the document land use classes were developed along with accompanying standards for the varying degrees of development that can occur on a caye. Use classes were also assigned to each caye according to suitability. The use class categories developed include residential, commercial and conservation, representing the various degrees of development intensities allows on cayes. Therefore CZMAI recommends the following as development standards under the informed management scheme for developing **the cayes** within Lighthouse Reef Atoll Region (**See Map 7&8)**. The framework for implementing the informed management coastal development scheme can be found in **Table 7.**

The Lighthouse Reef Cayes Region is limited in its potential for development by reason of its distance from the mainland, geomorphic and soil character, ecological and national and international importance in the case of Half Moon Caye and the world renowned Great Blue Hole, and size, as in the case of Hat and Sandbore Cayes. These all influence the carrying capacity of the region and subsequently, its development suitability.

The environment of the Lighthouse Reef Cayes Region is in general, ecologically fragile and particular care needs to be exercised in determining its development suitability and achieving the balance between the environmental sustainability and the need to facilitate

economic and other human activities. Consequently, the implications of human activities and natural hazards to the region, and the sustainability and life of the cayes is very important.

Hat Caye is situated on the south western end of the atoll. Patch reef dominates almost the entire shoal and flats and access has to be carefully navigated. While the caye is elevated above sea level, and is of the Sand Associated Cayes category, which would indicate suitability for development, its small size and the ecological sensitivity of its surrounding environment provides little scope for development, thus making it least suitable for development.

Long Caye is also situated on the south western end of the atoll. The south western and eastern sides of the island consist of patch reef with much of the near shore areas covered with sea grass. The island is dominated by coconut trees and sandy beaches, and there is a prominent shingle ridge on the north eastern half of the caye with an extensive internal mangrove wetland. The elevation above sea level of much of the caye and its identity as one of the Sand and Shingle Associated Cayes category would indicate suitability for development. However, consideration must be taken of the surrounding reef system, which has implications to accessibility and the functionality of the internal mangrove wetland and near shore sensitive ecologies. This would make the south western portion not suitable for development and the rest of the caye least suitable.

Half Moon Caye is situated on the lower eastern end of the atoll. It shares two distinct vegetation types. The western half supports low dense zericote forest while the eastern half, coastal vegetation with coconut trees and sparse ground cover. It is approximately 45 acres, of the Sand and Shingle Associated Cayes category, and elevated approximately eight (8) feet above sea level making it most suitable for development. However, its national and international importance and protected status combined with surrounding sensitive ecologies which have implications to accessibility, makes it least suitable for development.

Northern Two Caye is situated on the northern end of the atoll and is of the Sand Associated Cayes category. This is a relatively large island (1100 acres) surrounded by numerous patch reefs especially at the western end. Its near shore areas are dominated by sea grass and most of the island is elevated with sandy beaches on the eastern portions, and littoral woodlands on the western portion with some lower areas in the central region. By nature of its elevation, soil, size and attractive features, Northern Two Caye is most suitable for development, with the exception of the inner areas. However, consideration must be assigned to its surrounding sensitive ecologies, lagoons and mangrove marshes which leaves only a small area of the island can be developed further.

Sandbore Caye is situated at the extreme north western end of the atoll and is of the Sand Associated Cayes category. Its aquatic ecology includes numerous patches of coral, (some

permanently exposed) and sea grass beds in near shore and lagoonal areas. Due to its developed status and size, it has little scope for development.

Land tenure can be describes as a mixture between national and private lands as summarized in **Table 3** below

Table 4: Summary of Land Tenure of the Lighthouse Reef Atoll Cayes

Name of Caye	National		Lease		Property		Total Acreage
	Size	%	Size	%	Size	%	
Sandbore Caye	0	0	NA	0	12	100	12
Hat Caye	NA	0	NA	0	0.5	100	0.5
Half Moon Caye	45	100	NA	0	NA	0	45
Long Caye	NA	0	NA	0	620	100	620
Northern (2) Caye	0	0	NA	0	1100	100	1100
TOTAL	45				1732.5		1777.5

Residential Development: Recommended for General residential purposes – permanent residence, vacation home, time share, fisherman camps and other home industries. Residential 1 development has been recommended for portions of **Northern (2) Caye, Hat Caye and Long Caye.**

Table 5: Standards for Residential Development on Northern (2), Hat and Long Cayes

Use Category	Residential I
Primary Use	Residential
Secondary Use	Conservation
Minimum Lot Size	1 acre
Maximum # of lots per acre	1
Net Housing Density	1 house per acre
Maximum # of Habitable Rooms/acre	5
Maximum Building Coverage	20%
Maximum Site Clearance	20%
Building Setback Front	10 ft
Building Setback Side	10 ft

Building Setback Back	10 ft
Building Height	30 ft
Maximum # of Floors	2
Elevation	8 ft
Height to first floor	4 ft

Commercial Development: Land use in which income is generated and commerce is predominant. Includes shops, stores, hotels, office buildings, and warehouses. Commercial 1 development is recommended for portions of **Long Caye and Northern (2) Caye.**

Table 6: Standards for Commercial Development on Long and Northern (2) Cayes

Use Category	Commercial I
Primary Use	Commercial
Secondary Use	Residential
Minimum Lot Size	1 acre
Maximum # of lots per acre	1
Net Housing Density	4 units per acre
Maximum # of Habitable Rooms/acre	8
Maximum Building Coverage	50%
Maximum Site Clearance	50%
Building Setback Front	10 ft
Building Setback Side	10 ft
Building Setback Back	10 ft
Building Height	30 ft
Maximum # of Floors	2
Elevation	8 ft
Height to first floor	4 ft

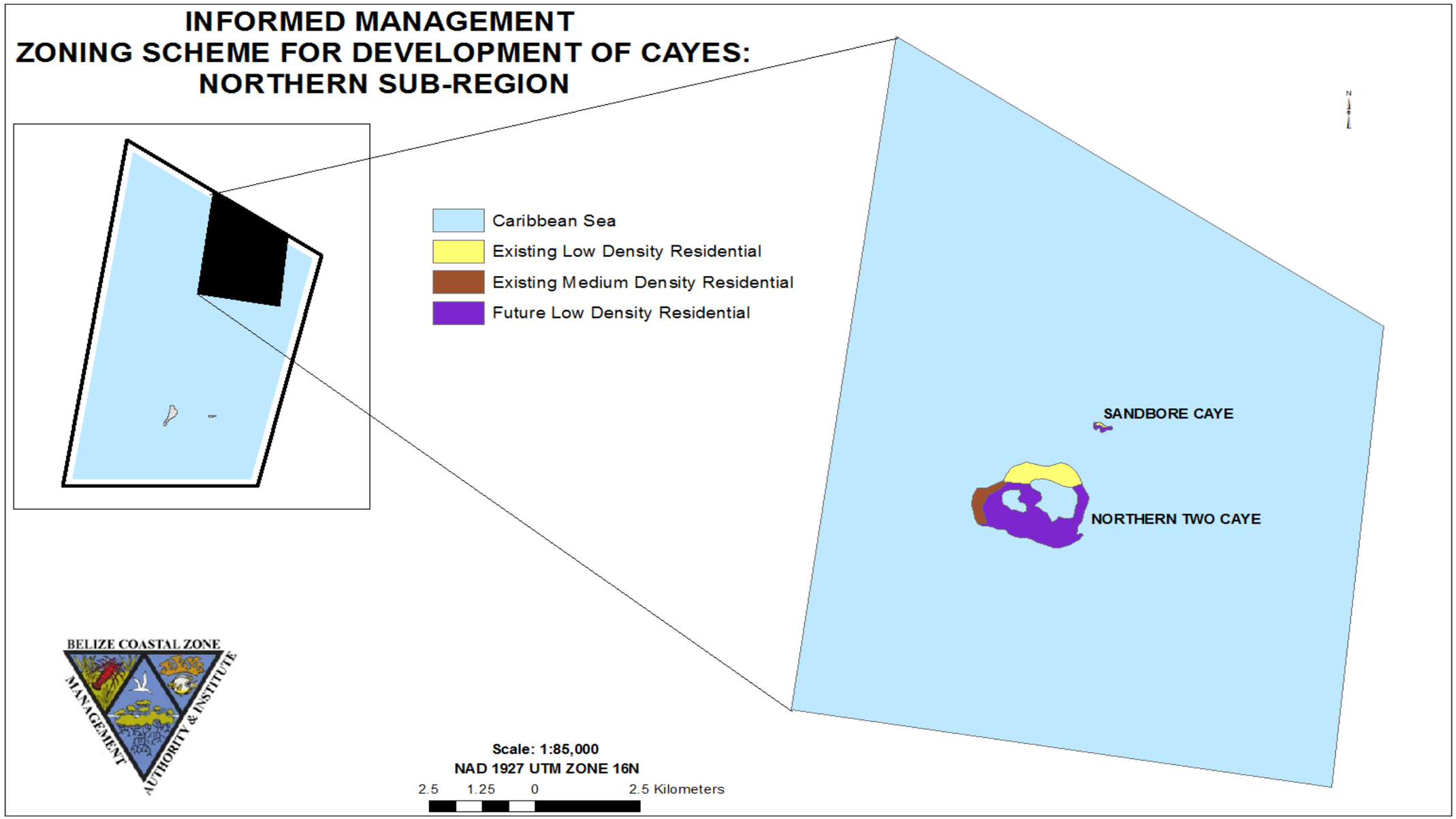
Conservation Development: Not recommended for major development but can accommodate very small scale infrastructure – Research stations, low scale ecotourism lodge, residential/fisherman's camps with temporary structures. Conservation 1 development is recommended for the **inner portions of Northern (2) Caye and South West portion of Long Caye.** Conservation 2 development is recommended for **Half Moon Caye, Sandbore Caye, and Middle portions of Long Caye.**

Table 7: Standards for Conservation Development on Lighthouse Reef Atoll Cayes

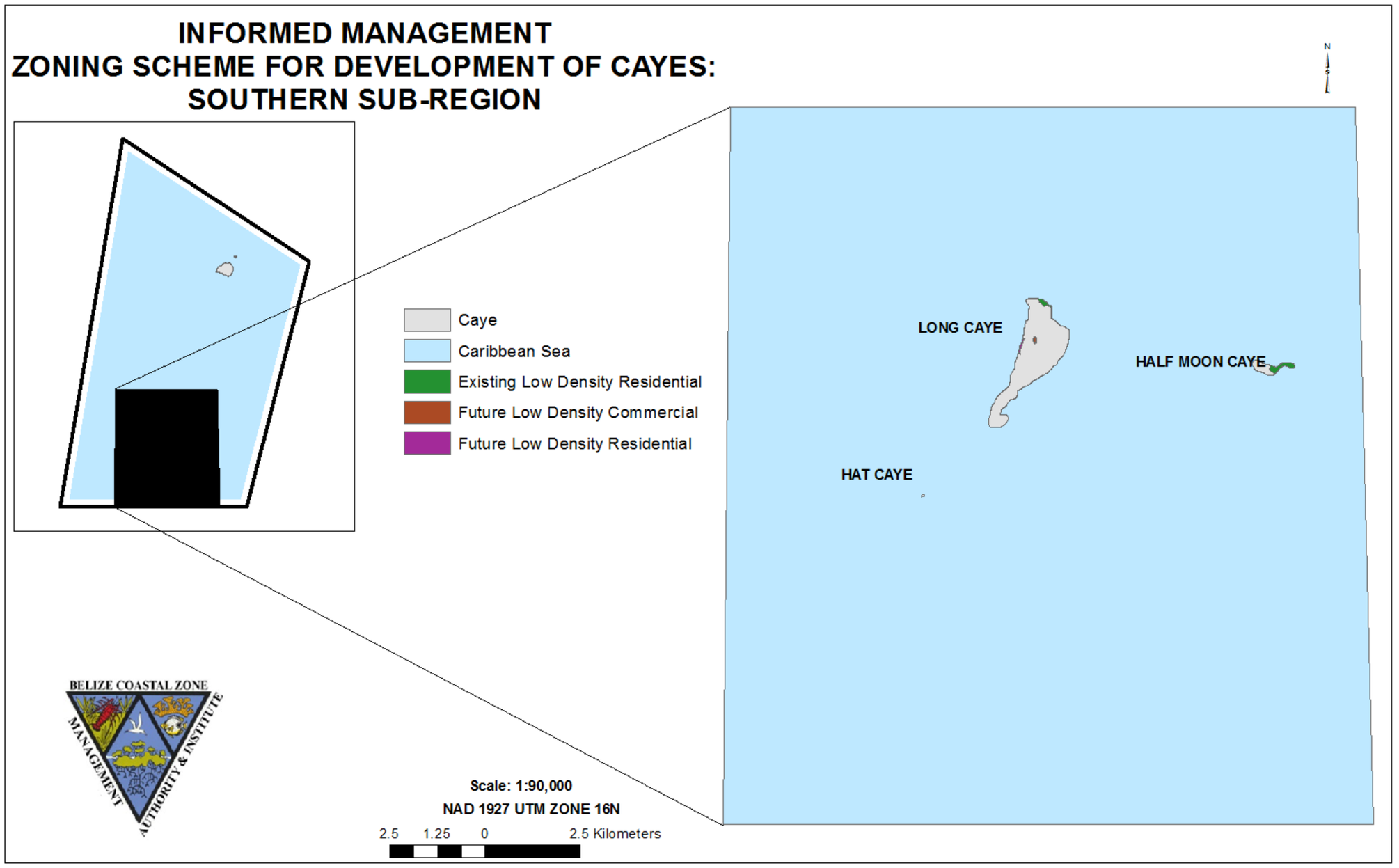
Use Category	Conservation I	Conservation II
Primary Use	Conservation	Conservation
Secondary Use	Fisherman Camp	Residential I
Minimum Lot Size	1 acre	1 acre
Net Housing Density	2 per acre	2 per acre
Maximum # of Habitable Rooms/acre	4	4
Maximum Building Coverage	4%	6%
Maximum Site Clearance	50%	50%
Building Setback Front	50 ft	50 ft
Building Setback Side	25 ft	25 ft
Building Setback Back	50 ft	50 ft
Between Buildings	25 ft	25 ft
Building Height	28 ft	28 ft
Maximum # of Floors	2	2
# of Pier per site	1	1

Table 8: Framework for Implementing Informed Coastal Development in the Lighthouse Reef Atoll Region

ZONE	CHARACTERISTICS OF ZONE	SCHEDULE OF PERMITTED USES			SCHEDULE OF RESTRICTED USES	SUPPORTING NATIONAL POLICIES	IMPLEMENTING AGENCY
		Dominant	**Compatible**	**Regulated**			
Coastal Development	Residential settlements, infrastructure, commercial/economic activities on land above water	1. Expansion of existing communities 2. Small-medium scale residential development 3.Small-medium scale commercial development 4. Community facilities 5. Supporting infrastructure	Small-scale, light industry Tourism facilities, such as small guest houses Subsistence agriculture production, and landscaping with decorative, native, non-invasive crops	Subdivision of land Establishment of small and medium-scale commercial and light-industrial development Establishment of residential expansion Solid and liquid waste management	1. Large-scale coastal agriculture production 2. Coastal aquaculture 3. Dumping of solid, toxic, hazardous waste and untreated liquid wastes, including grey water and sewage 4. Commercial or light-industrial development within residential zone 5. Residential development within commercial or light	Belize Building Act Cayes Development Policy Coastal Zone Management Act Environmental Protection Act Forest Act Hotels and Tourist Accommodation Act Housing and Town Planning Act Land Utilization Act Mines and Minerals Act	Central Building Authority Coastal Zone Management Authority Coastal Zone Management Authority Department of the Environment Forest Department Belize Tourism Board Ministry of Housing



Map 7: Informed Management Zoning Scheme for Coastal Development in the Northern Sub Region



Map 8: Informed Management Zoning Scheme for Coastal Development in the Southern Sub Region

Recommended Actions:

1. Limit further development on the cayes, based on their relative development suitability as described above. Steer development density in terms of low, medium, or high as recommended by development standards within these guidelines.

2. Limit the number of future piers to one for Hat Caye , and ensure that it is positioned on the leeward side of the island

3. Prohibit the construction of buildings on piers

4. Support the Lighthouse Reef Conservation Institute's 20/80 rule for land use in which 20% of the land mass is developed and the remaining 80% remains in its natural state

6.4 Marine Dredging and Mineral Extraction

Dredging and sand mining can have disastrous effects on the habitats of particular species and on economic and recreational use of the region. While no dredging activity has been observed in the region, it is likely that there may be instances of dredging or sand mining activity to increase land mass or land rehabilitation, particularly in cases of post storm disruption. For instance, there is concern that since Sandbore and Hat Cayes have lost land mass in the past during major storm events like hurricanes, there may be future requests for land reclamation projects that would entail dredge and fill activities. However, it is the strong recommendation of the Lighthouse Reef Atoll coastal advisory committee that given the ecological significance and World Heritage Status of the region, there should be absolutely no dredging or mineral extraction activities permitted in this region. This recommendation is also expressed spatially in the Informed Management dredging zoning scheme for this region. Additionally, it was recommended that in order to discourage future proposals to dredge the area, particularly in support of deepening routes for marine traffic, there should be restrictions on the size of vessels that can enter the area.

Recommended Actions:

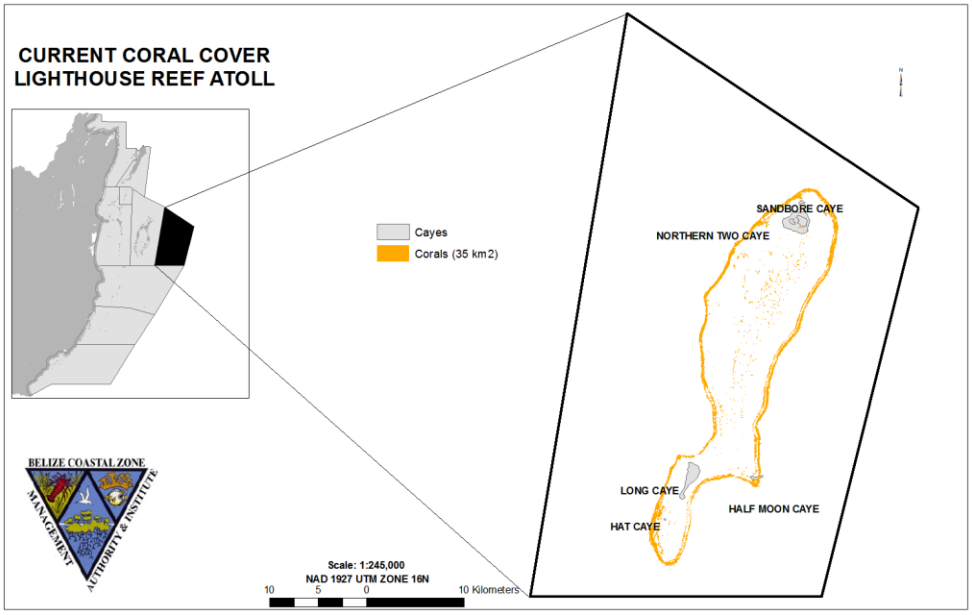
1. Discourage dredging activity unless required for land rehabilitation or the maintenance of the Port facility. In these cases, the activity must not disrupt the marine ecosystems or impact negatively on existing uses by other individuals or operations, and must be approved by the Department of the Environment and National Environmental Appraisal Committee

6.5 Sensitive Habitats

The Lighthouse Reef Atoll region is contains rich and diverse habitat. Both the Half Moon Caye and Blue Hole Natural Monuments, also World Heritage Sites, are located in this region. Both have long been recognized as areas with unique ecological and biodiversity that are of scientific importance to Belize, the world and humankind. These resources must be protected.

6.5.1 Corals

The atoll is characterized by a semi-emergent reef crest, which circumnavigates the atoll. Seaward are the fore reef areas characterized by branching, bolder type and plate-like coral forms. Leeward of the reef crest are the reef flat and pavement areas, which are followed by a lagoonal area of variable depths. This area is generally shallower than twenty feet and is punctuated by numerous patch reef systems. Some of the more common coral species include the smooth brain coral (*Diploria labyrinthiformis*), the mountainous star coral (*Montastrea annularis*) and the leaf coral (*Agaricia agaricites*).



Map 9: Coral Cover in the Lighthouse Reef Atoll Region

Coral cover in this region is about 35 square kilometres (**Map 9).** Results of the InVEST Habitat Risk Assessment (HRA) model suggest that currently 0.21% of the region's corals are at low risk, 96.67% at medium risk, and 3.12% at high risk (**Fig. 1**). The results also suggest that in a Conservation Zoning Scheme no corals would be at high risk. There would also be

proportionately less corals at medium risk than in the current. According to HRA model results, corals that were formerly at medium risk in the current scenario would be at low risk in a future Conservation Zoning Scheme, making the total percentage of corals at low risk in this scenario 36.8%, and at medium risk 63.2% (**Fig. 1**). In a Development Zoning Scheme, HRA model results suggest that the threat to corals would become increasingly higher. Only 0.21% of corals would be at low risk whereas 5.68% and 94.1% of present corals would be at medium and high risk, respectively (**Fig. 1**). In the proposed Informed Management Zoning Scheme, HRA results are indicating that 2.99% of corals would be at high risk, 1.69% of present corals would be at low risk, and 95.32% at medium risk (**Fig. 1**).

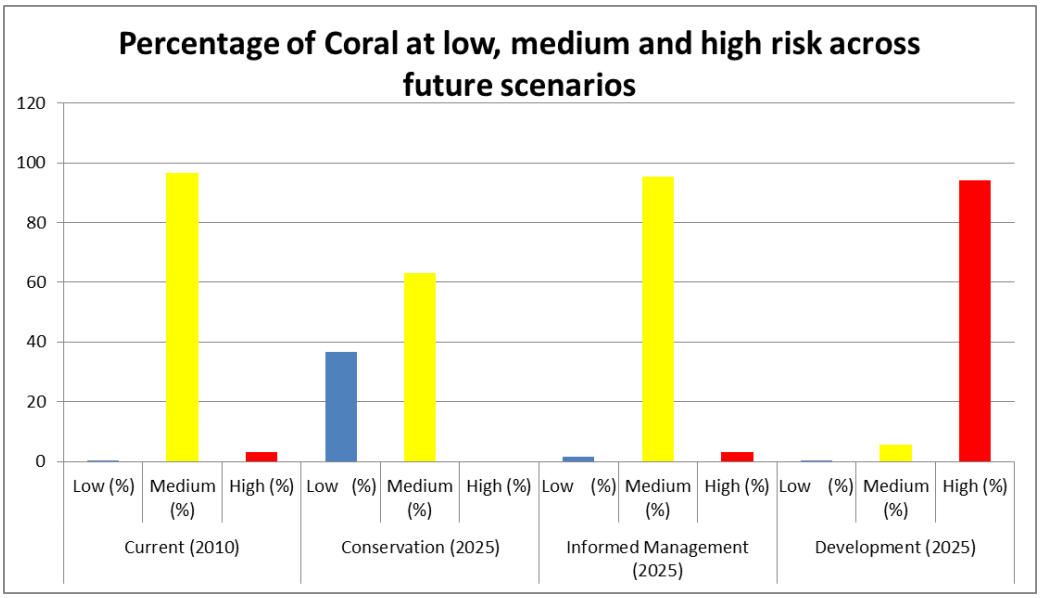
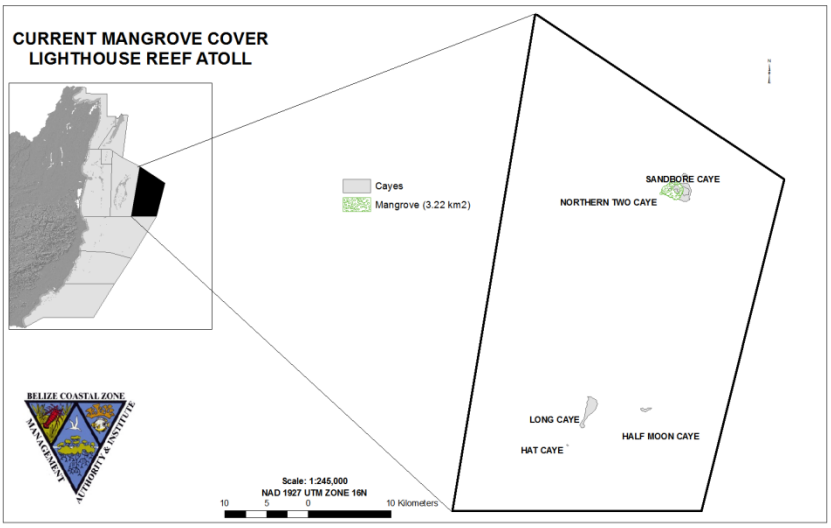


Figure 1: Risk to Corals in the Lighthouse Reef Atoll Region by Scenario

6.5.2 Mangroves

The dominant tree species is the Red Mangrove (*Rhizophora mangle*), while the White Mangrove (*Laguncularia racemosa*) and Black Mangrove (*Avicennia germinans*) are also present. These inhabit mostly the mangrove type cayes. Other significant vegetation include coconut (*Cocos nucifera*), Buttonwood (*Conocarpus erectus*), Red Gumbo Limbo (*Bursera simaruba*), Black Poisonwood (*Metopium brownie*), Wild Coco Plum (*Hirtella Americana*), Genip (*Grias cauliflora*) and the Zericote (*Cordia sebestena*), which is a critical habitat as it provides a nesting area for the red-footed Boobies and Frigatebirds.



Map 10: Mangrove Cover in the Lighthouse Reef Atoll Region

In this region, the total mangrove cover is approximately 3.22 square kilometers (**Map 10).** Results of the InVEST Habitat Risk Assessment (HRA) model suggest that currently 0.1% of the region's mangroves are at low risk, 99.9% at medium risk, and 0% at high risk (**Fig. 2**). The results also suggest that in a Conservation Zoning Scheme no mangroves would be at high risk. There would also be proportionately less mangrove at medium risk than in the current. According to HRA model results, mangroves that were formerly at medium risk in the current would be at low risk in a future Conservation Zoning Scheme, making the total percentage of mangroves at low risk in this scenario 0.73%, and at medium risk 99.27% (**Fig. 2**). In a Development Zoning Scheme, HRA model results suggest that the threat to mangroves would become increasingly higher. 0.1% of mangroves would be at low risk whereas 99.0% and 0% of present mangrove would be at medium and high risk, respectively (**Fig. 2**). In the proposed Informed Management Zoning Scheme, HRA results are indicating that no mangroves would be at high risk, 0.1% of present mangroves would be at low risk, and 99.9% of medium risk (**Fig.2**).

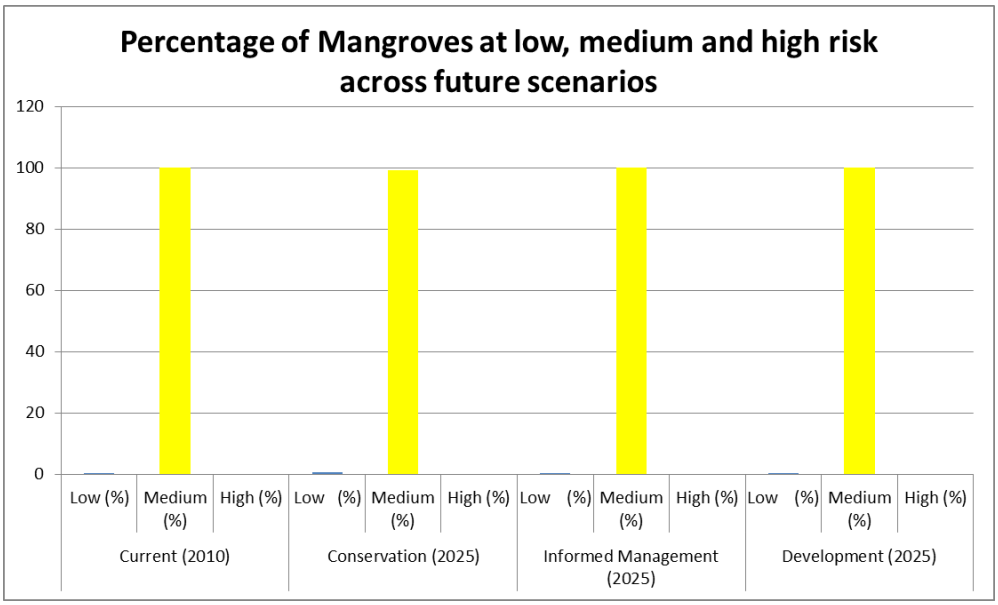
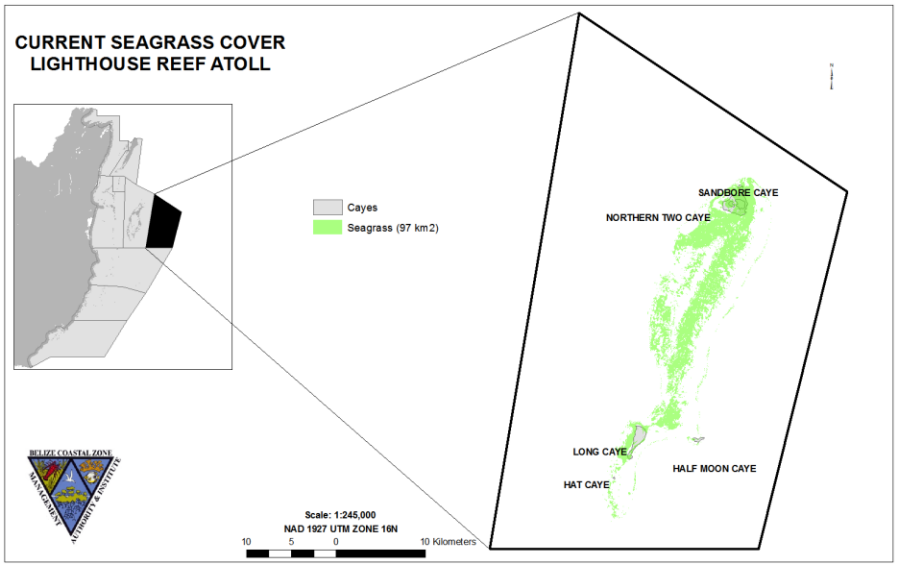


Figure 2: Risk to Mangroves in the Lighthouse Reef Atoll Region by Scenario

6.5.3 Seagrass

The most abundant sea floor vegetation is the turtle grass (*Thalassia testudinum*). Other plant species include Manatee Grass (*Syringodium filiforme*) and a number of Benthic Green Algae (*Caulerpa cupressiodes*) and Brown Algae (*Turbinaria turbinate*).



Map 11: Risk to Seagrass in the Lighthouse Reef Atoll Region

The total seagrass cover for the South Central region is approximately 97 square kilometres **(Map 11).** Based on the Habitat Risk Assessment (HRA) conducted for this region, approximately 0.07% of the region's seagrass are currently at low risk, 90.97% at medium risk, and 8.96% at high risk (**Fig. 3**). In a Conservation Zoning Scheme, HRA model results suggest a dramatic reversal of the level of risk to current seagrass in this region whereby no seagrass would be at high risk, 39.18% of seagrass would be at low risk and 60.82% at medium risk in 2025 (**Fig. 3**). In a Development Zoning Scheme, model results suggest that 96.98% of present seagrass would be at high risk. This zoning scheme also represents the only scenario in which seagrass are at high risk. The results also suggest that in the Development Zoning Scheme, 2.95% of seagrass would be at medium risk and 0.07% at low risk in 2025 respectively (**Fig. 3**). In the proposed Informed Management Zoning Scheme, the HRA model results suggests an improvement in the amount of seagrass that are currently at risk. Under this zoning scheme, 95.91% of present seagrass would be at medium risk. Additionally, the model results reveal that under this zoning scheme, 0..25% of present seagrass would be at low risk and 3.85% at high risk in 2025 (**Fig. 3**).

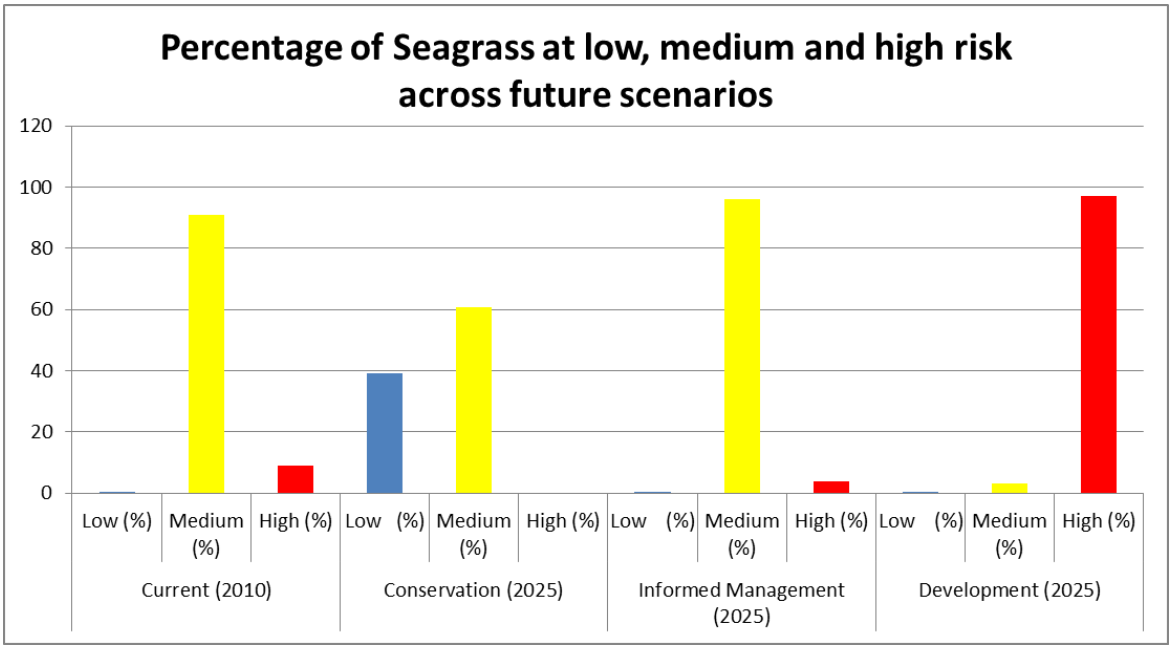


Figure 3: Risk to Seagrass in the Lighthouse Reef Atoll by Scenario

In discussing the results of the InVEST ecosystem models, and in particular the habitat risk assessment model, there is the need to consider limitations of the model, which are highlighted below:

- Results are should be interpreted on a relative scale within a study region and across habitats and stressors, but not to results from separate analyses.
- Results do not reflect the effects of past human activities.

- Results are based on equal weighting of criteria unless the user weights the criteria by importance or data quality.
- Cumulative risk is additive (rather than synergistic or antagonistic)
- Climate change impacts are not directly accounted for in model

Additional information on how this model works can be found in **Appendix B.1** of the Belize Integrated Coastal Zone Management Plan.

Recommended Actions:

1. Implement the Informed Management Zoning Scheme to limit certain activities, such as dredging, in specific areas in order to reduce the impacts to sensitive habitats

6.6 Utilities

6.6.1 Energy

The only source of energy supply in this region that may have the potential to threaten the environment is the use of diesel generators because of the noise and air pollution, the transportation and improper disposal of used lubrication oil, and the transportation and handling of fuel which can result in spills. The latter two can be mitigated against by proper handling and storage and subsequent transportation of used oils back to mainland. Solar and wind energy are environmentally friendly and are recommended for use by residential and vacation homes, and any ranger stations. However, cost effectiveness may be a factor. This could be combined with the use of a generator as a constant energy source.

6.6.2 Water

The prevailing source of water supply in the region is from the rain. This is possibly due to the quality and costs which basic catchment systems and rudimentary storage entail. Other water sources include bottled water, water from the public supply system from mainland Belize (the latter mainly during the dry season), and water produced through reverse osmosis and from wells. There is limited capacity for groundwater access. Due to its geomorphic and soil structure, the water from wells cannot be used for drinking and dependence will continue to be on rainwater and importation from the mainland, either through bottled water or the public water supply system. Where water quantity is required in large supply, this can be particularly problematic and can impact on the development capability of the region, especially if large-scale developments were to ever be contemplated. While reverse osmosis could be an alternative, this requires a consistent energy source and an adequate plan for the management of the brine by-product.

6.6.3 Airstrip

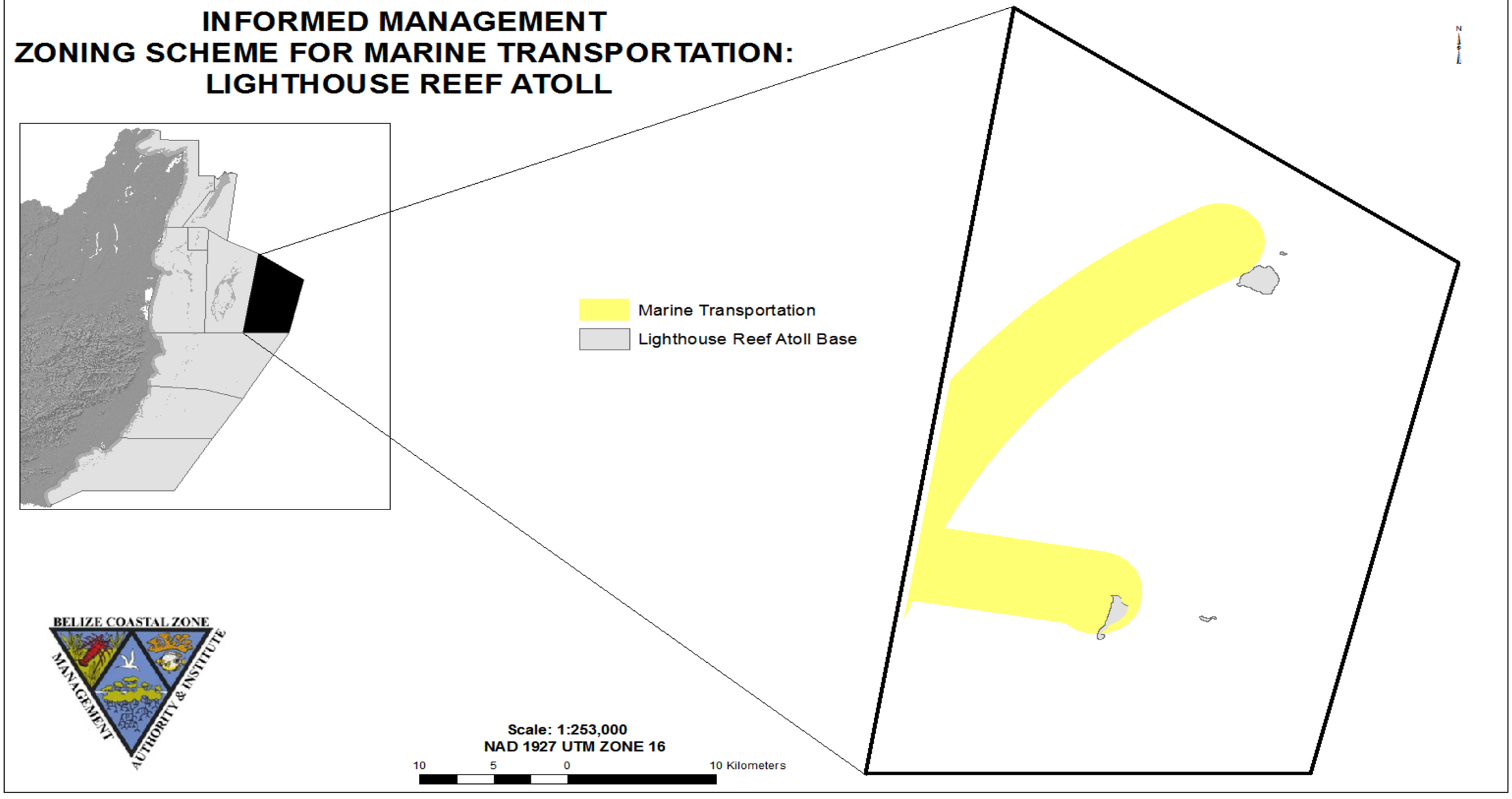
There is an airstrip at Northern (2) Caye. While the resort operation on this caye has ceased several years ago, the airstrip is still being utilized for the transfer of the skeletal staff that is hired to upkeep the area. In the past, clearance around the airstrip was performed on a regular basis. If operation were to re-occur on Northern (2) Caye, proper guidelines need to be established for the maintenance of the airstrip, including building materials, length and width of airstrip and the acceptable level of vegetation clearance around the airstrip. These guidelines should be in accordance with those recommended by the Department of Civil Aviation and the Belize Airports Authority.

6.6.4 Anchorage

There are several moorings in and around Lighthouse Reef Atoll, the majority of which can be found at Half Moon Caye. These moorings cater for live aboards and daily dive operators from San Pedro, Caye Caulker and Belize City. The carrying capacity for these moorings is approximately 350 tons. Occasionally, large vessels exceeding the carrying capacity of the moorings would visit Lighthouse Reef Atoll, and would anchor in the sandy area near to coral patches and seagrass beds. As a consequence, seagrass beds are being destroyed. This occurrence is commonly observed west of Long Caye as well. If such an activity continues to be encouraged, a proper location for anchorage needs to be identified.

6.6.5 Transportation

The accessibility to the cayes in the region using large vessels is limited due to the existence of shoals and patch reefs within and around the atoll. This suggests facilitating large vessels to the area may require dredging, sand mining and habitat disruption. Such alteration to the marine environment is not supported by local stakeholders. The region where marine traffic is permitted, however, needs to be clearly demarcated. Efforts should be made for improved infrastructure to demarcate these areas with buoys and markers to best guide vessels within the area. Particular areas that have posed navigational challenges for fishermen include Finger Cut, west of the Blue Hole, and areas around Northern (2) Caye, Sandbore Caye and Long Caye. Rather than using sticks as markers, the use of rebar, (reinforcing bars) was initially recommended. However, after careful consideration of the fact that boat hulls can be damaged from embedded rebars, the recommendation to use marker buoys is instead supported. The recommendation is for the use of buoys, no more than 3" in diameter as this would allow the buoy to submerge far easier than larger diameter buoys, minimize displacement or loss, and require less complex shackle systems of attachment.



Map 12: Informed Management Zoning Scheme for Marine Transportation in the Central Region

Table 9 Framework for Implementing Informed Management Marine Transportation Scheme

ZONE	CHARACTERISTICS OF ZONE	SCHEDULE OF PERMITTED USES			SCHEDULE OF RESTRICTED USES	SUPPORTING NATIONAL POLICIES	IMPLEMENTING AGENCY
		Dominant	**Compatible**	**Regulated**			
Marine Transportation	Marine area delineated for the use of watercraft, such as water taxis, cruise ships, etc, to transport people, goods and cargo between multiple destinations	1.Shipping operation activities 2. Port development and operation 3. Vessel traffic use	Dredging for the maintenance of necessary navigational lanes and ports of entry	Passage/entry of vessels Operation and construction of ports	1. Fishing 2. Marine recreational activities 3. Anchoring that leads to disturbance and destruction marine habitats, including but not limited to, coral reef system, seagrass beds, etc 4. Exploration and extraction of petroleum 5. Construction of any illegal structure that would obstruct shipping and navigation 6. Disposal of solid and liquid wastes from boats and ships 7. Transportation of illegal goods, such as drugs and weapons, and human trafficking	Belize Port Authority Act Belize National Coast Guard Service Act Customs Regulation Act Defence Act Environmental Protection Act Harbours and Merchant Shipping Act Immigration Act Maritime Areas Act Marine Dredging Policy (Draft) Mines and Minerals Act	Belize Port Authority Belize National Coast Guard Customs Department Belize Defence Force Department of the Environment Belize Port Authority Immigration Department Ministry of Foreign Affairs Mining Unit, Ministry of Natural Resources Geology and Petroleum Department

Recommended Actions:

1. Encourage the use of solar and wind power in the case of resorts and any residential development, as they are unlikely to cause the environmental problems (spillage, fumes, noise) associated with diesel generators

2. Encourage collaboration between the relevant agencies and stakeholders to ensure that water supply is provided through practical, and environmentally friendly means

3. Establish guidelines for the maintenance of the airstrip at Northern (2) Caye in accordance with the approved guidelines of the Civil Aviation Authority

4. Identify proper locations for anchorage of vessels at exceed the current carrying capacity of moorings

5. Utilize buoys as markers for the demarcation of the marine transportation and navigational zone

6. Designate and establish safe mooring sites, using color-coded mooring buoys to correspond to vessel tonnage limits and quantity

6.7 Pollution Control

In order to avoid problems associated with improper solid waste disposal, proper solid waste management plans (SWMP) should be employed to effectively collect, transport, separate and dispose of solid waste. Garbage should be separated and disposed. Organic waste such as trees, leaves and grass should be collected and composted on site. Material that is recyclable should be transported back to the mainland for disposal. It would be ideal if a recycling program could be established. However, consideration must be given to the fact that in most cases, there are no facilities to support on-site recycling. In the past, it was recommended that some of the garbage be burnt and buried on site. However, stakeholders of this region have strongly recommended that this practice be discontinued as it is not acceptable to burn solid wastes, such as plastics. Instead such inorganic, non-biodegradable wastes should be transported to the mainland for final disposal. This is the arrangement that the management of Half Moon Caye Natural Monument currently uses. Solid wastes are separated, and the inorganic wastes are brought to Belize City for final disposal.

For wastewater disposal, it is best to select a low-cost, environmentally-friendly system based on the waste load, desired level of treatment and cost-effectiveness. Latrines are still being used by fisherfolk at Sandbore Caye. However, the discontinuation of the use of this technology is recommended as it is viewed as being crude and primitive. Some stakeholders have recommended that stakeholders of the region explore technologies such as the *Clivus Multrum* composting toilet is considered as separates solid and liquid wastes, in addition it allows for grey water treatment that goes into a leach field. Rather than prescribing certain technologies, however, some stakeholders insist that the system selected is based on the wastewater treatment needs.

Treatment of Wastes on Cayes

Due to the fragile nature of the cayes and atolls septic tanks and soak-aways are not recommended as a means of handling household waste. Increasing numbers of users create increasing amounts of waste; Long Caye returns all non- organic waste to the mainland by vessel, this does increase the net cost incurred but dramatically reduces the impact of waste generation. As important as waste disposal is, such disposal must follow defined guidelines and transgression of these guidelines must be halted through sensible, applicable measures of waste disposal for all parties concerned; from resort to research station and stakeholders to guests. Also, since there are no established solid waste management on cayes, the CZMAI recommends the following based on the Long Caye Eco-Guidelines produced by Pleasure Island Limited for the handling of waste on **cayes:**

Human waste must be treated with composting toilets. Septic tanks, cesspools and sewers should be prohibited.

- Gray water must be treated, and all dwellings and buildings must have a gray water treatment system approved by DOE before construction.

- Organic wastes must be collected and disposed of in composting bins.

- However possible, recycling and garbage separation is encouraged.

- Frequent removal of solid waste from the cayes for treatment and proper disposal on the mainland.

Recommended Actions:

1. Ensure proper solid waste management plans for wastes generated at each caye in order to effectively collect, transport, separate and dispose of solid wastes. The possibility of establishing on-site recycling programs should be explored

2. Select appropriate wastewater treatment technology based on waste loads, desired treatment level and cost-effectiveness

6.8 Social Amenities

Even though development in the region is envisaged to be low intensity, it is important that infrastructure such as walkways are placed on land, and buoys and markers in the sea to direct vessels and humans away from fragile and sensitive ecosystems. Therefore channels must be clearly marked as best as possible to allow entry of small vessels to the region.

Recommended Actions:

1. Attach as conditions to approval, the placing of walkways on the land, and buoys and markers on sea respectively

6.9 Conservation

Of the almost 40,000 acres that comprise the Lighthouse Reef Atoll Region, approximately 27% or the equivalent of 10,711 is under protected status. Notwithstanding, the other cayes of the region are also of scientific, socio-economic and cultural importance to the country. The role of the cayes in coastal protection, and their contributions to the fishing and tourism industries, scientific and economic opportunities and their relationship to the survival of the barrier reef cannot be understated. Furthermore, given the unique biodiversity and social and cultural importance of the region, it is recommended that the cayes remain in their natural state. With the few exceptions, these cayes cannot sustain any further development. These exceptions are notably, the northeastern portions of Northern (2) Caye and Long Caye. Mangroves should be restored on Hat Caye. The owners of Long Caye and the creators of the Lighthouse Reef Conservation Institute recommend that the south eastern portion of the caye becomes the Long Caye Preserve. This area is mostly a mangrove wetland and includes a wetland lagoon. They also recommend that a research facility be established in the area of the preserve. **(See Maps 14 & 15).**

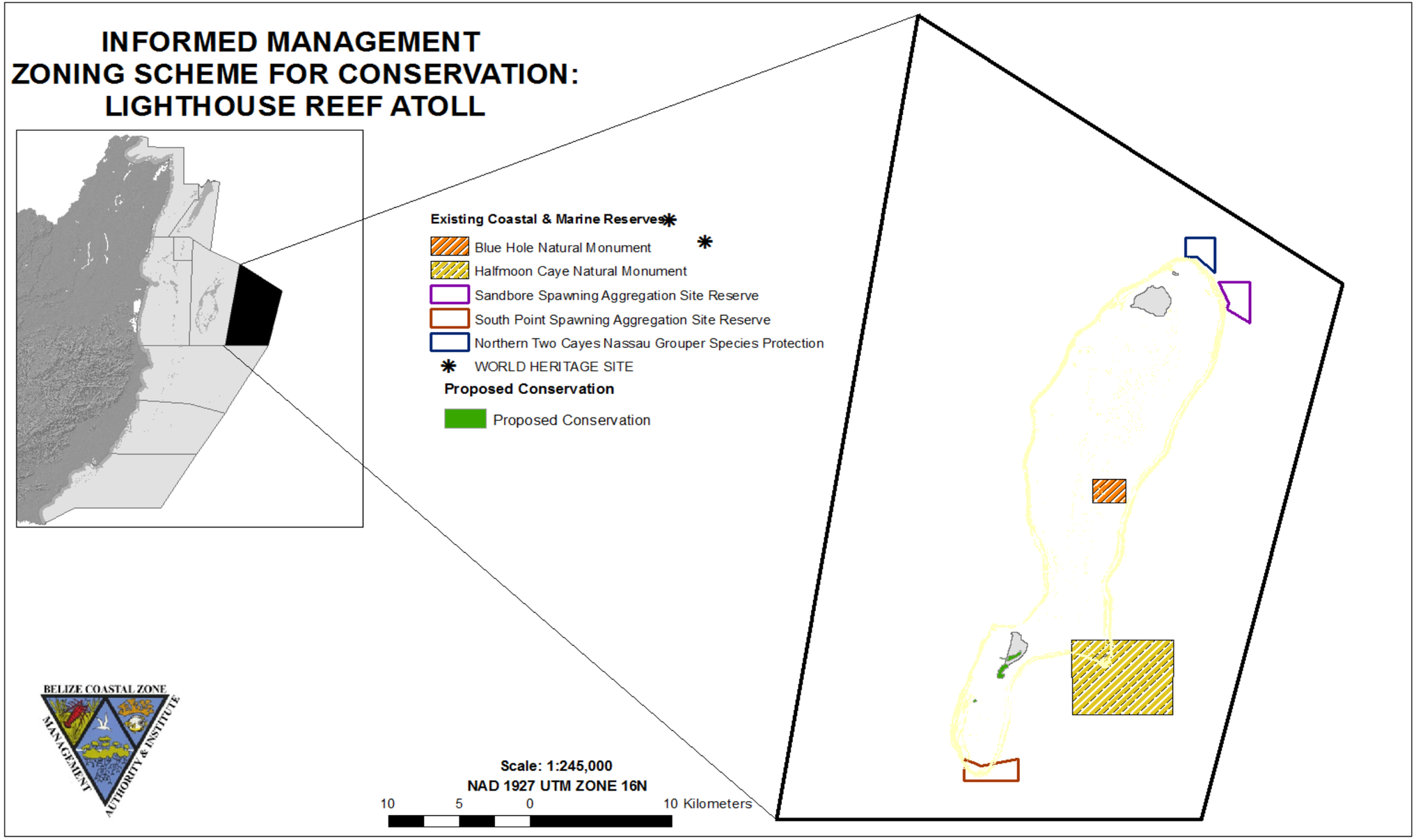
Lighthouse Reef Atoll is now the only unprotected atoll in Belize the LRACAC recommends that these coastal zone management guidelines should reflect a commitment to expand MPA status to include Lighthouse Reef Atoll. With the implementation of the Managed access program at LRA a special S.I. would be needed which would declare the area a fisheries management zone. This would provide some protection for the fisheries industry if passed.

Recommended Actions:

1. Ensure the continuity of conservation efforts for the entire region

2. Provide foundation for any new initiatives for protected areas for the region through land use assignment provisions

3. Complement existing management plans for the two protected areas in the region



Map 13: Informed Management Zoning Scheme for Conservation in the Lighthouse Reef Region

Table 10: Framework for Implementing Informed Conservation in the Lighthouse Reef Atoll Region

ZONE	CHARACTERISTICS OF ZONE	SCHEDULE OF PERMITTED USES			SCHEDULE OF RESTRICTED USES	SUPPORTING NATIONAL POLICIES	IMPLEMENTING AGENCY
		Dominant	Compatible	Regulated			
Marine Conservation	Coastal and marine areas delineated for the retention of critical habitats and ecosystems for a diversity of marine life, fish spawning aggregation sites, replenishment zones, biodiversity areas	1. Coastal and marine reserves 2. Breeding, spawning, feeding area for marine life 3. Replenishment zones 4. Seagrass rehabilitation 5. Mangrove planting 6. Foraging area for manatees, dolphins, crocodiles 7. Nesting beaches for sea turtles	1.Research and education 2. Marine Recreation and Tourism	Tourism and recreation (snorkeling and diving) Research and education Establishment of new reserves	1. Fishing within "no-take"/replenishment zones, and spawning aggregation sites 2. Development of shoals 3. Anchoring that leads to disturbance and destruction marine habitats, including but not limited to, coral reef system, seagrass beds, mangrove forests, etc 4. Exploration and extraction of petroleum 6. Disposal of solid and liquid wastes from boats and ships 7. Shipping	Belize Port Authority Act Belize National Coast Guard Service Act Customs Regulation Act Defence Act Environmental Protection Act Harbours and Merchant Shipping Act Immigration Act Maritime Areas Act Marine Dredging Policy (Draft) Mines and Minerals Act	Belize Port Authority Belize National Coast Guard Customs Department Belize Defence Force Department of the Environment Belize Port Authority Immigration Department Ministry of Foreign Affairs Mining Unit, Ministry of Natural Resources Geology and Petroleum Department

6.10 Scientific Research and Education

The management plans for Half Moon Caye Marine Reserve and Blue Hole Natural Monument call for an integrated research and monitoring programme for the region as a strategy to maintain the long-term ecological integrity of biological diversity and sustainable resource use by dependent communities. These management plans also outline a framework for effective integrated research and monitoring of conservation targets, the development of a data management facility and the incorporation of community involvement from relevant stakeholders. .

Recommended Actions:

1. Implement the recommended research and educational activities for the region as outlined in the management plans for Halfmoon Caye Marine Reserve and Blue Hole Natural Monument.

7.0 IMPLEMENTATION STRATEGY

The Lighthouse Reef Atoll Region Coastal Zone Management Guidelines form a part of the Belize Integrated Coastal Zone Management Plan being developed by the CZMAI. After approval of the Plan by CZMAI's Board of Directors, it will be offered to the House of Representatives for endorsement. Implementation of these coastal management guidelines will be undertaken through two mechanisms: (a) centralized statutory control through the various Government departments, and (b) localized community and stakeholder participation. Following the mechanism of centralized statutory control, the regulatory and permitting agencies with management mandates for the coastal zone will implement the specific policy actions and informed management spatial zoning scheme that are recommended in the Plan.

While the government agencies have the authority of the law to back up its procedures, it is constrained by limited resources. In several instances, however, local NGOs and community-based stakeholder organizations have greater access to, and knowledge of, local conditions and activities, though they have no statutory powers to either assist or control development beyond those available through the Village Councils and Towns Councils Acts. For this reason, it is recommended that localized community and stakeholder participation complement the management efforts of centralized government and statutory agencies in implementing integrated coastal zone management. The Lighthouse Reef Atoll Region Coastal Advisory Committee (LRACAC), and other interested stakeholders of this region, will work closely with the Coastal Zone Advisory Council (CZAC) regarding monitoring and implementation of the guidelines.

Objectives of the Lighthouse Reef Atoll Region CAC include, *inter alia*, contributing to the drafting of the coastal zone management guidelines for their coastal region, supporting their initial approval, and monitoring and reporting to the Coastal Zone Advisory Council (CZAC) on the implementation of the guidelines. This means that the Committee will be expected to undertake the following tasks:

1. Develop, assess and approve the draft guidelines;
2. Forward the approved draft guidelines to CZMAI for approval;
3. Monitor the implementation and effectiveness of the guidelines;
4. Identify the appropriate time for a review of all or part of the guidelines;
5. Review and update the guidelines.

Planning is a continual process of recommendation, participation, implementation and review. These guidelines shall be monitored on a continual basis in order to establish its strengths and weaknesses. Through a management planning mechanism, the LRACAC, along

with CZMAI, will regularly update the guidelines, which will hopefully set a good example of representative, cooperative and adaptive management that is environmentally sound, rational and equitable.

Additional studies are needed in liaison with the relevant authorities and region's stakeholders. Such studies should reveal information which may help to further support sustainable development and to address the social, cultural and economic human use of the region and its resources.

8.0 CONCLUSIONS

The coastal zone management guidelines recommended for the region are not intended to be rigid, as changing socio-economic, cultural and environmental conditions may necessitate modifications. Similarly, changing shapes of the cayes and the health of habitats of the terrestrial and aquatic environments may also require this. As well, land tenure needs to be clarified.

Noteworthy however, is that it has resulted in the identification of sites for uses which may not otherwise have been considered for such, and the disqualification of sites for intended uses not conducive to sustainable development. This can transfer and disperse certain activities from accumulated point impacts, to the wider and other areas to reduce the pressures on environments that apparently are under stress from over use.

It is hopeful that the objectives outlined at the beginning can be realized through the recommended sector policies and management guidelines. More importantly though, is that the formulation of coastal zone management guidelines is a starting point to ensuring the sustainable use and development of the Lighthouse Reef Atoll Region.

9.0 REFERENCES

Belize Tourism Board. 2008. Travel and Tourism Statistics. Belize City, Belize.

Belize Tourism Board. 2011. *National Sustainable Tourism Master Plan for Belize 2030*. Available from http://www.sustainabletourismbz.org/dmdocfree/final_compiled_plan.pdf (accessed June 2012)

Cho, L. 2005. Marine Protected Areas: A tool for integrated coastal management in Belize. Ocean and Coastal Management 48: 932-947.

Coastal Zone Management Authority and Institute (CZMAI). 2001. *Cayes Development Policy*

Coastal Zone Management Authority and Institute. 2003. *The National Integrated Coastal Zone Management Strategy for Belize*. Prepared by Halcrow Group. 94p. Available from http://www.coastalzonebelize.org/wp-content/uploads/2010/04/national_integrated_CZM_strategy.pdf (accessed October 2012).

Cooper, E., Burke, L., Bood, N., 2009. Coastal Capital Belize: The economic contribution of Belize's coral reefs and mangroves. WRI working paper, World Resources Institute, Washington D.C. 53 p. Available from http://pdf.wri.org/working_papers/coastal_capital_belize_wp.pdf

Development Solutions. 2004. *Lighthouse Cayes Region Volume 7. Development Guidelines*. Coastal Zone Management Authority & Institute.

Gibson, J. (Ed.) 1989. Proceedings of the International Coastal Resources Management Workshop. San Pedro, Ambergris Caye, Belize, 23 -25 August, 1989. Wildlife Conservation International, Belize. 193p

Government of Belize. 1998. *Belize Coastal Zone Management Act*, Chapter 329, Laws of Belize, Revised Edition, 2000.

Grimshaw, T. 2003. *Draft National Aquaculture Zoning Plan*. Tunich-Nah Consultants & Engineering, ECOWORKS. Belize City, Belize.

Lands and Surveys Department. 2012. *Draft National Guidelines for Subdivision and Consolidation of Land in Belize*. Ministry of Natural Resources and Agriculture, Belmopan, Belize.

Pleasure Island Limited. (2010). *Amended and Restated Eco Guidelines*. Long Caye: Pleasure Island Limited.

Statistical Institute of Belize. 2010. Belize Population and Housing Census 2010.

10.0 APPENDICES

10.1 Background

The coastal zone is one of Belize's greatest assets and its magnificent Barrier Reef Reserve System is a renowned World Heritage Site. It is the longest barrier reef in the Western Hemisphere, extending approximately 280 km from the northern to southern borders of the country (Cooper et al. 2009). Belize's coastal zone has complex and dynamic marine ecosystems that support innumerable ecological processes and a vast array of marine life and habitats. In addition to its important ecosystem functions, the coastal zone is vital to the Belizean way of life. The highly productive coastal zone is the resource base for a broad range of economic activities. In fact, approximately thirty-percent of the country's gross domestic product is directly linked to these commercial activities that take place within the coastal zone (Cho 2005). The coastal zone also has important social and cultural values to the Belizean people, especially to approximately 40% of the population that reside on the coast and in offshore areas (SIB 2010).

Over the past decades, rapid economic development and population growth have taken place in the coastal zone and inland areas of Belize. World-renowned snorkeling and diving draw over 800,000 tourists to the region annually, driving the construction of new development (BTB 2008). These occurrences have led to increasing pressures on coastal and marine resources, with implications to the livelihoods of those that depend upon them. These anthropogenic threats stem from various developmental activities associated with tourism and recreational facilities, population growth and expansion, utility supply, dredging and mineral extraction, land clearance, pollution, waste disposal, fisheries and aquaculture. These threats are compounded by natural hazards, global warming, rising sea levels, and the vulnerability of sensitive ecological systems to climate change. Thus, it is imperative now more than ever to ensure that the coastal zone is utilized in a manner that will continue to support important ecological functions, as well as social, cultural and economic prosperity for current and future generations.

For many years, and even today, management of the Belizean coastal zone has been under the regime of sectoral planning. However, The need for an integrated approach to optimally manage Belize's coastal resources was made resoundingly clear at a historic meeting in 1989 when a wide cross-section of stakeholders from various sectors, including scientists, marine managers, private sector, and coastal communities converged in San Pedro, Ambergris Caye (Gibson 1989). Integrated coastal zone management (ICZM) brings together all decision-making agencies to ensure integration among their policies and management plans, to ultimately improve and maintain the quality of coastal and marine ecosystems. A defining feature of Belize's ICZM plan is balancing national economic development needs with conservation priorities within a spatially defined area over a specified timeframe. The development of site-specific coastal zone management guidelines, as a component of the Belize ICZM Plan, serves as

a means to guide management decisions and to form the basis on which decisions are made to regulate the development and use of coastal and marine resources within the coastal zone.

10.2 Summary of Enabling Legislation and Implementing Agencies For Enforcement Of The Informed Management Zoning Scheme

The various governmental organizations and agencies with management mandates for the coastal zone that are needed to implement these guidelines, to synchronize the efforts of the CZMAI via the Belize Integrated Coastal Zone Management Plan, and to strengthen inter-agency coordination for integrated coastal zone management include:

Belize Agricultural Health Authority – The Belize Agricultural Health Authority Act requires applications for licenses, permits or certificates to import and export animal products, animal feed, and plant products into and out of Belize following inspection as it affects the region. The Lighthouse Reef Atoll Region CAC should be included in any discussion on policy formulation on agricultural import and export as it affects the region.

Belize Port Authority – The Belize Port Authority Act requires applications for boat and captain licenses and for the construction and operation of private ports for the region. Also, The Harbors and Merchant Shipping Act requires the Authority to regulate the passage of vessels in and out of Belizean waters as well as the maintenance and delineation of vessel routes, lighthouses and wharfs. The Lighthouse Reef Atoll Region CAC should be included in any discussion on policy formulation on vessel licencing and shipping as it affects the region

Belize Tourist Board – The Belize Tourist Board Act requires applications for hotel licenses for the region. The Lighthouse Reef Atoll Region CAC should be included in any discussion on policy formulation on hotel development as it affects the region.

Belize Trade and Investment Development Service (BELTRAIDE) – The Belize Trade and Investment Development Service Act requires that foreign trade and investment be liaised through the BELTRAIDE organization. The Lighthouse Reef Atoll Region CAC should be included in any discussion on policy formulation on major developments as it affects the region.

Central Building Authority – The Housing and Town Planning Act provides for the regulation of the use and development of land through qualitative measures that is, building densities, land use class assignments etc. However, it does not address the structural integrity of buildings, a component of the development. The Central Building Authority, by way of the Belize Building Act, is legislated specifically to address this, and provides for the appointment of Local Building Authorities to administrate the Act. Thus, the Lighthouse Reef Atoll Region CAC can be appointed as the Local Building Authority for the Lighthouse Reef Atoll Region. However, this may require strengthening the Lighthouse Reef Atoll Region CAC with technical expertise to do this. The alternative is to coordinate this function with the Belize City, Ladyville, Mullins River & Gales Point.

Department of Environment – The Environmental Protection Act requires applications for environmental clearance for the region. The Lighthouse Reef Atoll Region CAC should be included in any discussion on policy formulation on environmental protection as it affects the region.

Fisheries Department – The Fisheries Act requires applications for fishing license for the region. The Lighthouse Reef Atoll Region CAC should be included in any discussion on policy formulation on fisheries as it affects the region.

Forest Department – The Forest Act requires applications for the removal of mangroves in coastal areas for the region. The National Parks System Act requires the establishment of National Parks, Nature Reserves, Wildlife Sanctuaries, and Natural Monuments to preserve ecologically important and sensitive areas. The Wildlife Protection Act empowers the Forest Department to determine species to be prohibited from hunting practices as it sees fit. The Lighthouse Reef Atoll Region CAC should be included in any discussion on policy formulation on mangrove removal and designation of protective status to sensitive areas and species as it affects the region.

Geology & Petroleum Department – The Petroleum Act requires applications for oil exploration and issuing of parcel contracts for the region. The Lighthouse Reef Atoll Region CAC should be included in any discussion on policy formulation on petroleum activities as it affects the region.

Hydrology Unit, Ministry of Natural Resources - The Water Industry Act requires all entities to apply for a Water Abstraction License where the water source is limited to a natural water body: surface or groundwater. The Lighthouse Reef Atoll CAC should be included in any discussion on policy formulation on water use as it affects the region.

Lands and Surveys Department - The Land Utilization Act requires applications for subdivisions for the region, any demarcation of special development areas, any allocation of land in the coastal region, this includes any construction on seabed. The Lighthouse Reef Atoll Region CAC should be included in any discussion on policy formulation on land as it affects the region.

Mining Unit, Ministry of Natural Resources– The Mines and Minerals Act requires applications for dredging, oil exploration and sand mining permits for the region. The Lighthouse Reef Atoll Region CAC should be included in any discussion on policy formulation on dredging and oil exploration as it affects the region.

Ministry of Health – The Public Health Act requires the Director of Health to make arrangements for health inspectors to enforce building and health standards for the region. The Lighthouse

Reef Atoll Region CAC should be included in any discussion on policy formulation on public safety as it affects the region.

National Emergency Management Organization – The National Emergency Management Act requires that sites be declared as vulnerable areas for the region and policy formulation on disaster management be effectuated. The Lighthouse Reef Atoll Region CAC should be included in any discussion on policy formulation on issues of national preparedness as it affects the region.

Solid Waste Management Authority – The Solid Waste Management Act requires the Solid Waste Management Authority to make arrangements for garbage collection or the engagement of contractors for the region. The Lighthouse Reef Atoll Region CAC should be included in any discussion on policy formulation on garbage collection as it affects the region.

10.3 CHECKLIST FOR HUMAN USE/DEVELOPMENT OF THE COASTAL ZONE

DEVELOPMENT ACTIVITY/HUMAN USE	PONSIBLE AGENCIES
1. Coastal Agriculture **Governing Legislation/Policy:**	
Banana Industry Act	○ Banana Control Board ○ Banana Growers Association ○ Ministry of Agriculture
Belize Agricultural Health Authority Act	○ Belize Agricultural Health Authority
Citrus (Processing and Production) Act	○ Citrus Control Board ○ Citrus Growers Association ○ Ministry of Agriculture
Environmental Protection Act	○ Department of the Environment
Land Utilization Act	○ Land Utilization Authority ○ Ministry of Natural Resources
Meat and Livestock Act	○ Belize Livestock Producers Association ○ Belize Agricultural Health Authority ○ Ministry of Agriculture
Papaya Growers Association Act	○ Papaya Growers Association ○ Ministry of Agriculture
Pesticide Control Board Act	○ Pesticide Control Board ○ Ministry of Agriculture

Sugar Cane Industry (Control) Act	○ Belize Sugar Cane Board

DEVELOPMENT ACTIVITY/HUMAN USE	RESPONSIBLE AGENCIES
2. Coastal Aquaculture **Governing Legislation/Policy:**	
Fisheries Act	○ Fisheries Department
National Aquaculture Policy (Draft)	○ Aquaculture Unit, Ministry of Agriculture
Environmental Protection Act	○ Department of the Environment
Belize Trade and Investment Promotion Service Act	○ Belize Trade and Investment

DEVELOPMENT ACTIVITY/HUMAN USE	RESPONSIBLE AGENCIES
3. Coastal Development **Governing Legislation/Policy:**	
Belize Building Act	○ Central Building Authority
Belize City Council Act	○ Belize City Council
Belize Trade and Investment Promotion Service Act	○ Belize Trade and Investment Development Services
Cayes Development Policy Coastal Zone Management Act	○ Coastal Zone Management Authority
Disaster Preparedness and Response Act	○ National Emergency Management Organization
Electricity Act	○ Belize Electricity Limited
Environmental Protection Act	○ Department of the Environment

Forest Subsidiary Act	○ Forest Department
Hotels and Tourist Accommodation Act	○ Belize Tourism Board
Housing and Town Planning Act	○ Ministry of Housing
Land Utilization Act	○ Land Utilization Authority
Mines and Minerals Act	○ Mining Unit, Ministry of Natural Resources
Private Works Construction Act	○ Ministry of Works and Transport
Public Health Act	○ Ministry of Health
Public Utilities Commission Act	○ Public Utilities Commission
Solid Waste Management Authority Act	○ Solid Waste Management Authority
Telecommunications Act	○ Belize Telemedia Limited
Town Councils Act	○ Town Councils
Trade Licensing Act	○ City/Town Councils
Water and Sewerage Act Water Industry Act	○ Belize Water Services Limited ○ Hydrology Unit, Ministry Natural Resources
DEVELOPMENT ACTIVITY/HUMAN USE	**RESPONSIBLE AGENCIES**
4. Conservation **Governing Legislation/Policy:** Fisheries Act	○ Fisheries Department
Forest Act	○ Forest Department

Private Forests (Conservation) Act	○ Forest Department
National Parks System Act	○ Ministry of Agriculture, Fisheries, Forestry, the Environment and Sustainable Development
National Protected Areas Policy and System Plan	○ National Protected Areas Secretariat
Wildlife Protection Act	○ Forest Department
Coastal Zone Management Act	○ Coastal Zone Management Authority

DEVELOPMENT ACTIVITY/HUMAN USE	RESPONSIBLE AGENCIES
5. Marine Dredging **Governing Legislation/Policy:**	
Mines and Minerals Act	○ Mining Unit, Ministry of Natural Resources
Dredging Policy	○ Mining Unit
Environmental Protection Act	○ Department of the Environment

DEVELOPMENT ACTIVITY/HUMAN USE	RESPONSIBLE AGENCIES
6. Fishing **Governing Legislation/Policy:**	
Fisheries Act	○ Fisheries Department
Coastal Zone Management Act	○ Coastal Zone Management Authority

DEVELOPMENT ACTIVITY/HUMAN USE	RESPONSIBLE AGENCIES
7. Marine Transportation **Governing Legislation/Policy:**	
Belize Port Authority Act Harbours and Merchant Shipping Act	○ Belize Port Authority

Private Works Construction Act	○ Ministry of Works and Transport
Customs Regulation Act	○ Belize Customs Department
Maritime Areas Act	○ Ministry of Foreign Affairs
Defence Act	○ Belize Defence Force
Immigration Act	○ Immigration Department
Dredging Policy	○ Mining Unit, Ministry of Natural Resources
Environmental Protection Act	○ Department of the Environment
DEVELOPMENT ACTIVITY/HUMAN USE	**RESPONSIBLE AGENCIES**
8. Marine Recreation **Governing Legislation/Policy:**	
Fisheries Act	○ Fisheries Department
Ancient Monuments and Antiquities Act	○ Archaeology Department
National Institute of Culture and History Act	○ National Institute of Culture and History
Belize Tourism Board Act	○ Belize Tourism Board
Public Health Act	○ Ministry of Health
DEVELOPMENT ACTIVITY/HUMAN USE	**RESPONSIBLE AGENCIES**
9. Oil Exploration **Governing Legislation/Policy:**	
Environmental Protection Act	○ Department of the Environment
Petroleum Act	○ Geology and Petroleum Department

10.4 FIGURES

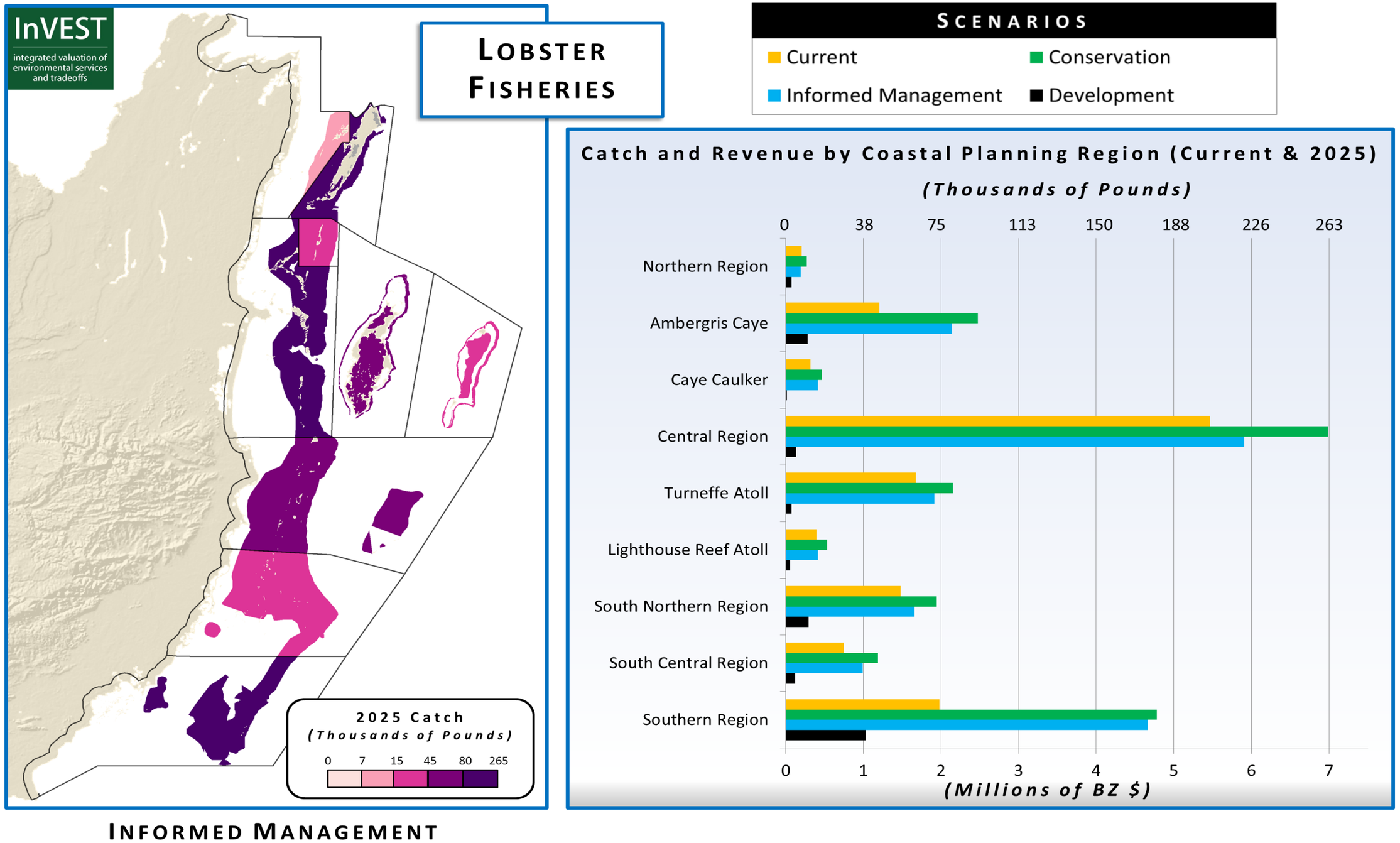


Figure 4: Lobster Fisheries Catch and Revenue by Scenario

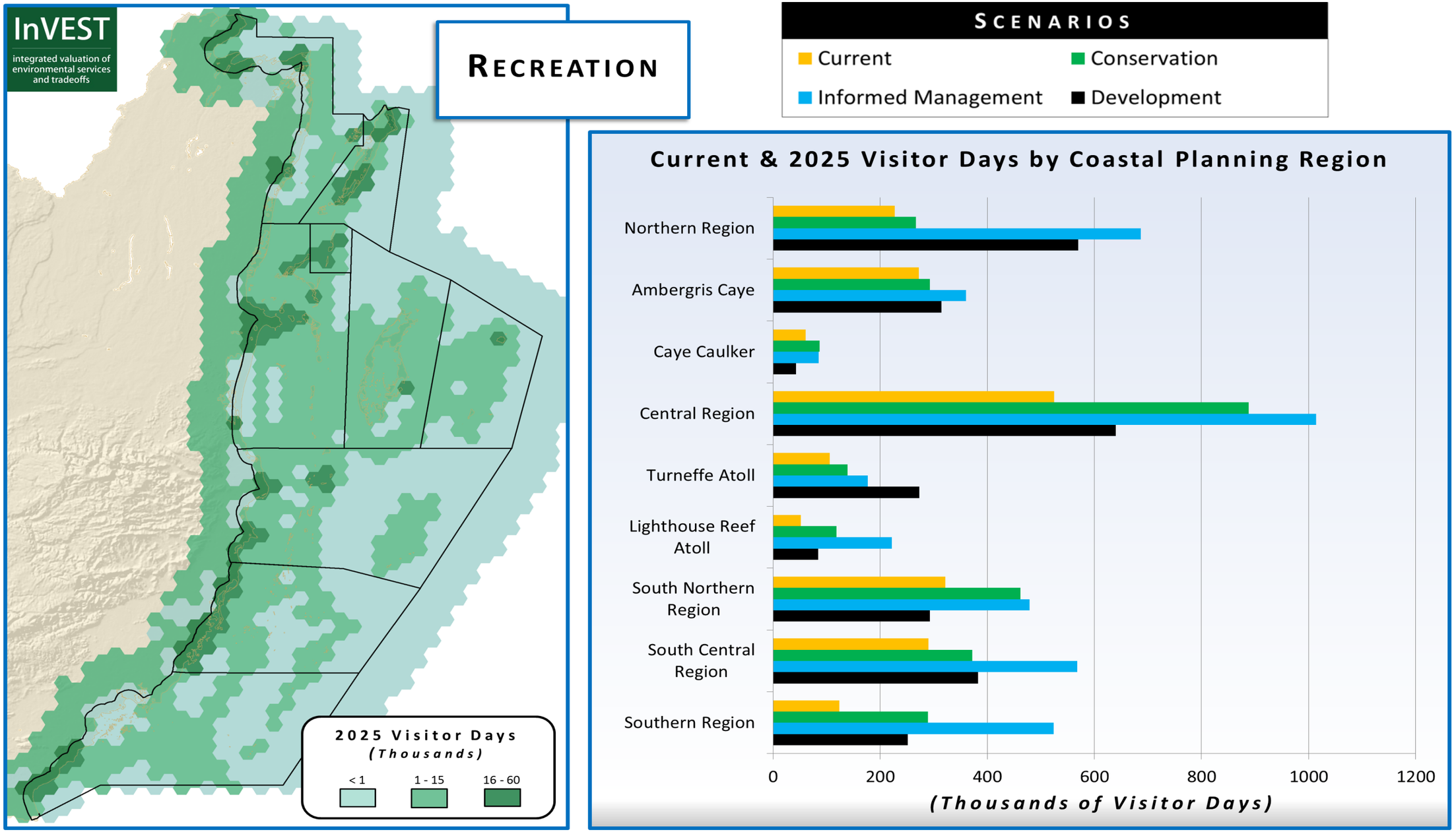


Figure 5: Annual Visitation for Marine Tourism and Recreation by Scenario

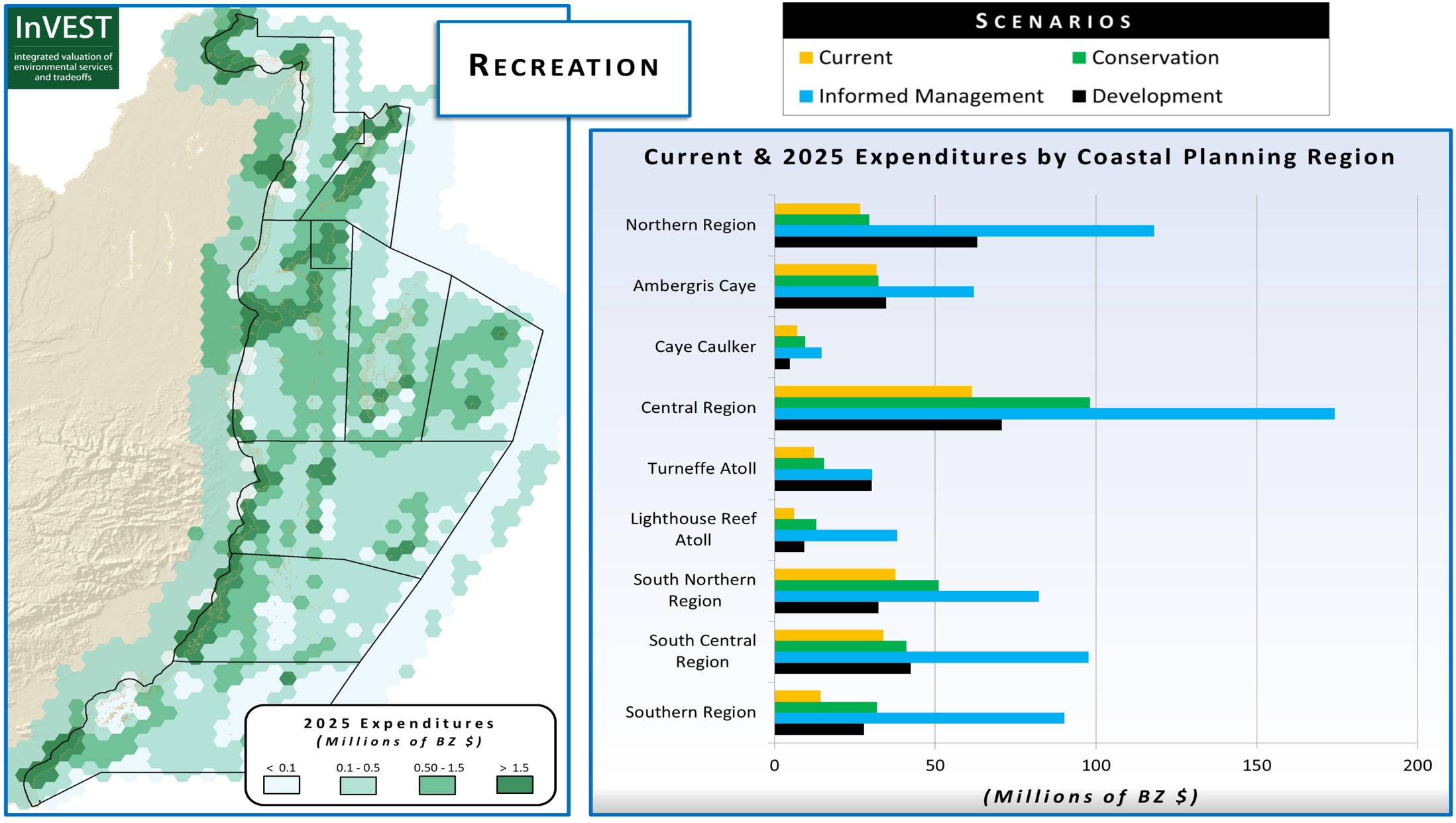


Figure 6: Annual Expenditures for Marine Tourism and Recreation by Scenario

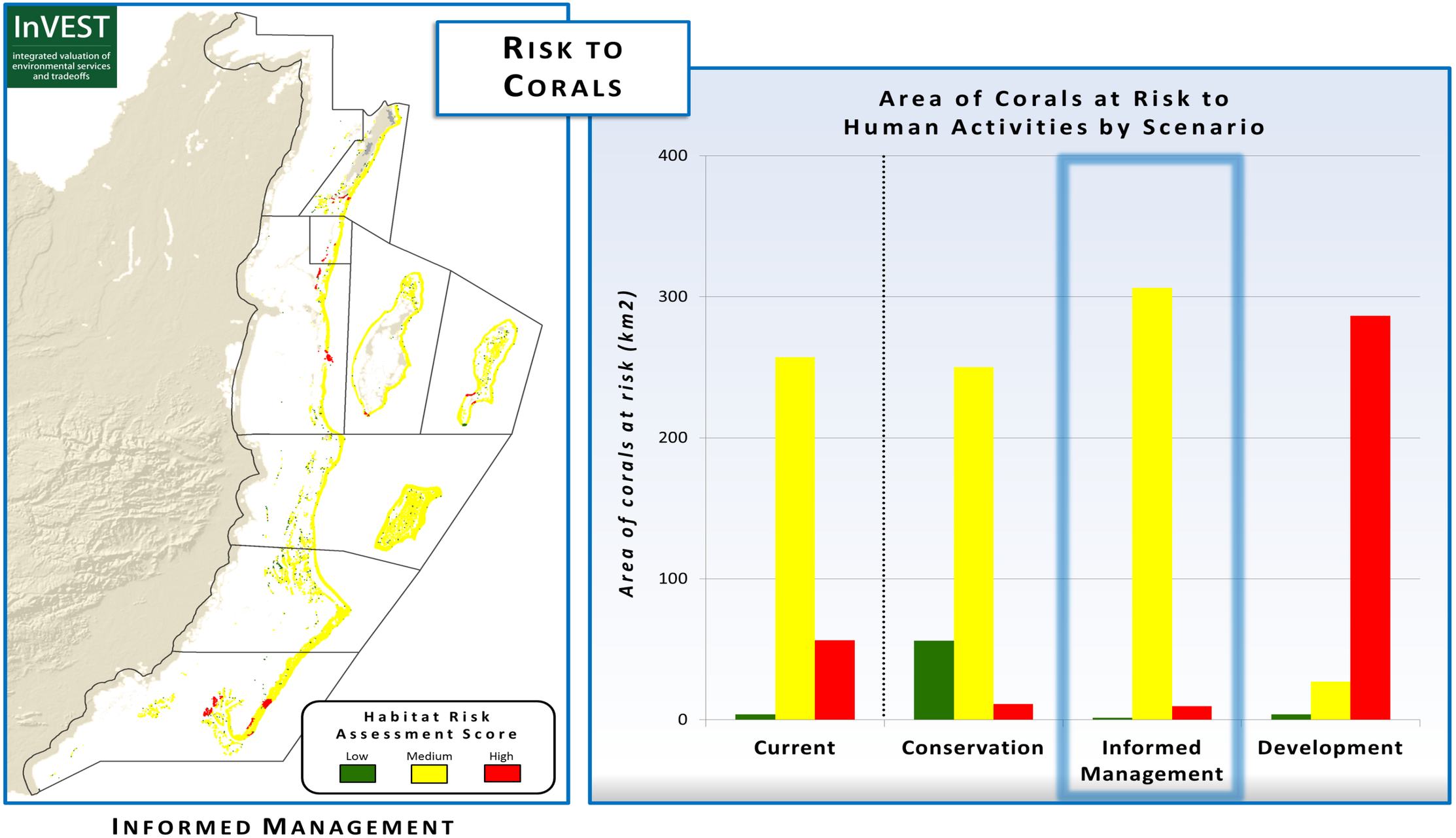


Figure 7: Area of Corals at Risk from Human Activities by Scenario

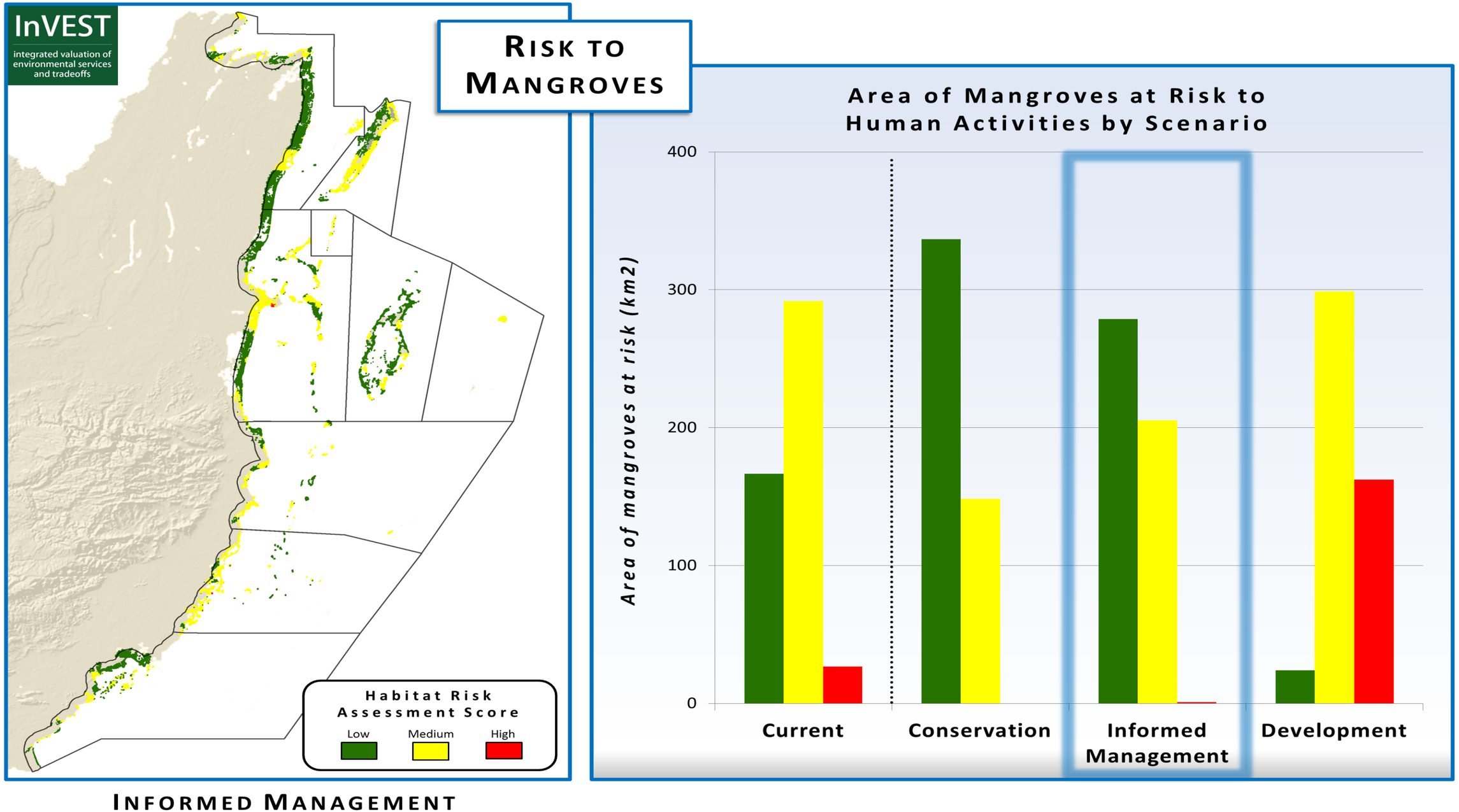


Figure 8: Area of Mangroves at Risk from Human Activities by Scenario

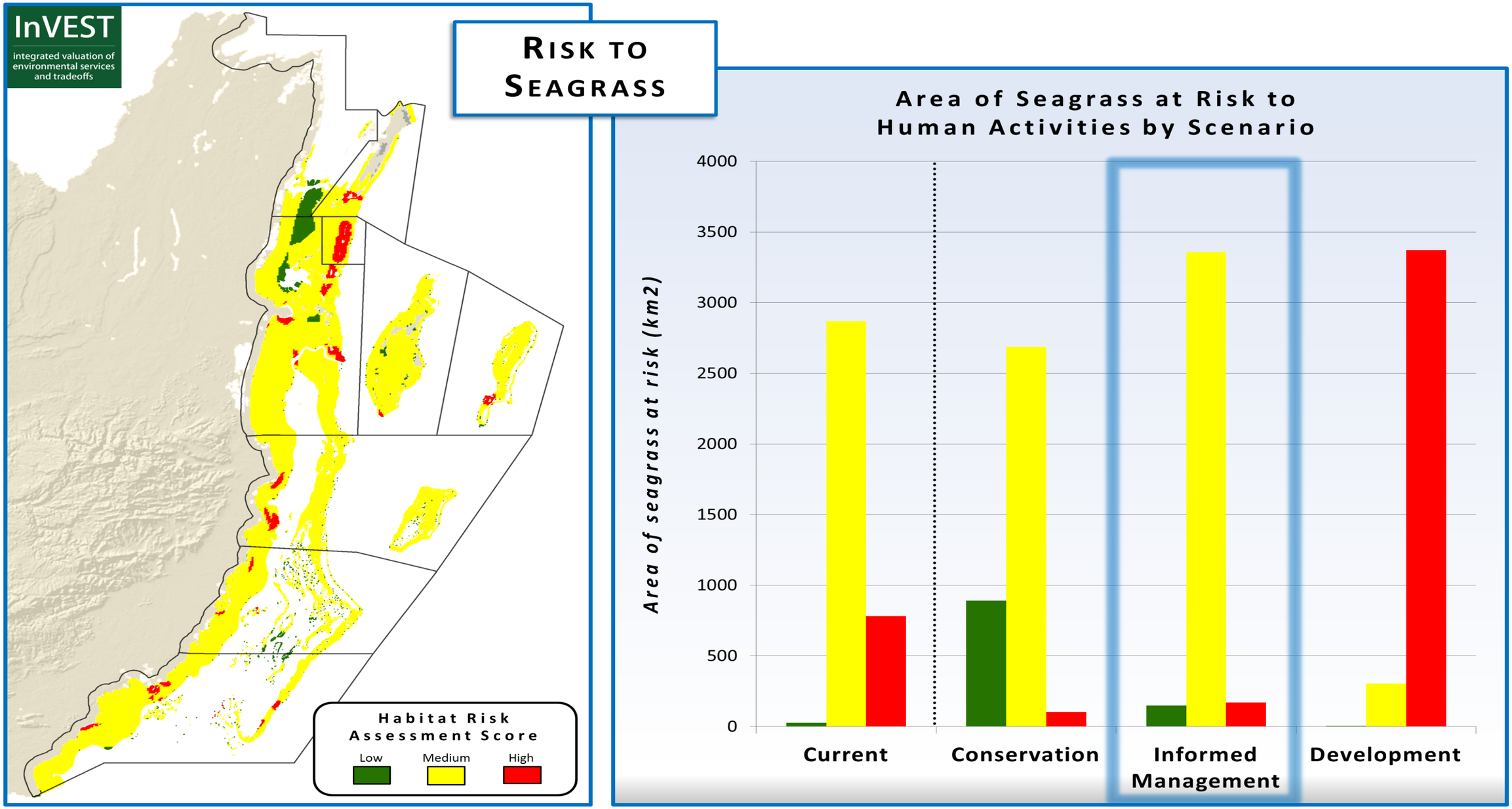
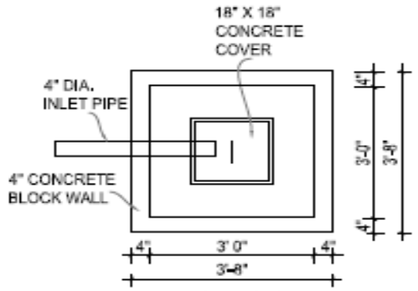
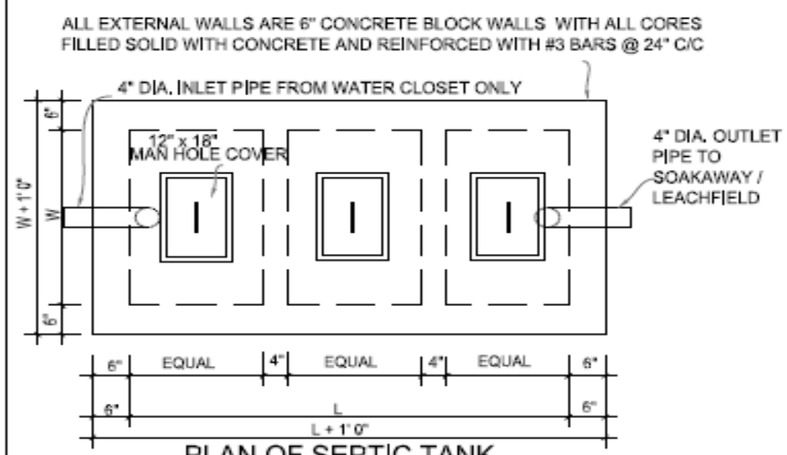


Figure 9: Area of Seagrass at Risk from Human Activities by Scenario



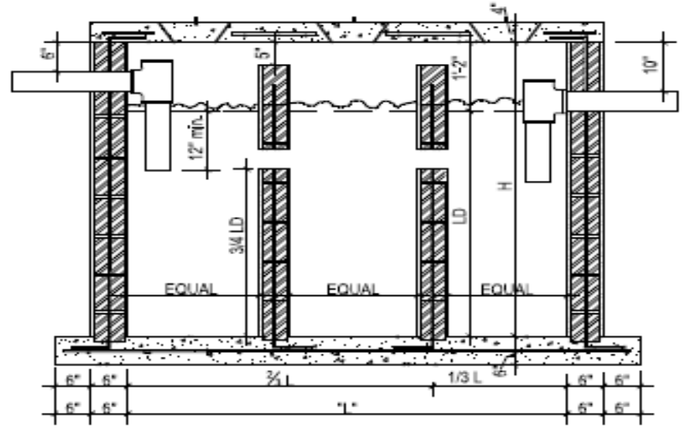
PLAN OF SOAKAWAY

SCALE: 3/8" = 1' 0"



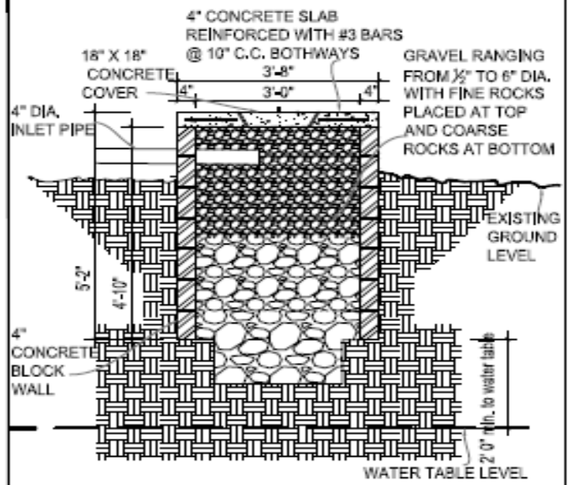
PLAN OF SEPTIC TANK

SCALE: 1/2" = 1' 0"



DIMENSIONED SECTION THRU SEPTIC TANK

SCALE: 1/2" = 1' 0"



SECTION THRU SOAKAWAY

SCALE: 3/8" = 1' 0"

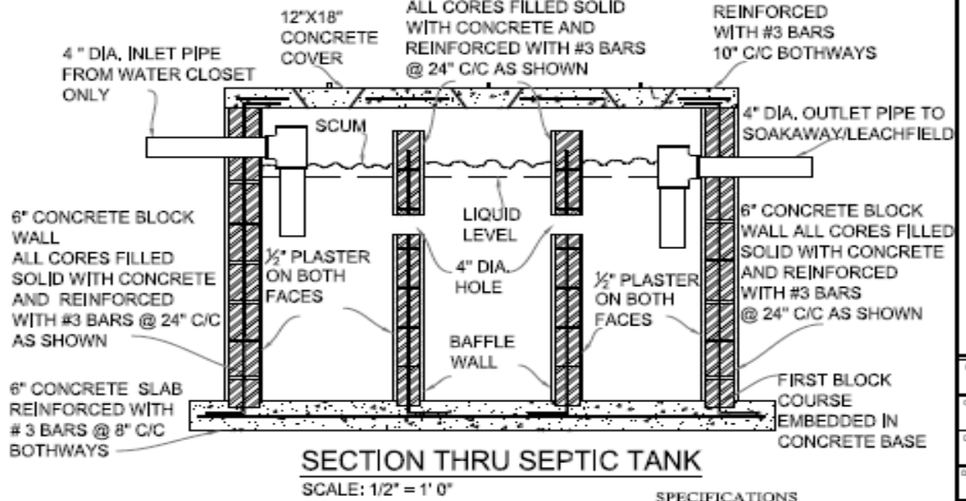
SOAKAWAY DETAILS

FOR RESIDENTIAL AND OTHER LOW IMPACT BUILDINGS ONLY

MAXIMUM NO. OF PERSONS SERVED	LIQUID CAPACITY OF TANK		INTERNAL DIMENSIONS							
			LENGTH (L)		WIDTH (W)		LIQUID DEPTH (LD)		TOTAL DEPTH (H)	
	GALLONS (APROX.)	CUBIC FT.	FT.	IN.	FT.	IN.	FT.	IN.	FT.	IN.
4	500	67	5	0	3	0	4	0	5	2
6	600	81	7	0	3	0	4	0	5	2
8	750	101	7	0	3	6	4	0	5	2
10	900	121	7	6	3	6	4	6	5	8
12	1100	148	8	6	4	0	4	6	5	8
14	1300	174	10	0	4	0	4	6	5	8
16	1500	201	10	0	4	6	4	6	5	8

SEPTIC TANK SIZING CHART

FOR RESIDENTIAL AND OTHER LOW IMPACT BUILDINGS ONLY



SECTION THRU SEPTIC TANK

SCALE: 1/2" = 1' 0"

SPECIFICATIONS

1. Inlet pipe must dip 12" below liquid level in tank.
2. Tank must be air and water tight.
3. Invert level of outlet pipe must be 2" minimum below top of baffle wall.

SEPTIC TANK DETAILS

FOR RESIDENTIAL AND OTHER LOW IMPACT BUILDINGS ONLY

Central Building Authority
3rd Fl. Coastal Zone Management Bldg.
Princess Margaret Drive - P.O. Box 2376
Belize City, Belize, Central America
Ph.: 223-2616, Fax: 223-5738
Email: centralbuildingauthority@yahoo.com
Website: www.cbabelize.com

CBA

PROJECT TITLE: TYPICAL RESIDENTIAL SEWAGE DISPOSAL SYSTEM

SHEET TITLE: SEPTIC TANK AND SOAKAWAY DETAILS

CLIENT / ADDRESS: C.B.A.

REFERENCED BY:	P.E.S.
CHECKED BY:	MIN. OF HEALTH
DRAWN BY:	M.E.G.
DATE:	APRIL 2010
SCALE:	AS SHOWN
SHEET NO.:	1
TOTAL NO. OF SHEETS:	1

Figure 10: Septic Tank and Soakaway Details for Residential and Low-Impact Buildings