

# **Evaluation of Cayo Rosario System and the Cayo Rosario Development Project**



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**Definitions**

Water habitats – Includes bottom sediment (sand, mud and silt), vegetation (seagrass and algae), macro-invertebrates (benthic and epibenthic organisms) and mobile organisms (primarily fish).

Caye habitats – Include all vegetation inundated surrounding and found inside the caye

Household size – number of members in a private household

## EXECUTIVE SUMMARY

The evaluation highlights major implications in conservation and sustainability of activities around Cayo Rosario.

1) The terms of reference (ToR) emitted by the Department of the Environment (DoE) are adequate. However, the Environmental Impacts Assessment (EIA) report does not abide with many articles in the ToR which makes the evaluation and report biased to favor development that will lead to ecological and socio-economic degradation and loss.

2) The methods used in this evaluation are standard and recognized scientific methods. The evaluation highlights that:

a) The socio-economic importance of the flats fishery in northern Belize, that includes San Pedro Town, is approximately 1,226 direct jobs and annual economic impact of BZ\$ 64.7 million.

b) The habitats or waters around Cayo Rosario are important fishing areas for the flats fishery and reef fishery (a type of recreational fishing) sectors. For the flats sector, the area provides a refuge, feeding and resting zone for bonefish, permit and tarpon. For the reef fishing sector, the area provides bait fish used in reef fishing but also crevalle jack captured by both sectors.

c) The areas on the south end, west and north side of Cayo Rosario are three ecologically important water habitats (bottom and mobile organisms in the water). The habitats in the south, where the over the water structures are proposed to be built, is the most important of all three habitats. However, these habitats are dependent on all other areas around Cayo Rosario and also on the mangroves found within Cayo Rosario as part of the coastal habitat mosaic.

d) There are 120 guides that comprise the flats and recreational sectors that directly depend on the ecological integrity of Cayo Rosario. Collectively, the guides and e direct dependents have a total household size of 338 individuals.

3) The conclusion is that the vegetation in Cayo Rosario and the surrounding habitat waters are interdependent, therefore the loss and degradation of any or part will have negative ecological and socio-economic impacts to the northern complex of Belize.

## 1.0 INTRODUCTION

### 1.1 General Introduction

Hol Chan Marine Reserve (HCMR) was established in 1987 under the Fisheries Act (Government of Belize 2000a) and encompassed a total of 18 km<sup>2</sup> of coral reefs, seagrass meadows and mangrove wetlands (Government of Belize 1989). In 1999 it was expanded to include Shark Ray Alley (Zone D) (Government of Belize 1999) and in 2008 to include the Cangrejo Shoals (Zone B and C) making the total coverage of the HCMR 55.4 km<sup>2</sup> (Government of Belize 2008).

In 2010 a community initiative spearheaded by the San Pedro Tour Guides Association, the Ambergris Caye Citizen for Sustainable Development and the HCMR staff commenced work in protecting Mexico Rocks, the fly-fishing shoals on the leeward side of Ambergris Caye and its associated wetlands. After several public consultations it was agreed that the targeted areas be added as an extension of the HCMR. This extension increased the size of the HCMR to 414.5 km<sup>2</sup> or over seven times its previous size. Legislation was signed into law and Gazetted on the 28<sup>th</sup> March, 2015 as Statutory Instrument No. 18 of 2015 (Government of Belize 2015). Four new zones were annexed to the marine reserve including a complete no-take zone in Mexico Rocks, a conservation zone on the wetlands of central Ambergris Caye and five sub-zones for catch and release sport fishing on leeward Ambergris Caye.

### 1.2 Current Issues

Over recent years, Ambergris Caye has witnessed an increase of unplanned and unsustainable development. These developments have frequently occurred near or encroaching within the boundaries of the HCMR. Such is the case of Cayo Rosario Development. The island of Cayo Rosario is located on leeward Ambergris Caye. The island itself is privately owned and excluded as part of the HCMR, nonetheless the surrounding waters and submerged bottom are in the middle of “Conservation Zone IV” of the “General Use Zone E”. The developers have presented an investment plan along with an Environmental Impact Assessment which seeks Government permission to build a hotel/condo complex on the island including 45 over the water bungalows that infringe into Conservation Zone IV of the HCMR (The Cayo Rosario Group 2017a).

All conservation zones within General Use Zone E were classified under that protection status after careful consultation with local stakeholders who identified these areas as important marine

habitats for bonefish and permit. These two fish species are a vital component of the fly-fishing tourism industry in Ambergris Caye since it supports the livelihood of many fishing guides and generates millions in revenue for the tourism industry (Fedler 2014).

### **1.3 Present Condition**

The EIA has been vetted (The Cayo Rosario Group 2017a) and approved by National Environmental Appraisal Committee (NEAC). However, after review of the EIA process it is alleged that the document is not proper and does not represent the actual condition on the ground in terms of ecology and socioeconomics. The EIA also does not adhere to many terms as stipulated in the Terms of Reference (ToR) emitted by the Department of the Environment (The Cayo Rosario Group 2017b). Furthermore, after the first consultation, NEAC requested that the developer review and address issues brought up during the consultation stage. The Developer produced an addendum to the original EIA document (The Cayo Rosario Group 2017c) but a consultation was never conducted thereafter. The EIA with the addendum has been approved by NEAC and the Environmental Compliance Plan was issued to the developer.

The purpose of this assessment is to review the current EIA and addendum to identify weaknesses that has led to mischaracterization of the ecology and socioeconomics of the area. Additionally, field data will be collected to compare and contrast with the developers' EIA information.

### **1.4 Objectives**

General:

- Prepare a summary of the project, inclusive of brief history, development and concerns.
- Review and evaluate the EIA and addendum placing special emphasis on an ecological assessment of the island and marine environment where the proposed development would occur.
- Conduct a Rapid Rural Appraisal to determine types and level of use by local communities.
- Conduct a Rapid Ecological Assessment to determine the current condition of bonefish and permit population in Conservation Zone IV with the main focus at the proposed development site.
- Compare and contrast results of both rapid assessments with finding of EIA Review.



## 2.0 METHODOLOGY

### 2.1 Study area

The assessment will involve particularly the community of San Pedro Town, Ambergris Caye (Figure 1) and also the aquatic and associated habitats of Cayo Rosario (Rosary Caye).

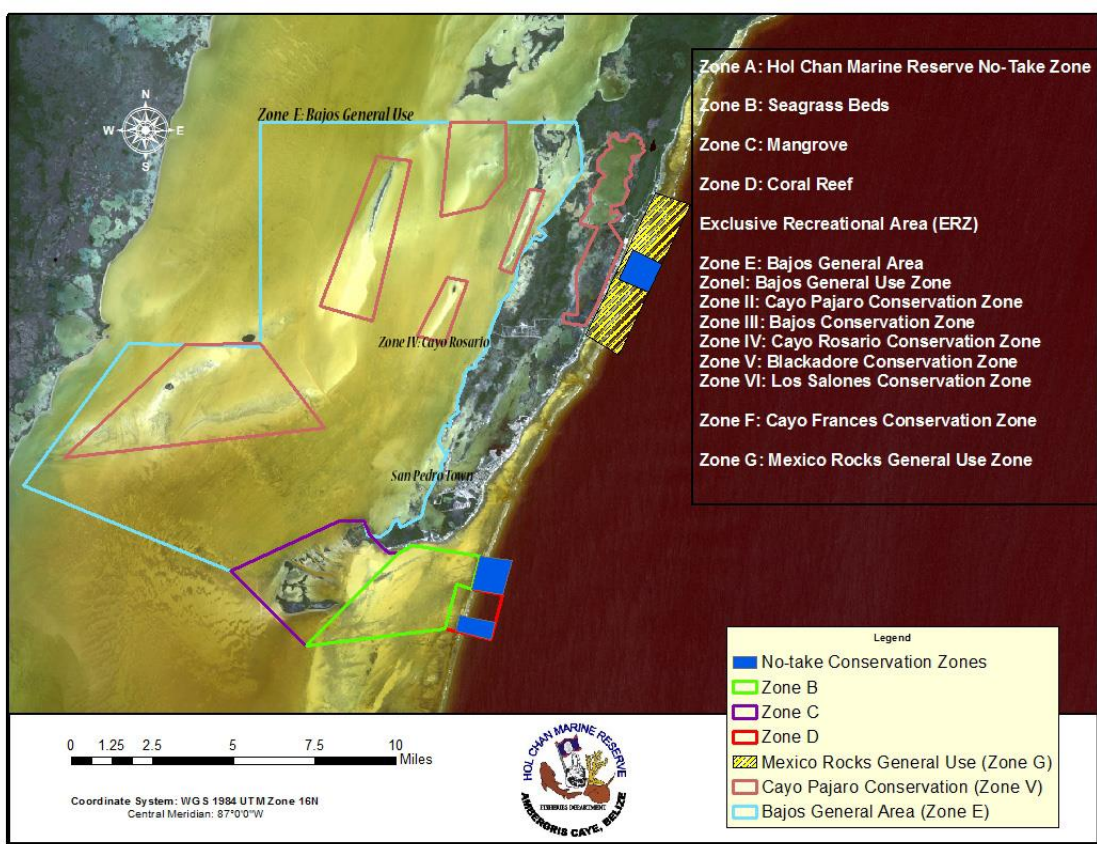


Figure 2. Cayo Rosario in the Hol Chan Marine Reserve complex of San Pedro Town, Ambergris Caye

## 2.2 Approach

A scientifically recognized method known as mixed-methods approach (Perez-Cobb et al. 2014; Perez et al. 2019b, a) was used to evaluate the development project. This method encompasses approaches in fisheries management, sociology, anthropology, ethnology and management. The approach consisted of a Rapid Rural Appraisal and a Rapid Ecological Assessment which encompassed various methods as highlighted in Figure 2.

1	<b>Secondary sources of information</b> <ul style="list-style-type: none"><li>•Secondary source of information (EIA, supplemental information, scientific papers, laws and regulations, mangement plans) were reviewed.</li></ul>
2	<b>Local knowledge</b> <ul style="list-style-type: none"><li>•Face-to-face interviews were used on key informants from the flats and reef fishery sector who identified other users of Cayo Rosario to establish characteristics of activities (daily and seasonality) that occur in Cayo Rosario. Interviews were stopped after the third or fourth informant provided no additional information or repeated similar responses.</li></ul>
3	<b>Ecological sampling</b> <ul style="list-style-type: none"><li>•A list of species was conducted to characterization the aquatic and non-acuatic species via observation (presence), mark-recapture, seining, point intercept and roving diver.</li></ul>
4	<b>Field notes and participant observation</b> <ul style="list-style-type: none"><li>•Information from participant observation in activities (flats fishing, meetings and other related activities) were also gathered through field notes.</li></ul>

Figure 1. Mixed-methods approach consisted of multiple methods to conduct the evaluation

## 2.3 Rapid Rural Appraisal

### Revision of secondary sources of information

Scientific peer-reviewed publications were obtained from various journals to evaluate the biological, ecological and socio-economic importance of Cayo Rosario and its adjacent ecosystems. These publications consisted of biological, ecological and socio-economic studies conducted in Belize or adjacent ecosystems of the Caribbean such as the border close to southern Mexico.

Other secondary sources consisted of the Environmental Impacts Assessment (EIA), Annexes (eg. Terms of Reference, ToR) and Supplemental Information I and II obtained from the Department of the Environment's website (<http://www.doe.gov.bz/index.php/eias>). These were reviewed to assess the compliance and validity of the project.

Regulations and laws associated to the environment and resources management were obtained from the Belize Legal Information Network of the Government of Belize (<http://www.belizelaw.org/web/lawadmin/index2.html>) and the management plan for Hol Chan Marine Reserve from the Office of Hol Chan Marine Reserve. These were used to assess that the project was in accordance with local authorities and resource managers.

**Local knowledge** was collected using questionnaires which consisted of open and close questions following. They were applied using face-to-face interviews to key informants using the snow ball technique. It consisted of local authorities or managers identifying a highly experienced and knowledgeable informant and user of Cayo Rosario. Informants then identified another and so on. Interviews were stopped after the third or fourth informant provided no additional information or repeats similar responses.

Google earth pro ([www.googleearth.com](http://www.googleearth.com)) was used to draw polygons and paths on a) the presence of bonefish, permit, tarpon and other fish species captured in recreational-sport fisheries, b) estimated size (small, medium, large or mixed) or weight of fish per school or area, b) seasonality (months present (eg. march to June); c) observation of fish activity or behavior (feeding, resting, or likely migrating/come from another area).



General demography of users of Cayo Rosario was developed to determine the direct social impacts. It consisted on establishments/businesses and its number of employees, type of jobs and household size of each employee.

**Field notes and participant observation.** Information from participant observation in activities (flats fishing, local meetings and workshops) as well as those made during the RRA and REA will be registered as field notes to compliment the assessment.

## 2.4 Rapid Ecological Assessment

**Visual survey and satellite imagery** of Cayo Rosario was used to document mangrove cover in and around Cayo Rosario. Visual survey consisted of documenting presence of mangroves around the caye. Satellite imagery was a combination of Google Earth Pro ([www.google.com/earth/](http://www.google.com/earth/)) and QGIS 3.6 ([www.qgis.org](http://www.qgis.org)) to generate vegetation map and fishing area maps.

### Mark-recapture

Conduct seining using 20 m seine with 1 inch stretched mesh north, south, east and west around Cayo Rosario. These seines were conducted 50 m from the lowest water mark. These measurements were obtained using Google Earth Pro ([www.googleearth.com](http://www.googleearth.com)) and the point were registered in a G.P.S for location in the field. All organisms for each of the 4 sites and seines were placed in separate containers. Two samples of fish and invertebrates were kept for identification to the lowest taxonomic level possible. The samples were then preserved and placed in the local museum for future reference.

### Seining

Seining was conducted using a 5 meter seine with 5 cm stretched mesh and a mesh bag. Two individuals dragged the leads of the net as close to the bottom for 5 minutes and covered a distance of about 5-10 meters parallel to the caye. The net was closed and all organisms in the mesh bag were separated in separate by group: fish, vegetation and macro-invertebrates.

Identification was conducted in a lab and taxonomic keys and verification using online catalogues: FishBase ([www.fishbase.org](http://www.fishbase.org)), AlgaeBase ([www.algaebase.org](http://www.algaebase.org)), Sealifecase

(<https://www.sealifebase.ca>), SeaShells ([www.gastropods.com](http://www.gastropods.com)), Jaxshells (<https://www.jaxshells.org>), iNaturalist (<https://www.inaturalist.org>), (<http://species-identification.org>), Worldwide Mollusc Species Database (<http://www.bagniliggia.it/WMSD/Htm>). All organisms were rinsed with distilled water and preserved in alcohol at 20%.

### **Point-intercept and rover diver observation**

Six sites around Cayo Rosario were selected as samples sites for benthic cover. The sites were approximately 10 meters parallel to Cayo Rosario (Figure 2). The 50 meter transect lines were also laid parallel except Sites 1 and 4 which were laid in a south and north direction respectively. The presence of any benthic vegetation and substrate was recorded at every 10 cm. The species and number of any other organism on the left and right of the transect were recorded using rover diver observation. Both methods involved video recording and was processed later.

### **2.5 Analysis**

All data were input in excel to produce pie charts and bar graphs. Also data were input in SPSS to produce contingency tables to summarize data.

## 3.0 RESULTS AND DISCUSSION

### 3.1 Rapid Rural Appraisal

The evaluation consisted of a holistic approach. It encompassed a cross sectorial and bio-socio-economic assessment of the Cayo Rosario Project. Several sectors that were associated are: 1) Flats fishing and reef/bottom fishing sector, 2) Tourism sector, and 3) Conservation & management sector. The biological aspect consisted of macroinvertebrates, general fish population demographics, fishing areas and vegetation, the social aspect of labor force and household population size, and the economic aspect of total economic impact of flats fishing only.

#### **Revision of secondary source of information**

The revision of Belize's regulations indicate protection of habitats (seagrass, mangroves and coral reefs) from direct and indirect degradation and destruction (Table 1). Also, management plans of protected areas in northern Belize and country-wide provide provisions for adequate use of resources and protection measures of habitats as priority for social and economic benefit of communities and entire country (Table 2). For instance the guidelines for the construction of over the water structures clearly indicate no such structures to be constructed in marine protected areas (Government of Belize 2010). Such construction contradicts Belize's legislation (Table 3) and would directly destroy and degrade habitats which would leave users of the habitats without a source of income to local residents and affect the tourism expectation and quality of the flats and reef fishing sector. However, all of the documents from The Cayo Rosario Group contravenes all of the ecological or environmental and socio-economic welfare abovementioned (Table 4). As stated by users of the Cayo Rosario area "we are not against development. The developers can build in their property but they need to respect our right to use the areas around Cayo Rosario. The habitats and the water are important to us as from them we obtain our source of income and our clients, whom are anglers-tourists, get satisfaction and quality service we offer in flats and reef fishing".

Table 1. Showing Peer-reviewed scientific papers associated to Hol Chan Marine Reserve and the Cayo Rosario Development Project

<b>Authors</b>	<b>Topic</b>	<b>Major points of interest</b>
Peter J. Mumby 2005 (Mumby 2005)	Connectivity of reef fish between mangroves and coral reefs: Algorithms for the design o marine reserves at seascape scales	Juvenile coral reef fish depend on mangroves but as they grow to pre-adult and adults the move to seagrass and then to coral reefs habitats (known as ontogenetic migration).
Héctor A. Hernández-Arana and Ameneiro-Angeles Brenda 2011 (Hernández-Arana and Ameneiro-Angeles 2011)	Benthic biodiversity changes due to the opening of an artificla channel in a tropical lagoon (Mexican Caribbean)	Coastal development modify benthic substrate and affects positively and negatively the biodiversity benthic community (organisms). Sessile (immobile) fauna (such as as microalgae and seagrass) cannot move and suffer permanent changes. Mobile organisms are also affected. Environmental Impact Assessments need to consider these pre and post-changes to the ecosystem.
Anthony J. Fedler 2014 (Fedler 2014)	2013 Economic impact of flats fishing in Belize	Flats fishing generates approximately Bz \$ 64.7 million annually and 1,226 jobs for northern Belize which includes San Pedro Town. This sector generates a total economic impact of Bz \$112 million annually and 2,123 jobs for the country.
Susana Perera-Valderramaa, Héctor Hernández-Aranab, Miguel-Ángel Ruiz-Zárateb, Et al 2017 (Perera-Valderrama et al. 2017)	Temporal dynamic of reef benthic communities in two marine protected areas in the Caribbean	Large scale development result in human impacts on benthic communities that reduces biodiversity and function (eg. scuba diving in marine protected areas).
Juan J. Schmitter-Soto, Alfonso Aguilar-Perera, Alicia, Alicia Cruz-Martínez, Roberto L. Herrera-Pavón, Aura A. Morales-Aranda, Dorka Cobián-Rojas 2018 (Schmitter-Soto et al. 2018)	Interdecadal trends in composition, density, size and mean trophic level of fish species and guilds before and after coastal development in the Mexican Caribbean	Since 1995 to 2015 there has been a regional trend where the number of fish and species have decreased due to the detrimental effects of coastal development that affect benthic habitats.
Addiel U. Perez, Juan J. Schmitter-Soto, Aaron J. Adams & William D. Heyman 2019 (Perez et al. 2019b)	Connectivity mediated by seasonal bonefish ( <i>Albula vulpes</i> ) migration between the Caribbean Sea and a tropical estuary of Belize and Mexico	Adult bonefish live in less than 1 km of a coastline where they spend 7-8 months (February to September). Bonefish then move out of home ranges to reef areas to spawn for 3-4 months (October to January).
Addiel U. Perez, Juan J. Schmitter-Soto, Aaron J. Adams, Roberto L. Herrera-Pavón 2019 (Perez et al. 2019a)	Influence of environmental variables on abundance and movement of bonefish ( <i>Albula vulpes</i> ) in the Caribbean Sea and a tropical estuary of Belize and Mexico	The flats habitats in the bay area of Ambergris Caye are important refuge and feeding areas for bonefish. Such habitats, including benthic substrate are needed to be considered in protected areas conservation and management.

Table 2. Management plans and strategies associated to Hol Chan Marine Reserve

<b>Plan and author</b>	<b>Resource manager</b>	<b>Major points of interest</b>
Hol Chan Marine Reserve Management Plan 2019 (Hol Chan Marine Reserve 2019)	Hol Chan Marine Reserve (Co-manager)	The plan under the Fisheries Act was established to address destructive practices that were affecting coral reefs, seagrass beds and mangrove ecosystems. It specifically established “to ensure, increase and sustain the productive service and <b>integrity</b> of the marine resources for the benefit of all Belizeans of present and future generations”.
Bacalar Chico Natural Park and Marine Reserve (Green Reef Environmental Institute 2004)	Belize Fisheries Department (Government manager)	The plan was established because of a) the unique natural characteristics of terrestrial and marine ecosystems, b) historical archaeological monuments which gave the area a cultural importance, and c) the livelihoods and economy dependent on healthy resources. This area is a World Heritage Site under UNESCO.
National Integrated Coastal Zone Management Strategy 2016 (Coastal Zone Management Authority and Institute (CZMAI) 2016)	Coastal Zone Management Institute (Government manager-statutory body)	The plan recognizes economic, social, cultural and environmental drivers that affect coastal resources. It also recognizes the need to maintain ecological integrity of ecosystems for maintenance of Belize’s economy, way of life (livelihoods). It calls for “allocation, sustainable use and planned development” through good governance “to improve the quality of coastal ecosystems and communities they support”.
Northern Belize Coastal Complex Management Action Planning Outputs, Summary 2015 (Sarteneja Alliance for Conservation and Development 2015)	Wildtracks, Forest Department, Belize Fisheries Department	Recognizes the interconnectedness of mangroves, sand beaches, seagrass beds and reef and the importance of these habitats to maintain biodiversity which is integral for livelihoods, culture and economy of northern communities of Belize.
Corozal Bay Wildlife Sanctuary Management plan (Sarteneja Alliance for Conservation and Development 2019)	Sarteneja Alliance for Conservation and Development (Co-manager)	Established for the protection of wildlife (manatees and birds). It is designed to also protect and manage coastal and caye mangroves which are important ecologically and socially: for bird nesting, storm barriers and nursery grounds and for assuring livelihoods (commercial small-scale fishery, sport fishery and environmentally sustainable tourism) of local Belizeans.
National Biodiversity Strategy and Action Plan 2016-2020 (Government of Belize 2016)	Ministry of Forestry, Fisheries, Environment and Sustainable Development	A strategic 5year action plan for conservation and sustainable use of biological resources. It recognizes “the importance of the environment for maintaining health and quality of life in Belize and the need for strengthening environmental protection”.

Continuation: Table 2. Management plans and strategies associated to Hol Chan Marine Reserve

Plan and author	Resource manager	Major points of interest
National Tourism Master Plan for Belize 2030 (Belize Tourism Board and Ministry of Tourism Civil Aviation and Culture 2011)	Ministry of Tourism and Civil Aviation	Mainly focused to structure the tourism industry as sustainable but in terms of a business by increasing tourism infrastructure, services and visitation. The plan recognizes Belize as tourism destination thanks to the “excellent natural resources and strong cultural heritage” but does not integrate sustainability of natural resources. Its Sustainable Tourism Development Program is designed for conservation of natural resources for its stability as a business and competitiveness and not for the livelihoods and culture of Belize.
National Environmental Guidelines for Overwater Structures 2010 (Government of Belize 2010)	Department of The Environment	Indicates “no overwater structures will be allowed to be built over any section of the Belize Barrier Reef or other coral reef structure; and, Over Water structures will be severely restricted within the Marine Protected Areas” and “No overwater private dwellings will be allowed/ permitted”. It also indicates “Failure to comply with this condition shall be grounds for revocation of the license”. Finally, when the impact of habitat loss has been identified to be one of the greatest threats to fisheries resources, then the “Permitting agency should implement a policy of no-net-loss of certain critical habitats, such as riparian and littoral forests, fringing mangroves, corals and sea-grass beds, and ...”
Belize National Protected Areas System Plan (Salas and Shal 2015)	Ministry of Forestry, Fisheries and Sustainable Development of the Government of Belize	Recognizes that biodiversity conservation becomes an integral part of the national social and economic development “The main strategy to achieving the articulated environment and sustainable development goals is to incorporate environmental sustainability into development planning and strengthen protected areas management.” It recognizes that healthy ecological and environmental systems in the landscape and seascape are important to ensure social, cultural, and economic benefits for local and national development.. It also indicates “the urgent and critical need for increased public and private sector understanding, appreciation and support for protected areas” and that “The main strategy to achieving the articulated environment and sustainable development goals is to incorporate environmental sustainability into development planning and strengthen protected areas management”.



Table 3. Regulations associated to Hol Chan Marine Reserve and the Cayo Rosario Development Project

<b>Regulations</b>	<b>Major points of interest</b>
Mangrove Regulations 2018 (Government of Belize 2018)	Places greater emphasis on the management and conservation of mangroves in the mainland and cayes. It recognizes the importance of mangroves in coastline protection, contribution to our economy, and their aesthetic, ecological, and environmental values and functions.
National Park System Act Chapter 215 (Government of Belize 2003a)	Provides measures for the conservation, protection and preservation of areas with special characteristics (species and environmental) in Belize.
Fisheries (Hol Chan Marine Reserve) Regulations 2015 (Government of Belize 2015)	Declared new zones in the bay area that includes Cayo Rosario under special management. The law declared all the surrounding waters and submerged bottom as part Conservation Zone IV of the General Use Zone E.
Environmental Protection (Effluent Limitations) Regulations 2003 (Government of Belize 2003b)	Controls and regulates the discharge of effluents (eg. domestic effluent such as toilet flushing) that would impact in any inland or marine environment. For example Class I waters (“waters that due to inherent or unique environmental characteristics or fragile biological or ecological characteristics...”) include “waters containing coral reefs, seagrass and mangroves” and “critical breeding, nursery or forage areas for aquatic and terrestrial life”.
Pollution (Amendment) Regulations 2009 (Government of Belize 2009a)	A mechanism to control air, water, land and noise pollution (from chemicals)
Environmental Impact Assessment Regulation (2007 amendments) (Government of Belize 2007)	Provides provisions for the “studies needed in the identifying, predicting, evaluating, mitigating and managing the environment, and key social and economic impacts of development projects...” by a “suitable qualified person” who “possesses academic training, technical expertise obtained in the field and/or knowledge obtained as a result of formal and informal education and training in the field of Natural Sciences...”
National Lands Act Chapter 191 2000 (Government of Belize 2000b)	Sets a 66ft. reserve along all water frontage
Mines and Minerals Act Chapter 226 (Government of Belize 2003c)	Addresses dredging and mining in land and water bodies (including dredging and filling in of land)
Wildlife Protection Act Chapter 220, revised edition 2000 (Government of Belize 2000c)	Regulates the hunting, research and trade of wildlife. The regulation prohibits the “hunt any wildlife species employing any fire, trap, poison, spring gun, gin, pitfall, light or electric device or missile containing an explosive...”.

Table 4. Cayo Rosario Development Project associated documents

Documents	Authors	Major points of interest
FINAL Environmental Impact Assessment for CAYO ROSARIO DEVELOPMENT PROJECT Ambergris Caye Area (The Cayo Rosario Group 2017a)	Cayo Rosario Group Development	Most of the content is poorly presented. Figures are wrongly labeled and the descriptions are vague. The Environmental Impact Assessment (EIA) does not comply with the Terms of Reference set by the Department of the Environment. Particularly with the use of scientific methods which make the entire EIA unacceptable.
ANNEXES of Environmental Impact Assessment for CAYO ROSARIO DEVELOPMENT PROJECT Ambergris Caye Area (The Cayo Rosario Group 2017b)	Cayo Rosario Group Development	Provides the curriculum of the consultants and it clearly shows they do not possess the qualifications to make such EIA. It also includes the social survey which was poorly designed to assess the importance of the area to the community.
CAYO ROSARIO DEVELOPMENT PROJECT Ambergris Caye Area Supplemental Information (The Cayo Rosario Group 2017d)	Cayo Rosario Group Development	The original design contemplated 90 over the water structures (north and south of Cayo Rosario), 15 island villas, and 12 mangrove bungalows. The scaled down re-design proposes 46 over the water structures (south of Cayo Rosario), 0 island villas and 38 more island villas. It call for dredging of 51,678 m <sup>3</sup> (likely of sand and mud from the fish zones used by residents of San Pedro). It also includes a long list of individuals from the tourism sector (from Belize and abroad) who expressed via signature and letters opposing the over the water structures.
Environmental Impact Assessment for CAYO ROSARIO DEVELOPMENT PROJECT Ambergris Caye Area ADDENDUM (The Cayo Rosario Group 2017c)	Cayo Rosario Group Development	Indicates that the development group has captured the essence that local users of the area do not want development on the “outside edges” of the island but on “top of the island” which means <b>no over the water structures and for the development to take place in the group’s property.</b>

## Local Knowledge

Key informant **interviews** show the flats and reef fishery are the primary users of Cayo Rosario area (Table 5). Other users were recreational tourism (kite surfing and jet skiing). There is a total of 120 individuals directly employed in flats fishery sector, reef fishery sector and tour-operators that depend on the area. These individuals have families that was comprised of children or spouse and this totaled to 338 individuals as the household population. This socio-economic benefit of Cayo Rosario represents a portion of what the sector generates annually. For instance, the flats sector generates annually approximately 1,226 jobs and generates Bz \$ 64,744,504 million in direct and indirect revenue for northern Belize and a total economic impact of Bz \$112 million and 2,123 jobs for the entire country (Fedler 2014). Thus, development at Cayo Rosario will degrade and eventually destroy the fishing areas for local residents and with it the socio-economic gain of the flats fishing sector for San Pedro and the entire country of Belize.

Table 5. Number of employees and their household dependents by establishment and sector.

Sector	Establishment	Number of employees	Household size
Flats fishery	El Pescador	76	208
	Omar's Freelance fishing	3	14
	Bluebonefish	8	31
	Tres Pescados	7	19
	Cayo Frances	2	4
	Go Fish	8	25
	Freelance guides	8	9
Recreational fishery (reef fishing: rams and reefs)	Freelance guides	1	3
Tour-operators	Amigos del mar	1	3
	Freedom Tours	6	22
<b>TOTAL</b>		<b>120</b>	<b>338</b>

Local knowledge indicated Cayo Rosario is populated by bonefish, permit, tarpon and crevalle jacks (Figures 4-6). These species except Crevalle jacks (Figure 7) are protected as catch and release only under Statutory Instruments 114 (Government of Belize 2009b) and 115 (Government of Belize 2009c) of the laws of Belize. The area is also rich in bait fish which is used by both fishing sectors to catch fish. Abundances of all of these fish species, according to local knowledge, vary seasonally and schools vary in number of individuals and size of individuals. For instance bonefish in the bay are larger are in average smaller than those in the Caribbean sea (Perez et al. 2019b). Also small-sized bonefish are most abundant during the dry and rainy season and large-sized bonefish are most abundant during the cold front season (Perez et al. 2019a).

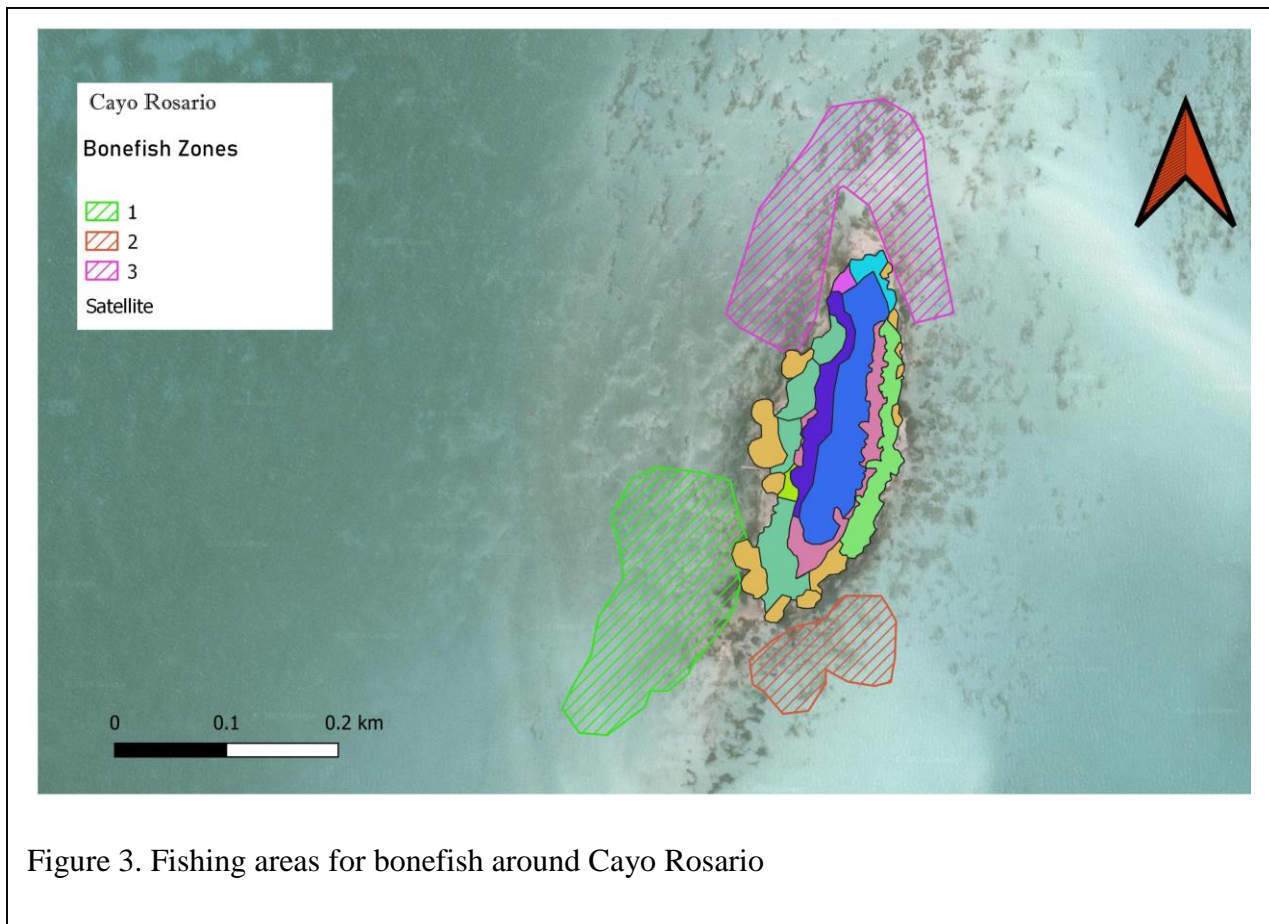


Figure 3. Fishing areas for bonefish around Cayo Rosario

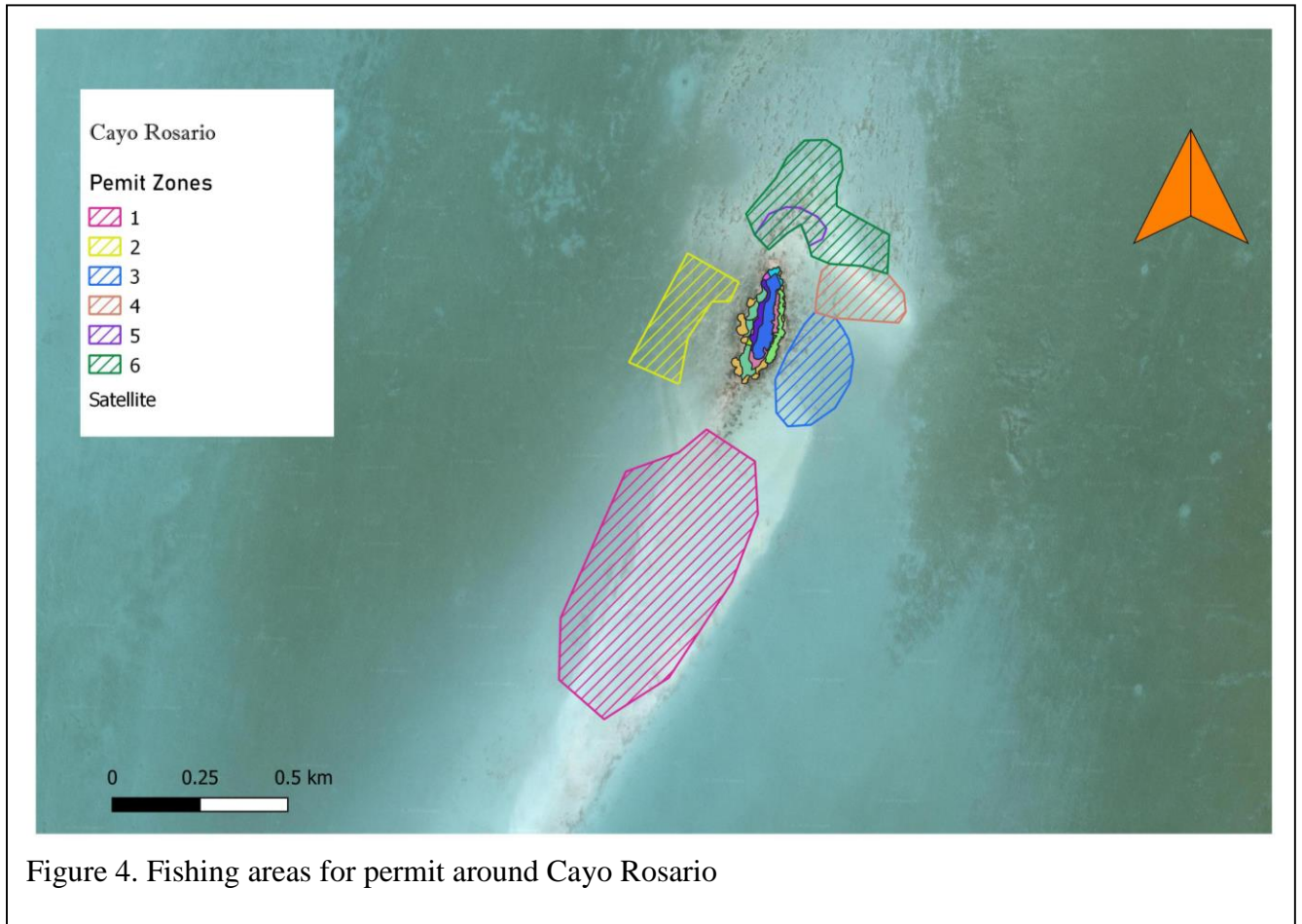


Figure 4. Fishing areas for permit around Cayo Rosario

Bonefish can be found in the south, west and north areas surrounding Cayo Rosario (Figure 3). However the south end has two major areas where large schools of e medium- sized bonefish (pre-adults and young adults of 10-14 inches) seek refuge from winds and temperature (Zone 1) and also large sized bonefish (adults known as “grandpas” of 18-24 inches) seeking refuge or resting when they are not feeding (Zone 2). Lastly, zone 3 is comprised of medium sized (adults 16-18 inches) bonefish, but these fish are present only seasonally and at particular times of the day. Other studies has also shown that the presence of bonefish and other species can vary from day to day and from month to month because fish use a variety of habitats or areas to feed, seek refuge and reproduce season (Perez et al. 2019a).

Similarly, this study found permit to occupy Cayo Rosario seasonally. However, the foraging areas (feeding and predator evasion) for permit (Figure 4) were outside the areas where bonefish rest, feed and seek refuge. The size of permit varies in all of the zones and they are always observed to be feeding. This regular feeding activity is a top reason anglers travel to Belize and fish the Cayo Rosario area. Some permit schools can be found seasonally 3-4 months of the year in zone 3, where permit can be between 15-17 lbs (or over 25 inches), and in schools of 50-300 permit, and up to 600 permit. These permit feed in the sandy-muddy flats that stretch nearly 3 kilometers (1.9 miles), and they seek refuge from predators and fishing boats in the deeper waters on the west and east of the shallow flat (locally known as “cordillera”).

Tarpon is also found seasonally on the flats surrounding Cayo Rosaria, often as single individuals (Figure 5). Jacks, on the other hand, are found year round, with abundance changing seasonally. Large schools of 100-200 jacks (Figure 6) are common during peak seasonal abundance. These jacks likely use the habitats around Cayo Rosario as part of a larger feeding area that includes other nearby habitats that are part of the overall coastal habitat mosaic. Barracuda is also commonly present, with seasonal changes in abundance. (Figure 7). The tarpon, jacks, barracuda, and even permit rely on the baitfish that are found around Cayo Rosario. Baitfish are present year round, but are especially important prey for game fish when they are in seasonal high abundance. It is clear as shown in the figures that the south end of Cayo Rosario supports a diverse ecology that is important to the economically valuable recreational-sport fishing conducted by the residents of San Pedro Town.





Figure 5. Fishing areas for tarpon around Cayo Rosario

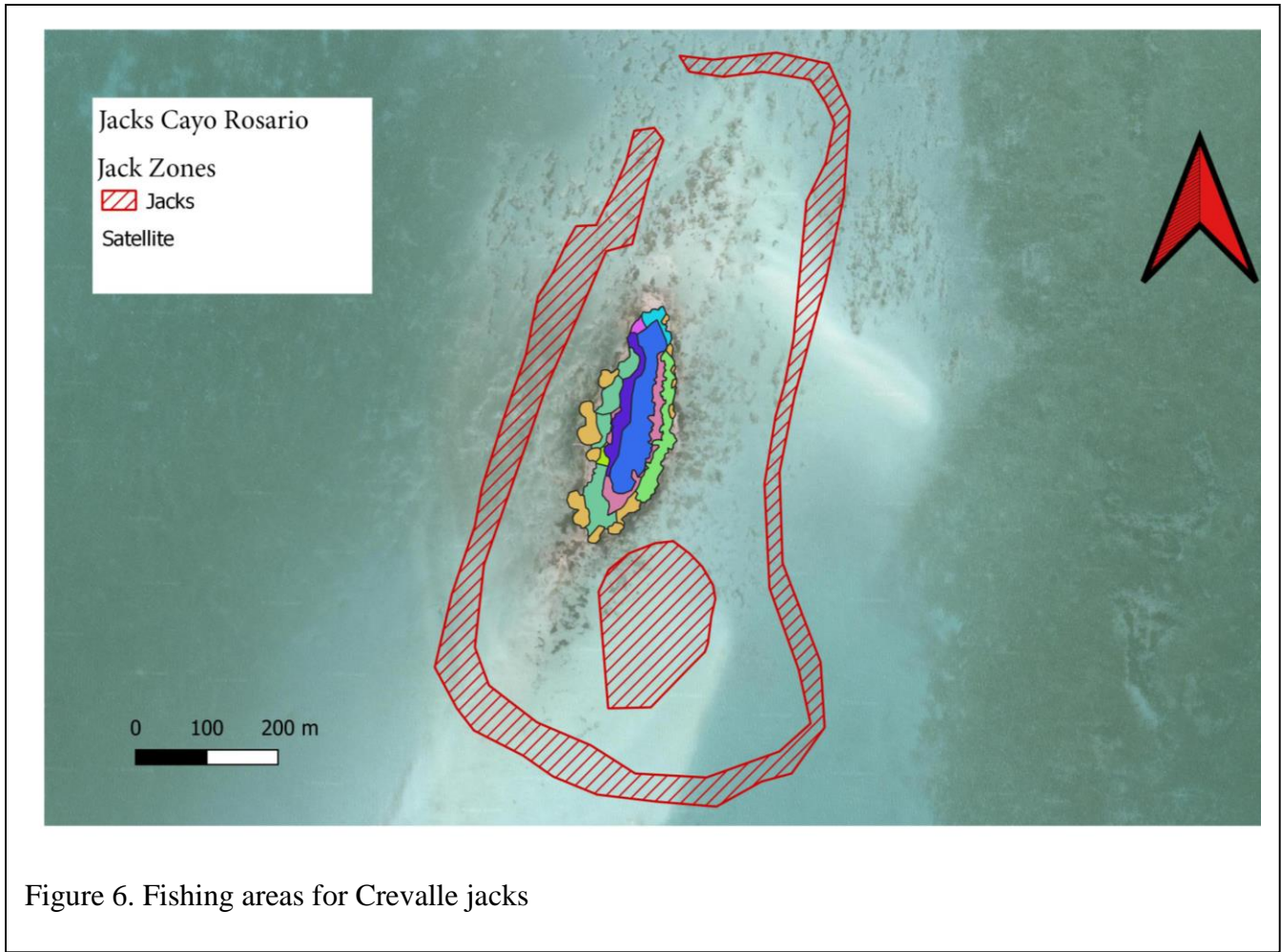


Figure 6. Fishing areas for Crevalle jacks

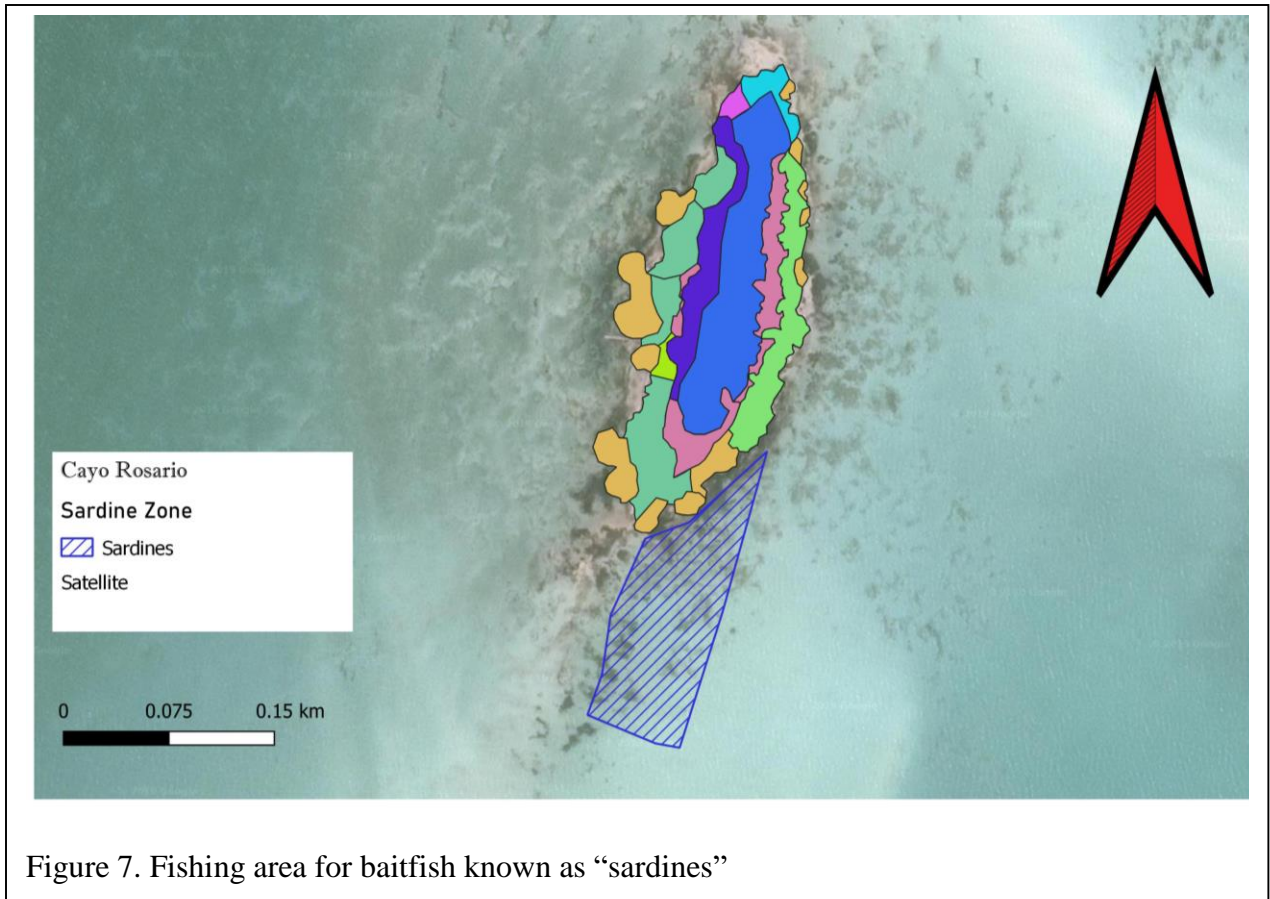


Figure 7. Fishing area for baitfish known as “sardines”

### 3.2 Rapid Ecological Assessment

**Visual survey and satellite imagery** of Cayo Rosario show mangroves have typical zonation that follow an order of black mangroves, white mangroves and red mangroves from an east to west direction (Figure 8). Most important are the large variety and dense areas of vegetation on the south and west site of the caye: in particular, red mangroves more than 15 feet high with large prop roots. Mangroves are important as their prop roots trap and retain sediment from the caye, provide shelter to juvenile fish and invertebrates, and add organic matter (i.e. leaves) into the benthic substrate. This organic matter is a food source to many microscopic organisms. Thus, mangroves are the base of a large food web that makes this an essential habitat.

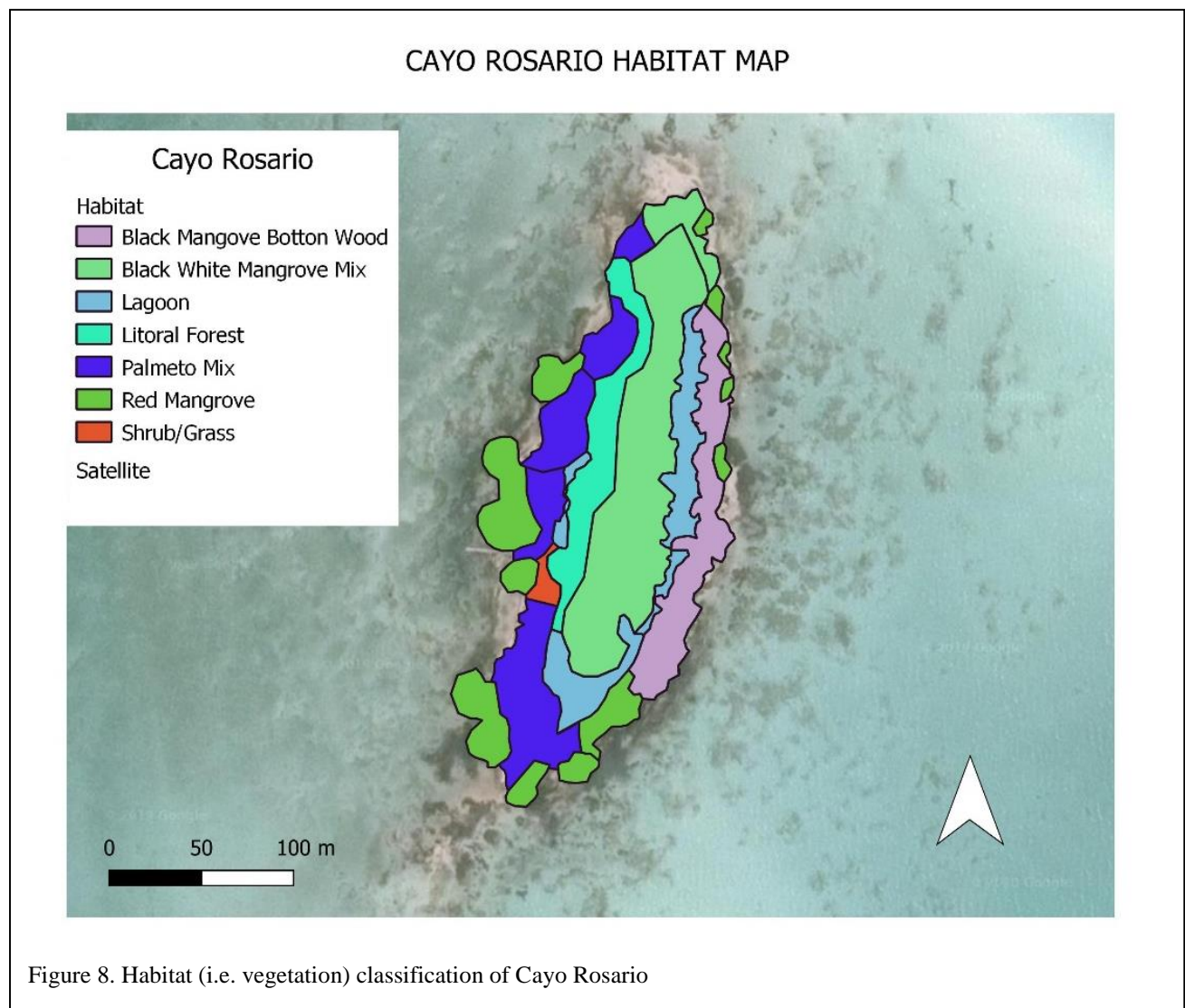


Figure 8. Habitat (i.e. vegetation) classification of Cayo Rosario



Google Earth Satellite imagery was imported into QGIS and digitized to create a habitat map and calculate percent coverage for coverage analysis (Table 6). Mangroves are the dominant species of plant with Red Mangrove having a total coverage of 17.6% and Black/White Mangrove mix 30.3 Percent. We recorded a total of 12.8% Black Mangrove/Butonwood Mix. These three Mangrove habitat categories comprise over 60% of the island total coverage. Palmetto Mix is also common with a coverage of 16.1%. The central lagoon comprises only 12% of the total coverage. Littoral Forest is restricted to portions of the island and only cover 10.1%. This data indicates that this island is dominated by mangrove wetlands.

Table 6. Percentage cover per meter square of vegetation in Cayo Rosario

Habitat	Area (sq. Meters)	Percent Cover
Red Mangrove	4894.7	17.6
Palmetto Mix	4455.4	16.1
Black/White Mangrove Mix	8411	30.3
Black/Butonwood Mix	3552	12.8
Littoral Forest	28.16	10.1
Lagoon	3330	12.0
Shrub/Grass	-	1.1

A Rapid analysis was conducted using Google Earth Time lapse imagery to determine If there has been significant erosion over time. Dredging will be done to reclaim 75% of the island. The EIA document claims dredging is necessary to restore portion of the island that has been lost to erosion. However, there is no proof or justification within the document that erosion has reduced the size of the island (Figure 9). There is no indication that this has occurred and at what time scale. It does mention that the island has healthy mangrove stands and it is a fact that mangrove protect shorelines from high energy surf. Furthermore, the sand banks immediately adjacent to the island formed through process of accretion of calcium carbonate sediments. Additionally, the developing group and the EIA claim that 75% of the island has been lost. However, a quick review of Google Earth images since 2001 to 2016 confirms that the claim is untrue (Figure 9).

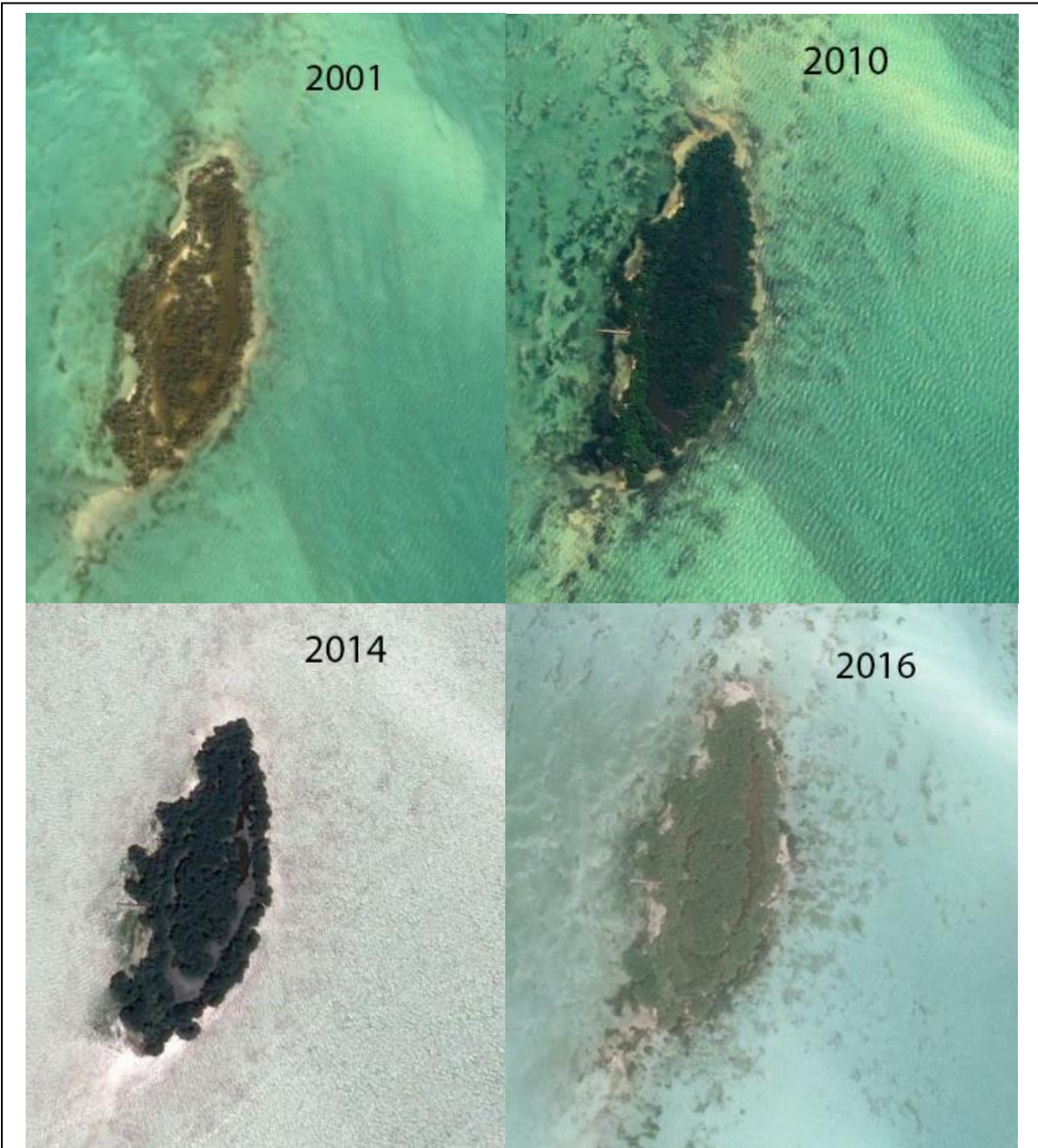


Figure 9. Time scale Google Earth images from 2001 to 2016 of Cayo Rosario



**Mark-recapture** using seine nets corroborated local knowledge of large sized bonefish in the southern end of Cayo Rosario. From a large school of bonefish a total of 61 bonefish were tagged and measured (Figure 10). Bonefish were mostly large adults with an average size of 33.3 cm. The remaining individuals were counted and a total of 503 bonefish were released untagged. Thus, the school was comprised of 564 large bonefish. Another school of bonefish was recorded on the southwestern portion of the island. This school was not netted but the size was estimated to well over 800 individuals. This school was comprised mostly of juvenile bonefish.

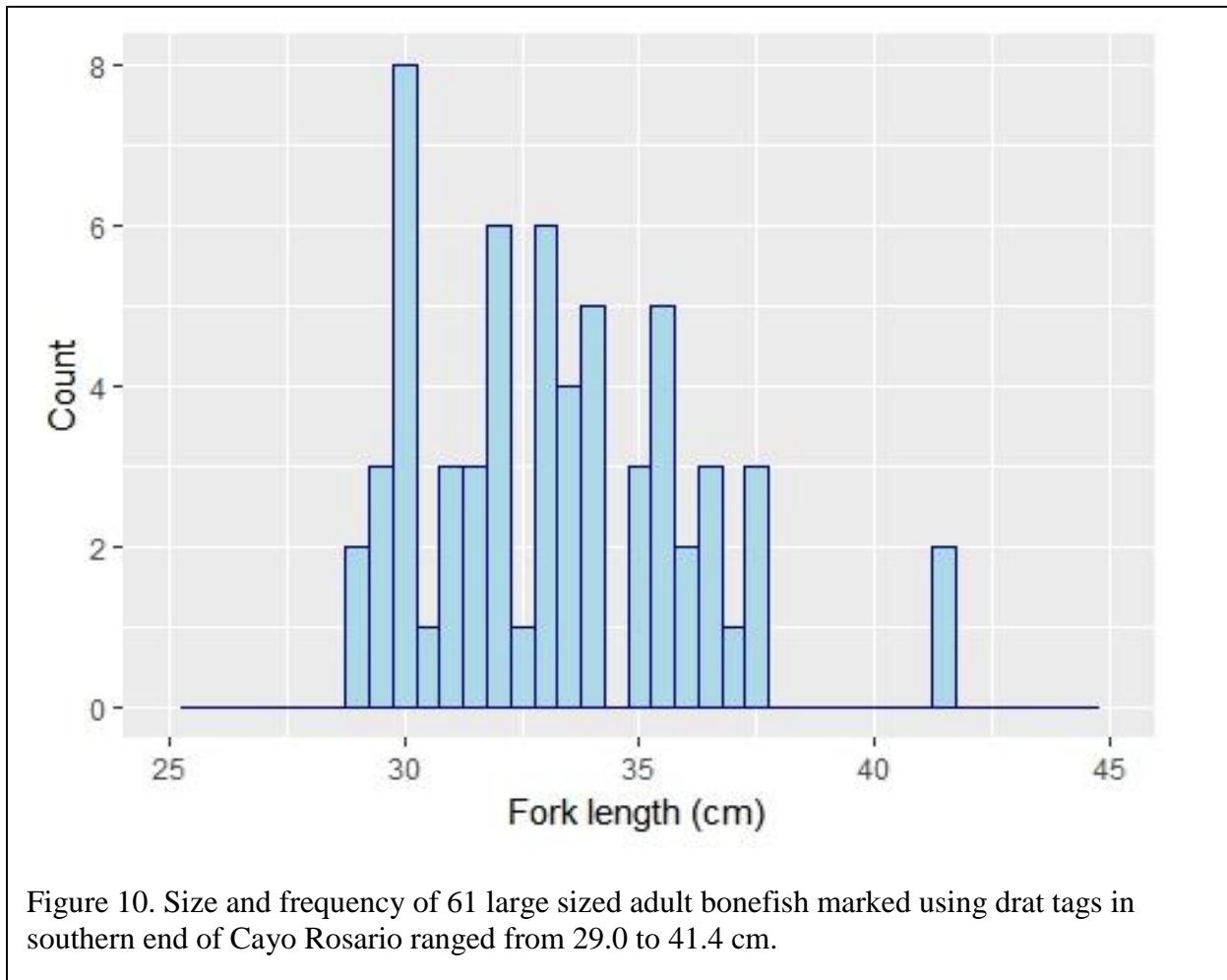


Figure 10. Size and frequency of 61 large sized adult bonefish marked using drat tags in southern end of Cayo Rosario ranged from 29.0 to 41.4 cm.

**Seining and rover diver observation** that took place in Cayo Rosario started from the south end (Site 1), west side (Site 2& 3), north side (Site 4) and east side (Site 5 & 6). There were 7 species present and most were juveniles with average sizes less than 10.1 cm (Table 7). All 7 species were present on the south, west and north sides, with 4 of these species present on the east side. Additionally, these areas, and in particular the northern side, also harboured spiny lobster, stone crabs, parrotfish, dog snapper, grey snapper, blue stripped grunt, french grunt and juvenile sergeant major due to the unique rocky habitat with many crevices for shelter.

Other ecological importance of Cayo Rosario is a courting zone for nurse shark. On September 30<sup>th</sup>, over 25 nurse shark were observed in the sandy flat south end and about 200 meters from the caye.

Table 7. List of fish found around 6 samples sites around Cayo Rosario

Scientific name	Common name	Fork length (cm)	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Number of specimen	Average size (FL in cm)
<i>Archosargus rhomboidalis</i>	Sea bream	8.4		x			x		3	7.4
<i>Atherinomorus stipes</i>	Hardhead silverside	5.2			x	x			10	5.1
<i>Eucinostomus jonesi</i>	Slender mojarra	4.7			x	x		x	13	4.56
<i>Gerres cinereus</i>	Yellowfin mojarra	6.5	x	x					3	10
<i>Harengula jaguana</i>	Scaled herring	4.6			x				1	4.6
<i>Sphoeroides spengleri</i>	Bandtail puffer	3.1	x				x		2	2.7
<i>Sphyraena barracuda</i>	Barracuda	13.5	x	x		x	x		8	10.1

A similar pattern was found with the diversity of aquatic vegetation (Table 3) and macro-invertebrates (Table 8). Sites 1 to 4 in the south, west and north sides accounted for the highest number of species. Aquatic vegetation stabilizes the benthic substrate, produces oxygen, and is a primary producer that supports an important food web, and provides habitat to fish and invertebrates.

Table 8. List of aquatic vegetation found around 6 samples sites around Cayo Rosario

Scientific name	Common name	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
<i>Acetabularia caliculus</i>	Green mermaids wide glass		x	x	x		
<i>Acetabularia crenulata</i>	Mermaids wine glass				x		
<i>Batophora occidentalis</i>	Green algae	x		x	x	x	x
Chlorophyta	Green algae		x		x		
<i>Dictyosphaeria</i> sp.	Green algae					x	
<i>Dictyota</i> sp.	Brown algae			x	x		x
<i>Halodule beaudettei</i>	Shoal grass				x		
<i>Laurencia intricata</i>	Red algae	x	x		x	x	x
<i>Rhizophora mangle</i>	Red mangrove		x		x		x
Rhodophyta	Red algae	x			x		
<i>Thalassia testudinum</i>	Turtle grass	x	x	x	x	x	x

Table 9. List of macro-invertebrates found around 6 samples sites around Cayo Rosario

Scientific name	Common name	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Number of specimen
<i>Batillaria minima</i>	West Indian false cerith	x						103
<i>Brachidonte exustus</i>	Scorched mussel	x	x	x	x			11
<i>Brachidontes modiolus</i>	Yellow mussel	x			x			68
<i>Callinectes ornatus</i>	Shelling crab			x				5
<i>Cerithium eburneum</i>	Ivory cerith	x	x		x			76
<i>Cerithium muscarum</i>	Flyspeck cerith	x		x				25
<i>Chione cancellata</i>	Cross-barred venus		x					1
<i>Fasciolaria tulipa</i>	True tulip	x						2
<i>Gammarus mucronatus</i>	"Sea lice"	x						3
<i>Haminoea petiti</i>	Thumb nails				x			2
<i>Lampanella minima</i>	"Sea snail"		x	x	x			31
<i>Lioberus castanea</i>	Chestnut mussel	x						1
<i>Littoraria nebulosa</i>	Cloudy periwinkle	x						4
<i>Melampus coffea</i>	Coffe bean snail			x				1
<i>Mercenaria campechiensis</i>	Southern hardshell clam			x				1
<i>Neopanope packardii</i>	Southern grassflat crab	x	x		x			86
<i>Nereis</i> sp.	Polychaete worm	x						1
<i>Pagurus annulipes</i>	Banded hermit crab	x			x			26
<i>Panopeus bermudensis</i>	Mud crab	x						1
<i>Penaeus</i> sp.	Penaeid shrimp	x			x			16
<i>Phacoides pectinatus</i>	Thick lucine	x						1
<i>Pinctada longisquamosa</i>	Scaly pearl oster			x	x		x	5
<i>Platynereis</i> sp.	Annelid worm				x			1
Polychaete Orbiniidae	Bristel worm or polychaete				x			3
Polychaete Terebellidae	Polychaete worm				x			1
<i>Retilaskeya emersonii</i>	Emerson's miniature cerith	x						2
<i>Rocinela signata</i>	Parasitic isopod	x						2
<i>Volvarina abbreviata</i>	Margin snail	x						3

**Point intercept** sampling revealed that Contrary to the findings reported in the EIA, the point-intercept sampling revealed that the substrate is comprised of vegetation, mainly seagrass and algae (Figure 11) and not bare rock as stated in the EIA (The Cayo Rosario Group 2017a). In fact it is comprised of vegetation, mainly seagrass and algae. These are important to the ecosystem and the primary reason for its productivity, the energy it introduces for aquatic organisms including fish. Sand, which was sandy-muddy, was commonly found in all sampling sites. This type of sediment differs from the sand (more coarse) in the flats plain where permit feed. Sandy-muddy bottoms are important as burrowing habitat as shelter and feeding for macro-invertebrates.

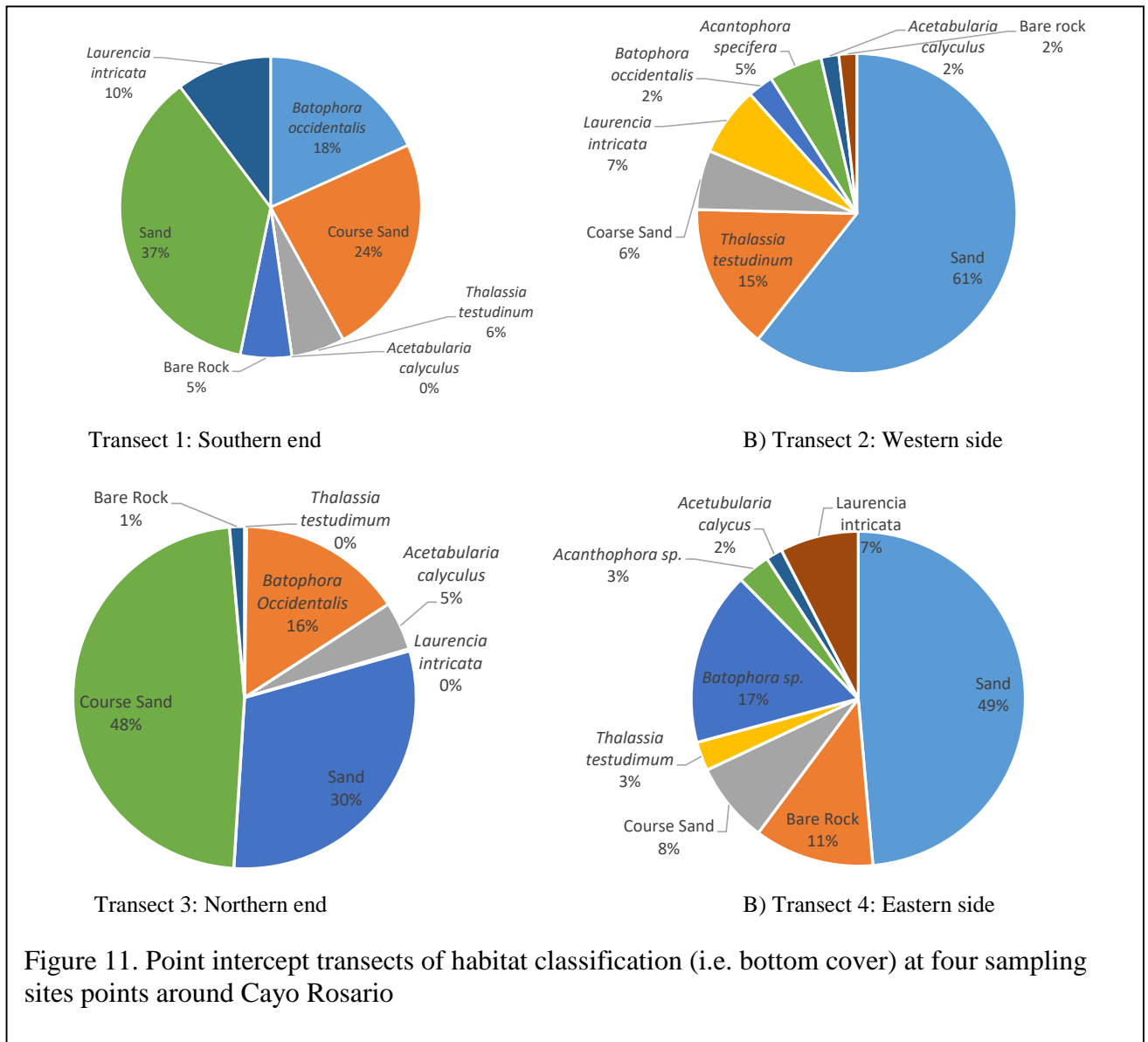


Figure 11. Point intercept transects of habitat classification (i.e. bottom cover) at four sampling sites points around Cayo Rosario

## 4.0 CONCLUSIONS

A total of 46 over the water Structures will be built well with the boundaries of conservation Zone IV (E) of the Hol Chan Marine Reserve. This is the main area of conflict and disagreement between the developer and stakeholders. The latter includes local fly-fishing guides and reef fishing guides who use the area in a daily basis. Some items that can be pointed out and have not been clearly justify in the EIA include:

- It contravenes the goals and objectives of the Hol Chan Marine Reserve Regulation of 2015 which legally established this area as conservation zone.
- The EIA fails to adequately assess biological assets, especially in the proposed area where the over the water structures will be built. It claims that fish density and biodiversity is low and sport fishing species such as the bonefish, permit and tarpon were not detected in the surveys conducted. This is the case because:
  - 1) the assessment methodology did not used scientific methods and were completely inadequate. “The Australian Institute of Marine Science Long-term Monitoring Program (AIMSLTMP) as well as the Global Coral Reef Monitoring Network: and Reef Check” are specifically designed for coral reef ecosystems. Coral reefs host 25% of all living organisms in the ocean and only occupy a tenth of a percent of oceans. Life is concentrated in relatively small areas, therefore short transects replicated over specific areas of reef can generate acceptable and reliable data. Cayo Rosario is not a coral reef ecosystem.
  - 2) Fish species such as permit, bonefish and tarpon are highly transient and only use these sand flats in specific times of the day and seasonally feed, seek refuge (from weather patterns) and reproduction (spawning, migratory routes or resting areas). Given that these fish species are distributed over a larger area and not concentrated as in a coral reef, it expected that ten transects used in the EIA would yield no sightings in one or two visits. The EIA technicians or consultants they failed to realize this and opted to use inadequate methodologies

because they lacked knowledge, experience and educational background. Survey sites as indicated in “Image 2” of the EIA show that the area of sand flats where the overwater structures will be constructed was not surveyed.

The northern, western and southern end of Cayo Rosario were the most diverse areas. However, from these three areas, the southern end where the intended over the water structures are proposed to be build was the most diverse. This site contained fish species that support the flats fishery (bonefish and permit) and the reef fishery (bait fish). The area was also rich in vegetation and macro-invertebrates, which are prey for all of these important fish species.

Fish species, vegetation and macro invertebrates, as well as mangroves from the Cayo Rosario are ecologically interdependent. The destruction and alteration of any of these will eventually affect all the others until the abundance of all is reduced. This reduction will eventually affect livelihoods of the flats and reef fishery sector as there will be no fish. With no fish there are no clients (anglers) and without anglers there is no income. Without income there will be no local expenditures by Belizeans, which will hurt the local economy and culture.

**This study advises that construction is only adequate for private dwellings (houses) of owners and not for large-tourism purposes as the caye is not a large one. Such construction should be ecologically sound where minimal damage to mangroves (vegetation around the caye) is conducted. If there is any dock planned to be constructed it is recommended to be on the east side of Cayo Rosario. It is also recommended for no dredging of sand or sediment to occur anywhere around Cayo Rosario.**

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