# Placencia Lagoon

## Rapid Environmental Assessment

Working Draft

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## Acknowledgements

This initiative, towards the establishment of Placencia Lagoon as an important part of Belize's National Protected Areas System, would not have been possible without the long term motivation and commitment of people like Adrian Vernon, and of the members of the Friends of Placencia Lagoon. We would like to thank them for their input into both the environmental assessment and management planning process. Also critical to the process has been the interest and commitment from people living in all three key communities – Seine Bight, Placencia and Independence – they have been instrumental in providing information and the development of key recommendations throughout the environmental assessment and management planning process.

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# Executive Summary

Placencia Lagoon has been identified in several national planning initiatives as a gap in the National Protected Areas System (NPAS). The area is significant in its representation of mangrove ecosystems, providing nursery functionality for many commercial fish species, including the critically endangered Goliath grouper. A small traditional artisanal fishery is reliant on commercial fish species in the lagoon, providing an important protein and income source for low income families, particularly in Seine Bight. The sheltered estuarine environment is also a critical nursery area for many commercial and non-commercial reef species, helping support a reef fishing industry that supports coastal communities across Belize.

The seagrass beds provide a critical filtration service, removing sediments and contaminants from agricultural and development runoff before these can be carried to the more fragile reef. These seagrass beds include the largest expanse of the globally vulnerable clover grass (*Halophila baillonii*) in the world, a favoured food for the Antillean manatee (*Trichechus manatus manatus*), the endangered regional sub-species of the West Indian manatee. Belize is considered a regional stronghold for this species, and Placencia Lagoon has been identified as one of four key areas for ensuring continued viability of this species at national level.

Sport fishing is an important income-generating activity linked to the lagoon, particularly when the coastal waters are too rough. The sport fish populations, however, have been impacted significantly by the use of gillnets within the lagoon system. The area has significant eco-tourism appeal, particularly for low-noise, low-impact kayak or small watercraft tours. The birdlife, manatees and aesthetic beauty of the area have the potential to form the basis of a flourishing eco-tourism industry in all three communities - particularly Seine Bight.

**Placencia Lagoon – Summary of Key Points**

- One of the largest coastal lagoons in Belize, with high productivity and good connectivity to the reef – under-represented within the National Protected Areas System
- Influenced by the coastal oceanographic conditions of the Southern Barrier Reef System and the terrestrial conditions of the surrounding watershed catchments
- Focal area for human settlement, tourism, local fishery and aquaculture development
- Critical for future resilience and adaptation to climate change for both natural resources and communities
- Largely intact, functional mangrove ecosystems, important for shoreline stabilization
- Important seagrass beds, filtering sediment and contaminants before estuarine water reaches the coral reef, protecting and maintaining the health of the reef
- Seagrass and mangroves provide critical nursery areas for commercial marine species, supporting local and national fishing industry
- One of four national, key areas for the maintenance of viable populations of the Antillean manatee (*Trichechus manatus manatus*)
- Important global representation of the vulnerable clover grass (*H. baillonii*)
- Estuarine fish species supporting local fishermen
- Supporting tourism and tour guides as an ecotourism destination based on its wildlife and aesthetic beauty, and as a sport fishing venue

Industries on the southern coastal plain have had a significant past impact on the health of the lagoon system. In 2006 / 2007, effluent from the shrimp farms caused the die-off of large expanses of seagrass, with a decline in biodiversity associated with this ecosystem. Community consultations indicate that the water quality declined, with decreased water clarity, fish die-offs and increased presence of “pica pica”, reducing the recreational values of the area for swimming. The manatee population was also considered to have declined, with individuals moving out of the lagoon system to other seagrass areas, such as the Harvest Caye and the Sennis River areas. The lagoon has, however, shown great resilience, with a gradual improvement of the environment as the shrimp farms established settling ponds and managed their effluent more effectively. Seagrass has now returned, as have the manatees.

Whilst there is improvement in the water quality, there are still significant impacts that affect the lagoon system, primarily associated with development. Mangrove clearance, dredging, and increased sewage and solid waste site runoff leaching into the lagoon are all currently reducing the quality of the environment. It is also thought that agrochemical contamination in the associated watersheds from large scale banana and citrus industries may also be impacting the water quality. These are all issues that can be more effectively managed if the Placencia Lagoon can be established as a component of the National Protected Areas System.

Coastal lagoons are poorly represented in the NPAS, and yet are critical for the maintenance of a healthy reef, on which Belize’s tourism and fishing industries are largely based. This environmental assessment has been developed to assess the relevance of the area for protection of its biodiversity and ecosystem values, and to provide information for the management planning for the area. The assessment was completed through fieldwork, literature review and extensive community consultation in the three key stakeholder communities of Placencia, Seine Bight and Independence. Expert input has also been sought, and biodiversity and socio-economic research compiled and incorporated into this assessment.

The urgent next steps have been identified for the declaration and management of the area for long term sustainability.

***Short Term / Next Steps***

*1. Develop Statutory Instrument defining the protected area and the regulations (Forest Department)*

*2. Approval of management plan for the Placencia Lagoon as a Wildlife Sanctuary (2) or, for the interim, a Wildlife Sanctuary with Ministerial permission for development of a sustainable, rights-based traditional fishery (Forest Department / NPAS)*

*2. Delineation of boat channel and no wake zone at mouth of Placencia Lagoon to address potential for manatee collisions (Port Authority)*

*3. Develop collaborative partnerships with the Forest and Fisheries Departments and the Department of the Environment, with training of rangers for effective enforcement of Fisheries regulations and development legislation*

*4. Identification and engagement of local, traditional fishermen toward participatory and collaborative development of a rights-based traditional fishery*

## 1.0 Background

Placencia Lagoon has been identified several times in national level assessments as a key gap in the National Protected Areas System (Zisman, 1990, revised 1996; Miller et al., 1995; Walker et al., 2012). The need for the protection of mangroves associated with the lagoon was also identified in the Mango Creek Special Development Area Plan (approved in 1997). At local level, protection of the lagoon and these associated mangroves is seen as a key priority by the Friends of Placencia Lagoon (FoPL), a local NGO with multi-sectoral representation. Under the National Protected Areas System Rationalization exercise, it has been proposed that the area be declared a Wildlife Sanctuary (2), managed under the Forest Department (Walker et al., 2012), with the following objectives (FoPL, 2013):

- **Biological:** Protect mangrove forests and fringing ecosystems, seasonally and permanently inundated wetlands, and estuarine system, endangered species and nursery habitats for marine life
- **Safety:** Create buffer zones for flood and wind control and to ease effects of climate change
- **Economic:** Increase tourism revenues through promotion of the Placencia Lagoon as environmentally conscious community and eco-tourism destination.
- **Traditional Use:** Maintain traditional rights-based low-impact fishing

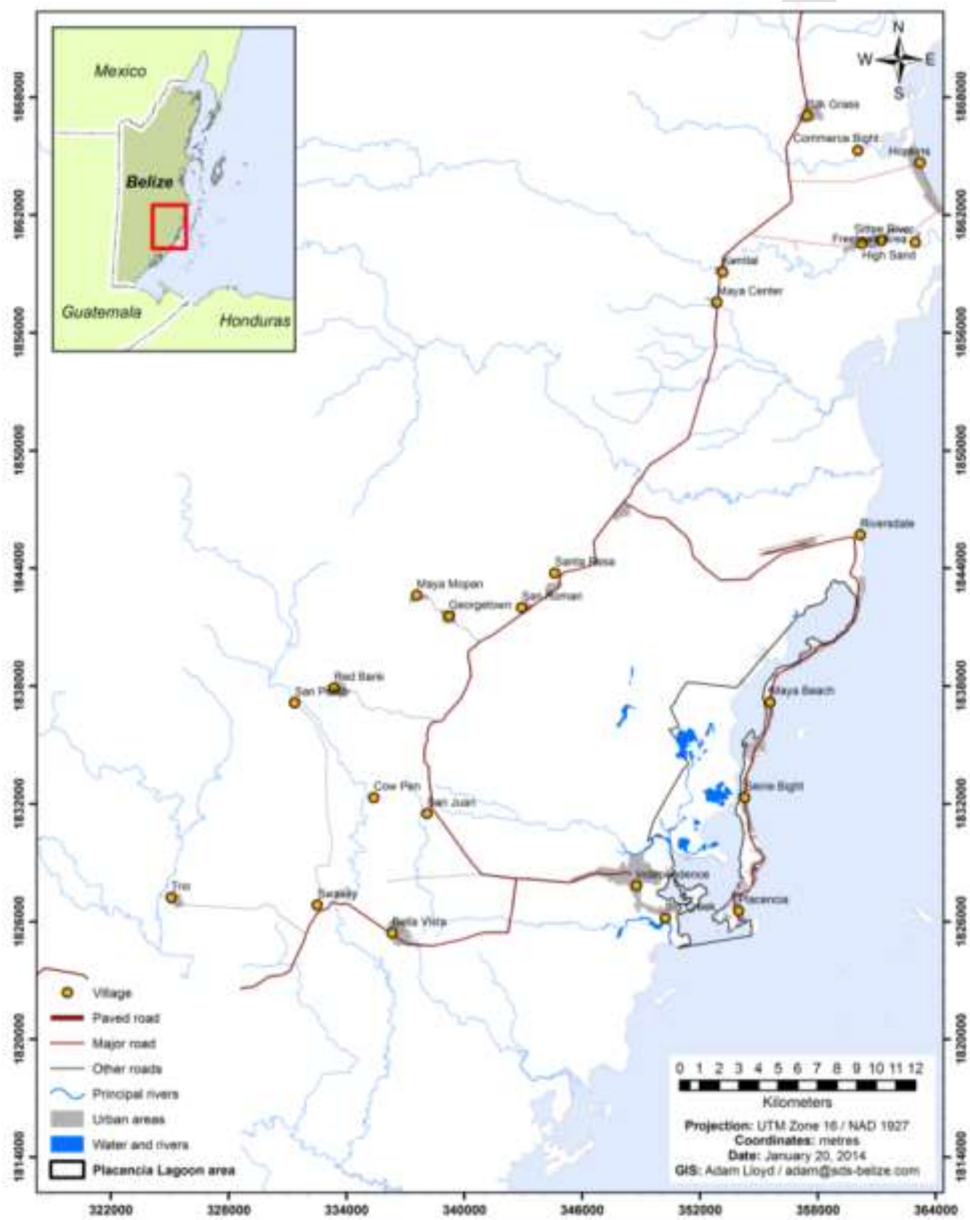
As with other Wildlife Sanctuary (2) sites, permitted use would allow for sustainable natural resource extraction of fish stocks in the Lagoon, based on traditional use; with all other uses being restricted to non-extractive tourism, research and education.

This Environmental Assessment presents the current baseline knowledge available on the lagoon area, providing a foundation for the development of the management plan, a pre-requisite for declaration of the area as part of the National Protected Areas System. Information is based on a combination of fieldwork, literature review, expert input, extensive stakeholder consultation and integration of multi-sectoral stakeholder input.

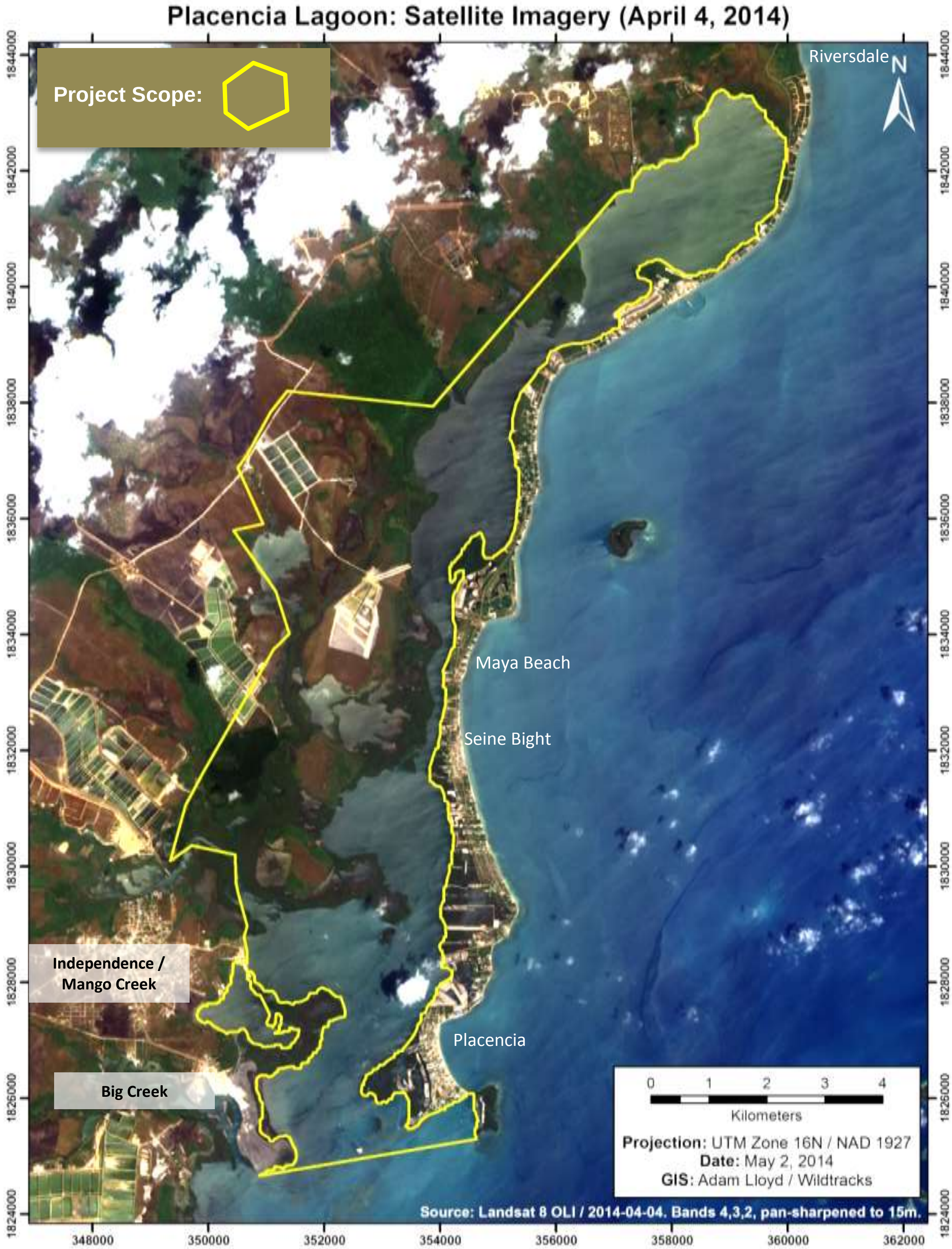
### *1.1 Location and Site Description*

Placencia Lagoon is located in Stann Creek District, in southern Belize. It is a semi-enclosed, shallow, coastal estuarine system with an area of approximately 30km$^2$, running north-south for approximately 24km, from UTM 16 359 000E; 18 4360 N to UTM 16 351 600 E; 18 25500 N, and is 3.2km at its widest, opening to the sea at its southernmost point. The lagoon is separated from the sea by a narrow sand spit (the Peninsula) that stretches southwards for approximately 25km, forming its eastern shoreline, and lies in a landscape of associated wetlands, mangroves, pine savanna and tropical broadleaf forest.

Four communities have been established on the peninsula itself. The three traditional communities are Placencia, at the southern tip, with Seine Bight and Maya Beach further north (Map 1, Map 2). The Seine Bight village lands have traditionally extended northwards to the north end of the peninsula to Riversdale, inclusive of Maya Beach. Whilst Maya Beach votes as part of Seine Bight, the 2010 census counts them as two distinct communities. They do have very different characteristics, so are addressed as separate communities in this assessment. The merged communities of Independence and Mango Creek (referred to collectively as Independence) are situated near the western mouth of the lagoon, on the mainland, at the southern mouth of the lagoon, as is the deep water port at Big Creek.




***Map 1: Landscape Context - Communities of the Placencia Lagoon Landscape***



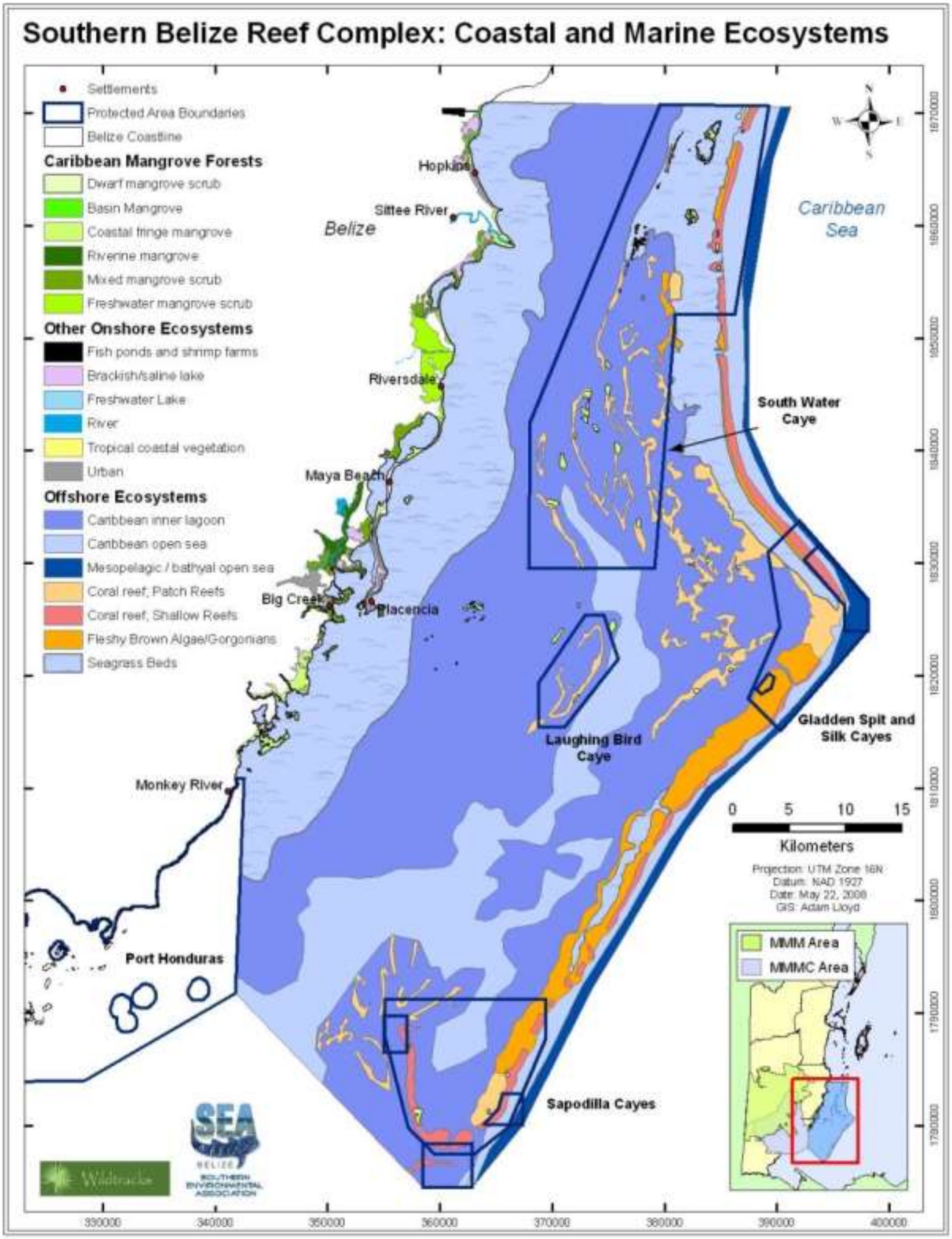

***Map 2: Placencia Lagoon – Satellite Image (April 4, 2014)***

The peninsula itself, to the east of the lagoon, is under significant pressure from development, being a national focal point for coastal tourism in Belize. In addition to the communities mentioned, it supports large tourism and residential developments, with increasing alteration of the lagoon shoreline from mangrove clearance, dredging and landfill activities, and construction of seawalls.

To the west, the lagoon borders the low-lying southern coastal plain, a strip of flat land running parallel to the coast, and stretching westwards for up to 20km, to the Maya Mountains Massif. Three water catchments drain into the lagoon from the Maya Mountains and the coastal plain – Santa Maria Creek, August Creek (encompassing Mango Creek) and Big Creek. On the western shoreline of the lagoon itself, much of the natural mangrove remains, though like the mangrove of the Peninsula, it is also under pressure from development activities, with its proximity to the water pushing up the land's development value.  Immediately behind this shoreline lies the majority of Belize's aquaculture industry – the shrimp farms, with their historical impacts on the lagoon. Moving further west, the coastal plain is dominated by sandy soils supporting pine savanna, with tropical forest in areas of deeper, richer alluvial soils. Large banana and citrus plantations, the primary agricultural industries in the area, have replaced much of the natural vegetation in areas where deeper, more fertile soils exist – generally along river courses. Large cattle farms are also located on the coastal plain, with potential impacts on Placencia Lagoon.

A little over three kilometers south of the southern tip of the peninsula lies Harvest Caye, the site designated for development of Belize's southern cruise ship terminal, due to be operational by late 2015. There are significant implications from the presence of a cruise ship tourism hub with a mainland disembarkation point just east of Independence, at Malacate Beach, particularly in terms of boat impacts, increased stress to natural resources, and increased waterside development around the Independence area.

Placencia Lagoon is also a component of a complex seascape - the Southern Belize Reef System (SBRC), a system-level conservation management area that stretches southwards from the northern boundary of South Water Caye Marine Reserve to the northern boundary of Port Honduras Marine Reserve, and south-eastwards from the coastline of Belize to the Sapodilla Cayes and the outer reef (Map 3). The SBRC currently encompasses four marine protected areas - Laughing Bird Caye National Park (LBCNP), Gladden Spit and Silk Cayes Marine Reserve GSSCMR), South Water Caye Marine Reserve (SWCMR), and Sapodilla Cayes Marine Reserve SCMR). Three of these (LBCNP, SWCMR, and SCMR) are components of the Belize Barrier Reef System - World Heritage Site, representing classic examples of fringing, faro and barrier reefs. Also covered within the SBRC are four legally protected critical spawning aggregation sites, including Gladden Spit, the largest aggregation known in the Mesoamerican Reef  ecoregion. Under the NPAS Rationalization exercise, the SBRC was amended to also include Port Honduras Marine Reserve.




***Map 3: Placencia Lagoon as part of the Southern Belize Reef Complex***

## 2.0 Social Context and Community Perceptions

### *2.1 Key Stakeholder Communities*

Four primary stakeholder communities have been identified during the Placencia Lagoon assessment – Placencia, Seine Bight, Maya Beach and Independence (including Mango Creek) (Table 1). Each community perceives the lagoon in a different way, depending on the level of dependence on the lagoon resources, but all communities recognize the need to balance conservation and development (Community consultations and focal group meetings, 2014).

| Key Stakeholder Communities of Placencia Lagoon | | | | |
|---|---|---|---|---|
| **Community** | **Location (UTM)** | **Population (approx.)** | **Population components** | **Comments** |
| **Placencia** | E16 0354025<br>N18 26600 | 1,753 | Predominantly Creole | Historically a fishing community – now primarily a tourism-based economy. Some manatee-watching based eco-tours / sport fishing within the lagoon system |
| **Seine Bight** | E16 0354300<br>N 18 32183 | 1,310 | Garifuna | Historically a farming / fishing community – now moving towards a more tourism-based economy. Includes the primary fishers dependent on the lagoon system. |
| **Maya Beach** | E16 0355630<br>N 18 37000 | 229 | Expatriate / Mixed | A retirement community – predominantly Americans / Canadians / Europeans |
| **Independence / Mango Creek** | E16 0349370<br>N18 28040 | 4,014 | Mixed primarily Creole | Primarily a residential area for employees in Placencia and Big Creek, and in the citrus industry. Some tourism, mostly associated with Placencia, and a small number of fishermen who target Placencia Lagoon. Some farming on the high ridge on caye within the lagoon (under lease - 3 to 4 farms) |
| [1]**CSO Census data, 2010;** | | | | |

***Table 1: Key Stakeholder Communities of Placencia Lagoon***

Traditionally, the Placencia Lagoon has been used as a fishing ground for fishers from Placencia, Seine Bight and Independence / Mango Creek. However, since the late 1980's, the long stretch of sandy beach and the scenic vistas of the peninsula have attracted developers, with the construction of houses and hotels, spread out along both the beach front and lagoon front from Placencia northwards.

The three communities have grown exponentially over the last thirty years, and the associated increase in population of both residential expatriates and Belizean support sector (Table 2) has also brought its own impacts, - including increased grey water and sewage contamination, solid waste management issues. Other development impacts have also increased exponentially, ranging from the establishment of the first shrimp farm in 1983, to the exponential, largely unplanned development of hotels, resorts and retirement homes on the peninsula over the last fifteen years, as a result of increasing investment from the tourism sector.

| Community | 2000 census | 2010 census |
|---|---|---|
| Placencia | 501 (178 HH) | 1,753 (644 HH) |
| Seine Bight | 871 (221 HH) | 1,310 (324 HH) |
| Maya Beach | | 229 (99 HH) |
| Independence | 1,082 (263 HH) | 4,014 (972 HH) |

***Table 2: Populations and number of households – 2000 and 2010 censuses, SIB.***

All four communities have road access, 24 hour electricity and water, primary and high school education, and access to health care. Employment on the Peninsula is focused primarily on tourism and fishing. Independence, whilst also providing labour for the tourism industry on the Peninsula, has greater employment opportunities in the agricultural sector (particularly banana, citrus and aquaculture) and with the deep water port at Big Creek.

***2.1.1 Placencia.*** Established in the late 1800's, Placencia is traditionally a predominantly Creole community, focused historically on fishing and coconut farming for oil production. In the 1970's, fishing became the primary income source for the community, until more recent years, when the community has shifted to a largely tourism-based economy, focused primarily on the long, sandy beach, the accessible reef to the east of the peninsula, and the option to see whale sharks at the reef drop-off at Gladden Spit, to the east, during full moon between April and July.

The lagoon was once more important to community livelihoods than it is today, providing fish for the table when bad weather restricted fishing off-shore. Now it provides an important tourism destination when the sea is too rough to take guests out to the reef, with activities such as sport fishing, manatee watching and eco-tours. Before the Peninsula road was upgraded, the water taxi provided the easiest access from the mainland, and still runs a regular service from Independence, bringing workers and visitors across the lagoon each day. The mangrove-lined creeks of the lagoon also provide a sheltered harbor for the many boats associated with the reef tourism business during tropical storm events, with mangroves breaking the force of the storm winds and sheltering the boats from destructive wave action.

Placencia is a significant tourism destination for visitors and an important financial contribution to the local economy. The number of hotels in the area has increased from 63 (445 beds) in 2003 to 119 (730 beds) in 2012, the highest growth rate within the country for 2012 (BTB, 2012).

Currently, there are considered to be very few fisherfolk in Placencia who rely on subsistence fishing in the lagoon to support their families (estimates range from 1 to 3 families. Fishermen general focus on lobster fishing in the coastal zone (Placencia consultations, 2014), but those who do are considered to

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be the most vulnerable sector in the community to changes to the system – whether these changes are towards protection or impacts from development. A small number of low-income families also rely on the collection of dead mangrove for fuel. Some extraction of sea cucumber currently also takes place from the lagoon to provide the export market.

Placencia stakeholders are now focused primarily on the tourism aspects of the lagoon – the aesthetic values and the wildlife-associated touristic values (particularly sport fishing and manatee watching). There is strong recognition of the link between the health of the lagoon and the social and environmental resilience of the community, with a high level of awareness of the nursery functionality of the lagoon for reef and sport fishing species and its role in maintaining the viability of Belize's population of Antillean manatee. As a tourism-based community, there is also recognition of the importance of maintaining the aesthetic beauty of the lagoon and surrounding mangroves, as well as the wildlife, and of the income generation potential the lagoon provides.

***Priority areas of concern expressed during stakeholder consultations in Placencia included:***

- the continuing, environmentally-unsustainable development taking place to the north, on the lagoon-side of the peninsula, and the impacts this may have on the long term viability of the lagoon system.
- the new cruise ship terminal being established on Harvest Caye, and the potential impacts of tenders bringing guests into the lagoon system
- the potential for oil spills, particularly in the Big Creek area
- the potential for flooding of shrimp farms and of the planned sewage facility holding ponds during storm events, with contamination of the lagoon

***2.1.2 Seine Bight*.** One of ten Garifuna communities in Belize (National Garifuna Council of Belize, 2011), Seine Bight was established in 1869, and has a more agricultural background than other communities on the Peninsula, with traditional farmlands once being located to the west of the lagoon. Farmers would cross the lagoon to Jenkin's Creek, then proceed on foot to the Georgetown area, where they had access to deeper, more productive alluvial soils. The community has evolved a culture of seasonal migration to the agricultural plantations on the coastal plain, and semi-permanent migration to the United States to work, with funds sent back to support families in the community. This outward migration resulted in the absence of the more active and dynamic sectors of the population at a time when the adjacent Placencia community was starting to invest in improved marine access and tourism infrastructure. Without the benefits of active engagement and the marine-based economy of Placencia, Seine Bight has been slower to develop the investment and infrastructure needed for a shift to tourism, though this is now starting to change.

The community was heavily impacted by Hurricane Hattie in 1961, with 90% of buildings destroyed, resulting in approximately forty-five families relocating to the Georgeville farming area, with support from the Government through land grants, the establishment of a school and provision of access to health care (Key, 2002).

Seine Bight is considered the most vulnerable of the peninsula communities with the highest reliance on small-scale, traditional fishing for home consumption. As a result, it has been (and will be) more deeply impacted by changes to the lagoon than the other communities. There has been a recent shift in focus from agriculture and fishing to the increasingly important employment in the tourism sector – particularly in the hotel and restaurant industries.

***Priority areas of concern expressed during stakeholder consultations in Seine Bight included:***

- the proposed location of the sewage treatment plant, and whether it will impact the lagoon, especially during storm events
- decreasing accessibility to lagoon with increased shoreline development
- removal of mangrove and access to the 66' shoreline
- increasing impacts of unregulated dredging

***2.1.3 Maya Beach.*** Linked to, and slightly to the north of Seine Bight is the more wealthy retirement satellite community of Maya Beach, first established in 1964, and gradually expanding to include a cultural mix of both expatriates (predominantly American and Canadian) and local community members. The community profile of Maya Beach more closely resembles that of Placencia rather than Seine Bight.

***2.1.4 Independence.*** On the western shore of the lagoon lies Independence, providing the current primary point of entrance to the lagoon from the southern coastal plain. The town itself is not focused on the waterfront, with only limited access to the water, primarily for boat access.

Independence provides housing and services for employees in the tourism and agricultural industries of the area, particularly for the tourism and support industries of the Peninsula, with employees commuting by water taxi on a daily basis. It also serves the port at Big Creek, one of the primary historical reasons for the development of the community. As one of three commercial ports in Belize, Big Creek is a national import / export hub, originally established by Fyffes for the export of bananas, but now handling a wide range of products, including citrus and oil.

A small number of local fishermen use the lagoon for both subsistence and retail purposes, and there is strong community recognition of the value of the fringing mangroves in protecting houses from wind damage during storm events (Community consultations, Independence, 2014). Development on this western side of the lagoon has been slower than on the Peninsula, with the development focus on the sandy beaches of the peninsula itself. However, as land runs out on the peninsula, the focus is shifting to this western shore, with survey lines cutting through the fringing mangrove. This focus is predicted to increase with the operationalization of the new cruise industry, based from Harvest Caye, which has Malacate Beach as its primary disembarkation point, on the south east shore of Independence.

The views of stakeholders from Independence provided a development perspective, and a request for continued dialogue of all stakeholders towards balancing conservation and development requirements (Community consultations, 2014).

***Priority areas of concern expressed during stakeholder consultations in Independence included:***

- potential impacts to the Malacate area (currently important as a bait fishing area) from dredging and fill – as it develops as a disembarkation point for cruise tourism tenders
- the impacts of establishing Placencia Lagoon as a protected area, and whether / how this will affect development
- damage to lagoon ecosystems from poorly planned / implemented development, with declining water quality and increased sedimentation, impacting the reef - affecting its appeal to the reef tourism market.

### *2.2 Socio-Economic Context*

A socio-economic survey conducted in 2008 provided information on the primary income sources in the three key communities, comparing it with data from 2000. Income generation per household was higher on average in Placencia, where the focus was primarily on tourism. Seine Bight showed the lowest income generation, despite its proximity to Placencia and an increasing focus on jobs in the tourism industry (particularly hotels and restaurants) (Table 3).

| Community | Commercial Fishing | Recreational Fishing | Tour Guiding | Boat Captain | Taxi Driver | Diving | Hotel/ Resort Worker | Restaurant Worker |
|---|---|---|---|---|---|---|---|---|
| **Placencia (n=455)** | 26.5% | 17.2% | 31.6% | 30.2% | 7.6% | 12.7% | 28% | 11.4% |
| **Seine Bight (n= 316)** | 4.7% | 4.7% | 0 | 1.5% | 1.5% | 1.5% | 26.5% | 6.3% |
| **Independence (n=1,258)** | 0.7% | 4% | 0.7% | 0.7% | 0 | 0 | 3.4% | 2% |

***Table 3: Primary marine-based income sources (MMAS / Catzim, 2009)***

The primary income generating activity in the Peninsula communities is tourism (Table 3) – the tourism industry is the number one foreign exchange earner in Belize, with over one million visitors travelling to Belize in 2014. Over 320,000 of these were overnight visitors, with a further 960,000+ arriving through cruise ship visitation (Central Bank / BTB, 2014). Tourism expenditure in Belize exceeded Bz$639 million in 2012 – predominantly from the overnight sector, which contributed 86.4% (Bz$552.2 million) of total expenditures, despite being only a fraction of the total number of tourists (BTB, 2013). Tourism in Belize is primarily natural- and cultural-resource based, with visitors focusing on the cayes, coastal communities and coral reef (particularly snorkeling, diving and sport fishing), and inland protected areas. Nationally, the tourism industry accounts for 28% of employment, and also supports restaurants, transport providers (including water taxi services and internal airline companies), boat captains, tour operators and a number of other service providers, as well as those employed directly by the tourism industry (BTB, 2013).

Commercial fishing has been the traditional foundation for Placencia, primarily focused on the reef, shallow coastal waters and to a lesser extent, in the coastal lagoon - 26.5% of surveyed households identified fishing as one of their primary sources of income in 2008 (Table …; MMAS / Catzim, 2008). There is less importance placed on fishing in the other two key communities – Seine Bight and Independence - though those that are artisanal fishermen in these communities, with a heavy dependence on the fish resources, are considered the most vulnerable to impacts from development or changes in the lagoon management regime, and are therefore identified as key stakeholders.

Agriculture is also an important income source in the larger landscape context, particularly on the southern coastal plain, with the expanding footprint of large banana and citrus plantations and the establishment of cattle farms. These, along with the aquaculture facilities, provide employment for a significant number of people, bringing seasonal migrants and permanent workers to the area. Generally, however, these employment opportunities in the agricultural sector are more accessible to people of Independence than the communities of the Peninsula.

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## 3.0 Conservation Importance of the Placencia Lagoon Area

Coastal lagoons such as Placencia Lagoon consist of complex, dynamic, interconnected ecosystems, with high connectivity between mangroves and seagrass, and between the freshwater and marine environments. Protection and effective management of these coastal ecosystems is an important component of integrated coastal management, and is particularly critical in the management of coastal biodiversity and the fishery industry. The Placencia Lagoon ecosystems are also considered important in the development of community adaptation mechanisms for predicted climate change impacts, particularly for the vulnerable communities of the Peninsula.

### *3.1 Role within the National Protected Areas System*

Placencia Lagoon is not currently protected, but has been highlighted several times as a gap in the National Protected Areas System (NPAS). It was one of twelve sites identified for inclusion within the NPAS in 1995 (Miller et al., 1995), and one of twenty-three sites highlighted as gaps in 1996 (Zisman, 1996). The 1996 assessment focused particularly on the unique nature of the Peninsula, and the importance of the area as a productive fishing ground. The value of the mangroves on the western side of the lagoon was also recognized in the Mango Creek Special Development Area Development Plan, approved in 1997, for ensuring continued environmental services provided by the system. The lagoon is important for the representation of coastal lagoons within the NPAS, and protection would contribute to the viability of threatened species in Belize, including one of the largest global extents of the vulnerable clover seagrass (*Halophila baillonii*) (IUCN, 2015). It is also considered one of four key sites important for continued viability of the endangered Antillean manatee (Auil Gomez, 2011, Walker et al., 2012).

There is also recognition of Placencia Lagoon's importance as part of one of Belize's secondary biological corridors, providing ridge-to-reef corridor functionality, linking the Maya Mountains Massif to the Southern Belize Reef Complex from Cockscomb Basin Wildlife Sanctuary via Mango Creek Forest Reserves 1 and 2 (as stepping stone conservation areas), and Placencia Lagoon itself.

Protection of the Placencia Lagoon is identified as a mechanism that would contribute to fulfilment of Belize's biodiversity commitments under the Convention on Biological Diversity, in bringing coverage of Caribbean Open Sea and Caribbean Mangrove Forest within the National Protected Areas System closer to the 10% target, if fringing mangroves and national cayes are included in the designation.

In 2012, as part of the rationalization process for the National Protected Areas System Placencia Lagoon was again highlighted for its importance as an important estuarine system (Walker et. al., 2012). Recommendations under this process included:

- Designation of Placencia Lagoon system as a Wildlife Sanctuary (2) by Statutory Instrument to allow conservation management with continued traditional fishing, based on the development of a sustainable fishery plan and use agreement with traditional users

- Non-extractive use designation for all other biodiversity
- Integration of management of adjacent private protected areas that support mangrove conservation contiguous with the conservation area
- Management under a co-management partnership with SEA

### *3.2 Ecosystem Services*

As an estuarine system, the Placencia Lagoon area performs a number of valuable ecosystem services. The mangroves and wetlands adjacent to the lagoon act as natural buffers between the land and water, providing flood protection in extreme rainfall events - absorbing flood waters and dissipating storm surges. The mangroves and other estuarine plants also help prevent erosion and stabilize the shorelines and lagoon benthos. Water draining from the Maya Mountains through the agricultural areas of the coastal plain carries sediments, nutrients, and pollutants to the lagoon, as does effluent and run-off from urban areas adjacent to the lagoon system. These are largely filtered out by the mangroves, herbaceous swamps and salt marshes, where they exist, before they reach the lagoon, and are then further settled and filtered by the slow moving waters of the estuarine system, and the extensive seagrass beds, before they reach the marine environment. This filtration process creates cleaner and clearer water, particularly important for the maintenance of healthy reefs offshore, supporting the fisheries industry, and for the aesthetic beauty and recreational activities appreciated by Belizeans and tourists alike.

Placencia Lagoon provides a sheltered nursery for marine and estuarine species, with protective mangrove root systems and extensive seagrass beds in close proximity to each other, and with high connectivity to the Belize reef. The lagoon is considered regionally important for recruitment of a significant number of commercial marine species - particularly for its role in the lifecycles of species such as grunts, jacks, mullet, snook and snapper species, for the critically endangered goliath grouper (*Epinephelus itajara*), for sport fishing species such as bonefish, and for spiny lobster. These species support fishing in many of the coastal fishing communities – both inside the lagoon, and on the reef – the nursery functionality of the lagoon is recognized by fishermen not only on the peninsula but also to the south, in Punta Gorda (Stakeholder consultations, 2014; Ramirez, pers. comm., Rio Grande Fishermen Co-operative, 2014).

The fringing mangroves have historically provided important structure for colony nesting and roosting birds such as brown pelicans, egrets, herons and ibis, considered of high touristic value events (Stakeholder Consultations, Placencia, Seine Bight, Independence, 2014). The mangroves and mangrove-lined creeks within the lagoon also play an important role in providing shelter from tropical storm impacts, protecting wildlife, communities and boats against hurricane threats. Both local fishing boats and the larger tourism-focused charter sailboats are taken to sheltered areas within the lagoon and creeks (particularly Flour Camp Creek) during extreme tropical storm events (Stakeholder Consultations, Placencia, Seine Bight, Independence, 2014).

***Perception of changes in the condition of the lagoon and lagoon landscape over the last ten years***

- Fishermen used to be able to fish for an hour and have a good catch. This would include up to 30lb goliath grouper. Now they can be out for an entire day and not catch the same weight of fish (SB)
- Crocodiles and waterbirds were common – they are now hard to see (SB)
- Fish species have changed…catfish are now common in the lagoon – this is a species that wasn't present / common previously (SB, I)
- Seasonal migration patterns of fish to and from the lagoon to the coral patches offshore have changed (P)
- There has been extensive destruction of mangrove, with the loss of aesthetic beauty and protection values (SB)
- Local fishermen see the mangrove clearance around Seine Bight as altering fish distributions, resulting in fishermen having to go further to catch fish – with more expense and more time for less catch (SB)
- With the increased intensity of hurricanes and the removal of the natural vegetation, people in Seine Bight no longer feel safe in the community during tropical storms and will now evacuate. This is also a concern for people in Independence with the increased mangrove clearance for development in front of the community (SB, I)
- There is less protection for fishermen when storms catch them out on the water – they find that property developers are unwilling to let them seek shelter along the mangrove edges and in the canals of developments (SB)
- There have been significant changes in water quality in the past from shrimp farm effluent, thought to be resulting in fish kills and the die-off of much of the seagrass in the central portion of the lagoon. The added nutrient also caused the mangroves to grow excessively tall, but without good roots – leading to them being toppled in storm winds. The shrimp farms have now addressed these impacts (P)
- Current reduced health of the lagoon system is attributed largely to development impacts – particularly mangrove removal and dredging, and increased leaching of sewage into the lagoon (P, SB, I)

***Community Consultations, 2014***

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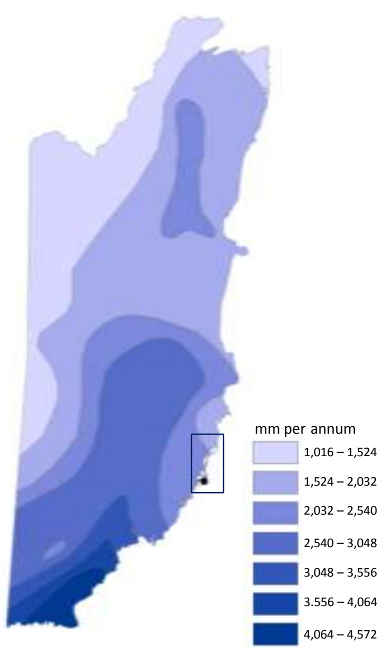
# 4.0 Physical Characteristics

### *4.1 Climate*

**Temperature and Rainfall**

Belize lies within the outer tropical geographical belt, with a noticeable variation in average monthly rainfall and temperatures. It can be divided into two climatic regimes – subtropical in the northern lowlands and central inland areas, and tropical in the southern Stann Creek and Toledo regions. Placencia Lagoon lies at the southern limit of Stann Creek, at its border with Toledo District, on the edge of the southern coastal plain, with a climate influenced not only by the proximity to the Maya Mountains, but also to the Caribbean Sea.

The majority of the lagoon system lies within the 2,000 – 2,500mm a year rainfall belt. The northern most end of the lagoon falls within a slightly drier rainfall belt – 1,500 – 2,000mm a year. Continuous climate data sets have been maintained at Big Creek, at the southern end of the lagoon. There is significant variation in precipitation throughout the year, with a pronounced dry season stretching from January through to the end of June. Minimum monthly rainfall as low as 53mm in March, the driest month. This is followed by a wetter season (July to December) with maximum monthly rainfalls in the region of 350mm. This is punctuated by a mini dry season in August/September. The majority of the rain falls within the hurricane season, particularly between September and December, associated with passing tropical storms (Figure 1, Table 4).



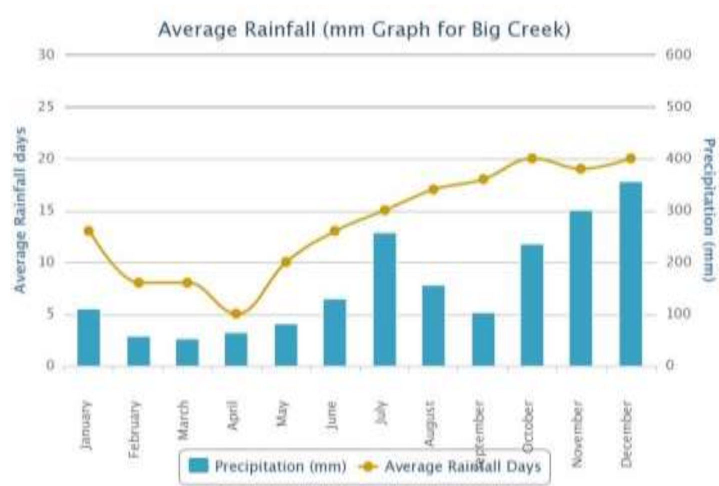




***Figure 1: Averaged Monthly precipitation data for Big Creek, 2000 – 2012 data (www.worldweatheronline.com)***

Air temperature fluctuates throughout the year from a minimum monthly low of 22°C to a high of 30°C, based on 2000 – 2012 data. Daily averages show greater variation – in 2014, the daily low was recorded as 15°C (January $17^{th}$, 2014), with a high of 35°C (May $8^{th}$, 2014) (Figure 2; Table 4).

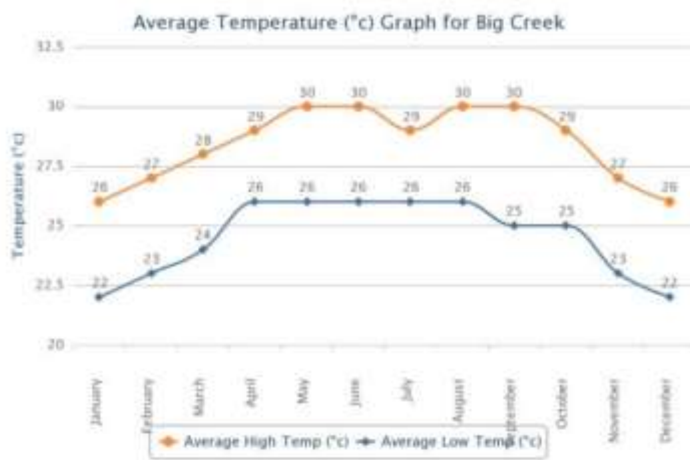



***Figure 2: Averaged monthly temperature data for Big Creek, 2000 – 2012 data (www.worldweatheronline.com)***

| Parameter | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Avg | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Precipitation (mm) | 111.1 | 58.2 | 53.6 | 65.3 | 82.6 | 129.3 | 258.4 | 156.1 | 103.2 | 235.3 | 301.6 | 355.9 | 149.9 | 1,799.5 |
| Max Air Temp (°C) | 26 | 27 | 28 | 29 | 30 | 30 | 29 | 30 | 30 | 29 | 27 | 26 | 28.4 | - |
| Min Air Temp (°C) | 22 | 23 | 24 | 26 | 26 | 26 | 26 | 26 | 25 | 25 | 23 | 22 | 24.5 | - |
| Mean Air Temp (°C) | 24 | 25 | 26 | 27.5 | 28 | 28 | 27.5 | 28 | 27.5 | 27 | 25 | 24 | 26.5 | - |

***Table 4: Monthly precipitation, and maximum, minimum and mean air temperature data for Big Creek, 2000 – 2012 (www.worldweatheronline.com)***

**Weather Systems:** Belize is affected by three very distinct seasonal weather systems: trade winds, cold fronts / northers and tropical storms. All three have an influence on the rainfall and temperature patterns, on the water level, and on the flow of water through Placencia Lagoon.

- ***Trade Winds*** – the predominant winds, blowing from the east and north-east
- ***Cold Fronts / Northers*** - high-pressure cold fronts moving down from the north, occurring between October and April
- ***Tropical Storms*** - occurring between June and November, originating in the mid-Atlantic

**Tropical Storms:** Tropical storms affect Belize every year, with the effects being felt particularly strongly on the coastal areas. Originating in the Atlantic Ocean over warm, tropical waters, these storms are non-frontal, developing highly organized circulations, and ranging in scale from tropical depressions and tropical storms (with sustained wind speed < 74 mph) to hurricanes (with sustained wind speed > 74 mph). These storms move westward towards the Caribbean, gathering strength until they hit land. The projected potential storm surges for the Placencia have been estimated based on the strength of the hurricane (Table 5; BAL, 2014) and dependent on the directional approach of the storm. The maximum predicted for the Placencia Lagoon area is considered to be 8m, with the level of impact on the lagoon ecosystems and adjacent landscape being dependent on the level of vegetation clearance on the Peninsula itself, and on the cayes within the lagoon system.

| Storm Category | Predicted Maximum Storm Surge (Placencia) |
|---|---|
| 1 | 1m |
| 2 | 2.5m |
| 3 | 3.5m |
| 4 | 4.5m |
| 5 | 8m |

***Table 5: Predicted Maximum Storm Surge for Placencia (BAL, 2014, from OAS/USAID, 1999)***

The hurricane season stretches from the month of June through November, with historical records identifying nine hurricanes and nine tropical storms that have passed within a 50-km radius of the lagoon system (Table 6; NHC, 2014). An additional storm, Mitch, has also been included as it had a huge impact on the area, even though it was outside the 50km radius. Whilst many hurricanes often have very focused paths of destruction, their effects are wide ranging, particularly in coastal areas. As well as the physical and mechanical damage to the ecosystems, hurricanes also stir up the water, increasing turbidity and can reduce water clarity for a significant time after the storm event itself. Water clarity can be further reduced following tropical storms by the associated heavy rainfall, which exacerbates erosion and increases sediment transport from the rivers. The increased turbidity and reduced salinity has the potential to also significantly impact seagrass distribution and condition, as well as fish movements within the system.

| Name | Cat. | Year | Date Passed Placencia | Distance of eye from Placencia |
|---|---|---|---|---|
| Not named | H1 | 1906 | 13th October | 40km N |
| Not named | TS | 1918 | 26th August | 24km N |
| Not named | TS | 1921 | 17th June | 50km N |
| Not named | TS | 1931 | 16th August | 50km N |
| Not named | TS | 1933 | 30th September | 12km N |
| Not named | TS | 1934 | 8th June | 10km E |
| Not named | H1 | 1941 | 28th September | 40km S |
| Not named | TS | 1943 | 23rd October | 12km SE |
| Not named | H1 | 1945 | 4th October | 14km SE |
| Abby | H2 | 1960 | 15th July | 10km S |
| Anna | H1 | 1961 | 24th July | Seine Bight |
| Francelia | H3 | 1969 | 3rd September | 35km S |
| Laura | TS | 1971 | 21st November | Placencia |
| Fifi | H2 | 1974 | 19th September | 16km S |
| Greta | H2 | 1978 | 19th September | 50km N |
| Gert | TS | 1993 | 18th September | 40km NE |
| Mitch* | H5 | 1998 | 28th October | |
| Iris | H4 | 2001 | 9th October | 10km S |
| Matthew | TS | 2010 | 25th September | 12 km S |
| Barry | TS | 2013 | 17th June | Big Creek |

TS: Tropical Storm H: Hurricane
H1: Category 1: winds > 74 – 95mph
H2: Category 2: winds 96 - 110mph
H3: Category 3: winds 111 - 130mph,
H4: Category 4: winds 131 – 155mph
*Whilst Mitch did not pass within 50km, it had a huge impact on the area

***Table 6: Hurricanes Affecting Placencia Lagoon (<50km) (www.nhc.noaa.gov)***

In 1931, tropical storm winds removed approximately 90% of the traditional palmetto and thatch houses on the Peninsula (Boles et al., 2011), and more recently, Hurricane Iris (2001) and Hurricane Mitch (1998) have had significant impacts on infrastructure and natural ecosystems. In late October, 1998, Hurricane Mitch swept across the Gulf of Honduras. The storm then became stationary for 2 days adjacent to the Bay Islands of Honduras, 196

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miles (315 km) south of Placencia. At Gladden Spit, 35km east of Placencia, the storm tide reached 2.8m (FoN, 1999), and caused substantial damage to property on the Peninsula.

In 2001, Hurricane Iris, with winds of 140mph, passed almost directly over Laughing Bird Caye, 18km to the east of Placencia, with waves of between 4 and 5.5 meters above normal (Bood, 2001), and a storm surge on the peninsula itself estimated at between 2.5 and 4.5 metres (Tiefenbacher et al., 2004). The eye made landfall approximately 10km south of Placencia. The impacts on the communities of the peninsula were significant – a first evaluation estimated that between 80 and 85% of the tourism infrastructure in Placencia, Seine Bight and Maya Beach were significantly damaged by the storm, with structural damage to hotels and restaurants, and the destruction of bridges, piers and dive shops servicing the tourism industry. Independence, too, suffered major structural damage estimated at between 90 - 95%, though Big Creek was estimated as lower, at between 75 – 80% (Reliefweb International, 2001). Despite the shelter offered by the mangrove channel at Big Creek, the Wave Dancer, one of the larger live-aboard dive boats capsized, resulting in the deaths of 18 people.

Hurricane impacts to the vegetation were evident from the northern end of the Placencia Lagoon system southwards, with forests, mangroves and littoral vegetation on both the beachfront and lagoon edge showing signs of defoliation and wind burn between Riversdale and Seine Bight. To the south of Seine Bight, trees had broken crowns or were completely uprooted, with the intensity of damage increasing towards the southern tip of the peninsula, where impact to the vegetation was most severe. Erosion was localized, and occurred primarily on the eastern lagoon shoreline, where protective mangroves had been removed for development. The lagoon and its shores were littered with debris carried by the wind, and the sea offshore showed signs of significant disturbance, with high turbidity and floating, uprooted seagrass – impacts estimated to spread for between half a mile and a mile from the coast (Reliefweb International, 2001). Post event recommendations included that "*the importance of observing the 66 feet reserve (vegetation and mangroves) along all permanent water bodies. Since this legal requirement has constantly been breached, the Governmental agencies responsible for its implementation and enforcement should pursue its implementation more vigorously. This would help in preventing the loss of property and the loss of revenue during and after storm events*." (Reliefweb International, 2001).

To the west, the highest impact area on the Southern Coastal Plain was identified as a southerly slanted corridor between Seine Bight Village and the Swasey Branch, a secondary "ridge-to-coast" corridor identified during national land use planning, composed of a series of forested, protected area stepping stones within an agricultural landscape. Heavy rainfall resulted in flooding and rapid sheet flow off the agricultural areas – primarily banana – and storm winds caused widespread damage to the banana crops. Whilst there were concerns of contamination of water by agro-chemicals, the level of dilution was considered so great that this was less of an issue than anticipated.

Hurricanes are predicted to become stronger in the future, as a result of climate change, and will continue to play an important part in shaping the future land and seascape. Concerns have been raised as to the potential of flooding of the shrimp farms and future sewage settling ponds, resulting in massive post-storm contamination of the lagoon system. For the shrimp farms, this is addressed in the EIAs, with modelling of elevation and analysis of storm surge predictions. Projections place the lowest berm above the maximum predicted flood surge level, and with the protection of mangroves and distance from sea, the chances of a surge reaching are considered low (BAL, 2014 (draft)). However this may not adequately address the issue of overflow from the pools during major storm events.

### *4.2 Hydrology*

The Placencia Lagoon is the largest coastal lagoon in southern Belize, and is separated from the sea by a long, narrow spit – the Peninsula – that is connected to the mainland in the north, and runs from north to south, parallel with the coastal plain. The Placencia lagoon system lies behind this spit, and is composed of a series of four wider lagoons connected by mangrove-lined channels, opening into the Caribbean Sea at its southern end. With three catchment areas - the Santa Maria Creek, August Creek (encompassing Mango Creek) and Big Creek - draining into the estuarine lagoon system, the hydrology of this area is heavily influenced by freshwater drainage from the Maya Mountains to the west (Map 4). It is also influenced by the flow of saline water into the lagoon from the south, where the lagoon meets the sea.

Salinity ranges from 0 ppt in the rivers and creeks to 35 ppt near the mouth of the estuarine system, and is a reflection of the amount of freshwater flowing in from the watersheds, and saltwater exchange with the Caribbean Sea. Higher salinities in the southern lagoon compared with the northern lagoon reflect this interchange between the lagoon and the sea.

Tidal fluctuations within the lagoon are considered to be microtidal, ranging from 12 to 45 cms. Water flow within the southern portion of the lagoon is generally north to south, moving at a rate of about 0.05 to 0.15 m/s. Faster flow rates of up to 0.3 m/s have also been recorded during peak rainfall events (Boles et al. 2011). Assessment of currents at Harvest Caye, in coastal waters 3.3km south of the mouth of Placencia Lagoon, indicates that at the mouth of the lagoon, the majority of surface currents are wind driven, and flow to the south (I.E. 2013). The slow flow rate

**Watersheds of Placencia Lagoon**

The Santa Maria Creek watershed has an area of 247 km2, and includes Hemsley Creek, Silver Creek and several other small, unnamed creeks. The terrain is relatively low-lying, with a maximum elevation of 500 meters at its westernmost boundary. Some creeks flow directly in the lagoon while others flow into wetlands that display connectivity to the Placencia Lagoon.

The August Creek Catchment has an area of 250 km2, and includes Mango Creek and August Creek, which converge at the lower section of the catchment, before they flow into Placencia Lagoon. Flour Camp Creek, Jenkins Creek and several minor waterways also contribute to the net discharge of Mango Creek. The low relief of the catchment makes it very vulnerable to annual flooding events.
The Big Creek Watershed is the smallest of the three catchments adjacent to the Placencia Lagoon and has an area of 59 km2. The principal waterway, Big Creek, is fed by numerous small streams and flows into the southernmost end of Placencia Lagoon. The majority of the lands in this basin have an elevation of less than 20 meters, and therefore have a moderate flood risk potential.

*Adapted from Meerman et al., 2010*

and shallow nature of the lagoon system leads to it being very vulnerable to the anthropogenic impacts that have been occurring in the adjacent area - increased sediment load, nutrient-rich discharge from shrimp ponds, agrochemicals and leaching of over-stressed sewage infrastructure.

Seven water quality monitoring sites have been established along a north-south transect from the north end of the lagoon to the south (Map 5), and a series of parameters measured, including depth, pH, dissolved oxygen, temperature, conductivity, salinity and turbidity. Nitrate and phosphate were also measured, from near-surface water samples. Data from monthly sampling conducted between June 2013 and June 2014 provides an indication of changing conditions within the lagoon system. Data from a single monitoring survey in January, 2014 is used here to provide a snapshot of conditions (Table 7;

| Placencia Lagoon Water Quality Monitoring Sites Outputs, January, 2014 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Site Name** | **Location (UTM WGS 84,)** | **pH** | **DO%** | **DO mg/l** | **Salinity (ppt)** | **Turbidity / m** | **Nitrate ($NO_3$-N mg/l** | **Phosphate ($PO_4$ mg/l)** | **Depth (m)** |
| **PLAG 1** | 358728 1842698 | 8.62 | 104.0 | 7.91 | 10 | 1.2 | 0.03 | 0.09 | 1.9 |
| **PLAG 2** | 355752 1839334 | 8.51 | 96.8 | 7.04 | 12 | 1.0 | 0.12 | 0.12 | 2.0 |
| **PLAG 3** | 354354 1836835 | 8.60 | 99.9 | 7.03 | 14 | 1.9 | 0.17 | 0.15 | 1.3 |
| **PLAG 4** | 354100 1834162 | 8.57 | 88.5 | 6.04 | 16 | 1.0 | 0.17 | 0.17 | 1.7 |
| **PLAG 5** | 353187 1828862 | 8.73 | 96.6 | 6.35 | 29 | 1.4 | 0.47 | 0.03 | 1.8 |
| **PLAG 6** | 353139 1825840 | 8.60 | 96.4 | 6.30 | 33 | 1.9 | 0.90 | 0.11 | 1.5 |
| **BC 1** | 350510 1825930 | | | | | | | | 7.6 |

NOTE: When interpreting the water quality monitoring data for DO, it should be noted that a potential sensor error was flagged during the surveys (SEA, draft report, 2015).

***Table 7: Placencia Lagoon Water Quality Monitoring Outputs, January 2014 Snapshot (SEA data, 2015)***
Parham-Garbutt, 2014).

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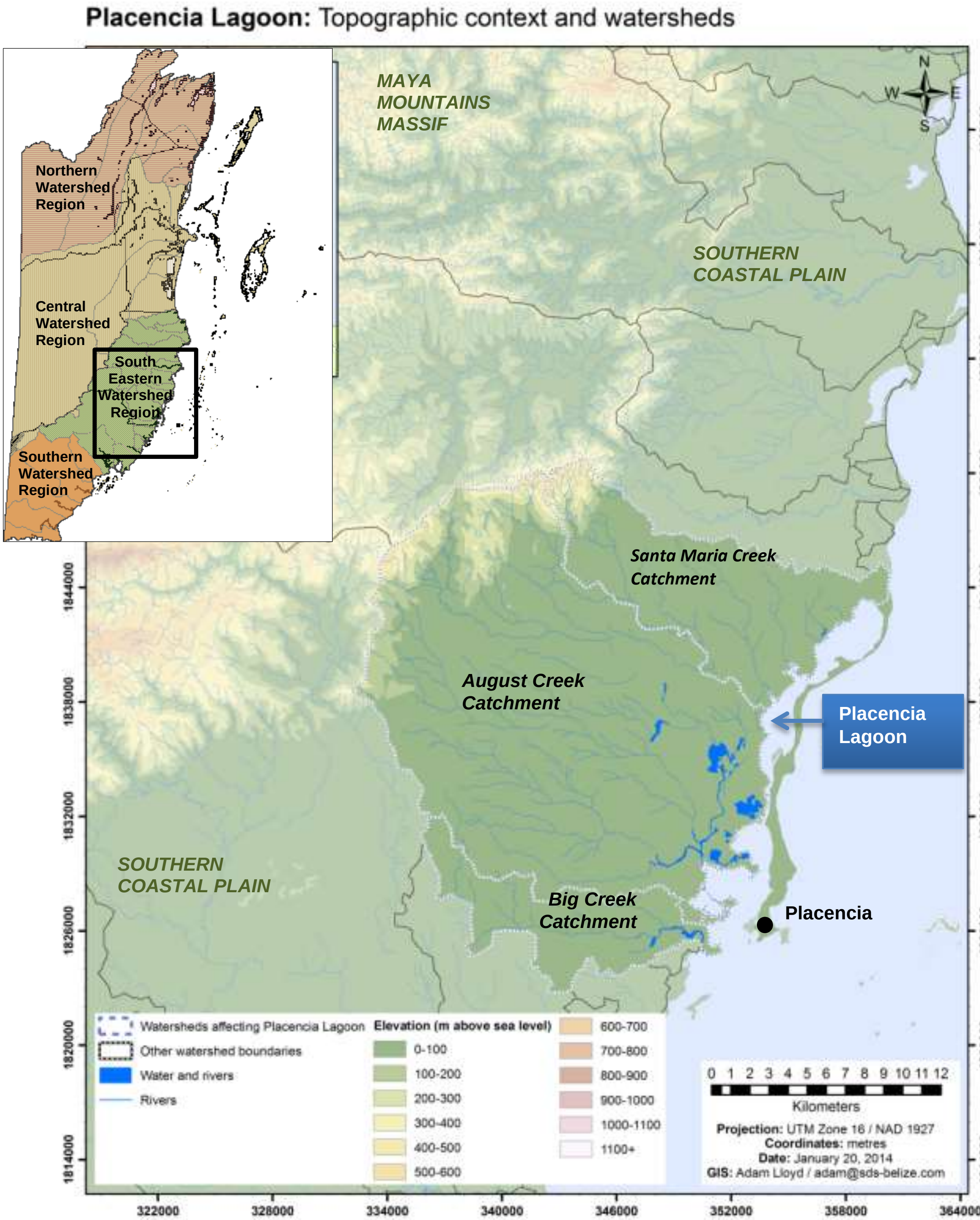
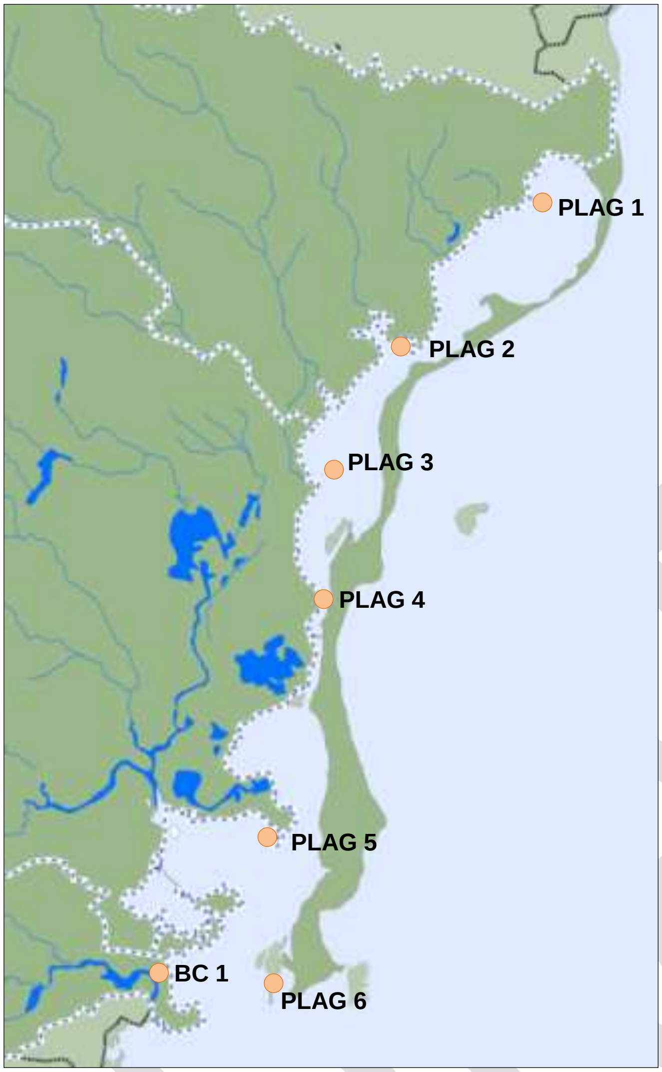



***Map 4: Water Catchment Areas of the Placencia Lagoon***




***Map 5: Water Quality Monitoring Transect Points***

**pH:** pH is a measure of the acidity or alkalinity of water, with pH 7 being neutral, pH readings lower than 7 are acidic, and those above 7 are alkaline (or basic). A difference of one pH unit is equivalent to a ten-fold change in acidity or alkalinity. The pH of an estuary tends to remain relatively constant, as the chemical components in seawater resist large changes to pH, and is generally between 7 and 9. That of Placencia Lagoon ranges from 8.51 to 8.73, averaging 8.61 - within the range of acceptability. Whilst this parameter is not expected to change significantly in the short term, the baseline developed for long term monitoring is important, particularly with the predicted (and observed) increase in $CO_2$ concentrations linked to climate change. As carbon dioxide in the ocean increases, ocean pH decreases, with the water becoming more acidic. Biological activity, however, may significantly lower pH in an estuary, as in cases of eutrophication following nutrient contamination. Sudden changes in pH can act as an indicator for agricultural runoff, sewage/grey water discharge, etc.

**Temperature:** Water temperature will vary seasonally and cannot be captured by a single survey. However data from the monthly water quality monitoring programme (June 2013 to June 2014) shows that the average temperature for the lagoon water ranges from a low of 27.1°C in January to 30.8°C in May.

**Salinity:** Estuarine systems generally have salinity levels between 0.5 and 30 ppt. Placencia Lagoon shows characteristic properties of an estuarine system, with salinity increasing from north to south. In the north and central portions of the lagoon, the salinity is influenced primarily by the inflow of freshwater into the system from the catchment areas to the west. During the snapshot survey in January 2014, values ranged from 10ppt in the north of the lagoon to 33 ppt at the lagoon mouth, where it meets the sea. The majority of estuarine organisms are affected by the changing salinity of the marine protected area. It affects the distribution of seagrass, which in turn will affect the distribution of manatees and fish reliant on the seagrass ecosystem. Turtle grass (*Thalassia testudinum*), for example, declines when salinities fall to 20 ppt, and will not grow in salinities below 17 ppt. It is therefore restricted to the southern reaches of the lagoon system, where there is a greater influence from the influx of seawater, and is not recorded in the upper lagoon areas with lower salinities (Parham-Garbutt, 2014). Mangrove snappers, a characteristic estuarine species, show a preference for a salinity range of 9 ppt to 23 ppt (Serrano et al., 2010). Bull sharks, too, favour lower estuarine salinities, with preferences ranging from 10 ppt to 30 ppt (Curtis et al., 2011). The variation in salinity is important in the life cycles of several key commercial fish species, with changes in salinity triggering migration and reproduction, resulting in juveniles growing in an estuarine environment free of several predatory species found in more saline waters.

**DISSOLVED OXYGEN**

***mg/l : milligrammes of oxygen per litre of water***

- A measure of how much oxygen is physically present in the water
- Total possible range of 0 to 20 mg/L
- Warm water has a lower oxygen capacity than cold water, i.e. the warmer the water, the less oxygen it is able to hold.
- Oxygen content less than 5 mg/L is considered to be poor.
- >9 mg/L is considered optimal for high fish diversity
- Very few species, even those adapted to hypoxic conditions, are able to survive in <3 mg/L

***%: percentage saturation***

- A measure of how much oxygen is present in the water in comparison to the maximum the water could hold at that temperature.
- Super-saturation (>100%) occurs when water is fast moving or air bubbles form/are present.
- 80-120% is considered to be good.
- <60% and >120% is considered to be poor.
- The DO concentration for 100% air-saturated water at sea level is 8.6 mg/L at 25°C.

- DO percent saturation values of 80-120% are considered to be excellent and values less than 60% or over 125% are considered to be poor.
- DO concentration of 4 – 5 mg/L and above are considered acceptable for estuarine environments (U.S. Environmental Protection Agency),
- Concentrations below 5 mg/L may adversely affect the functioning and viability of aquatic communities.
- Concentrations below 2 mg/L will lead to mortality of aquatic organisms.

As salinity increases, the amount of oxygen that water can hold decreases. Salinity can also result in increased turbidity when freshwater meets salt water, reducing light availability for photosynthesis. Salinity varies widely by season and is affected by rainfall and evaporation, currents, and temperature. Average salinity in Placencia Lagoon decreases in the wet and cold front seasons, both from direct rainfall and from increased freshwater flow into the lagoon, from both sheet water runoff and rivers / creeks.

**Turbidity:** A measure of water clarity – of how much the material suspended in water (algae, sediment and other suspended solids) decreases the passage of light through the water. The lower the amount of light that can pass through the water, the harder it is for plants to photosynthesise. Turbidity fluctuates throughout the lagoon dependent on local substrate characteristics, weather conditions and wave actions, erosion, dredging and other development activities, boat traffic, and activities in the watershed. Water clarity is generally considered to be better in the southern portion of the lagoon, near the estuary mouth.

**Dissolved oxygen (DO%):** Dissolved Oxygen content is a measure of the ability of waters to support aquatic life - Dissolved oxygen (DO) is important in biological processes, with access to DO being a basic requirement for the majority of aquatic organisms within the lagoon system, whether plants or animals.

There is an inverse relationship between the solubility of oxygen, and temperature and salinity that determines species density and distribution within the estuary. This is particularly important in a shallow estuarine system such as Placencia Lagoon, where higher temperatures increase metabolic rates of organisms, yet reduce dissolved oxygen availability, resulting in potential fish kills. The shallow nature and limited flushing of the system, and its function in settling organic matter and pollutants as they enter the estuary, results in the potential for low oxygen availability. Conversely, strong north and southeast winds result in mixing of oxygen in the surface water layer, with concentrations as high as 100%, and sometimes above (super-saturation).

Turbidity will also affect the water's ability to take up oxygen. Oxygen is more easily dissolved into water with low levels of dissolved or suspended solids. Waters with high levels of salinity, such as at the mouth of Placencia Lagoon, have lower concentrations of DO.

Dissolved Oxygen levels in Placencia Lagoon range from 88.5% to 104.4%, averaging 97.1% (6.04 mg/l to 7.91 mg/l, averaging 6.78 mg/l) - lying within the acceptable range for maintenance of biodiversity. This can shift rapidly, however, as a result of excess nutrients from watershed pollution (such as agro-chemical runoff or leaching of sewage effluent), which will cause eutrophication – an over-stimulation of algal growth. This accelerates the rate of oxygen depletion and reduces the level of available oxygen in the water. When these factors are particularly strong, or combined, the result may be fish kills. Fish kills can also be linked to high temperatures, with warmer water being able to hold less dissolved oxygen than cooler water.

**Nitrates and Phosphates:** In the snapshot transect (Parham-Garbutt, 2014) Nitrate values range from 0.03 $NO_3$-N mg/l in the northern end of the lagoon (PLAC1) to 0.9 $NO_3$-N mg/l at the southern end (PLAC6), reflecting a steady increase towards the southern end. Over the year (June, 2013 to June 2014) average nitrate levels for the lagoon varied from 0.4 mg/l to 2.06 mg/l (SEA, draft report, 2015). During the annual monitoring, peak nitrate levels were recorded in June 2013, corresponding to the start of the wet season.

Phosphate values range from 0.03 $PO_4$ mg/l to 0.17 0.03 $PO_4$ mg/l, though are less significantly tied to the north-south gradient. Lowest phosphate levels were recorded near the mouth of Mango Creek / Flour Camp Creek (PLAC3), whilst highest levels were recorded from the entrance to the northern, upper lagoon (PLAC4). Over the year (June, 2013 to June 2014) average nitrate levels for the lagoon varied from 0.06 mg/l to 0.68 mg/l (SEA, draft report, 2015). During the annual monitoring, peak phosphate levels were recorded in June 2013, corresponding to the start of the wet season.

The levels of both nitrates and phosphates lie within legal standards, and are lower than ten years previously. This is thought to be indicative of recent measures towards more effective effluent management by shrimp farms (SEA, draft report, 2015). The mandatory settlement ponds and the use of mangroves as a final filter ensure that the shrimp farm effluent now surpasses the current required minimum standards (TNCE, 2013).

The presence of streptococci in the lagoon (Halcrow, 2012), the high peaks of *Escherichia coli* in the middle lagoon (60/100ml), and high coliform bacteria counts are indicative of poor sewage treatment – an issue that has been identified and is currently being addressed though the development of a wastewater treatment plant. However, there are concerns that the current proposed site for the sewage treatment plant and proximity to Flour Camp Creek may also have significant impacts, not only on the quality of lagoon water, but also on the quality of water extracted by the shrimp farms, with the potential to negatively affect shrimp quality and production.

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### *4.3 Geology, Soils and Land Use*

Placencia lagoon lies at the eastern edge of the Central Coastal Plain, on a Pleistocene bedrock deposited by shallow seas between 1.6 million and 8,000 years ago (Cornec, 1986). This bedrock underlies the majority of the land directly surrounding the Placencia Lagoon system, and stretches into the water catchment systems that flow into it. It is overlain by recent alluvial deposits originating from the Maya Mountains.

The soils of the Peninsula itself are a combination of recent deposits, with coarse coastal sands to the east, facing the Caribbean Sea, and saline organic silt and mangrove peat deposits on the lagoon side (Map 6; Table 8; King, 1993). These saline organic deposits are also found in the mangrove areas to the west of the lagoon and are characterised by anaerobic, grey muds. Lagoon bottom sediments are relatively uniform mud or fine sand.

The poorly drained pine ridge soils predominant on the coastal plain to the west behind the mangrove fringe are composed of mature deposits laid down several million years ago (Baillie et al. 1993). These acid soils are characterized by their extremely low nutrient content, supporting only pine and open scrub savanna. The top soils tend to be sandy, above impermeable clay, leading to extremes of saturation and desiccation. Whilst not suitable for agriculture, the underlying clay soils are ideal for aquaculture development, with several shrimp farms located on creeks flowing into the lagoon, providing them with ready access to freshwater.

Where the plain is traversed by rivers, alluvial deposits provide deeper, richer soils of high value for farming, supporting agriculture (primarily banana and citrus) upstream of the lagoon. King et al. (1993) mapped agricultural values and land use limitations within the project area (Map 7) – the majority of the coastal plain surrounding the lagoon system is of limited agricultural value, with low nutrient content, flooding in wet season and experiencing drought conditions in dry. The more fertile soils lie further from the immediate coastal plain, in areas with alluvial soils, along the middle reaches of the creeks. It is these areas that are being used for current agriculture – predominantly for citrus and banana plantations.

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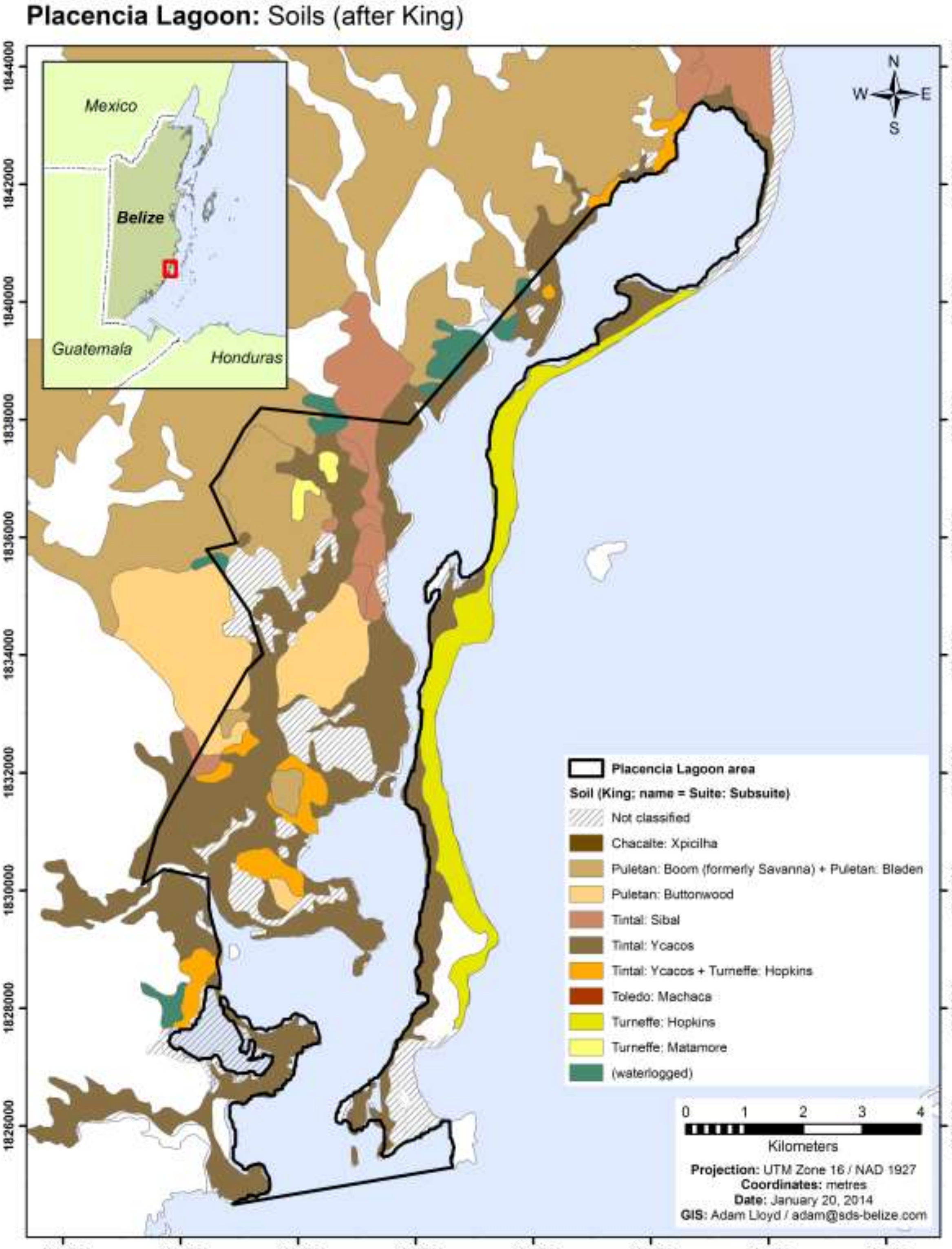
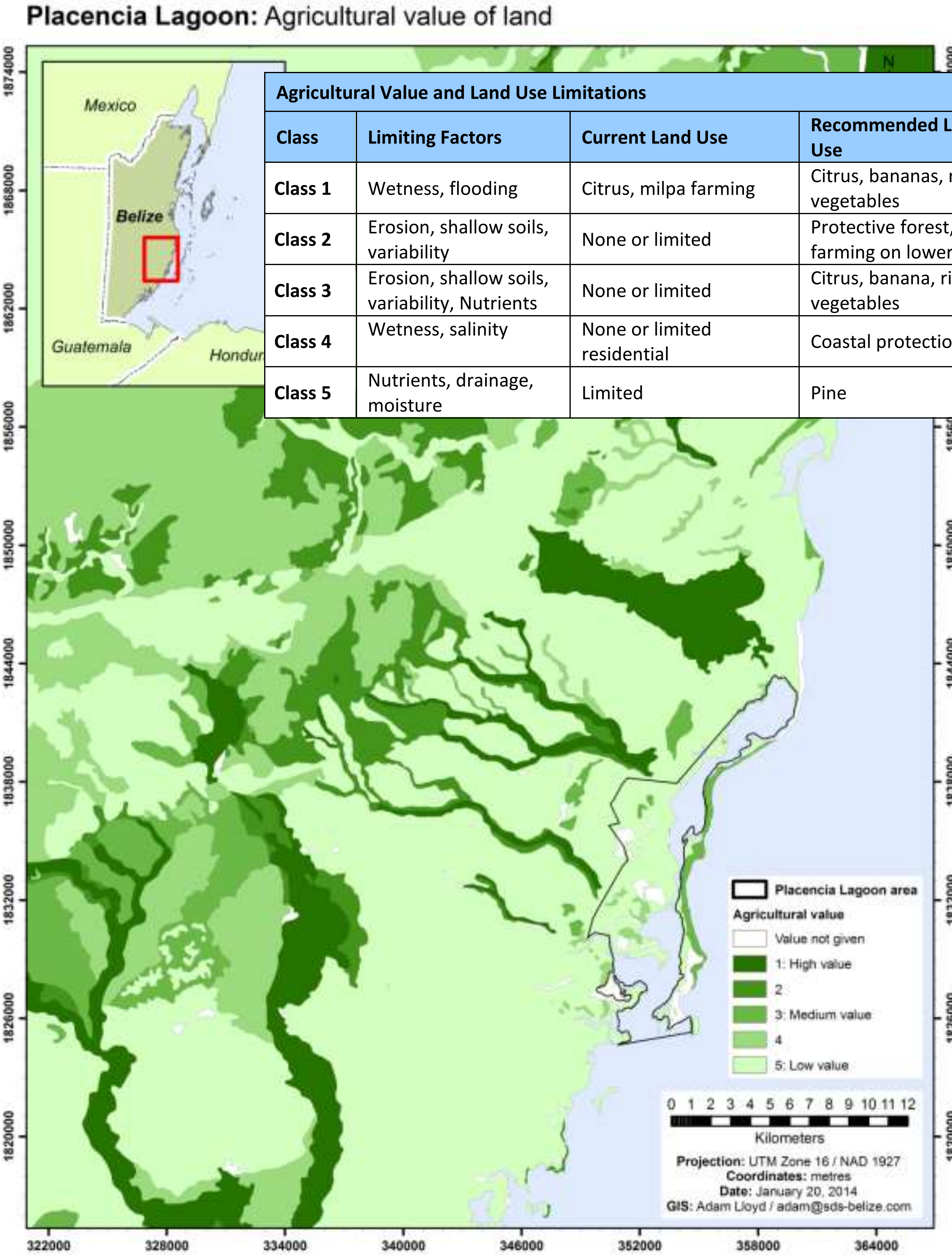



***Map 6: Soils of the Project Area (Wright, 1952)***

**Land Regions, Land Systems and Soil Types within the Placencia Lagoon Landscape**

| Land Region | Land System | Soil Type<br>*Suite: Sub-suite* | Characteristics | Location within the Placencia Lagoon Landscape |
|---|---|---|---|---|
| **Northern Coastal Plain** | Sibal Swamp (SW) | ***Savanna Plain Tintal:***<br>Sibal | Formed in depressions in the coastal plain, soils are washed in with sheet flow during rains. Permanently waterlogged mineral and organic soils of freshwater swamps, with a wet peat surface extending to a depth of 50cm or more, overlying waterlogged soils derived from poorly drained alluvium | The Savanna Plain subunit follows the course of an old creek that once drained into Placencia Lagoon from the west, and an area to the north of the lagoon, behind Riversdale. Within the adjacent landscape, west of the lagoon, this soil supports mixed mangrove scrub. To the north, the vegetation is characterized as shortgrass savanna with shrubs, dwarf mangrove scrub and littoral forest. |
| **Central Coastal Plain** | Puletan Plain (TP) | ***Puletan*** | Formed on old coastal deposit with much of the parent materials coming from the Maya Mountains. Quartz sand and clay. Characterized by sheet flow on the soil surface flowing to nearest creek / Sibal swamp area. Sandy, acid, heavily leached top soils of the lowland pine overlying an impervious clay subsoil, characterized by low fertility and poor drainage in the wet season, with droughty conditions in the dry season. | The most extensive area of Puletan Plain within the adjacent landscape corresponds to areas of higher ground with short grass savanna with scattered trees or shrubs lying to the west of the lagoon, between the lagoon and Flour Camp Creek. |
| | Matamore Strand Plain (SB) | ***Turneffe:***<br>Ycacos | Formed on old coastal strand ridge. Deep, pale silicaceous sand coastal deposits that are acidic, base deficient and droughty. Overlying a brackish water table | The dominant soil of the Placencia Peninsula ridge, particularly of the east facing coastline |
| | Belize Saline Swamps (TY) | ***Tintal:***<br>Ycacos<br>***Tintal + Turneffe***<br>Ycacos + Hopkins | On the lower tidal flat areas, deeper, permanently wet mineral and organic saline soils of mangrove swamps. The higher tidal flat areas consist of sandy coastal deposits with beach forest vegetation. | Covering much of the adjacent landscape, underlying the large expanses of mangrove on the western lagoon, and much of the west facing coast of the Peninsula. |

***Table 8: Soil Types within the Placencia Lagoon Landscape***




**Agricultural Value and Land Use Limitations**

| Class | Limiting Factors | Current Land Use | Recommended Land Use |
|---|---|---|---|
| **Class 1** | Wetness, flooding | Citrus, milpa farming | Citrus, bananas, rice, vegetables |
| **Class 2** | Erosion, shallow soils, variability | None or limited | Protective forest, Milpa farming on lower slopes |
| **Class 3** | Erosion, shallow soils, variability, Nutrients | None or limited | Citrus, banana, rice, vegetables |
| **Class 4** | Wetness, salinity | None or limited residential | Coastal protection |
| **Class 5** | Nutrients, drainage, moisture | Limited | Pine |

***Map 7: Agricultural Value of Soils of the Placencia Lagoon Landscape (after King, 1993)***

## 5.0 Biodiversity Assessment

**Introduction**

The project area for this biodiversity assessment goes beyond the lagoon itself – the proposed protected area. However, the central focus has been on the aquatic and estuarine components of the Lagoon, as these form the proposed Placencia Lagoon Wildlife Sanctuary (2).

A number of research projects and biodiversity assessments have been conducted in the area linked to improving the viability of the lagoon system. Seagrass and manatees, both threatened and both considered key indicators of system health, have been the focus of several studies. A baseline of seagrass extent within the lagoon was established in 2001 (Gallego, 2003). Seagrass monitoring has continued under the global SeagrassNet monitoring programme, providing data on seagrass densities (Short 2006; Parham-Garbutt, 2014). Work has also been conducted on the contribution of seagrass in its role as a nursery area, for the maintenance of commercial fish populations (Arravillaga et al. 1999, Smith, 2006). Two international NGOs - Wildlife Trust and then Sea2Shore - have worked on assessments of the manatee population inside and outside the lagoon system.

Ongoing water quality monitoring has also been conducted, with concerns of declining biodiversity health within the system. (Smith, 2008).

**5.1. Ecosystems of the Placencia Lagoon Area**

Placencia Lagoon is a large estuarine system fed by freshwater rivers, creeks and surface runoff from adjacent terrestrial habitats. Salinity increases closer to the mouth of the Lagoon, but fluctuates significantly with seasons, wind direction and rainfall. Much of the Lagoon is flanked by mangrove ecosystems that differ in their species composition and

***Ecosystems of the Placencia Lagoon Area***

***Seagrass***
***Brackish lake***
***River***
***Caribbean Mangrove Forest:***

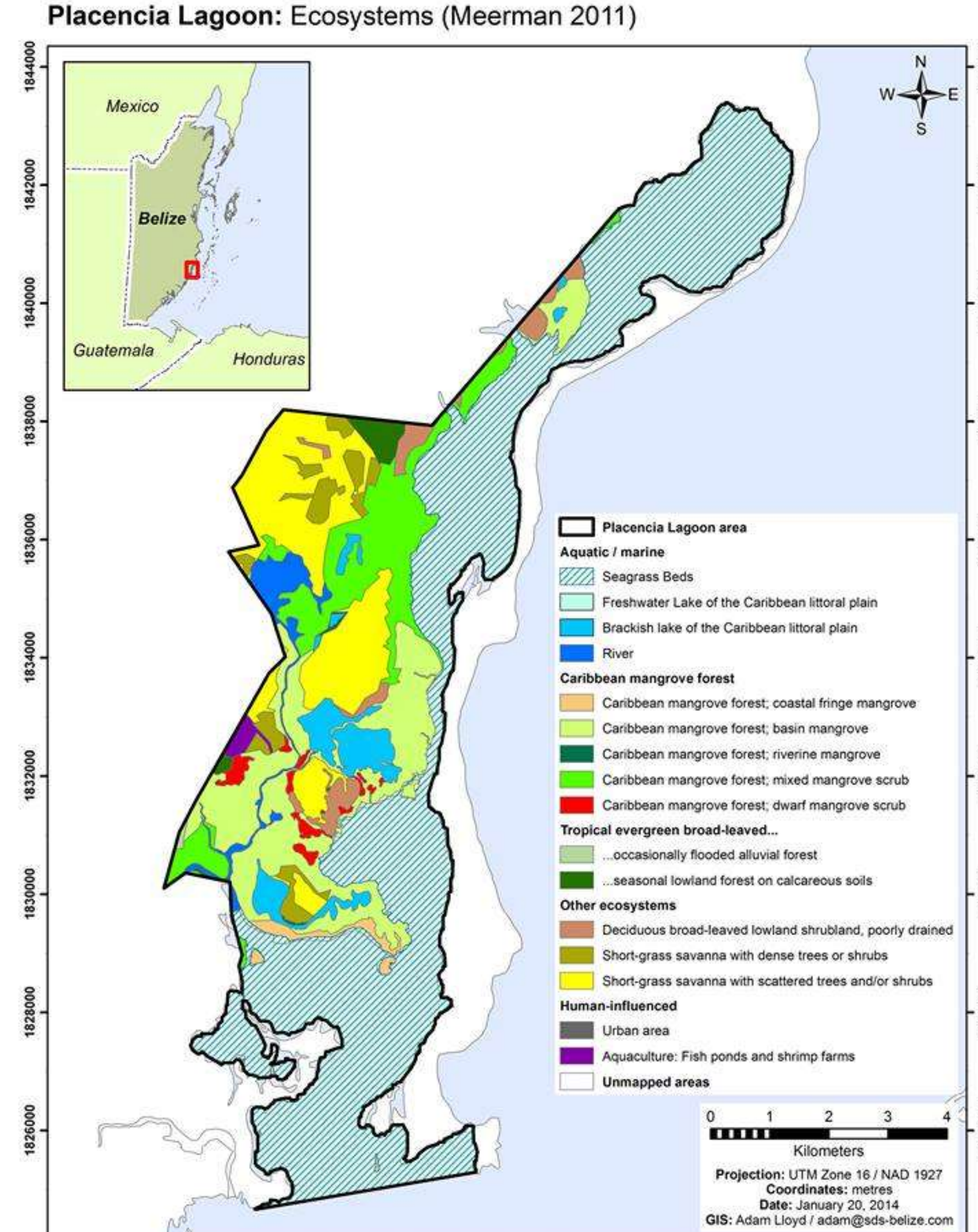
- ***coastal fringe mangrove***
- ***basin mangrove***
- ***riverine mangrove***
- ***mixed mangrove scrub***
- ***dwarf mangrove scrub***

***Tropical Evergreen Broad-leaved Forest:***

- ***occasionally flooded alluvial forest***
- ***seasonal lowland forest on calcareous soils***

***Deciduous broad-leaved lowland shrubland, poorly drained***
***Short-grass savanna with dense trees or shrubs***
***Short-grass savanna with scattered trees or shrubs***
***Urban areas***
***Aquaculture (Fish ponds and shrimp farms)***

***Meerman, 2011***




***Map 8: Ecosystems of Placencia Lagoon (Meerman, 2011)***

stature depending on the degree and extent of inundation / waterlogging, salinity, depth and organic content of the soils. Inland from most of these mangrove ecosystems are coastal savannas – occurring on poor, sandy soils that overlay impervious, clay-based sub-soils (Map 8).

Littoral forest used to occur on higher sandy soils on much of the eastern half of the Peninsula, but has largely been removed for tourism development and urban expansion, with only small pockets of natural vegetation remaining. Broad-leaved forest ecosystems occur on alluvial soils with a higher organic content, generally without the distinct clay subsoil that underlies savanna systems. Broadleaf shrublands are sometimes found on intermediate soils, such as in the northwest area near creek mouths.

Two distinct aquatic ecosystems are identified for the Placencia Lagoon area:

- ***River***
- ***Brackish Lagoon of the Caribbean littoral plain***

### 5.1.1 River

*UNESCO Ecosystem Code: SA1a*

Three primary water catchments drain into the lagoon from the Maya Mountains and the coastal plain – Santa Maria Creek, August Creek (encompassing Mango Creek) and Big Creek, passing through agricultural areas of the Southern Coastal Plain (primarily bananas, citrus and cattle) and shrimp farms).

A number of rivers and creeks flow through the coastal plain to the west of the lagoon. Big Creek and Mango Creek originate from the eastern slopes of the Maya Mountains, with tributaries adding to their flow from the coastal plan as they meander towards the coast. Big Creek's estuarine mouth opens to the sea immediately south of the mouth of Placencia Lagoon, whereas Mango Creek opens directly into the lagoon, just north of Independence Village. Flour Camp Creek joins Mango Creek near the estuarine mouth, and is an important drainage through wetlands, running more or less parallel to the western shore of the lagoon, through areas of inundated dwarf mangrove. These larger rivers and creeks are important freshwater sources, particularly for the manatee population of the area.

Smaller creeks such as Silver Creek and Santa Maria Creek, and the numerous unnamed creeks, drain the savannas immediately west of the lagoon, and historically would have been inhabited by the critically endangered Central American river turtle, and is still home to furrowed turtle and Belize's two species of crocodile. Fish species more indicative of freshwater – cichlids such as the bay snook and Maya cichlid, targeted by hook and line fishermen.

**5.1.2 Brackish lake of the Caribbean littoral plain**
*UNESCO Ecosystem Code: SA1b(5)*

Placencia Lagoon is a semi-enclosed, shallow, coastal estuarine system opening into the Caribbean Sea at its southern-most point. Several brackish lakes are located within the savanna landscape west of Placencia Lagoon, fed by creeks and sheet runoff from the adjacent savannas and with varying saline intrusion from the Lagoon. They typically have a grey clay mud substrate, too mobile to anchor much rooted vegetation. Those lakes that drain to the lagoon through small, mangrove-lined creeks are likely to be important fish nursery grounds.

Coastal lagoons are considered particularly important for their role in the different life stages of many commercial and sport fish species including grunts, jacks, mullet, snapper species, bonefish and snook, and for the spiny lobster, providing a nursery area in the sheltered seagrass beds and mangrove roots. The waters of the Lagoon are an important feeding and resting ground for Antillean manatees, and provide a sheltered environment for sponges, crustaceans and molluscs, also important components of this ecosystem.

Placencia Lagoon is known historically for its normally clean and clear waters. The health of the aquatic environment relies on the mangroves and wetlands adjacent to the lagoon acting as natural buffers between the land and water, filtering out land-based contaminants, preventing erosion, dissipating storm surges and absorbing flood waters in extreme rainfall events. It also relies on seagrass as the base of the food chain, and in its role in filtration, settling out those sediments and contaminants that reach the water before reaching the lagoon mouth.

Decreasing water quality in Placencia Lagoon was once attributed primarily to aquaculture, with several years of direct effluent discharge into the creeks feeding the lagoon. Algal blooms, excessive aquatic plant growth and fish kills were reported in the past, (2007 – 2008), particularly adjacent to shrimp farm effluent outlets, and pointed to eutrophication as a result of excessive nutrient load (Ledwin, 2010). Past monitoring of shrimp farm effluent – both direct nutrient sampling and indirect sampling of phytoplankton (Smith, 2006), raised awareness of the level of contamination from shrimp farms (Ledwin, 2010), and assisted in providing leverage for funding for improving environmental practices of the shrimp farms in dealing with their effluent, establishing baselines for environmental certification (Smith, 2008). Changes in effluent management have significantly reduced contamination, and the water quality has started to recover (Parham-Garbutt, 2014). Current impacts are attributed more to increasing coastal development (particularly mangrove clearance and extensive dredging activities for landfill and boat access) and poor sewage management.

The decrease in the extent of seagrass recorded in 2007 / 2008 was reflected by a shift in the general distribution of manatees to the coastal areas further south of Placencia, to the Harvest Caye / Indian Lagoon area (Community consultations, 2014). Recent surveys, however, suggest that the population is returning in response to the recovery of the seagrass beds, and by 2011, manatees were observed returning to the area in larger numbers (Vernon pers. comm.).

As well as the seagrass meadows, the lagoon also supports a number of species of algae. By far the most predominant is the spiny seaweed *Acanthophora spicifera,* a species that is important in providing food, habitat structure and refuge for fish and invertebrate species. The next most abundant is *Caulerpa verticillata,* a green alga found growing primarily in association with mangroves – in Florida, this species is considered to be an indicator of escalating nutrient enrichment and eutrophication (Lapointe et al., 2005).

***Algae of Placencia Lagoon***
- *Acanthophora spicifera*
- *Acetabularia calyculus*
- *Gracilaria tikvahiae*
- *Dictyota cervicornis*
- *Halimeda spp.*
- *Padina santae-crucis*
- *Caulerpa sertularioides*
- *Caulerpa verticillata*

***David Vernon***

***Key Concerns***

1. ***Reduced water clarity – dredging and release of accumulated toxins from dredged substrates***
2. ***Reduced water clarity - increased erosion of land following mangrove clearance***
3. ***Impacts from poor sewage management on the Peninsula***
4. ***Potential impacts from flooding of sewage ponds once sewage system has been established for the Peninsula***
5. ***Potential storm event impacts from flooding of aquaculture facilities***
6. ***Potential reduced water quality in southern portion of lagoon as a result of increased impacts of cruise ships***

### *5.1.3 Seagrass Beds*
*UNESCO Ecosystem Code: VIIIA*

The shallow lagoons of the Placencia Lagoon system have traditionally had extensive seagrass cover over much of the area. Seagrass meadows are essential for maintaining the ecological health of the lagoon, with an important role in nutrient cycling and sediment stabilization. Mono-species meadows extend into mangrove prop roots in depths ranging between 0.6 and 2.2 m on mud and fine sand. This matrix of connected ecosystems provides a critical foraging area for many fish and invertebrate species, and act as an important nursery environment for commercial and non-commercial fish species - it has been demonstrated that juveniles of most major sport fish and commercial species align more closely with seagrass food sources, highlighting the importance of this ecosystem as the base of the food web supporting the lagoon fishery (Smith, 2005). These seagrass beds, along with the sheltered waters and quiet mangrove creeks of the lagoon, and the availability of freshwater, attract the Antillean manatee

Five species of seagrass are nested within the seagrass target:

- Turtle grass — *Thalassia testudinum*
- Manatee grass — *Syringodium filiforme*
- Shoal grass — *Halodule wrightii*
- Paddle grass — *Halophila decipiens*
- Star/Clover grass — *Halophila baillonii*

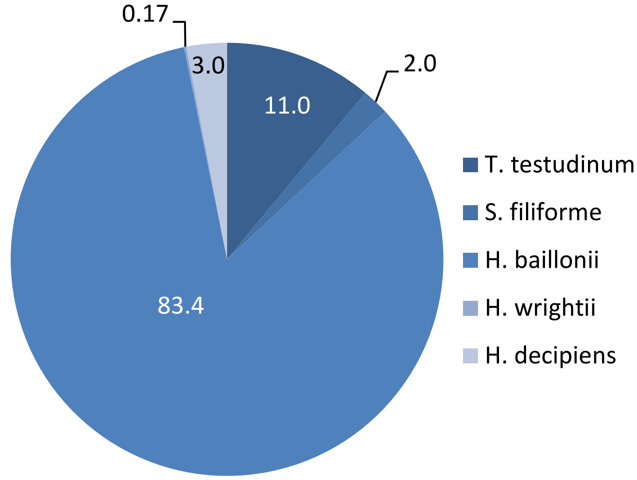


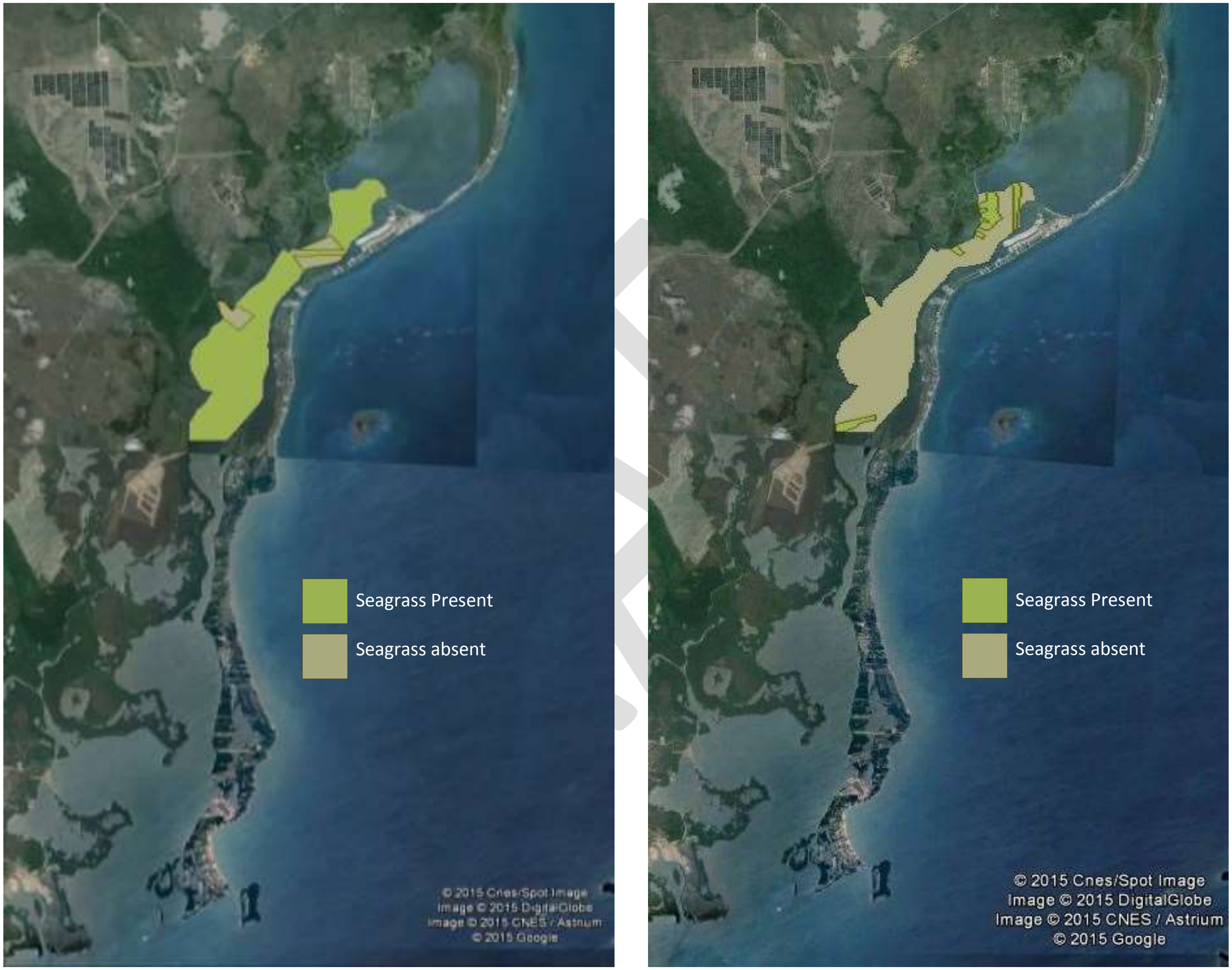

***Figure 3: % Species Composition***
(A. Parham-Garbutt**,** 2014)

Of these, clover grass (*Halophila baillonii*) has the highest abundance in the lagoon, contributing 83.4% to the total seagrass composition (Figure 3, Parham-Garbutt, 2014). This species is globally Vulnerable, with a severely fragmented distribution, and is only known from seven approximate locations, predominantly within the Caribbean Sea (IUCN, 2014). In Belize, it is recorded at only two sites – in Placencia Lagoon and in the sea by Barranco Village, in Toledo District. Placencia Lagoon, with the largest recorded extent of *H. baillonii* in Belize, is therefore considered important in the protection of this globally representative population (Short, 2011). This species is a preferred food plant of the Antillean manatee, and one of the reasons for their continued presence within the lagoon system.


***Halophila baillonii in Placencia Lagoon (IUCN / Short/ www.seagrassNet.org)***

In a recent survey of thirty sites throughout the lagoon, twenty were monospecific meadows dominated by *H. baillonii*. This species is more adaptable to lower light conditions and lower salinity than the other four, and is present primarily in the upper and middle reaches of the lagoon, where light penetration is relatively low (Parham-Garbutt, 2014). The remaining ten sites were located at the southern end of the lagoon, closest to the sea, where visibility is good to very good, and were of mixed species composition – a combination of *T. testudinum, S. filiforme, H. wrightii* and *H. decipiens* – species that generally require higher salinities and clearer water (Parham-Garbutt, 2014).

Seagrass is present throughout the lagoon system, but has fluctuated both temporally and spatially, with significant declines in seagrass extent between 2003 and 2008, with seagrass cover declining from 83% cover to 7% (Table 9; Map 9; Ledwin, 2010), and reduced in some parts to 0%. This coincided with increased nutrient loading from shrimp farm effluent being released directly into the lagoon, and




***Map 9: Distribution of seagrass in Placencia Lagoon 2003 and 2008, adapted from Smith et al., 2009 (Olgalucia Gallego, 2003 and Tim Smith / Adrian Vernon, 2009)***

increased dredging activity on the west-facing shoreline of the Placencia Peninsula. Over this time, the lagoon showed a 19% decline per year in seagrass shoot density – the highest rate of decline in condition recorded globally (Short et al., 2006). Areas where mangroves had been removed for development showed reduced abundance of the seagrass *H. bailloni*i, and areas adjacent to recent developments also demonstrated a higher number of flowering plants, considered a possible sign of stress (Short et al., 2006). Increased epiphyte production was observed in the northern part of the lagoon, with strands of filamentous green algae covering leaves (Auil et al., 2007). Though information is too limited to define exactly where responsibility lies for the extensive seagrass decline in middle Placencia Lagoon, it is very likely that increased shrimp effluent, commercial and residential development (Ledwin, 2010), increased sediment load from dredging and poor sewage management should be considered to be major contributing factors (Auil et al., 2007).

| **Lagoon Area** | **% Seagrass Cover** | |
|---|---|---|
| | **2003** | **2008** |
| Upper Lagoon (Halodule/Halophila) | 40% | 20% |
| Middle lagoon (H. bailloni., T. testudinum, H. wrightii) | .>60% | 0% |
| Southern Middle lagoon | 80-100% | 2% |
| Lower lagoon / Roberts Grove | 10% | 5% |
| Southern Lower Lagoon | 75 -80% | 60-75% |

***Table 9: % Seagrass cover comparison, 2003 – 2008. SBRC, 2009. Data from T. Smith / S. Ledwin)***

In the last three years, the shrimp farming industry has become a global leader in the move to environmental and social certification under the Aquaculture Stewardship Council. Belize will be the first country in the world to achieve certification, and the first to have 75% of its shrimp farms certified (Bood, pers. comm., 2015). As a result, significant mitigation actions have been implemented by the shrimp farms, with improved management of shrimp feed ratios, and the construction and use of settling ponds for improved effluent discharge management. These improvements are requirements of the market-driven certification requirements. The link between the shrimp farm effluent and the health of the lagoon is supported by the recent improvement in seagrass extent within the lagoon following these mitigation actions.

***Seagrass: Key Concerns:***

1. ***Reduced water clarity and increased erosion of land following mangrove clearance and dredging activities***
2. ***Eutrophication impacts from poor sewage management, increasing epiphyte load and reducing access to sunlight, resulting in disappearance of seagrass beds***
3. ***Removal of seagrass by dredging activities***

***5.1.4 Mangroves***

The extensive mangroves of the lagoon play a key role in the maintenance of ecosystem and human landscape integrity. The red mangroves, in particular, provide protection for wildlife that uses the shallow lagoon. They protect the shoreline from erosion, and provide protection for buildings and for the many boats, fishing skiffs and charter catamarans harboured in the lagoon during extreme storm events. Three key mangrove species occur in the Placencia Lagoon area:

- Red mangrove *Rhizophora mangle*
- Black mangrove *Avicennia germinans*
- White mangrove *Laguncularia racemosa*

…as well as buttonwood (*Conocarpus erectus*), a mangrove associate

***Mangrove-lined creeks, both natural and man-made, are important components of the lagoon ecosystem***

The red mangrove roots are valuable as structural support for sponges, molluscs, crabs and other invertebrates, whilst the leaves provide nutrients for plankton, which serves as the basis of the detrital food chain. The red mangroves are also particularly important in providing critical nursery functionality for commercially valuable fish species – a function recognised by fishermen not only of the Peninsula, but also of Punta Gorda (Community Consultations, Placencia, Seine Bight and Independence; Ramirez, pers. comm., Rio Grande Fishermen Co-operative, 2014). The mangroves of the western shoreline are important in filtering runoff from the surrounding aquaculture and agricultural lands, removing excessive nutrients and contaminants before they enter the lagoon itself.

The mangrove cayes, in particular, provide safe roosting and nesting sites for birds, with protection from predators through their isolation from the peninsula and mainland. The osprey and common black hawk both show a tendency to use mangroves as nesting sites, as do white ibis, brown pelicans and black-crowned night herons. The lagoon and inundated dwarf mangrove mudflats and shallow waters provide foraging areas for sandpipers and other shore birds – both resident and migrant, and support a variety of waterbirds…including white ibis, roseate spoonbills, eleven species of herons and egrets, cormorants, anhinga, migratory and resident ducks.

The mangrove ecosystems surrounding Placencia Lagoon, and especially up the western side on either side of Mango Creek and Flour Camp Creek are more heterogeneous than indicated at the level of resolution of the National Ecosystem Map (Meerman, 2011). Tall riverine mangrove, standing up to 13 or 14m in height, lines one or both banks of the Creek in a relatively narrow belt and then grades into extensive tracts of lower mixed mangrove scrub just a few metres from the Creek edge, providing a spectrum, grading from one to the next of the five distinct mangrove ecosystems identified in the Placencia Lagoon area:

***Coastal fringe mangrove***
*UNESCO Ecosystem Code: I.A.5.b.(1).(d)*

This ecosystem is generally found in narrow strips along the sheltered shoreline of the lagoon. The fringing mangrove consists predominantly of red mangrove (*Rhizophora mangle*), with characteristic arching stilt roots that reach out into the water. This provides a critical natural barrier, breaking the force of waves and protecting the shoreline from erosion. It is also these roots that provide a sheltered nursery area for juvenile fish and invertebrates, and structure for a number of sedimentary species such as mangrove oysters.

***Coastal fringe mangrove***

***Basin mangrove***
*UNESCO Ecosystem Code: I.A.5.b.(1).(f)*
Generally occurring on waterlogged peaty soils, this ecosystem is dominated by tall red mangroves (*Rhizophora mangle*), varying in height depending on inundation cycles and nutrient availability. In areas where past eutrophication has occurred from the release of shrimp farm effluent, mangroves have developed fast, growing taller than normal. There are concerns that this growth form may be more vulnerable to wind damage, with the heights of the trees being disproportional to the strength of the root base, leading to tree fall, with associated de-stabilization of creek banksides, and increased erosion.

***Basin mangrove***

Where water depth is less and tidal flushing, amplitude and kinetic energy of floodwaters decrease, other mangrove species and associates become established. Where salinity reaches levels above 50%, black mangrove (*Avicennia germinans*) dominates. With its pneumatophores, an adaptation for life in the waterlogged soil, this species has an ecological advantage in these areas where, in addition to being highly saline, the oxygen content of the soils may be very reduced (anaerobic soils). Where salinity is about 30-40%, dominant species include *Avicennia germinans*, white mangrove (*Laguncularia racemosa*) and *Rhizophora mangle*. When disturbed, as at the mouth of mangrove fern (*Acrostichum aureum*) becomes the dominant species.

***Riverine mangrove***
*UNESCO Ecosystem Code: I.A.5.b.(1).(e)*

Growing on nutrient-rich alluvium, riverine mangroves can attain an impressive stature. Examples along Flour Camp Creek are amongst the most pristine in Belize, with red (*Rhizophora mangle*) and white (*Laguncularia racemosa*) mangroves standing 15+m high.

***Riverine mangrove***

***Mixed mangrove scrub***
*UNESCO Ecosystem Code: I.A.5.b.(1).(c)*

Found on less waterlogged soil than most other mangrove ecosystems, mixed mangrove scrub varies significantly in species composition. *Avicennia germinans, Laguncularia racemosa* and *Rhizophora mangle* may all be present in different ratios. Other characteristic species include palmetto (*Acoelorraphe wrightii*), mangrove fern (*Acrostichum aureum*), buttonwood (*Conocarpus erectus*), *Eragrostis prolifera, Myrica cerifera* and mangrove vine (*Rhabdadenia biflora*).

***Mixed mangrove scrub***

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***Dwarf mangrove scrub***

*UNESCO Ecosystem Code: UNI.A.5.b.(1).(a).*

Generally found on waterlogged and seasonally inundated coastal mudflats, this ecosystem is dominated by stunted red mangrove (*Rhizophora mangle*), generally standing no more than 1.5m tall. Mangrove stands can be densely packed in some areas, or thinly scattered in others. A few herbaceous plants and grasses may be found in association with the mangroves, along with the mangrove vine (*Rhabdadenia biflora*). Where a rock substrate occurs close to the soil surface, the dwarf mangrove tends to grade into a marine salt marsh ecosystem with succulent species such as glasswort (*Salicornia bigelovii*).

***Dwarf mangrove scrub***

Mangroves were formerly widespread within the Placencia Lagoon area, both on the western (mainland) and the eastern (inland side of the Peninsula) shores. Whilst the roles mangroves play in maintaining the health of the ecosystem are widely recognised, coastal development is rapidly removing this ecosystem, along the water's edge along the Peninsula. There is still extensive clearance of mangroves along the eastern shore of the lagoon, with an associated reduction in the essential ecosystem services they provide. With the establishment of a cruise ship disembarkation point south of Independence, on the western shore of the lagoon, mangrove clearance in this area for development is predicted to increase

***Key Concerns:***

1. ***Reduced mangrove extent with removal of mangroves for waterfront development***
2. ***Reduced stability of shoreline with removal of fringing mangroves, resulting in increased erosion and water turbidity***
3. ***Reduced nursery functionality of the lagoon, with reduced contribution to national fishery industry***
4. ***Reduced protection of life and property during storm events***

### *5.1.5 Tropical evergreen broad-leaved forest*

The low-lying southern coastal plain is dominated by sandy soils supporting pine savanna, with tropical forest in areas of deeper, richer alluvial soils. Much of the natural vegetation remains on the western shoreline of the lagoon, where suitable soils occur, but the majority of the forest on the Peninsula has been removed to make way for coastal development. Nested within the tropical forest target are five distinct ecosystem types:

- Tropical evergreen broadleaved alluvial forest - occasionally flooded
- Tropical evergreen broadleaved seasonal lowland forest on calcareous soils
- Deciduous broadleaved lowland shrub land, poorly drained
- Short grass savanna - dense trees or shrubs
- Short grass savanna with scattered trees and / or shrubs

These forests and savannas support a range of animal species indicative of forests of the coastal plain, including fox, coati, raccoon, agouti, paca and jaguar.

***Tropical evergreen broad-leaved occasionally flooded alluvial forest***
*UNESCO Ecosystem Code: IA1f(2)*

Generally found on relatively deep, poor soils that are low in calcium and subjected to occasional (freshwater) flooding, this forest is often exposed to fire from adjacent savanna habitats during the dry season, though such fires rarely penetrate far into the forest. The canopy is generally low, and the forest is often scrubby in structure. It is usually associated with smaller creeks crossing savanna ecosystems. Commonly encountered plant species include Acacia *sp., Coccoloba sp.,* bay cedar (*Guazuma ulmifolia*), glassy wood (*Guettarda combsii*), pigeon plum (*Hirtella racemosa*), *Miconia spp.* Wild guara (*Mouriri excels*), palmetto (*Sabal mauritiiformis*), cutting grass (*Scleria bracteata*), negrito (*Simarouba glauca*), emery (*Vochysia hondurensis*) and polewood (*Xylopia frutescens*).

***Tropical evergreen broad-leaved seasonal lowland forest on calcareous soils***
*UNESCO Ecosystem Code: IA2a (1)(b)K*

Occurring on deep, sandy and calcium-rich soils that are moderately well drained, this ecosystem includes both moisture-dependent and drought-resistant plant species. Common plant species include palmetto (*Acoelorrhaphe wrightii*), cohune (*Attalea cohune*), cocano boy (*Bactris major*), warree cohune (*Bactris Mexicana*), Santa Maria (*Calophylum brasiliense*), ceiba (*Ceiba pentandra*), *Chrysophyllum sp.,* wild grape (*Coccoloba belizensis*), *Coccoloba schiedeana,* Grand Betty (*Cupania belizensis*), palm (*Desmoncus orthacanthos*), fig (*Ficus spp.*), *Hampea trilobata,* salam (*Lysiloma bahamense*), arrowroot (*Maranta arundinaceae*), allspice (*Pimenta dioica*), *Pouteria sp.,* palmetto (*Sabal mauritiiformis*), raintree (*Albizia saman*), quamwood (*Schizolobium parahybum*), negrito

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(*Simarouba glauca*), *Spondias radlkoferi,* horseballs (*Stemmadenia donnell-smithii*)*,* mahogany (*Swietenia macrophylla*)*,* mayflower (*Tabebuia rosea*)*, Tabernaemontana arborea,* banak (*Virola koschnyi*)*, Vitex gaumeri,* emery (*Vochysia hondurensis*) and *Zuleania guidonia*.

***Deciduous broad-leaved lowland shrubland, poorly drained***

*UNESCO Ecosystem Code: IIIA1b(a)*

Found on poorly drained sandy soils overlying sandy clay, there is very little vertical water movement through the soil, with most water movement being lateral sheet drainage. It is frequently exposed to fire during the dry season. Predominant plant species include *Agarista sp., Clusia sp.,* sandpaper tree (*Curatella americana*)*,* craboo (*Byrsonima crassifolia*)*,* Caribbean pine (*Pinus caribaea*)*, Quercus sp.* Herbs and grasses include *Andropogon spp., Cyperus spp, Dichanthelium aciculare, Eragrostis maypurensis, Panicum laxum, P. pilosum, Setaria tenax, S. parviflora, Scleria ciliata, Sporobolus indicus,* and *Trachypogon plumosus*.

***Short-grass savanna with dense trees or shrubs***

*UNESCO Ecosystem Code: VA2a(1/2)*

This ecosystem is considered a less degraded version of ***Short-grass savanna with scattered trees*** – to which it rapidly degrades in the presence of frequent anthropogenic fires. It differs primarily in having a higher density of pine trees of all size classes, and a denser broad-leaf component.

***Short-grass savanna with scattered trees and/or shrubs***

*UNESCO Ecosystem Code: VA2a(1)(2)*

Occurring on acidic, nutrient deficient course soil over a finer red clay-based subsoil, this ecosystem is often waterlogged during the wet season and parched during the dry season. There is very little vertical water movement through the soil, with most water movement being lateral sheet drainage. This ecosystem is naturally exposed to fire during the dry season, however with the increasing frequency of anthropogenic fires is causing a significant decrease in species diversity as the open forest degenerates to an open short-grass savanna. It is often dominated by Caribbean pine (*Pinus caribaea*), with other common species including palmetto (*Acoelorrhaphe wrightii*), craboo (*Byrsonima crassifolia*), cocoplum (*Chrysobalanus icaco*), pigeon plum (*Hirtella racemosa*), oak (*Quercus oleoides*) and polewood (*Xylopia frutescens*).

***Key Concerns:***

1. ***Reduced extent of natural terrestrial vegetation, with reduced biodiversity, from clearance for agriculture, aquaculture and urban expansion / tourism development***
2. ***Increased agrochemical runoff with increased clearance of terrestrial ecosystems***

A provisional plant species is included in Annex One

## 5.2 Fauna

Whilst the project area encompasses both aquatic and terrestrial components, the recommendations for the establishment of the protected area are that it be contained to the lagoon system and mangrove cayes. This assessment covers both environments, but focuses primarily on the biodiversity of the lagoon itself.

### *5.2.1 Mammals*

Three aquatic / semi aquatic species have been recorded during the Environmental Assessment (Walker et al., 2015) from direct sightings, community consultations or literature review (Table …). A further ten terrestrial species are reported for the Placencia Lagoon landscape

Two marine species have been verified as present within the lagoon system – the Antillean Manatee (*Trichechus manatus manatus*), a regional, endangered sub-species of the West Indian manatee, and the bottlenose dolphin (*Tursiops truncatus*). Of these two, the Antillean manatee is considered a key species of the lagoon, and an important indicator of lagoon health, and is therefore assessed in more detail. The dolphins are more transitory in their presence, moving in and out of the lagoon dependent on food resources. There are also reports that the spotted dolphin (*Stenella frontalis*) has been seen in the lagoon, but these still require verification.

***Target Species: West Indian Manatee***

Belize is considered a regional stronghold of the Antillean Manatee (*Trichechus manatus manatus*) a sub-species of the West Indian manatee. With a range that extends from Mexico south to southern Brazil, and inclusive of the Caribbean islands, this sub-species is considered globally Endangered (IUCN, 2014), based on:

> *"..a current population estimate of less than 2,500 mature individuals that is predicted to undergo a decline of more than 20% over the next two generations (estimated at ~40 years for an unexploited population, based on T. m. latirostris data) without effective conservation actions, due to current and projected future anthropogenic threats (habitat degradation and loss, hunting, accidental fishing-related mortality, pollution, and human disturbance) (IUCN, 2014)*

In Belize, this large, slow-moving mammal was historically subjected to huge past hunting pressure, as it provided an easy-to-catch protein source for coastal communities. This large-scale exploitation reduced the manatee population to critically low levels. With a very low reproductive rate, small number of offspring and significant time investment in calf rearing, manatees are particularly vulnerable to even small impacts on their population, taking many years to recover. This is further compounded by the low genetic variation in the population, considered a direct result of the limited gene pool surviving the past



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hunting, reducing the ability of this species to adapt rapidly to a changing environment (Hunter et al., 2010).

In 1936, Belize declared a moratorium on the hunting of manatees, and subsequently provided legal protection for the species under the Wildlife Protection Act (1981), with enforcement responsibility through the Forest Department. Whilst it is difficult to develop accurate population statistics for the national manatee population, it is thought to have gradually increased to its current level of an estimated 1,000 individuals (Auil, 2011).

At the national level, three protected areas (Corozal Bay, Swallow Caye and Gales Point Wildlife Sanctuaries) have been designated in key manatee areas to increase protection of this species, and a National Manatee Working Group is established to support national and site-level conservation measures. The primary threat in Belize is watercraft collision, identified as the cause of death in at least 56% of the 23 manatee strandings verified in 2014 (a further 11 strandings were also reported, but no site assessment was possible to confirm cause of death) (Galves, 2015). Development impacts and water contamination from coastal development, inadequate sewage management and poor solid waste management are also contributing to the stresses on the population, impacting  availability and condition of seagrass, the primary food,  and increasing the presence of heavy metals and other contaminants in the environment. Over the years, increased information and awareness of the general public has led to reduced poaching, greater public support for conservation measures, and improved reporting of manatee strandings.

Whilst Placencia Lagoon was not originally included in the list of three Wildlife Sanctuaries designated as part of the national strategy for increasing viability of this species, the Placencia Lagoon to Indian Hill Lagoon area and associated coastline has always been considered important for maintenance of Belize's manatee population (Zisman, 1996). A sheltered lagoon system with shallow estuarine waters, large expanses of seagrass, easy access to freshwater, and protection from the strong waves generated by tropical storm events, the area is used by individuals of all ages, mating herds and nursing mothers with calves. Anecdotal reports suggest that the creeks to the west of the lagoon are important calving grounds, with mothers able to move out to graze on the sheltered seagrass beds of the lagoon when the calves are just a few days old. It is thought that manatees may also respond to incoming tropical storms by sheltering in the lagoon system to escape from the worst of the storm waves (community consultations, 2014).

Manatees are an important component of the Placencia Lagoon ecosystem, maintaining seagrass beds, providing nutrient enrichment from faecal matter and aiding in seagrass dispersal with the release of rooted fragments dropped when feeding. Faecal analysis from Southern Lagoon and Swallow Caye, to the north of the Placencia area, identified seagrass species as the principle component of the diet, averaging approximately 78% of faecal composition. This was followed by red mangrove (average of 8%), algae (3%) and invertebrates (0.5 to 6%). Of the seagrass species in these two sites, *Halodule wrightii* was the predominant food source in both sites, followed by *Thallasia testudinum* and *Ruppia* *maritima* (Allen, 2014). In Placencia Lagoon, *Halodule wrightii* is thought to have been replaced as the preferred food item by *H. baillonii* (Short et al., 2006).

Historical aerial survey data from 1997 to 2001 shows fluctuations in the manatee counts for the lagoon, ranging from 10 in April 2001 to 68 in January 1997, with a mean count of 33.6 during that time frame (Table 9). The 2007 national aerial survey also recorded manatees along the coast between the two lagoons, between Harvest Caye and the mainland, and in Indian Lagoon itself (CZMAI, 2007), an area identified by stakeholders as an important transit route for this species between grazing areas (stakeholder consultations, 2014). Whilst aerial surveys provide a snapshot of manatee presence in the area, they don't indicate daily movement of individual manatees in the system, and their use of areas adjacent to the lagoon. This can be better assessed through satellite tracking.

| Month /Year | Number of manatees |
|---|---|
| Jan 97 | 68 |
| Apr 97 | 30 |
| Aug 97 | 19 |
| Dec 97 | 46 |
| Mar 99 | 47 |
| Aug 99 | 21 |
| Mar 00 | 31 |
| Sep 00 | 30 |
| Apr 01 | 10 |

***Table 9: Historical aerial survey data for Placencia Lagoon, 1997 – 2001 (CZMAI data)***

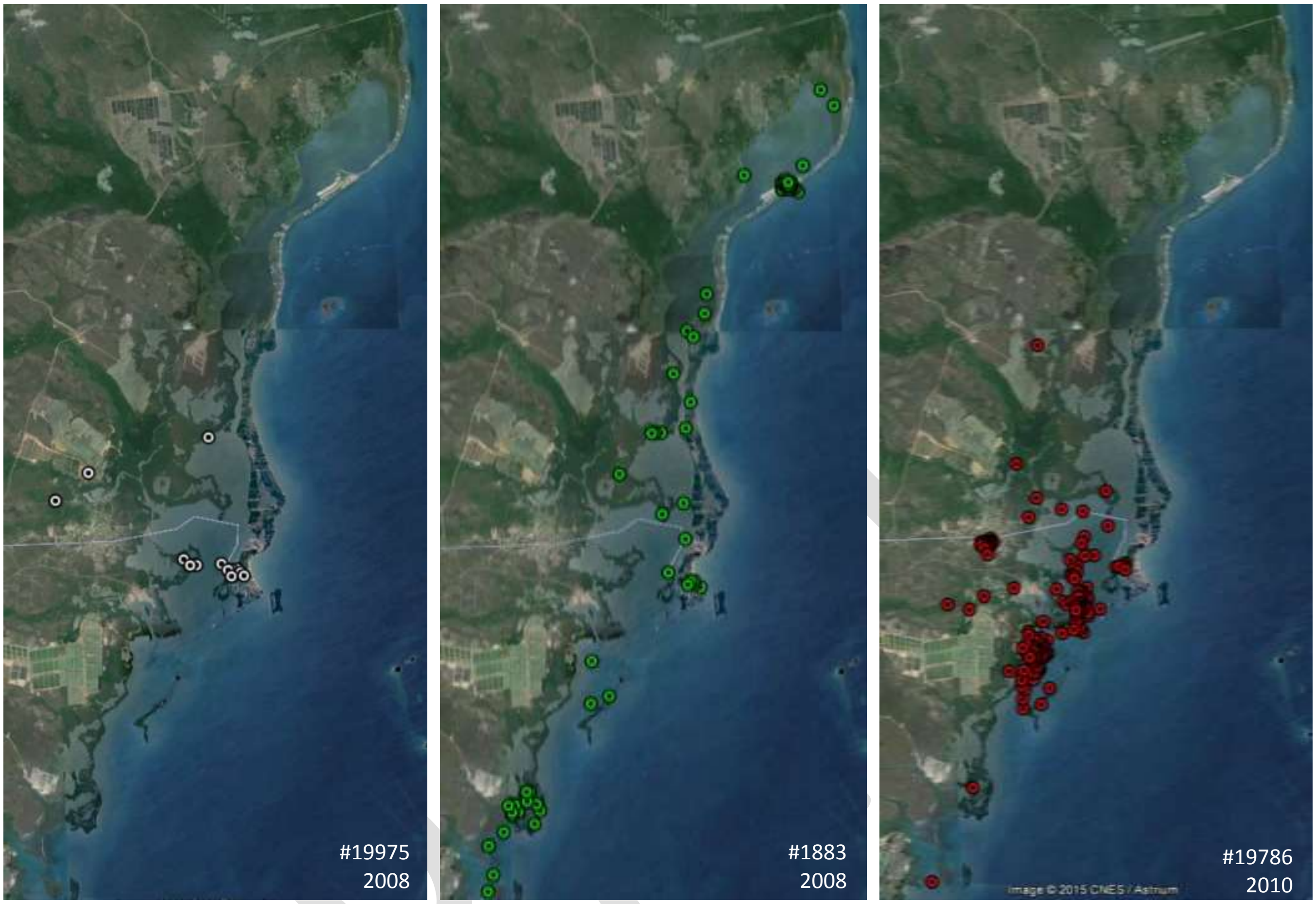
A recent aerial survey conducted in 2014 identified 62 individuals within the lagoon itself (2014 regional survey data, LightHawk et al., 2014; Map 10) – eight in the northern lagoon, twenty five in the middle lagoon (including one in the mouth of Santa Maria Creek), and twenty nine in the southern portion lagoon (Regional survey data, Lighthawk et al., 2014). It should be noted that this is based on actual sightings…the actual number of manatee present would be higher. The highest density was observed to the west of the appropriately named Manatee Bay area, and the "Manatee Bay Estates" property. The second area of high density highlighted by the regional survey data, and the area at greatest risk, is at the mouth of the lagoon, where it empties into the coastal waters. One individual manatee was recorded in Big Creek, beyond the port itself, and another at the mouth of the creek (2014 regional survey data, Lighthawk et al., 2014). A further five manatees were recorded in the adjacent Sennis River area.


***Map 10: Provisional distribution of manatees in Placencia Lagoon, May, 2014 (Regional Survey Data, Lighthawk et al., 2014).***

Whilst aerial surveys provide a snapshot of manatee presence in the area, they don't indicate daily movement of individual manatees in the system and their use of areas adjacent to the lagoon. This can be better assessed through satellite tracking. A number of manatees have been tracked in the Placencia Lagoon area, with relevant available data for three individuals (Manatee #19768 and Manatee #1883, and #5192 (Map 11; Data from Sea to Shore Alliance / Wildlife Trust)). Whilst there is insufficient information to draw any conclusions, a number of observations can be made from the data on their movements:

- Both manatees #1883 and #19786 travelled along the coastline between Monkey River and Placencia Lagoon
- A significant number of the location records (54.2%) for Manatee #1883 were in the Sennis River / Indian Lagoon area
- A significant number of the location records (38.0%) for Manatee #19786 were from the coastline between Harvest Caye and the mainland
- All three manatees used the mouth of Placencia Lagoon, with 35.5% of the location records for Manatee #19786 coming from this area
- The majority of the location records for Manatee #19975 are within the southern portion of Placencia Lagoon
- Both Manatee #19975 and #19786 travelled up creeks during the tracking periods
- A significant number of location records (13.9%) for Manatee #1883 come from the canals of the Placencia Residences, in the northern area of the lagoon
- There is very little use of the coastal water along the Peninsula by these three manatees

The concentration of manatees in key boating areas (at the lagoon mouth and the mouth of the creek that links the lagoons) is also of high concern. Reports of boat strikes in the lagoon are currently infrequent…but still at least one a year (community consultations, 2014). The mouth of the lagoon, where it empties into the coastal waters has been highlighted as an area of high manatee density, based on the regional survey data and is considered at high risk for future watercraft collisions. This southern area is already one of high boat activity, with tourism and fishing boats entering and leaving the lagoon. With plans currently being implemented for the development of Harvest Caye as a cruise ship terminal, and Malacate Beach as the primary disembarkation point for tenders, this area will be seeing increased boat traffic, potentially with non-local boat captains, with predicted increases in manatee mortality.




***Map 11: Mapping of movements of three manatees in the Placencia area (Sea2Shore data, 2008, 2010)***

The second area of high risk was identified as the feeding area in the aptly named Manatee Bay, with boats and manatees being funneled into the narrower creek that connects the upper and lower lagoons. Despite the return of seagrass to the Maya Beach area, there are concerns that extensive, poorly managed dredging activities in that area, primarily for landfill, will affect future seagrass health and distribution, and in turn the abundance and distribution of manatee (Community Consultations, 2014).

Pollution is also considered a threat to the population…the slow moving estuarine waters and the filtering function of the seagrass assist the deposition of sediments before the waters reach the sea and the coral reef. However, this same ecosystem function also concentrates pollutants in the seagrass beds that can then accumulate in manatee tissue as they graze. Tissue samples from a juvenile male caught in Placencia Lagoon were found to have a cobalt concentration ten times higher than the population average, and lead and zinc concentration three times higher (Ramey, 2010). It is suggested that this may be due to foraging in areas of high agricultural contamination. Such heavy metal contamination has toxic impacts on mammals, and is likely to cause an immune-suppression response that would be detrimental both at the level of the individual and the population using the area. Due to the mobility of the population in and out of the lagoon system, however, it would be difficult to pinpoint the actual source of contamination as originating in the Placencia Lagoon landscape.

Whilst outside the project area, the key manatee use area between Harvest Caye and the mainland is also considered an area of concern, with dredging impacts such as silt plumes associated with the development of the new cruise ship terminal affecting seagrass and increased boat traffic. No manatees were recorded in the Harvest Caye area during the 2014 regional survey. The Harvest Caye development and planned boat-based tourism packages to the coastal lagoons have the potential to seriously impact the manatee population, with increased mortality, stress, and migration away to potentially less sheltered areas. Changes in manatee distributions are already being seen, with individuals reported from Tarpon Caye and the reef, areas where they have not been encountered historically by local fishermen and tour guides (Stakeholder consultations, 2014).

There are verified reports from Seine Bight of a manatee being killed and butchered for its meat (2010). Whilst the case was prosecuted, the fine was considered too low to be a significant deterrent. During this assessment, a dead manatee was reported from the Harvest Caye area at the end of 2014, and an injured manatee in Mango Creek in early 2015 (Hagan, pers. comm.). One natural death is known to have occurred in 2014 - the drowning of a female caused by pressure from a mating herd of males – thought to be exacerbated by dredging activities reducing the area of shallow water refugia available for females when being harassed by males.

***Other Species***

The Atlantic bottlenose dolphin (*Tursiops truncatus*) is reported as a transient species in the lagoon (Vernon, pers. comm.), using it as part of its much larger home range and moving in and out of the lagoon dependent on food resources. There are also reports of the occasional sighting of spotted dolphin (*Stenella frontalis*), but these still require verification.

The Neotropical river otter is semi-aquatic, and well adapted to the more freshwater areas of the lagoon system. This species isn't seen regularly, but has been reported crossing the narrow Haulover area, at the north end of the lagoon system, from coast to lagoon (Vernon, pers. comm.).

Ten terrestrial species have been recorded adjacent to the lagoon system and creeks. These are predominantly generalists of the pine savanna and broadleaved forest of the creek and river floodplains, and several are actively hunted (armadillo, paca and white-tailed deer), particularly in the broadleaf forest to the north-west of the lagoon, for the table and local market (community consultations, Seine Bight). Historically, the savannas and forests adjacent to the lagoon system would have maintained mammal species similar to those of Payne's Creek National Park to the south. However, heavy hunting pressure, the reduced extent of broadleaf forest, and forest fragmentation will have greatly reduced the ability of the area to support the wider ranging species such as tapir, white-lipped and collared peccary.

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There has been no work conducted on smaller mammals – bats and rodents. Primates are not reported from the immediate landscape adjacent to the Placencia Lagoon.
A provisional mammal species list is included in Annex One

***Key Concerns:***

1. ***Removal of key manatee feeding areas by dredging***
2. ***Impacts from increasing watercraft on manatees in key manatee use areas – increased mortality, migration away from area with increased noise and human presence***

### *5.2.2 Birds*

The Placencia Lagoon area supports a wide range of bird species associated with the lagoon, adjacent savannas and wetlands, and tropical broadleaf forest. Two site surveys of the lagoon itself and adjacent terrestrial ecosystems were carried out between January 25th and 26th, and March 8th and 9th, 2014 (Martinez, 2014). In addition, confirmed records from previous bird surveys have been included, as well as birds recorded at and adjacent to the shrimp farms of the area between June and September 2014 (Meerman 2014), in 2013 (Jones, 2013), and considered indicative of the species found in the Placencia Lagoon area.

A total of 191 bird species have been recorded from the Placencia Lagoon Area. Of these, 61% are resident species or year round visitors, 35% are winter visitors (including transients), 3% are summer visitors and two records are of vagrant species (Figure 4).

As well as being indicators of ecosystem health, the species associated with the lagoon are considered to be one of the tourism assets for the area. The density and diversity of birds using the lagoon system has thought to have declined over recent years, with a number of human impacts altering species distribution (community consultations, 2014). The establishment of the shrimp farms on the adjacent coastal plain has led to a shift in bird distribution, attracting charismatic species such as roseate spoonbill, jabiru and wood stork away from the lagoon and adjacent wetlands, to congregate at the food-rich drying ponds. A survey in late 2013 at the Aqua Mar shrimp farm also recorded 250 black-bellied plovers, 500 American coots and 110 blue-winged teal (Jones, 2013) – birds that would otherwise be distributed throughout the lagoon system. Whilst there has been a shift in distribution of these species, the plentiful food supplies may have increased the viability of these species.

***Common Bird Species of Placencia Lagoon***

Double-crested Cormorant
Magnificent Frigatebird
Brown Pelican
Great Blue Heron
Little Blue Heron
Great Egret
Snowy Egret
White Ibis
Yellow-crowned Night Heron
Royal Tern
White-crowned Pigeon
Pale-vented Pigeon
Mangrove warbler
Yucatan Vireo
Green-backed Heron
Anhinga
Golden-fronted Woodpecker
Pigmy kingfisher
Least Tern

***David Vernon***

Three rookeries have historically been active on cayes in the lagoon system – of these, only one still remains. Development has had a significant impact on these important bird colonies, with the removal of the white ibis caye behind Rum Point, and with increasing boat traffic around the egret and heron rookery at Mango Creek channel mouth, causing movement of the birds to another, less disturbed, unknown location. The remaining rookery, established on a small caye behind the Cocoplum development, provides a nesting area predominantly for brown pelicans and black-crowned night herons. However, with the increased focus from tours, it is possible that poor tour guide practices may ultimately lead to the disappearance of this colony from the lagoon as well (Vernon, pers. comm.).

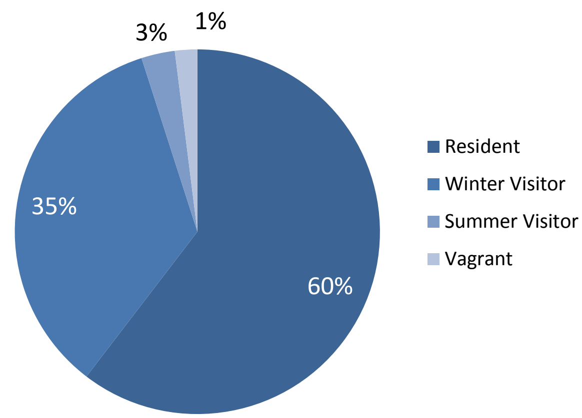


***Figure 4: Bird species breakdown: Seasonality***

Nineteen bird species of National Concern have been recorded during the surveys within the Placencia Lagoon area (Table 10). One of these, the olive-sided flycatcher (*Contopus cooperi*) is also of global concern, listed as Near Threatened (IUCN, 2015). The critically endangered Yellow headed parrot (*Amazona oratrix*) is expected to occur in the pine savanna areas, but was not reported during the surveys.

Some migratory species such as the Wood Thrush and Hook-billed Kite have specialized ecological requirements provided by the coastal/littoral vegetation of the proposed reserve area. Sightings of occasional transient species occur from time to time, the most recent being white pelicans in the lagoon system, reported in 2015 by fishermen (D. Vernon, pers. comm.).

| Species | Status in Belize |
|---|---|
| Brown Booby | Vulnerable |
| Brown Pelican | Vulnerable |
| Neotropic Cormorant | Vulnerable |
| Double-crested Cormorant | Vulnerable |
| Magnificent Frigatebird | Vulnerable |
| Great Blue Heron | Vulnerable |
| Snowy Egret | Vulnerable |
| Tricolored Heron | Vulnerable |
| Black-crowned Night Heron | Vulnerable |
| Yellow-crowned Night Heron | Vulnerable |
| White Ibis | Vulnerable |
| Roseate Spoonbill | Vulnerable |
| Wood Stork | Vulnerable |
| Black-bellied Whistling Duck | Vulnerable |
| Muscovy Duck | Vulnerable |
| Sandwich Tern | Vulnerable |
| Least Tern | Vulnerable |
| Olive-sided Flycatcher | Data Deficient |
| White-crowned Pigeon | Vulnerable |

***Table 10: Bird Species of National Concern***

### *5.2.3 Reptiles and Amphibians*

The combination of estuarine lagoon, riparian, broadleaf forest and savannah habitats is part of a distinct physiographic area (the southern coastal plain) that is thought to encompass 78% of Belize's total herpetofaunal diversity (Stafford and Meyer, 2000), The area defined for the environmental assessment is predicted to provide habitat for close to 100 species of reptile and amphibian, including:

| | |
|---|---|
| 19 amphibians: | 2 salamanders |
| | 17 anurans (frogs and toads) |
| | |
| 78 reptiles: | 2 crocodilians |
| | 3 marine turtles |
| | 7 freshwater turtles |
| | 29 lizards |
| | 38 snakes |

Within the aquatic environment and fringing shoreline, the proposed footprint of the protected area, the herpetofauna that will be afforded effective protection is far more limited. Few species occur within a strongly saline environment of the southern and central lagoon. The critically endangered hawksbill turtle is reported as feeding within the lagoon - this species is also thought to have once nested in significant numbers on the Placencia beach ridges, up to several decades ago. Loggerhead and green turtle nests have also been recorded on the then sparsely inhabited beaches of the Peninsula (Miller, 1984, Moll, 1985, Gillet, 1987, Smith, 1989)), though even in 1983, traditional nesting sites on the Peninsula were already being considered to be in decline (Smith e al., 1992). Turtles are still using the Peninsula for nesting – with the identification of a hawksbill nest in 2010 (Hagan, 2010), though the large scale development will have made much of the beach less attractive to turtles as safe nesting sites. Only Hawksbill is thought to make occasional use of the lagoon itself (Vernon, pers. comm.).

Impacts to the turtle populations have been ongoing. They have historically featured in the diets of the coastal communities, and hawksbill turtles were once heavily fished for their shells. In the mid-1970's, the Placencia Fishermen's Cooperative was reportedly exporting large quantities to France, causing a noticeable decline in the national hawksbill turtle population. Reports from 1982 indicated that there was a transboundary trade in turtle eggs from the Peninsula to Guatemala and Honduras, with eggs being sold at US$1.00 each. In 1986, landing data for Placencia for sea turtles included 116 turtles (predominantly hawksbills), with a combined weight of 10,545kg (an average of 90.9kg per animal). In 1989, before the moratorium on hunting turtles, green and loggerhead turtles were reported as both actively fished by local fishermen, and dressed and sold locally in Placencia for US$0.50 to US$0.75lb. Turtle populations were also reported to be impacted by shrimp trawlers as part of the by-catch, when the trawlers were active off the coast of Placencia (Smith e al., 1992).

Legislation was enacted in 2002 making it illegal to fish sea turtles or to take their eggs, and since then, turtle populations have started to recover, with increasing numbers of hawksbill turtles being seen in the lagoon again.

Both the globally vulnerable American crocodile (*Crocodylus acutus*) and the less threatened Morelet's crocodile (*Crocodylus moreletii*), are reported as occurring within the lagoon and adjacent creeks. Nationally, the American crocodile is thought to have a population of fewer than 1,000 non-hatchling animals, with the highest populations located on the offshore cayes (Rainwater et al., 2011). Where this species exists in coastal lagoons such as Placencia Lagoon, it is competing for habitat with Morelet's crocodile. These coastal lagoons historically provided optimal habitat for Morelet's crocodile until hunting drove numbers near to extinction in the 1970's. The empty niches started to be filled by American crocodiles, which established a number of coastal populations. Following a hunting moratorium and improved protection under the Wildlife Protection Act, the Morelet's crocodile population has recovered significantly, and will once more be pressuring the American crocodiles for space and food resources.

As with the hawksbills, the high beach ridges of the Peninsula would have been excellent nesting habitat for American crocodiles prior to the recent development. Whilst there are no recent records of nesting by these species in recent times, with growing pressure on coastal areas, the protection of feeding grounds for the hawksbill turtle and crocodiles within the Placencia Lagoon system will be an important factor in their national protection. As with manatees, these species are very susceptible to disturbance – so adherence to best practices policies by tour guides and boat operators will be essential if these species are to survive in the long-term, especially in the face of the anticipated rapid increase in boat activity within the lagoon.

A provisional reptile and amphibian species list is included in Annex One

### *5.2.4 Fish of Placencia Lagoon*

The sheltered lagoon, with its seagrass beds and mangroves lying in close proximity to each other, and its high connectivity to the Belize reef, provides a critical nursery area for both lagoon and coastal commercial fish species. Placencia Lagoon is important for many species of fish, including the critically endangered Goliath grouper (*Epinephelus itajara*) and the vulnerable mutton snapper (*Lutjanus analis*). Many of these species are important in supporting the small-scale traditional lagoon and coastal fishermen from the adjacent communities (particularly Seine Bight, and, to a lesser extent, Independence), both directly through fishing in the lagoon, and indirectly through its role as a nursery for both fish and crustacean species. Fishing is currently primarily by hook and line and use of gillnets. Spear guns were also used before the lagoon water clarity decreased (Focal group consultation, 2014).

Globally, seagrass beds have been identified as nursery habitat for many marine species, with a large percentage of the fish fauna being composed of immature individuals. Many of Belize's commercially important species have complex life cycles that rely on the health of the entire marine ecosystem – utilizing the lagoon for its seagrass beds and mangroves when young, and the coastal waters and coral reef when more mature.

Isotope analysis shows that most major commercial species and sport fish of the lagoon are closely linked to seagrass (Smith, 2005), Juvenile silk, black, mutton, schoolmaster and dog-teeth snapper all being recorded. Here the young fish find shelter from predators and ample food

***Perception of changes in the condition of the lagoon and lagoon landscape over the last ten years***

Fishermen used to be able to fish for an hour and have a good catch. This would include up to 30lb jewfish. Now they can be out for an entire day and not catch the same weight of fish (SB)

- Crocodiles and birds were common – they are now hard to see. (SB)
- Fish species have changed…catfish are now common in the lagoon – this is a species that wasn't present / common previously. (SB, I)
- Seasonal migration patterns of fish to and from the lagoon to the coral patches offshore have changed (P)
- There has been extensive destruction of mangrove, with the loss of aesthetic beauty and protection values (SB).
- Local fishermen see the mangrove clearance around Seine Bight as altering fish distributions, resulting in fishermen having to go further to catch fish – with more expense and more time for less catch. (SB)
- With the increased intensity of hurricanes and the removal of the natural vegetation, people in Seine Bight no longer feel safe in the community during tropical storms and will now evacuate. This is also a concern for people in Independence with the increased mangrove clearance for development in front of the community (SB, I)
- There is less protection for fishermen when storms catch them out on the water – property developers won't let them shelter along the edges and in canals of developments (SB)
- There have been significant changes in water quality in the past from shrimp farm effluent, thought to be resulting in fish kills and the die-off of much of the seagrass in the northern and central portions of the lagoon. The added nutrient caused the mangroves to grow excessively tall, but without good roots – leading to them being toppled in storms (P)

***Community Consultations, 2014***

resources, particularly zooplankton and macrobenthic species. These are found in high densities in the turtle grass (*Thalassia*) communities (Smith, 2005). As they grow larger, and the seagrass can no longer provide sufficient protection, many then move to the mangrove roots, before eventually migrating out to the coast and the reef. One area identified as particularly important for its nursery functionality is the mosaic of mangroves and creeks south east of Seine Bight, at the bottleneck of the lagoon – an area also highlighted as important for sport fishing species (Vernon, pers. comm.).

Some species are found permanently in the lagoon system, others enter and then leave. The estuarine environment is constantly changing in salinity, requiring adaptation for species to be able to survive and thrive here. As a result, the fish species assemblage in the lagoon itself is predominantly of euryhaline species – species able to withstand the daily and seasonal shifts in salinity. The creek mouths have much lower salinities, grading into freshwater moving upstream. These support freshwater species such as cichlids, mollies and mosquitofish. A number of more salt-tolerant generalist species, such as the Mayan Cichlid (*Cichlasoma uropthalmus*) and banded tetras (*Astyanax aeneus*) can also be found in the low salinity waters of the lagoon during wet season, though in lower numbers. Freshwater species presence and density increases with distance from the lagoon mouth, and up the creeks.

The majority of commercial fish species favour the more brackish lagoon areas – lane (silk) snapper (*Lutjanus synagris*), mutton snapper (*L. analis*), grunts (Haemulidae) and grouper (Serranidae). Snook (*Centropomus undecimalis*), too, is considered important (MMAS, 2009). The lagoon is also important for supporting a healthy sport fishing industry focused on species such as bonefish (*Albula vulpes*), permit (*Trachinotus falcatus*) and tarpon (*Megalops atlanticus*). Sea cucumbers have also been extracted under license over the last two years, though in very low numbers (Community consultations, 2014).

Several ray species, including the longnose stingray (*Dasyatis guttata*) and cownose ray (*Rhinoptera bonasus*) use the estuarine system, congregating to mate in the shallow waters between the months of February and April. The lagoon then provides a sheltered nursery area for the pups when born.  Spotted eagle ray (*Aetobatus narinari*) and southern stingray (*Dasyatis americana*) have also been recorded, and may be present in the lagoon system year round. At one time, the small-toothed sawfish (*Pectinus pectinata*) was reported as abundant, but is now considered ecologically extinct, following heavy fishing pressure.  Needlefish, too, use the lagoon as a nursery.

Touristic species, such as the long-snout seahorse (*Hippocampus reidi*) are also present in the lagoon, but thought to have declined as a result of the dredging activities and reduced water quality within the lagoon, and also as a result of being bycatch during the historical shrimp trawling activities in the coastal waters in front of Placencia. The lagoon is considered important for sport fishing species, particularly when the weather is bad, reducing sport fishing options in the shallow coastal waters.

The lagoon also provides a transit route for diadromous species that migrate to freshwaters to spawn – species such as the catadromous mountain mullet (*Agnostomus  monticola*), which spends most of its adult life in freshwater, but travels to the sea to spawn. The juveniles then travel back upstream. The anadromous Atlantic cutlassfish (*Trichiurus lepturus*) (Vernon, pers. comm.) has also been recorded in the lagoon. This species travels to freshwater to spawn, but spends most of its adult life in the sea.

The commercial and artisanal fishermen consider fish populations to be far below previous levels, with reports of reduced numbers and altered distribution of fish species, as key foraging areas in the lagoon become more impacted by increasing development. They point to this as a primary cause of declines they are seeing, both from destruction of mangrove areas, and from dredging and sedimentation impacts on important seagrass foraging areas (Stakeholder Consultations, Placencia, Seine Bight, Independence, 2014). The proliferation of gill nets, and indiscriminate extraction of all sizes of fish by local and immigrant communities (particularly Santa Cruz) from the Southern Highway, and the Jamaican market for all sizes of fish, are also voiced as concerns.

The smalltooth sawfish (*Pristis pectinata*), a large elasmobranch primarily restricted to shallow coastal waters and brackish lagoons such as Placencia Lagoon, was once present in large numbers in the area until extensive fishing led to its local extirpation from the lagoon system in the early 1970's. This critically endangered species has disappeared from the majority of the shallow coastal lagoons in Belize, and there is a question as to whether it is still present in Belizean waters at all, and is now considered to be ecologically extinct in Belize (Graham, 2014). Decreases in other large fish species, such as the critically endangered goliath grouper (*Epinephelus itajara*) are raising concerns that these, too, may disappear on both the local and national scale. The goliath grouper has been fished since the first settlers arrived on the Peninsula and, as a result, both the individual size and the numbers of fish caught have decreased over the years, particularly with the introduction of gill nets, with that the population showing significant decline (Graham, pers. comm.). This pattern of decline has also been seen in other commercial species.

A provisional fish species list is included in Annex One

***Key Concerns:***

1. ***Impacts from unsustainable fishing practices (particularly gill nets)***
2. ***Development impacts on seagrass and mangroves, reducing nursery functionality of the lagoon ecosystems***
3. ***Removal of key feeding areas for both commercial and sport fish species through dredging***
4. ***Fish kills as a result of reduced oxygen content in response to eutrophication originating from nutrient runoff (agrochemicals, aquaculture, sewage) or pesticides***

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### *5.2.5 Invertebrates of Placencia Lagoon*

The red mangrove roots and seagrass meadows provide an important substrate for many sessile invertebrates – particularly sponges. The fire sponge (*Tedania ignis*) is the dominant species of sponge in the lagoon, and the only sponge recorded in the northern lagoon. Whilst it can tolerate lower salinities, it is found in higher densities in the more saline waters near the mouth of the lagoon (Vernon, pers. comm.). Here, where there is a slow but constant flow of water, the sponge species diversity is also higher, with examples of red finger sponges (*Amphimedon* spp.), blue encrusting sponges (*Haliclona* spp.) and black sponges (*Asteropus* spp.). Solid benthos also provide substrates for sessile filter feeder species such as the solitary black tunicate (*Phallusia nigra*), a historical invasive, and native of the Red Sea and western Indian Ocean. This species is now common throughout the western Atlantic region, including Belize (Fofonoff P. W. et al., 2003), and can tolerate the brackish waters of the lagoon system. The benthic-living beaded sea cucumber (*Euapta lappa*) is recorded from the lagoon (Vernon, pers. comm.)

Several Cnidaria species have been reported in the lagoon system – ranging from sessile anemones, knobby soft corals (*Carijoa* sp.) and branching thecate hydroids (*Sertularella* spp.) to more mobile jellyfish and sea combs. Like the black tunicate, the sessile, semi translucent glass anemone (*Aiptasia pulchella*) can also tolerate a wide range of salinities, and benefits from a symbiotic relationship with dinoflagellate algae that photosynthesize, supplementing its food. Comb jellies (*Mnemiopsis leidyi syn. mccradyi*), also known as sea gooseberries or sea walnuts, are reported from the Cocoplum area, as are their close relatives, the upside down jellyfish (*Cassiopea xamachana*) (Vernon, pers. comm.; Walker, pers. obs.). The upside down jellyfish is also symbiotic with photosynthesizing algae, and lives largely on the lagoon bottom, requiring relatively shallow, clear water to provide the light necessary for the algae to photosynthesize. The adult medusa are often found in congregations, with each individual sitting on the substrate with its tentacles raised up in the water, and only rising into the water when disturbed. The more active moon jellyfish (*Aurelia aurita*) is also commonly seen in the lagoon (Vernon, pers. comm.).

In shallow, protected areas, particularly in the southerly, more saline areas of the lagoon, the substrate has extensive evidence of the presence of the southern lugworm (*Arenicola cristata*), a burrowing polychaete that ingests sediment, extracting any organic material, then depositing a characteristic spoil mound of waste material. The more sessile filter-feeding tube worms (*Sabella* sp.) are also present in the shallow water.

Crustaceans form an essential part of the lagoon ecosystem, and include both crabs and shrimps. The red mangroves provide habitat structure for at least two species of arboreal mangrove crabs – the small, omnivorous mangrove tree crab (*Aratus pisonii*) and the brightly coloured red, orange and purple mangrove root crab (*Goniopsis cruentata*). Both of these live largely above the waterline, but have aquatic larvae that are thought to be particularly significant in the transfer of nutrients from the benthic and pelagic food webs. The mangrove tree crab is considered to be the primary herbivore of red



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mangrove leaves, leaving distinctive scraping marks on the leaf surfaces. It is also known to feed on seagrass, as do nematodes, crustaceans and small fish. The mangrove root crab has been observed feeding on mangrove propagules, insects and organic matter in Belize, and forages both on the mangrove trees and on exposed mud flats. Exposed mud flats along the lagoon edge also provide habitat for mangrove fiddler crabs (*Uca* spp.) – several species are recorded for Belize. These small crabs are restricted to the waterlogged soils close to the lagoon. The males are easily recognized for having one claw much larger than the other, used for combat and mating rituals - each crab is territorial with a defended area surrounding its single, centralized burrow. These burrows assist in soil aeration in the waterlogged soils, improving the conditions for mangroves in the area.

Two species of shrimp are common in the shelter of the mangrove roots of the lagoon - the ghost shrimp (*Neotrypaea affinis* syn. *Calianassa affinis*)), characterized by burrow-spill mounds created as it excavates its burrow, and the West Atlantic snapping shrimp (*Synalpheus brevicarpus*), which produces the frequently heard snapping sounds that emanate from the mangroves. Mysids (*Mysidium columbiae*), similar to the larger shrimps, also inhabit the lagoon (Vernon, pers. comm.).

The mangrove roots also provide a firm substrate for a number of mollusc species, which benefit from the high productivity of the mangrove system. Two species of oyster have been recorded within the lagoon system – the flat tree oyster (*Isognomon alatus*) and the mangrove oyster (*Crassostrea rhizophorae*). These two have differing salinity requirements, with the flat tree oyster dominating the lower, more saline lagoon, whilst the mangrove oyster is more abundant in the upper lagoon (Vernon, pers. comm.). Both species provide natural banks of filter feeders that

**Molluscs of Placencia Lagoon**

| | |
|---|---|
| ***Bivalves*** | |
| Mangrove Oyster | *Crassostrea rhizophore* |
| Flat Tree Oyster | *Isognomon alatus* |
| Ivory Barnacle | *Balanus eburneus* |
| Yellow Cockle | *Trachycarium muricatum* |
| Favoured Tellin | *Arcopagia fausta* |
| Lined Tellin | *Tellina alternate* |
| Pointed Venus | *Anomalocardia puella syn. auberiana* |
| Cross-barred Venus | *Chione cancellata* |
| Lady In-waiting Venus | *Chione intapurpurea* |
| Ark Clam | *Anadara spp.* |
| Red Brown Ark Clam | *Barbatia cancellaria* |
| ***Gastropods*** | |
| Crown Conch | *Melongena corona* |
| Tulip Snail | *Fasciolaria tulipa* |
| Jasper Cone | *Conus jaspideus* |
| Milk Moon Snail | *Polinices lacteus* |
| White-spotted Marginella | *Marginella guttata* syn. *Prunum guttatum* |
| Virgin Nerite | *Neritina virginea* |
| Olive Nerite | *Neritina reclivata* |
| Atlantic Bubble | *Bulla striata* |
| Common Dove Shell | *Collumbella mercatoria* |
| Mangrove Periwinkle | *Littorina angulifera* |
| Dark Cerith Snail | *Cerithium atratum* |
| Atlantic Modulus | *Modulus modulus* |
| Atlantic Auger | *Hastula hastata* syn. *Terebra hastata* |
| West Indian Star-shell | *Astraea tecta* |
| Coffee Bean Snail | *Melampus coffeus* |
| Sea Hare | *Aplysia* sp. |

***David Vernon, 2015***

contribute to reducing symptoms of eutrophication by decreasing phytoplankton biomass and reducing turbidity following excessive nutrient input to the system, whether from agrochemical pollution or sewage leaching In this role, they can be important in building resilience of the lagoon to increasing algal blooms as development continues to spread along the Peninsula and western shore. Removal of the mangrove habitat, however, will also remove this important environmental service. The mangrove oyster is farmed extensively in Cuba and Jamaica, and raft culture of this species has been considered as a potential for diversification of fisheries mechanism in Belize (Grimshaw, 2003). They have high fecundity and are fast growing, attaining harvesting size at 4-5 months, and can spawn as little as three months after settling, making them ideal for farming – except that they are heavily reliant on the mangrove substrate, and are therefore very sensitive to the clearance of mangroves (Hutchinson et al., 2014).

Ivory barnacles (*Balanus eburneus*) are also common on mangrove roots in the lagoon – particularly in the upper lagoon. These filter feeders are also found on many other substrates – pilings, sea walls, boats and other man-made structures. This species can tolerate a wide range of salinities – from 5 to 30ppt. Other bivalve molluscs – including cockles, clams, tellins, and venus - are all present in the lagoon burrowing deep into the soft sediment of the lagoon floor, and feeding on detritus.

Gastropods are also well represented in the lagoon, with a number of shallow-water, estuarine species being recorded. The crown conchs (*Melongena corona*), tulip snails (*Fasciolaria tulipa*), and moon snails are all predatory, feeding on small bivalves and other snails whilst the shiny Atlantic auger (*Hastula hastata*) specializes on polychaete worms. Other species, such as the West Indian star-shell (*Astraea* tecta) are herbivorous. Some species are specific to the lagoon mouth, where the salinity is highest, whereas others, such as the virgin nerite (*Neretina virginea*) are tolerant of both fresh and marine waters. Sea hares (*Aplysia* sp.) are also present – these gastropods have reduced shells, not visible from external examination, and are herbivorous, feeding on algae or cyanobacteria. Sea slugs (Nudibranchs of the *Chromodoris* genus)

Not all gastropods of the Placencia Lagoon area are restricted to the water. The herbivorous mangrove periwinkle (*Littoraria angulifera*) and the coffee bean snail (*Melampus coffeus*), an important detritivore, are found on red mangrove roots just above the water surface, with a preference for sheltered fringing mangroves such as those found in Placencia Lagoon. These species have planktonic larvae that are distributed through release into the sea.

The sea roach (*Ligia bauduniana*), an isopod often used for baiting small hooks for line fishing, is common on the waterlogged mud flats at the edge of the water, feeding on detritus and organic materials.

## 6.0 Anthropogenic Impacts that have shaped the Placencia Lagoon Area

The Placencia Lagoon area has been affected by mankind for perhaps as long as three millennia, with impacts rising and falling through the ages. The speed and irreversibility of these impacts has changed dramatically over the last 30 years, accelerating and bringing potentially permanent changes to the local environment. With rapid development and limited planning, much of the vegetation on the Peninsula has been cleared or become fragmented and extensive areas of the western portion of the watershed transformed from the wilderness it was into an intensively farmed landscape dominated by shrimp farms and banana plantations.

The general consensus from all stakeholders consulted is that the lagoon is not as healthy as it was in the early 1980's. The water clarity has decreased, with increased turbidity, reducing its recreational value for swimming (stakeholder consultations, Seine Bight, Independence, 2014). This is being attributed primarily to the increased development along the lagoon edge, with associated dredging of the lagoon bed, the clearance of fringing mangroves, and to historical impacts from the shrimp farms. Unsustainable fishing practices have reduced fish populations to almost critical levels and species are starting to disappear completely, as seen with the extirpation of the sawfish, with the advent of gill nets and their use in the lagoon system.

In addition to the land development impacts on the health of the aquatic ecosystems and biodiversity of Placencia Lagoon and the inflowing creeks, it has also resulted in considerable habitat loss and fragmentation for terrestrial flora and fauna. These impacts reduce the ability of the ecosystems to fully regenerate from the devastating impacts of significant tropical storm events – such as Hurricane Iris in 2001. The Placencia Lagoon area is therefore becoming increasingly isolated from source populations further afield.

### 6.1 Ancient History

Evidence of tool making indicates the presence of early hunters and gatherers on the shores of Placencia Lagoon maybe as long as 1,000 years before the Maya. However, it is the Maya who have left the most evidence of ancient use of the area. Historically the Maya had a significant presence in the coastal zone of the Northern Yucatan and Belize, with long-distance trade routes active along the coast, and from the coast to the interior along navigable rivers. In the Early Classic era (around A.D. 300), indications are that coastal traders, or local inhabitants associated with them, set up camps in the lagoon system to provide bases from which to gather and grind conch and oyster shells to create lime, used to soften corn (MacKinnon, 1986). Artifacts from Placencia Caye suggested the presence of an active trading station, with a sheltered harbor for trading canoes. The presence of pottery shards on the Peninsula originating from more northern communities supports the concept that there was trade with people using the lagoon (MacKinnon, 1986).

Coastal lagoons in the region, including Placencia Lagoon, have also been associated with salt making, an important industry supplying inland cities. Based on the artifacts that have been recovered, it has been determined that this area was active during Maya times, with at least seven salt making sites identified on the western shore in the Late and Terminal Classic Eras, and spanning the Terminal Classic / Postclassic transition (Map 12; Mackinnon et al., 1989). Radiocarbon and obsidian hydration dating places the sites as active around 790 to 1035 A.D. Fragments of fired clay cylinders have been identified from a number of sites - once used as pedestals, these were thought to be designed to elevate dishes of brine above a heat source, designed to evaporate off the water, leaving salt crystals. The jars themselves are thought to have been an average of 40cm in diameter, thick walled, and with tapered necks, based on pottery fragments found at one of the sites (no intact jars have been found). Fragments from other sites associated with the lagoon have suggested smaller jars of a similar shape (McKillop, 2008). The rims of the vessels are thick (as are the necks of jars) for ease of holding or carrying, but the vessel body walls are thin, suitable for conducting heat (McKillop, 2008). The cylinders found in the Placencia area were not as all well-made or uniform as at some other sites in the region, and studies suggest that the area, whilst important in the production of salt, did not produce the highest quality of product – this was assumed to have been imported from the Yucatan. However, it is thought to have been a production site for lower grade salt for general consumption (Mackinnon et al., 1989).


***Map 12: Identified Maya Sites of the peninsula After MacKinnon, 1986***

Mounds associated with the sites were identified as probable salt-making middens, composed of salt-making refuse and leached earth left over from the salt making process. The lack of evidence of rock foundations, food preparation items, burials or ritual activities suggests that the sites were not permanently occupied (Mackinnon et al., 1989).

During the Early Post-Classic Era, the majority of Maya activity became more focused on the cayes in front of Placencia, with extraction of marine resources, until the Late Post Classic, when a settlement developed on the southern tip of the Peninsula. The majority of the remnants of this final stage of Maya

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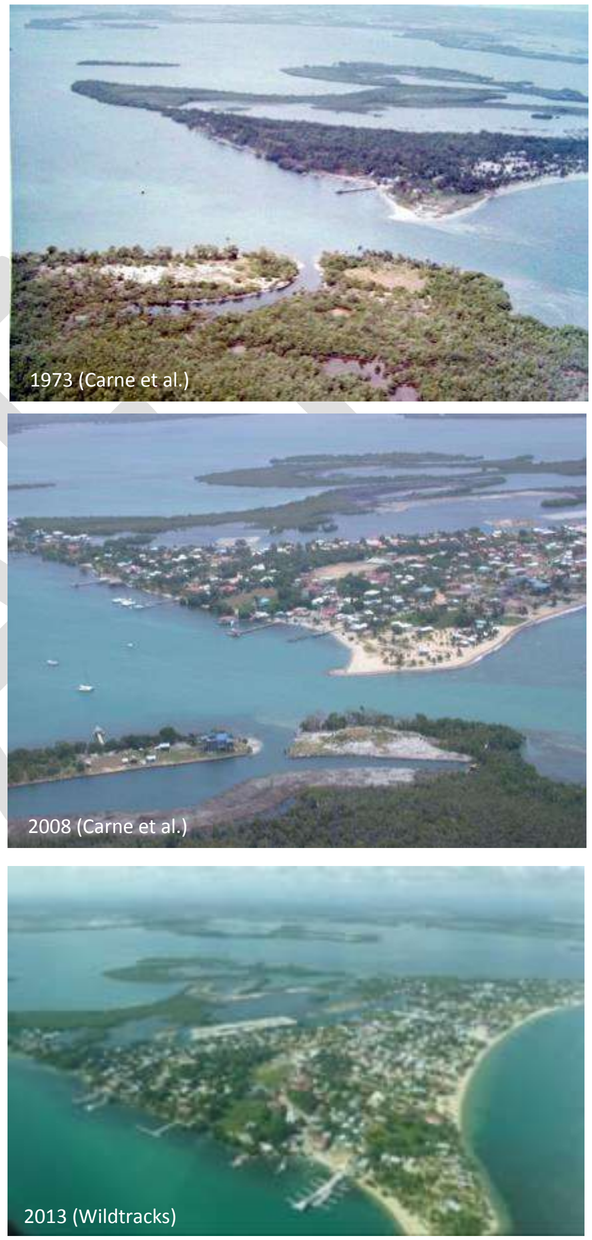
settlement have been largely erased by current development. A colonial site has also been identified on the Peninsula, but reports are that it too has been erased by development activities.

### 6.2 Recent History

The Placencia Lagoon landscape has changed since the Maya times, with a rise in sea level estimated at approximately 60cm over the past 2,000 years, inundating sites, and submerging features beneath sediment and soil layers (Dunn and Mazzullo 1993; Mazzullo, 2006). The general consensus from all stakeholders consulted is that the lagoon is not as healthy as it was in the early 1980’s. The water clarity has decreased, with increased turbidity, reducing its recreational value for swimming (stakeholder consultations, Seine Bight, Independence, 2014). This is being attributed primarily to the increased development along the lagoon edge, with associated dredging of the lagoon bed, the clearance of fringing mangroves, and to the historical impacts from the shrimp farms.




***Left: Development of the Placencia Peninsula, 1978 – 2013 (Carne et al.)***

A number of settlements are located on the southern coastal plain, within the three water catchments, an area totaling over 680 $km^2$. These include Mango Creek, Santa Rosa, San Roman, Maya Mopan, Georgetown, Independence, Big Creek, Riversdale, South Stann Creek, Bella Vista, and San Juan, with a cumulative estimated population of over 11,750 in 2010 (CSO, 2010). Banana, citrus, and shrimp farming are all important industries within the area – with over half of Belize’s aquaculture farms are located within these watersheds. Each of these communities, agricultural and aquaculture industries has impacts on the lagoon system and associated ecosystems. Big Creek, adjacent to the mouth of the lagoon, is the second largest deep-water port in Belize and serves as a major port for southern goods and oil. Expansion plans for the port have led to extensive clearance of mangroves at the mouth of the lagoon, removing significant buffering from future tropical storm events.

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In addition to the impacts of land development on the health of the aquatic ecosystems and biodiversity of Placencia Lagoon and the inflowing creeks, it has also resulted in considerable habitat loss and fragmentation for terrestrial flora and fauna. These impacts reduce the ability of the ecosystems to regenerate fully from the devastating impacts of significant tropical storm events – such as Hurricane Iris in 2001. The ability of wildlife to move back into the area as the habitats recover from these hurricane impacts is impaired as the area becomes increasingly isolated as a result of forest clearance for agriculture, from source populations further afield. This is further exacerbated by increased accessibility to the coastal plain to the west and north of the lagoon system for hunting – with historically 'remote' refugia losing this critical environmental service. Most game species and top predators are reported to be far less common now than they were just a few decades ago, and many species are reported to have disappeared from the Peninsula itself (community consultations, 2014).

**Threats impacting Placencia Lagoon**

- Mangrove clearance
- Water Pollution
  - Agrochemical pollution
  - Poor sewage management
  - Solid waste site run-off
  - Effluent discharge from shrimp farms
- Unsustainable fishing Pressure / Inappropriate fishing practices:
  - Undersize / out-of-season / restricted species
  - Spear fishing / gill nets
  - Non-traditional fishers
- Poor Boating Practices
  - Watercraft collisions with manatees
- Unsustainable development practices
  - Removal of fringing mangrove
  - Filling of low-lying land, changing drainage patterns and increasing water turbidity from runoff
  - Dredging (marinas, canals and for deeper boat access)
- Oil exploration and drilling
- Solid Waste management
- Invasive species

***Conservation Planning Workshop, 2014***

Over the past thirty years, the number of development impacts on the Placencia Lagoon area has increased exponentially, from the establishment of the first shrimp farm in 1983, to the exponential, largely unplanned development of hotels, resorts and retirement homes on the peninsula over the last fifteen years, as a result of increasing investment from the tourism sector. The associated increase in population of both residential expatriates and Belizean support sector has also brought its own impacts, with increased grey water and sewage contamination, solid waste management issues, etc. Independence, too, has developed - housing employees from the tourism and support industries who commute on a daily basis, and seasonal and permanent workers from the expanding large scale citrus and banana industries.

*While limited information makes it impossible to partition contributions to seagrass decline in middle Placencia Lagoon, it is very likely that both increased shrimp effluent from BAL and commercial and residential development were major contributing factors*
***Ledwin, 2010***


**1984:** Development limited to Placencia. Seine Bight and Independence

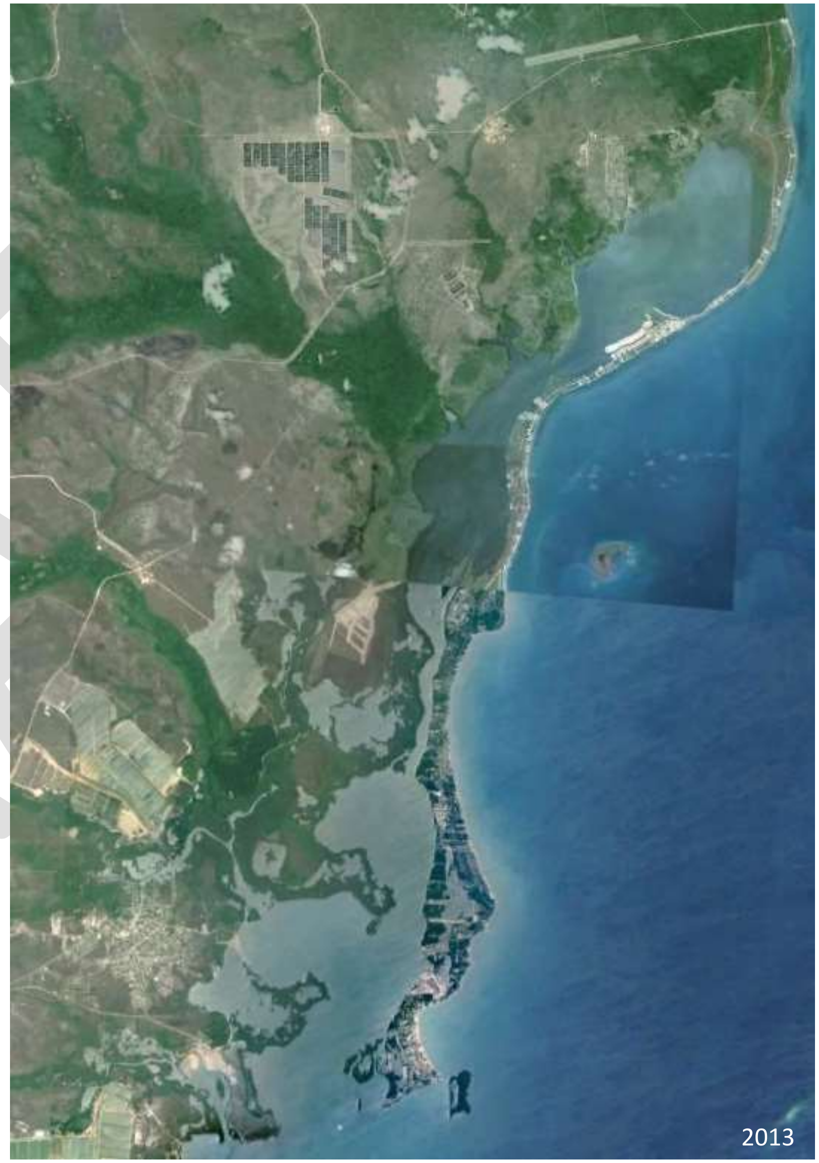

**1997:** Increased footprint of both Placencia and Independence. Establishment of first shrimp farms: Aquamar and Laguna Madre, and site clearance for Belize Aquaculture Ltd.


**2000:** Increasing development north of Placencia and Independence area. Establishment of Royal Mayan Shrimp Farm and site clearance for TexMar.


**2002:** Significant development along road north of Placencia. Fragmentation of forest corridor with construction of southern road access to Belize Aquaculture Ltd.

***Development of the Peninsula Lagoon landscape (TIME: http://world.time.com/timelapse2/)***






**2006:** Continued significant development along road north of Placencia. Expansion of shrimp farms Clearance for expansion of Belize Aquaculture Ltd. Significant landfill in Northern Lagoon

**2011:** Continued significant development along road north of Placencia and Seine Bight, increased dredging and land fill. Increased fragmentation of savanna ecosystem by roads. Continued significant landfill in Northern Lagoon

***Development of the Peninsula Lagoon landscape (TIME: http://world.time.com/timelapse2/)***

Land-based pollution is considered an increasing issue – the slow moving system with its low flush rate acts as a settling pond, concentrating pollutants in the sediment before the water reaches the lagoon mouth. With issues ranging from eutrophication from excessive nutrient runoff from the shrimp farms to reduced water clarity from poor management of dredging operations for marinas and landfill, and high pollution rates from the shrimp farms, banana plantations and inadequate sewage management, the quality of the lagoon ecosystem deteriorated significantly by 2007. Extensive seagrass beds largely disappearing from some areas of the lagoon. Water quality declined - water clarity decreased with the combined impacts of eutrophication from the shrimp farm effluent, with increasing issues of "pica pica" associated with the filamentous algae (*Trichodesmium* sp.), indicative of excessive nutrient load in the water. Sediment drift from dredging activities, and increased soil erosion from the removal of fringing mangrove from the eastern shore of the lagoon have also been a significant contribution to the decline observed. Some of these impacts are now being reversed – especially those attributed to the shrimp farms, as the aquaculture industry improves its environmental practices to comply with certification standards.

### *6.2.1 Tourism and Residential Development*

Placencia and Seine Bight were originally small coastal communities with poor access – Placencia focused on fishing, and Seine Bight on agriculture. Land speculation and development of the Peninsula started in the early 1980's, and by the late 1980's, it had become a focus of Government investment in tourism infrastructure. Improved access, with the construction of an airstrip and a better road, the lure of Belize's best beaches, vibrant off shore coral reef, and whale sharks has led to development in the area growing exponentially since then, changing the character of both the terrestrial environment and the lagoon.

Development is largely linked to the tourism and international retirement sectors, both seeking water-front property and scenic vistas. With the east coast of the peninsula already apportioned out and much of it developed, attention has now turned to the lagoon front.

***Community Perception of Development***

*Since the early 1980's, the trend has been for land speculation and unsustainable development – "dredging for land fill, creating silt, removing mangrove, negatively impacting biodiversity, and affecting entire food chains" (Placencia, Seine Bight).*

*Traditionally, hand dredging with shovels was used to provide small boat access, with minimal impact on the lagoon itself. The first serious, mechanized land reclamation occurred when Placencia expanded its village lands, with an influx of heavy equipment and trucks, dredging the lagoon silt and clearing the fringing mangroves.*

*Since then, there has been continuous dredging and filling of the inundated shallows, as the number of hotels and the market for retirement properties on the peninsula has increased exponentially. With much of the coastal land now sold and developed, the attention has been switching more and more to the lagoon-side.*

***Stakeholder consultations,***
***Placencia, Seine Bight and Independence, 2014***

A rapid assessment of development over time demonstrated that the development footprint had increased by an estimated 83.5% over the 35 years between 1973 and 2008 (Carne et al.). Placencia has become one of the most desirable property locations in Belize, with property values escalating over the last 20 years, gradually pushing up values further and further north on the Peninsula. The very high market values and development boom have spawned a significant degree of upper-end turnover, with mangrove wetlands being filled, developed and resold. The investments needed to convert mangrove mudflats into residential / hotel sites, and provide ready boat access, are not inconsiderable – but the financial incentives and environmental impacts from doing so are huge.

Few people would argue against the need to balance natural resource conservation and development needs. Most residents in the Peninsula communities would however argue that this balance is not being met, and are concerned by the lack of overall planning for the area –

There is a clear need to establish a master-plan for the whole Peninsula, as recognised by the Master Tourism Development Plan (NSTMP, 2011), with broad stakeholder participation, to identify the remaining areas best suited to further development, and those which should be left as green spaces for the benefit of both residents and tourists – to avoid the downgrading 'Cancun-ization' of this still highly desirable area. The natural resources of the lagoon are an integral part of the overall equation: what happens on the land impacts the water and vice versa. The scenic vistas out to sea and across the lagoon, with the feeling of unspoilt nature, is a significant component of the attraction of the entire Peninsula and reason for the high property values. If these values are not to be seriously impaired, a better balance between their conservation and future development must be achieved than is evident today.


***Map 13 Dredger and sediment plume adjacent to Harvest Caye southern point (Google Earth, 2015)***

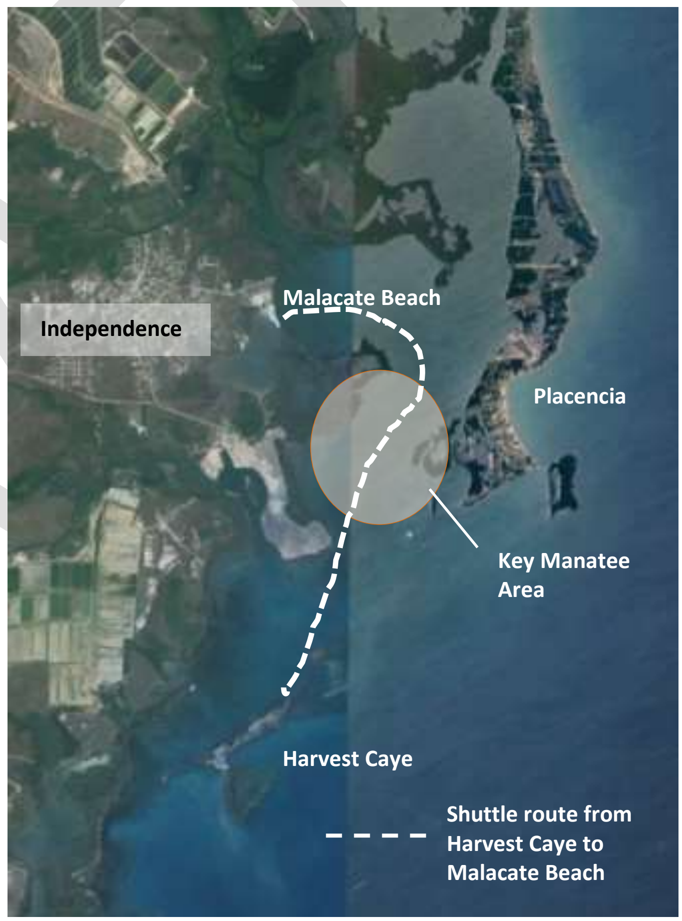
In contravention to the approved Sustainable Tourism Development Master Plan, Harvest Caye, just over 3km to the south of the mouth of Placencia Lagoon is being developed as a cruise ship port. In this development phase, there are already significant impacts to the seagrass in the travel routes used by manatees The EIA proposes "dredging of over a million cubic meters from the sea bed to create the marina, lagoon, channel, and a turning bay for ships" (BTIA-Placencia, 2014). Dredging is now in progress, with poor management of silt curtains resulting in extensive sediment plumes, with potential for large scale impacts on seagrass and other marine ecosystems south of the caye (Map 13; FoPL, pers.

comm.). There are concerns that the dredging may also impact the freshwater aquifer if taken too deep, with implications on water security for the adjacent communities (BTIA-Placencia, 2014). Removal of the mangrove ecosystem also removes the ecosystem services – filtering rainwater runoff, erosion prevention, fish nursery functionality and storm-wind buffering.

The potential impacts of the cruise ship tourism itself to the Harvest Caye and Placencia Lagoon area in late 2015 are predicted to be significant. Once construction on the caye has been completed, there will also be the additional pressures of sewage management and solid waste management for up to four cruise ships a day (a total passenger / crew capacity of approximately 13,400 people on a single day, based on four ships, as per the NCL schedule), both of which are already issues in the landscape.

Other identified areas of concern include:

- The disembarkation point for land-based tours is at Malacate Beach, in Placencia Lagoon, to the east of Independence Cruise tenders will be shuttling passengers back and forth across the mouth of Placencia Lagoon – a key manatee use area, as identified by aerial survey data (Map 14; LightHawk et al., 2014). At the level of planned maximum vistiation (four ships at one time) this will require significant numbers of cruise tenders, posing a very real and significant threat to the manatee population in this high value area, as well as to marine biodiversity as a whole. A similar situation exists in Belize City, where another key manatee area has experienced more than 20 manatee deaths in the first quarter of 2015, primarily as a result of tourism boat activities (Galves, 2015). With careful management, however, and strict enforcement of regulations, respect for No Wake Zones and marked boat channels, an encouragement of best practices and procedures, it should be possible to go a long way towards ameliorating these threats and impacts.




***Map 14: Shuttle route from Harvest Caye to Malacate Beach, and location of Key Manatee Area***

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- If the national grid system is unable to supply sufficient electricity for the ships, they will need to be self-supporting, with engines generating power during their stay, constantly on and producing noise and silt disturbance. Continuous noise pollution from cruise ships at port will affect marine mammals that rely on sound - particularly dolphins, but also manatees. This may be sufficient to drive manatees from the area. There will also be significant air pollution generated by the engines.

- Whilst indicating that freshwater for the port and cruise ships will be sourced from desalination of seawater, the sheer scale of demand on days when four ships are berthed at the caye, with over 13,000 visitors requiring water (more than double the resident population of the Placencia Lagoon area) may make this impractical, and result in access to local water resources, with drawdown of the local aquifer, and potential impacts on water security in the area. The threat of saltwater intrusion in this situation is very real, especially in the long term, with predicted climate change impacts.

- Cruise ships produce extensive sediment plumes when moving in shallow waters, with significant reduction in water clarity - this will have an ongoing and therefore cumulative impact on the health of the reef and seagrass in the adjacent area – and all those species that rely on these ecosystems.

- Release of bilge and ballast water into the water – cruise ships generate an estimated average of eight metric tons of oily bilge water for each 24 hours of operation. Release of ballast water has the potential to introduce invasive species and diseases into the coastal waters.

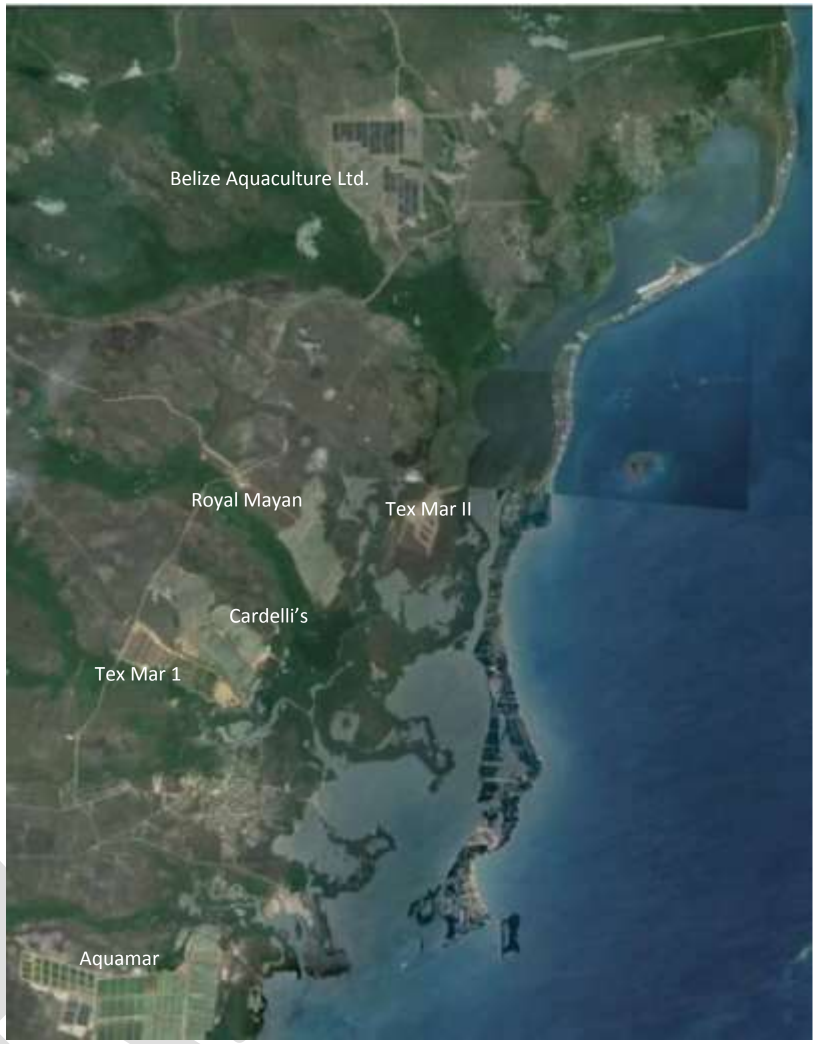
- Repainting of cruise ships is normally conducted whilst in port - the toxicity of the paint (often heavy metal based) used can be a serious issue in areas adjacent to the cruise ship port, affecting seagrass and other organisms (Including manatees) that rely on seagrass.

- The scheduled cruise ship activities are also a cause for concern – airboats and self-driven motorboats, as advertised by the cruise line, are not compatible with the wildlife of the area. Even if these activities do not take part in Placencia Lagoon itself, but are focused on the coastal lagoons to the west of Harvest Caye, they will still impact the wildlife of the area, including the same manatee population that moves in and out of the Placencia Lagoon.

It should not be forgotten that cruise ships also present an opportunity – there is potential for the establishment of a reasonably balanced use of the lagoon and its attractions by the cruise ship industry – but it will require a significantly more collaborative approach than has been achieved elsewhere in Belize. If, and when, the cruise ships start using Harvest Caye, SEA needs to be in a position to be able to manage the impacts within the lagoon, with rules, regulations and boat channels / No Wake Zones in place. Provision for an agreement for user fees from boat access to the lagoon system, as a first step, has the potential to support a significant portion of the management costs of the proposed Wildlife Sanctuary.

#### *6.2.2 Aquaculture*

In Belize, Whiteleg, or Pacific white Shrimp (*Litopenaeus vannamei*), forms the basis of the aquaculture industry. The first shrimp farm was established in Belize in 1983 and was followed by a rapid expansion, particularly on the southern coastal plain, where the physical and climatic conditions are most suited to the industry, and with easy access to uncontaminated water. Since then, more than half have the farms have closed, with 8 remaining within the Placencia Lagoon watersheds (Map 15). The effluent from these shrimp farms has had a major impact in the past on the water quality of the lagoon, before measures were put in place after 2010 to mitigate discharge runoff.




***Map 15: Shrimp farms of the Placencia Lagoon landscape***

Between 2000 and 2008, there were growing concerns of the impacts of shrimp farm effluent, combined with dredging in the Placencia Lagoon, on the ecosystem health of the lagoon system. Shrimp farms were using expensive feeds to ensure rapid shrimp growth, reducing turnover time. However, this practice resulted in the build-up of phosphorous and nitrogen in the ponds, both from uneaten shrimp food and from shrimp faeces, which were then released into the environment. Studies of the phytoplankton in 2006 concluded that the algae (primarily blue-green *Mycrocystis* sp.) and filamentous *Trichodesmium* sp. ('pica pica') encountered in creeks near shrimp farm discharge points were consistent with the release of nutrient rich water from the shrimp ponds, exceeding the ability of the natural mangroves to provide the filtration required for removal.

As with the sampling of phytoplankton, water and periphyton sampling in 2008 indicated elevated nitrogen and phosphate concentrations, increased solids and reduced dissolved oxygen in Santa Maria and Plantation Creeks, downstream of discharge canals from two shrimp farms (Table 11; Ledwin, 2010), with evidence of excessive algal growth and eutrophication (Smith, 2006). Accelerated shrimp production between 2003 and 2007, combined with little or no recirculating of farm water and direct

| Parameters (2008) | Site (Santa Maria Creek) | |
|---|---|---|
| | Above the shrimp farm outlet | Directly below the shrimp farm outlet |
| Salinity (ppt) | 17.13 | 3.00 |
| pH | 7.86 | 7.89 |
| Nitrite (mg/l) | 0.00 | 0.02 |
| Nitrate (mg/l) | 0.46 | 2.17 |
| Phosphate (mg/l) | 0.01 | 1.20 |
| Total Suspended Solids (TSS) (mg/l) | 17.75 | 56.86 |
| Dissolved Oxygen (DO) | 7.02 | 1.38 |

***Table 11: Example of surface water physical / chemical parameters above and below the shrimp farm effluent discharge point in Santa Maria Creek, 2008 (Ledwin, 2010)***

flushing of ponds into the creeks, is thought to have been tightly linked to the decline in the extent and condition of the seagrass beds in the middle section of Placencia Lagoon in the same period - from 83% of the lagoon area in 2003 to 7% in 2007 (Ledwin, 2010).

Following identification of these concerns, and international market requirements, there has been a significant push by shrimp farms to improve their environmental footprints, supported by IDB, WWF, and the European Union / Complete Caribbean. The shrimp farming industry in Belize has become a global leader in the move to certification under the Aquaculture Stewardship Council (ASC) – Belize will be the first country in the world to achieve ASC certification, and the first where 90% of shrimp farms are certified. With the more regulated use of shrimp feed required by certification, shrimp farms are finding that they are not only reducing the level of nutrient in their effluent, but also achieving a much better feed conversion rate, reducing expenditures. This improvement in environmental footprint is also supported by national environmental regulations. The Department of the Environment now requires that all shrimp farms install sedimentation ponds before effluent is discharged into the environment. The sedimentation ponds remove the majority of the nitrogen and phosphorus, making a significant difference to the water quality of effluent, and reducing the impacts on the lagoon ecosystem. Re-use of settled waters has also as also made a significant difference to the economics of shrimp farming in the area, reducing water exchange by 75%.

### *6.2.3 Wastewater Management*

There is currently no centralised wastewater or sewage management system for the Peninsula - each household and business is responsible for its own wastewater disposal, predominantly through the use of septic tanks and soak-away pits. A recent report assessed the septic systems of the Peninsula, and their impacts on the environment, with outputs demonstrating that the majority of households, and many of the businesses and hotels had inadequate wastewater disposal (Table 12; Halcrow, 2012).

| Category | Direct Discharge | Soak Pit | Septic System | Waste Water Treatment Plan |
|---|---|---|---|---|
| Households | 35% | 21% | 44% | 0% |
| Businesses | 10% | 36% | 54% | 0% |
| Hotels | 5% | 38% | 51% | 6% |

***Table 12: Current Wastewater Disposal Methods (Halcrow, 2012)***

An estimated 51% of Peninsula households, 46% of businesses and 43% of hotels are considered to have substandard waste management systems, discharging either directly into the soil, sand or lagoon, or into a soak pit, with a non-sealed base, allowing leaching into the substrate (Table 12; Halcrow, 2012). These systems are not suitable for the Peninsula, as the sandy soils and the high water table do not facilitate the absorption or filtering of contaminants (nitrates, phosphates and pathogens), with implications for health, and the potential for water contamination of both private wells as well as of the lagoon itself. Filtration time is too short and the soil medium too coarse to adequately destroy pathogens, as is demonstrated by the presence of streptococci in the lagoon water (Halcrow, 2012).

Whilst new hotels are required to have sanitation package plants that have the potential to reduce much of the contaminants, this is dependent partially on the motivation of the hotel owners to ensure these plants are maintained and receive some form of tertiary treatment to remove nutrients before being discharged into the environment.

#### *6.2.4 Fishing*

The combined impacts of unsustainable fishing, water pollution, mangrove clearance and dredging has significantly reduced commercial fish populations in the lagoon. With the removal of mangrove nursery areas and shallow seagrass foraging areas, there have been shifts in species distributions and composition, with changes in migration patterns of some species into and out of the lagoon system, increases in some species more tolerant of the changing environment, such as catfish and a reduction in other species such as goliath grouper. With the connectivity with the coast and reef, the fishing pressure isn't just from within the lagoon, but also a reflection of the general trend of over-utilisation of these species in Belize.

There is a conflict between the goal of developing a sustainable fishery, and the current legislation. It is proposed that the lagoon system be designated as a Wildlife Sanctuary (2), under the National Parks System Act, once revised in 2015 / 2016. Until then, however, declaration would be as a Wildlife Sanctuary. Under Belize law, wildlife sanctuaries are non-extractive, with any fishing considered illegal, unless by ministerial consent. In cases such as Placencia Lagoon, fishing has been a continuous traditional activity, the fishery being an essential resource for the fishing stakeholders.

Traditional use by stakeholder communities, however, is recognized under the National Protected Areas Policy and System Plan (NPAPSP, 2005), which seeks to harmonize the Belize National Protected Areas System with international criteria that:

> "*…Allow for the full range of management options under international designations including those allowing managed extractive use (in whole or in zones) and other approaches aimed at harmonious integration of human activity and conservation at landscape level*"

The NPAPSP also takes into account that:

> "*…Management of protected areas shall respect, preserve and maintain the traditional knowledge, innovations and practices of indigenous peoples and local communities provided that these do not conflict with the ecological integrity of the protected area and the various conventions and multi-lateral environmental agreements signed by the Government of Belize*"

It is therefore recommended that pending the enactment of the draft National Protected Areas System Act, which allows for planned and approved sustainable traditional extraction of fish within the Wildlife Sanctuary (2) designation, that Ministerial consent be sought as part of the protected area designation process for continued traditional fishing within the proposed Sanctuary. This would need to be based on the development of an effective sustainable fishery plan, agreed to by local, traditional users.

The socio-economic benefits from catch and release sport fishing suggest that it is a justifiable use in all but designated no-take zones identified during the sustainable fishery planning process.

**SEINE BIGHT COMMUNITY COMMENTS - FISHING**

- Seine Bight still has people who rely on the lagoon for putting food on the table. Now have to travel further from the village to be able to catch fish to sell.
- Fishing is primarily by hand lines, with some people using gillnets.
- 30 years ago, a fisherman could fish from 3:00pm to 6:30 and catch 20lb – 30lb in the Robert's Grove area – large snapper. Fish were abundant, and 30lb Goliath grouper were being caught
- Before mechanical dredging, fishermen could go anywhere and throw a line anywhere, and would catch fish.
- Now can fish all day and catch only 10lbs.
- Now have to fish inside the mangrove, away from the dredging area for smaller snapper
- Fishermen used  to catch fish where the seagrass meets the mangrove, at the edge of the lagoon.
- A lot of this seagrass has been lost - by Roberts Grove and Splash…all area to Maya Beach, south to Placencia
- Where seagrass has disappeared, the fish no longer congregate to feed – have migrated to other, less impacted areas.
- Fishermen therefore need to go further and spend more time fishing to catch the same amount of fish.
- Dredging, and mangrove removal has been the biggest impacting factor
- Proliferation of gill netting in areas prohibited by law also has a huge impact.
- Some people use poor practices for gill nets – setting across the creeks.  There is a need to enforce legislations… and make it fair for everyone – developers and fishermen

***Community consultations, Seine Bight, 2014***

***6.2.5 Climate Change***

Placencia and the Placencia Lagoon have been the subject of a number of assessments of predicted climate change impacts and potential for adaptation, with several organizations working to increase community resilience (SEA, 2010, Traladi et al., 2013, Rosenthal et al., 2013). The Peninsula is particularly vulnerable to tropical storm impacts, as shown by the destruction to property by Hurricane Iris. Peninsula resilience is being further eroded by the clearance of coastal mangroves and the dredging of canals eastwards from the lagoon, and the increasing extraction of water from the aquifer, to supply the expanding population.

| **Placencia Lagoon** | |
|---|---|
| **Potential Climate Change Impacts** | ▪ Increasing sea levels are a significant issue for the Peninsula communities, with much of the Peninsula itself being only a meter or two above sea level<br>▪ Erosion of low lying coastal areas with loss of protective coastal ridge and increased tidal / wave action<br>▪ Potential for significant change to the lagoon ecosystem – if the coastal ridge is eroded / submerged, the lagoon has the potential to become a coastal bay, with, increased tidal flow, increased salinity and better flushing of sediments.<br>▪ May lose estuarine characteristics and species, with a decrease in viability of *H. baillonii*, with a shift to more saline-tolerant *Thalassia* seagrass and associated in biodiversity and nursery functionality<br>▪ May lose appeal to manatees once the level of shelter provided decreases, and if H. baillonii disappears<br>▪ Greater flushing, resulting in less turbid conditions, combined with increased depth may increase seagrass cover and ecosystem productivity.<br>▪ Increased depth, so cycling not as great, with greater buffering of temperature and dissolved oxygen shifts<br>▪ Relocation of fringing mangroves inland<br>▪ Increased severity of exposure for coastal forests<br>▪ Greater vulnerability to hurricane impacts<br>▪ Greater seasonality of freshwater input and rapid salinity changes during storm events of increasing intensity<br>▪ Tropical storm events may cause storm surges and / or increased flooding of the Peninsula and the southern coastal plain. This may result in contamination of wells, flooding of shrimp ponds, settling ponds and sewage treatment ponds<br>▪ Predicted salt intrusion of the aquifer will result in ecosystem changes on the southern coastal plain as soils become too saline for current ecosystems, with a shift to mangrove dominated ecosystems near the eastern shoreline<br>▪ Migration of inundated mangrove inland as southern coastal plain becomes inundated, and ground-waters become more saline |
| **Resilience Features** | ▪ Mangroves have the capacity to migrate as sea level rises, and will slow the rate of loss of land, slowing the erosion rate (if not cleared).<br>▪ Coastal vegetation has a natural resilience to storms, with a high capacity to regenerate from severe tropical storm events, if anthropogenic impacts such as vegetation clearance are minimized.<br>▪ The lagoon may become more resilient to salinity and temperature peaks as the water level rises |

| Placencia Lagoon | |
|---|---|
| **To increase resilience** | ▪ Maintain fringing mangroves and natural coastal vegetation to slow rate of loss of coastal ridges and erosion of lagoon shorelines<br>▪ Zone coastal development to prevent exacerbation of climate change impacts in identified sensitive areas and prevent development in areas that will exacerbate the impacts of sea level rise and coastal erosion – coastal ridges.<br>▪ Ensure that the Peninsula remains intact, with no cross-Peninsula channels, as these will increase the vulnerability of the Peninsula to erosion during storms |

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## 7.0 Planning for the Peninsula

A number of plans have been developed that are relevant to the Peninsula, including Peninsula 2020 Initiative (2011), the Sustainable Tourism Master Plan (2011), and the South-Central region Coastal Zone Management Guidelines (CZMAI, 2013).

***7.1 Peninsula 2020 Initiative***. The *Peninsula 2020 Initiative* was a community-based planning exercise, and recognizes that prosperity has come to the Peninsula because of the aesthetic beauty of its environment: "*beautiful beaches, enchanting lagoon, offshore islands and coral reefs, all coupled with a laid back rural lifestyle*". The need to balance development and the environment was a common theme in the consultations, and continues to be so today. The primary concern focused on the need to clarify the national environmental policy, and ensure that regulations are evenly enforced, with greater decision making and enforcement powers for the village councils. Recommendations included:

- *More stringent enforcement of existing environmental regulations.*
- *More oversight powers and institutional strengthening for village councils.*
- *A permanent presence on the Peninsula by the Department of Environment and the Department of Geology and the Forest Department. (This presence could be one person who has legal authority to represent all three departments in enforcement matters.)*
- *Support for the Coastal Zone Management Authority's efforts to comprehensively control development on the many cayes off the peninsula's coast.*
- *Enactment of a moratorium on the granting of leases or conversion of leases to titles on crown land (or water) in and around the Placencia Lagoon in advance of placing the lagoon under officially protected status.*
- *The creation and dissemination of "best practices" manuals for responsible development of coastal areas and cayes.*

The 2020 Initiative also recognizes that commercial and subsistence fishing have formed the historical economic foundations for the communities of the Peninsula and are still considered important cultural and traditional activities, even though more recently, there has been a shift to tourism as the major financial support for the Peninsula communities. There is still a strong wish to ensure that fishing can continue into the future. Whilst not limited to the Lagoon, a number of recommendations were made for fishing:

- *The national government must provide stronger enforcement of fisheries regulations including foreign fishing in Belizean waters, closed seasons, and size limits.*
- *A total ban on gill netting should be enacted and enforced along the entire Peninsula coast and also in the Placencia Lagoon, as continued netting of creeks threatens snook and tarpon stocks.*
- *Financing costs for fisher folk should be lowered.*

- *Provision of improved education for fisher folk in new technologies.*

- *The fishing and tourism industries must be more tightly integrated in terms of culture, tourist activities, and supply chain.*

In defining sustainable tourism goals, the Peninsula 2020 Initiative highlighted that "*Placencia should not become a cruise port save for small ships"* a sentiment echoed by the other plans.

**7.2 Sustainable Tourism Master Plan.** The *Sustainable Tourism Master Plan,* endorsed by the Government of Belize, targets the Peninsula for containment of current development and consolidation in its destination Vision 2030 (NSTMP, 2011) focusing on:

> *"hosting a chain of mid- to low- density sun and beach resorts, a chain of charming villages such as Placencia, Hopkins and Dangriga, along with pristine and attractive beaches. This area will host high-end markets drawn by sun and beach, marine life and rainforest motivations; as well it will become the main hub for nautical tourism development and the first to attract pocket cruise market."*

The Sustainable Tourism Master Plan model for the Peninsula includes:

- *Preservation of most of the coastline and specially the Peninsula from out-of-scale development*
- *Conservation of a very fragile ecosystem that makes the place attractive*
- *Focus growth around existing settlements*
- *Release the pressure from real estate sector in other areas of the country*

The Plan stresses the need to exempt the lagoon from impacts of even pocket cruise tourism, and is supported by a series of objectives:

- *No cruise ship tourism on the Peninsula itself, but limit cruise ship tourist arrivals to the minimal extent in deference to the idea of developing outside the Peninsula*
- *Limit the development of the lagoon to protect the Peninsula and its sensitive and vulnerable ecosystems – primarily the extensive mangrove habitat*
- *Ban any new development projects in the area of the Peninsula and encourage coastline development from Riversdale further north*
- *Required tourism facilities and basic infrastructure (such as wastewater treatment) should be provided before attracting further tourists and opening of the international airport*
- *Avoid negative social impacts on local populations such as relocating local people for tourism development losing the authenticity of the destination*
- *Institute clear standards and policies for conservation of the natural environment to guide the scale and impact of development*

Development recommendations are for provision of incentives to upgrade and consolidate existing accommodation, with the addition of only 308 more rooms by 2025 – considered to be accommodation saturation level. The Plan also identifies the significant issues of waste water discharge and potential pollution of the lagoon that would be associated with further development of the area.

Pocket cruise tourism, catering for a maximum of 300 passengers per ship, is considered the only acceptable form of cruise tourism in the south eastern coast of Belize – conventional cruise tourism is not considered suitable for the Peninsula given the area's sensitive nature and the infrastructure requirement to support the larger numbers of visitors (NSTMP, 2011). Despite this, the decision has been made to locate the southern cruise ship port only 3km offshore from the southern point of the Peninsula, with cruise ship tenders projected to pass daily through the southern Placencia Lagoon, for disembarkation at Malacate Beach. (Note that this crosses a key manatee area, and is predicted to cause significant impacts to the manatee population if strategies are not put into place before the port is operational at the end of 2015 (Walker et al., 2015).

Also of concern is the potential use of the lagoon for airboat tourism, and by boat captains unfamiliar with the area, as advertised by the cruise industry, despite the recommendation of the STMP for maintenance of this system with minimal visitor impacts.

**7.3 South-Central region Coastal Zone Management Guidelines (CZMAI, 2013).** The South-Central Region Coastal Zone Management Guidelines are currently being presented to Cabinet, and highlight the Placencia Lagoon as an area in need of protection, based on its values as a as a nursery for much of the marine life in the area, including lobster, bonefish, permit, jewfish/goliath grouper, rays and the endangered Antillean manatee. It recommends "*seeking protected status for the Placencia Lagoon in order to protect its important coastal resources while also safeguarding the usufruct fishing rights for traditional (non-gill net) fishers of the area*."

Presented are a series of guidelines for development in the Placencia area based on the following goals:

1. *Encourage and promote the sustainable development of coastal and offshore areas within the South Central 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 South Central Region*

3. *Ensure sustainability of coastal resources by identifying areas in need of conservation and reducing user conflicts*

…and objectives:

- *Protecting the fishing resources and traditional fishing rights, especially for the fisherfolk from the communities of Placencia, Seine Bight, Riversdale, Independence and Maya Beach*
- *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*
- *Maintaining and protecting on going and future conservation, recreational and tourism areas and uses*
- *Preventing inappropriate high-impact, unsustainable developments that are incompatible with community needs*
- *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 South Central coastal zone*
- *Preserving the social and cultural values of the people and communities of the region that are connected to the environment*
- *Fostering and supporting a continued partnership among stakeholders for managing the coastal resources*
- *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*

Relevant fishing-related recommended objectives include:

- *Providing stronger enforcement of the Belize Fisheries Act and its regulations, including foreign fishing in Belizean waters, closed seasons, and size limits. Increased training of enforcement officer could serve an effective enforcement mechanisms*
- *Preserve mangrove areas important for the provision of fish nursery habitats*
- *Disseminate information to the general public via public awareness campaigns on an ongoing basis on fisheries legislations, especially the protection of fish species of conservation and/or commercial significance*
- *Secure long-term alternative livelihood options for traditional fishers of the region*
- *Limit dredging activities from areas within close proximity to important fishing grounds*
- *Conduct research on the relationship between abiotic factors, (such as salinity, temperature) and fish stocks*
- *Enforce a total ban on gill netting along the entire Peninsula coast and also in the Placencia Lagoon, as continued netting of creeks threatens snook and tarpon stocks*
- *Integrate tightly the fishing and tourism sectors in terms of culture, tourist activities, and supply chain*

Tourism-related recommendations include:

- *Placencia should not become a cruise port save for small ships.*
- *BTB and/or DOE should not recommend or approve tourism facilities that do not conform to these coastal zone management guidelines*.

Development-related guidelines include recommendations for dredging, and include:

- *Discourage dredging activity that falls outside of the Informed Management zoning scheme for marine dredging (around Big Creek and Independence)*
- *Require developers to finance and undertake replanting of seagrass and mangroves in areas that have been dredged*

**7.4 Stakeholder Consultations**

**Key Questions**
- *What is important to you about Placencia Lagoon?*
- *How do you use the lagoon?*
- *How has the lagoon changed over the last ten years?*
- *How would you like the lagoon to be in ten years' time?*

A series of exploratory stakeholder Consultations were held in the three key stakeholder communities (Seine Bight and Maya Beach were combined), focused on community perceptions, and guided by key questions developed to determine stakeholder relationship and reliance on Placencia Lagoon.

***7.4.1 Common themes across communities***

- It is important to take into consideration throughout the planning process the fact that the three different stakeholder communities (Placencia, Seine Bight/ Maya Beach and Independence) each have very different concerns.
- The lagoon is valued in all three communities for its ecosystem values, most specifically for the aesthetic beauty that attracts tourism, providing a destination for nature tourism, and attracting property development. As the 4th most important tourism destination in Belize, tourism provides job opportunities, and investment opportunities along the length of the peninsula.
- The protective values of the mangroves are considered important, as is the provision of fish as a protein source for low income families in all three communities. This is particularly true for those in Seine Bight.
- There is a recognized need to ensure that the most vulnerable sector, the local fishermen dependent on the lagoon for providing both food for the table and small scale commercial catch, are considered a high priority, and adequately integrated into any management regime.
- There is consensus among all three communities that the lagoon has declined in health since the 1980's. This has been attributed to combined development impacts (most specifically from dredging / mangrove clearance), and impacts from shrimp farm effluent.

- A current priority concern is related to the impacts of increased water traffic with the construction and operationalization of the cruise ship terminal to be built at Harvest Caye. Associated with this are also issues of waste disposal, noise and water pollution, and increased manatee mortality.
- There is concern as to how the future, planned sewage treatment plant may affect the lagoon, dependent on the selected location (still to be determined),
- Another identified threat is the desire of some developers to cut through the Peninsula in the north, as this would completely change the nature of the lagoon as an estuarine system, and open it up to increased chances of erosion.
- An identified opportunity in both Seine Bight and Independence meetings was the potential for the Placencia Lagoon and Peninsula to become a showcase for green development, balancing conservation and development. This would be of benefit to developers marketing their developments, to the tourism industry, and to the health and long term viability of the lagoon system.
- Improved management of the lagoon is considered important by all stakeholders, though there are concerns as to how this might impact personal freedom, particularly for developers.
- It was suggested that communities and the developers who have completed their developments be engaged to assist in restoring the lagoon, as equal partners – to move on from criticisms of who has caused what impact in the past, to a more positive one of how people can work together to improve the lagoon health in the future.
- There was discussion of the potential to use a green certification system similar to the shrimp farm certification, for hotels and property developments incorporating sound development policies – this would need buy-in from core developers, hotel owners, the Belize Tourism Board (BTB), the Belize Tourism Industry Association (BTIA) and technical input to ensure a robust scheme that would be attractive to the hotel owners and developments, and that could be integrated into international marketing.
- There was a general recommendation for strengthened surveillance and enforcement that is fair across communities, users and developers alike.

*An identified opportunity in both Seine Bight and Independence meetings was the potential for the Placencia Lagoon and Peninsula to become a showcase for green development, balancing conservation and development. This would be of benefit to developers marketing their developments, to the tourism industry, and to the health and long term viability of the lagoon system.*

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| What is important about Placencia Lagoon? | *Placencia* | *Seine Bight* | *Independence* |
|---|---|---|---|
| ***The Need for Balance*** | | | |
| Need balance between protection and development – both critical to the area | | | |
| The need for village expansion | | | |
| Better integration of the lagoon into development plans to ensure its continued integrity | | | |
| | | | |
| ***Ecosystem Values*** | | | |
| Fish as an important protein source for low income families | | | |
| Protection from tropical storms | | | |
| An important nursery for reef fish | | | |
| Provides dead red mangrove for fuel | | | |
| Hunting for game meat (north west side of lagoon) | | | |
| Natural filter before land-based waters reach the sea…filtering out agricultural pollution and sewage | | | |
| Natural carbon sink | | | |
| Supply of bait fish | | | |
| | | | |
| ***Economic Values*** | | | |
| Important nationally – the 4th largest tourism destination in Belize | | | |
| Aesthetic beauty for tourism | | | |
| An important resource for tourism – kayaking, bird watching….excellent for ecological tours | | | |
| Important resource for sport fishermen (snook, tarpon, permit) when the sea is rough | | | |
| Commercial fishing – lane and grey snapper, jacks, goliath grouper | | | |
| Sea cucumber has been fished from the lagoon for the last 2 years | | | |
| Tourism provides opportunities for local employment | | | |
| Development from tourism has brought the road, electricity, jobs | | | |
| | | | |
| ***Species Conservation*** | | | |
| Threatened species –both crocodile species, seagrass (*H. baillonii* – only found in two places in Belize), turtles – hawksbill, loggerhead | | | |
| West Indian manatee | | | |
| | | | |
| ***Transportation*** | | | |
| Transportation route / corridor | | | |
| Development from tourism has brought the road, electricity, jobs | | | |

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| How would you like the lagoon to be in ten years' time? | *Placencia* | *Seine Bight* | *Independence* |
|---|---|---|---|
| ***Ecosystem health*** | | | |
| Improved condition of the lagoon | | | |
| Maintenance of 66' mangrove buffer on lagoon edge | | | |
| More information on specific issues – sedimentation, water quality | | | |
| | | | |
| ***Effective Management*** | | | |
| Improved, planned management | | | |
| Effective enforcement | | | |
| Higher/ sensible fines and stiffer penalties for fishers and developers alike. Scaled to fit the illegal activity | | | |
| Engagement of village councils / village bylaws to improve enforcement and monitoring | | | |
| Greater community participation | | | |
| Protection of the Maya sites | | | |
| | | | |
| ***Future Use*** | | | |
| Opportunities for future generations in tourism as an alternative to fishing | | | |
| More tourism opportunities in Seine Bight | | | |
| Education – community members need to know more about the importance of the environment, and the importance of mangroves for marine life | | | |

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| Stakeholder Concerns | *Placencia* | *Seine Bight* | *Independence* |
|---|---|---|---|
| ***Current Threats*** | | | |
| Increased sediment load in water from dredging activities, and removing seagrass foraging areas | | | |
| Decreasing accessibility to lagoon with increased shoreline development | | | |
| Removal of mangrove from the 66' shoreline | | | |
| Land allocation by GoB without the knowledge of or consultation with the local authorities | | | |
| Outsourcing of employment – hiring of immigrants for less money | | | |
| Damage to lagoon ecosystems may be significant, with declining water quality and increased sedimentation, with impacts to the reef – affecting its appeal to the reef tourism market | | | |
| Political interference / corruption | | | |
| | | | |
| ***Potential Threats*** | | | |
| During heavy flooding, shrimp farms may overflow | | | |
| Future invasive species – *Tilapia* and *Lionfish* | | | |
| Potential for oil spills and limited capacity to respond effectively | | | |
| Impacts of cruise ship tourism | | | |
| Impacts to Malacate – dredging and fill | | | |
| The proposed location of the sewage treatment plant, and whether it will impact the lagoon, especially during storm events | | | |
| Desire of some developers to cut through the peninsula in the north – would completely change the nature of the lagoon | | | |
| Protected status for Placencia Lagoon will bring greater bureaucracy and will affect development | | | |
| Developers wanting to maintain the right to clear and create a beach in front of private land (Malacate), | | | |
| Any change will affect people – if the fish move out following poor development decisions, then fishermen would need to buy more fuel to travel further to catch fish. | | | |

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| **Stakeholder Recommendations** | ***Placencia*** | ***Seine Bight*** | ***Independence*** |
|---|---|---|---|
| ***Land Development Regulations*** | | | |
| Improved awareness of what can and can't be done in the area for land buyers | | | |
| Provision of a buffer zone between any dredging activity and the lagoon – leaving/replanting of the mangrove buffer zone between the development and the lagoon | | | |
| Permits should be required for any development | | | |
| Planned lagoon joint access points, minimizing fragmentation of mangrove buffer | | | |
| Restrictions on continued marine development | | | |
| Potential for zoning of development, particularly within the lagoon | | | |
| Monitoring of development, and establishment of a mechanism for reporting issues | | | |
| Setting development standards – certain requirements, certification system | | | |
| Ensuring access to the lagoon for fishing and recreation | | | |
| The regulations need to be managed and enforced fairly and properly | | | |
| | | | |
| ***Community Involvement*** | | | |
| There are three separate communities each with different concerns – the individual community needs to be taken into consideration throughout the planning process | | | |
| Vulnerable people - local fishermen and other vulnerable people who benefit from the lagoon need to be considered as a high priority | | | |
| A serious need for better regulation and proper management through a structured process – everyone should be willing to see how the lagoon can be developed and protected without infringing on personal freedoms or setting up barriers to development. Needs enough time for the best decisions to be made. | | | |
| A formal, participatory process - the three communities should be brought together to provide consensus – needs the time to include full participation, to encourage greater buy-in. This would give the breadth of opinion, and all stakeholders can come to an agreement. | | | |
| Mapping of different interests to provide rationalised, informed data for decisions | | | |

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| Stakeholder Recommendations | *Placencia* | *Seine Bight* | *Independence* |
|---|---|---|---|
| ***Community Development and Capacity Building*** | | | |
| Potential to become a model for balancing conservation and development | | | |
| Promotion of green development – Sustainable development guidelines | | | |
| Marketing Placencia for green development | | | |
| Development of more ecotourism activities within the lagoon –kayaking, heritage tours, etc. | | | |
| Organize as tour guides to promote heritage tours in the lagoon | | | |
| Engage developers who have finished developing to help build back the lagoon health | | | |
| Improved education / outreach to sellers to ensure buyers become aware of local development standards | | | |
| Older generations recognize the ecosystem importance and have seen significant changes, education for the younger generation is becoming increasingly important – teaching respect for the importance of these ecosystems i.e. Why maintaining mangrove is important, why there should be a 66' buffer, measures that are required for shrimp farms | | | |
| Community members need to become more proactive | | | |
| | | | |
| ***Collaboration*** | | | |
| Important that BTIA is engaged as a key member of Friends of Placencia Lagoon– can reach developers | | | |
| Community collaboration is key – the need to stand and move together, seeking sustainability of the lagoon – to sing the same song | | | |
| Communities and developers need to understand each other | | | |

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### 7.5 Summarized Key Recommendations for Establishment of Placencia Lagoon Wildlife Sanctuary

For the proposed Placencia Lagoon Wildlife Sanctuary (2) to move forward and become a reality, a number of key areas will need to be strengthened:

- There is good cross-sectoral support already, but this should be further strengthened - especially through further engagement of developers and traditional fishers
- Following recent re-structuring, SEA needs to revitalize its position in the communities and ensure that it can engage all stakeholders
- Stakeholders need to recognize and contribute to the participatory approach that will be followed in the management of the protected area

Some of the steps needed to achieve this include:

> *"With 98% of coastal and Lagoon lands on the Peninsula leased or scheduled for development, we need some very strict guidelines to preserve what we have. We do need reserves set up to protect the Lagoon. I also favor tax incentives for developers to preserve our mangroves".*
>
> ***Adrian Vernon***

1. Ensure that all village councils are fully on board, supportive and participating in the initiative
2. Ensure that traditional fishers are fully on board, and aware of the benefits and security they would have from a rights-based fishery management regime
3. Work with established and functioning coastal resorts and developments to integrate these sectors' interests – establishing areas of mutual interest and benefit
4. Maintain and strengthen the collaboration and support from the aquaculture industry
5. Engage the banana and citrus industry stakeholders, and open dialogue towards certification needs and areas of mutual benefit, reducing watershed impacts on the lagoon system
6. Communicate with cruise ship industry service interests, establish areas of agreement – including the possibility of zoned access (and zoned non-access), and potential fee structure to avoid direct confrontation
7. Ensure that all stakeholders appreciate the 'can satisfy all' approach – management protecting both development interests and investments as well as the biodiversity, natural resources and environmental services of the Lagoon
8. Initiate the process of determination of broad zonation needs and interests
9. Negotiate Conservation / Access Covenants with private landowners – especially shrimp farms – for the maintenance of mangroves and the environmental services they provide
10. Work closely with DoE towards acceptance of the goals and standards to be met by coastal developments, and engage the Department for effective surveillance and enforcement of development regulations
11. Ensure that current public awareness is maintained and strengthened, ensure transparency of planning and operations, and strengthen the perception of SEA as the most appropriate and

best situated organization to manage the proposed protected area, ensuring that cross-sectoral interests are respected

12. Collaborate with the Belize Manatee Working Group and CZMAI to coordinate efforts to help protect the lagoon's manatee population through establishment of marked boat channels in key activity areas (most specifically, at the mouth of the lagoon)

***Urgent / Short term activities for establishment of Protected Area status***

1. Develop Statutory Instrument defining the protected area and the regulations (Forest Department)

2. Delineation of boat channel and no wake zone at mouth of Placencia Lagoon (Port Authority)

3. Develop collaborative partnerships with the Forest and Fisheries Departments and the Department of the Environment, with training of rangers for effective enforcement of fisheries and development legislation

4. Identification and engagement of local, traditional fishermen toward participatory and collaborative development of a sustainable, rights-based fishery

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***Personal Comments (2014 / 2015)***

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## Annex One: Species Lists

| Mammals recorded in the Placencia Lagoon Project Area | | |
|---|---|---|
| **Species** | | **Record** |
| ***Didelphidae*** | | |
| Gray Four-eyed opossum | *Philander opossum* | Santa Maria creek area (Meerman, 2014) |
| Mouse Opossum | | Jenkin's Creek area (Meerman, 2014) |
| ***Dasypodidae*** | | |
| Nine-banded armadillo | *Dasypus novemcinctus* | Santa Maria creek area (Meerman, 2014)<br>Jenkin's Creek area (Meerman, 2014) |
| ***Erethizontidae*** | | |
| Mexican Hairy Porcupine | *Sphiggurus mexicanus* | REA Team (Walker et al., 2014) |
| ***Dasyproctidae*** | | |
| Central American agouti | *Dasyprocta punctata* | Jenkins Creek area (Meerman, 2014) |
| ***Agoutidae*** | | |
| Paca | *Agouti paca* | Santa Maria creek area (Meerman, 2014)<br>Jenkin's Creek area (Meerman, 2014) |
| ***Canidae*** | | |
| Grey Fox | *Urocyon cinereoargenteus* | Santa Maria creek area (Meerman, 2014) |
| ***Procyonidae*** | | |
| Northern raccoon | *Procyon lotor* | REA Team (Walker et al., 2014) |
| White nosed coati | *Nasua narica* | Jenkin's Creek area (Meerman, 2014) |
| ***Mustelidae*** | | |
| Neotropical River otter | *Lutra longicaudis* | Creeks, Northern Lagoon (D. Vernon) |
| ***Felidae*** | | |
| Jaguar | *Panterha onca* | Jenkin's Creek area (Meerman, 2014) |
| ***Cervidae*** | | |
| White-tailed deer | *Odocoileus virginianus* | Santa Maria creek (Meerman, 2014) |
| Red brocket deer | *Mazama americana* | Santa Maria creek area (Meerman, 2014) |
| ***Trichechidae*** | | |
| West Indian manatee | *Trichechus manatus* | REA Team (Walker et al., 2014) |
| ***Delphinidae*** | | |
| Bottlenose dolphin | *Tursiops truncatus* | Local consultations, 2014 |
| Atlantic spotted dolphin? | *Stenella frontalis* | SEA Report, 2014 |

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| **Mammal Species expected to occur in Project area** | | |
|---|---|---|
| **Species** | | **Broad Ecosystem Association** |
| ***Didelphimorpha*** | | |
| Virginia opossum | *Didelphis virginiana* | Pine savanna, Broadleaf Forest |
| Water opossum | *Chironectes minimus* | Creeks |
| ***Myrmecophagidae*** | | |
| Northern tamandua | *Tamandua mexicana* | Broadleaf forest |
| Silky anteater | *Cyclopes didactylus* | Broadleaf forest |
| ***Sciuridae*** | | |
| Deppes Squirrel | *Sciurus deppei* | Broadleaf Forest |
| ***Procyonidae*** | | |
| Kinkajou | *Potos flavus* | Broadleaf Forest, along creek edge |
| ***Mustelidae*** | | |
| Tayra | *Eira barbara* | Broadleaf forest, Pine Savanna |
| ***Felidae*** | | |
| Ocelot | *Leopardus pardalis* | Broadleaf Forest and edge of savanna |
| Margay | *Leopardus weidii* | Broadleaf forest |
| Jaguaroundi | *Herpailurus yagouarundi* | Broadleaf forest |
| Puma | *Puma concolor* | Broadleaf forest, Pine Savanna |
| ***Tapiridae*** | | |
| Baird's Tapir | *Tapirus bairdii* | Pine Savanna, Broadleaf forest |
| ***Tayassuidae*** | | |
| Collared Peccary | *Tayassu tajacu* | Broadleaf forest, Pine Savanna |

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**Birdlife of the Placencia Lagoon Area**
**Roni A. Martinez**

INTRODUCTION

More than 420 species of birds migrate yearly from their cold northern breeding grounds to warmer Neotropical areas. Of these migrants, diversity is highest in northern Central America and declines southward. In Belize, the first areas where these migrants arrive for wintering are Mangroves and Littoral Forests on the coast or similar habitat on the Cayes. These habitats also offer relatively safe sites for egrets and other wading birds to breed in larger colonies. Of 87 migrant species recorded in mangroves in the Neotropics, 15 species use it as their primary habitat, while 4 species are mostly restricted to mangroves or similar coastal habitats. This survey attempted to record all species within the proposed Placencia Lagoon protected area. The list is certainly not complete and further surveys will undoubtedly reveal more species.

METHOD

For this survey, Point Counts of thirty minutes were conducted at eight locations (PLR1 – PLR8) approximately 2 kilometers apart, along the mainland coast of the proposed reserve area. All birds seen and/or heard were recorded. Counts were started at 0600 and ended at 1700. All eight count sites were surveyed once from 0600 to 1100, and a second time from 1200 to 1700. Both the Mango Creek and Silver Creek tributaries were also surveyed. Additionally, walking transects were done between six points (approximately 2 kilometers apart) from Peninsula Point to Riversdale.

BIRD SURVEY RESULTS

This survey was carried out during January 25th and 26th, and March 8th and 9th, 2014 and for completeness, additional lists from previous bird surveys and eBird data were added. A total of 190 bird species have been recorded from the Placencia Lagoon Area. Of these, 62% are resident species or year round visitors, 35% are winter visitors (including transients), 3% are summer visitors and for completeness we included a single record of a vagrant species.

NOTE: ADDITIONAL SPECIES
(Walker, Z)

The following table includes species recorded during the R. Martinez surveys, as well as additional species recorded during surveys of the shrimp farm properties in the watersheds, representative of species of the Environmental Assessment project area (BAL, 2014 (draft)).

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| **Bird Species of the Placencia Lagoon Area (R. Martinez, 2014 + additional literature records)** | |
|---|---|
| **Species** | |
| **GREBES -POPICIPEDIDAE** | |
| Least Grebe | *Tachybaptus dominicus* |
| Pied-billed Grebe | *Podilymbus podiceps* |
| **BOOBIES AND GANNETS - SULIDAE** | |
| Brown Booby | *Sula leucogaster* |
| **PELICANS - PELECANIDAE** | |
| Brown Pelican | *Pelecanus occidentalis* |
| American White Pelican | *Pelecanus erythrorhynchos* |
| **CORMORANTS - PHALACROCORACIDAE** | |
| Neotropic Cormorant | *Phalacrocorax brasilianus* |
| Double-crested Cormorant | *Phalacrocorax auritus* |
| **ANHINGAS - ANHINGIDAE** | |
| Anhinga | *Anhinga anhinga* |
| **FRIGATEBIRDS - FREGATIDAE** | |
| Magnificent Frigatebird | *Fregata magnificens* |
| **BITTERNS AND HERONS - ARDEIDAE** | |
| Bare-throated Tiger-Heron | *Tigrisoma mexicanum* |
| Great Blue Heron | *Ardea herodius* |
| Great Egret | *Ardea alba* |
| Snowy Egret | *Egretta thula* |
| Little Blue Heron | *Egretta caerula* |
| Tricolored Heron | *Egretta tricolor* |
| Cattle Egret | *Bubulcus ibis* |
| Green Heron | *Butorides virescens* |
| Black-crowned Night-Heron | *Nycticorax nycticorax* |
| Yellow-crowned Night-Heron | *Nyctanassa violacea* |
| Boat-billed Heron | *Cochlearius cochlearius* |
| **IBISES AND SPOONBILLS - THRESKIORNITHIDAE** | |
| White Ibis | *Eudocimus albus* |
| Roseate Spoonbill | *Ajaia ajaja* |
| **STORKS - CICONIIDAE** | |
| Jabiru | *Jabiru mycteria* |
| Wood Stork | *Mycteria americana* |
| **AMERICAN VULTURES - CATHARTIDAE** | |
| Black Vulture | *Coragyps atratus* |
| Turkey Vulture | *Cathartes aura* |
| Lesser Yellowheaded Vulture | *Cathartes burrovianus* |
| **DUCKS - ANATIDAE** | |
| Black-bellied Whistling Duck | *Dendrocygna autumnalis* |
| Muscovy Duck | *Buteo albonotatus* |

| Bird Species of the Placencia Lagoon Area (R. Martinez, 2014 + additional literature records) / 2 | |
|---|---|
| **Species** | |
| **DUCKS - ANATIDAE** | |
| Blue-winged Teal | *Anas discors* |
| **KITES, EAGLES HAWKS AND ALLIES - ACCIPITRIDAE** | |
| Osprey | *Pandion haliaetus* |
| Hook-billed Kite | *Chondrohierax uncinatus* |
| Common Black-Hawk | *Buteogallus anthracinus* |
| Roadside Hawk | *Buteo magnirostris* |
| White-tailed Hawk | *Buteo albicaudatus* |
| **FALCONS - FALCONIDAE** | |
| Laughing Falcon | *Herpetotheres cachinnans* |
| American Kestrel | *Falco sparverius* |
| Merlin | *Falco columbarius* |
| Aplomado Falcon | *Falco femoralis* |
| Peregrine Falcon | *Falco peregrinus* |
| **CURASSOW AND GUAN - CRACIDAE** | |
| Plain Chachalaca | *Ortalis vetula* |
| **QUAIL - ODONTOPHORIDAE** | |
| Black-throated Bobwhite | *Colinus nigrogularis* |
| **RAILS, GALLINULES AND COOTS** | |
| Ruddy Crake | *Laterallus ruber* |
| Purple Gallinule | *Porphyrula martinica* |
| American Coot | *Fulica americana* |
| **LIMPKINS - ARAMIDAE** | |
| Limpkin | *Aramus guarauna* |
| **PLOVERS - CHARADRIIDAE** | |
| Black-bellied Plover | *Pluvialis squatarola* |
| Wilson's Plover | *Charadrius wilsonia* |
| Semi-palmated Plover | *Charadrius semipalmatus* |
| Killdeer | *Charadrius vociferus* |
| **STILTS AND AVOCETS - RECURVIROSTRIDAE** | |
| Black-necked Stilt | *Himantopus mexicanus* |
| **JACANAS - JACANIDAE** | |
| Northern Jacana | *Jacana spinosa* |
| **SANDPIPERS AND ALLIES - SCOLOPACIDAE** | |
| Greater Yellowlegs | *Tringa melanoleuca* |
| Lesser Yellowlegs | *Tringa flavipes* |
| Solitary Sandpiper | *Tringa solitaria* |
| Willet* | *Catoptrophorus semipalmatus* |
| Spotted Sandpiper | *Actitis macularia* |
| Long-billed Curlew | *Numenius americanus* |
| Ruddy Turnstone | *Arenaria interpres* |
| Sanderling | *Calidris alba* |

| Bird Species of the Placencia Lagoon Area (R. Martinez, 2014 + additional literature records) / 3 | |
|---|---|
| **Species** | |
| **SANDPIPERS AND ALLIES - SCOLOPACIDAE** | |
| Semipalmated Plover | *Charadrius semipalmatus* |
| Western Sandpiper | *Calidris mauri* |
| Least Sandpiper | *Calidris minutilla* |
| White-rumped Sandpiper | *Calidris fuscicollis* |
| Pectoral Sandpiper | *Calidris melanotos* |
| Short-billed Dowitcher | *Limnodromus griseus* |
| **GULLS, TERNS - LARIDAE** | |
| Laughing Gull | *Larus atricilla* |
| Ring-billed Gull | *Larus delawarensis* |
| Gull-billed Tern | *Sterna nilotica* |
| Royal Tern | *Sterna maxima* |
| Sandwich Tern | *Sterna sandvicensiscommon* |
| Common Tern | *Sterna hirundo* |
| Least Tern | *Sterna antillarum* |
| Black Tern | *Chlidonias niger* |
| **PIGEONS AND DOVES - COLUMBIDAE** | |
| Rock Dove | *Columba livia* |
| Pale-vented Pigeon | *Columba cayennensis* |
| Red-billed Pigeon | *Columba flavirostris* |
| Mourning Dove | *Zenaida macroura* |
| Common Ground-Dove | *Columbina passerina* |
| Plain-breasted Ground-Dove | *Columbina minuta* |
| **PARROTS - PSITTACIDAE** | |
| Olive-throated Parakeet | *Aratinga nana* |
| White-crowned Parrot | *Pionus senilis* |
| White-fronted Parrot | *Amazona albifrons* |
| Red-lored Parrot | *Amazona autumnalis* |
| **CUCKOOS AND ALLIES - CUCULIDAE** | |
| Squirrel Cuckoo | *Piaya cayana* |
| Mangrove Cuckoo | *Coccyzus minor* |
| Groove-billed Ani | *Crotophaga sulcirostris* |
| **BARN OWLS - TYTONIDAE** | |
| Barn Owl | *Tyto alba* |
| **NIGHTHAWKS AND NIGHTJARS - CAPRIMULGIDAE** | |
| Common Nighthawk | *Chordeiles minor* |
| **HUMMINGBIRDS - TROCHILIDAE** | |
| Green-breasted Mango | *Anthracothorax prevostii* |
| Canivet's Emerald | *Chlorostilbon canivetii* |
| Rufous-tailed Hummingbird | *Amazilia tzacatl* |
| Cinnamon Hummingbird | *Amazilia rutila* |
| Ruby-throated Hummingbird | *Archilochus colibris* |

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| **Bird Species of the Placencia Lagoon Area (R. Martinez, 2014 + additional literature records) / 4** | |
|---|---|
| **Species** | |
| **TROGONS - TROGONIDAE** | |
| Black-headed Trogon | *Trogon melanocephalus* |
| **MOTMOTS - MOTMOTIDAE** | |
| Blue-crowned Motmot | *Momotus momota* |
| **KINGFISHERS - ALCEDINIDAE** | |
| Ringed Kingfisher | *Ceryle torquata* |
| Belted Kingfisher | *Ceryle alcyon* |
| American Pygmy Kingfisher | *Chloroceryle aenea* |
| **WOODPECKERS - PICIDAE** | |
| Acorn Woodpecker | *Melanerpes formicivorus* |
| Golden-fronted Woodpecker | *Melanerpes aurifrons* |
| Yellow-bellied Sapsucker | *Sphyrapicus varius* |
| Ladder-backed Woodpecker | *Picoides scalaris* |
| Lineated Woodpecker | *Dryocopus lineatus* |
| Pale-billed Woodpecker | *Campephilus guatemalensis* |
| **TYPICAL ANTBIRDS - THAMNOPHILIDAE** | |
| Barred Antshrike | *Thamnophilus doliatus* |
| Dusky Antbird | *Cercomacra tyrannina* |
| **ANTTHRUSHES - FORMICARIIDAE** | |
| Black-faced Antthrush | *Formicarius analis* |
| **TYRANT FLYCTACHERS - TYRANNIDAE** | |
| Northern Beardless Tyrannulet | *Camptostoma imberbe* |
| Greenish Elaenia | *Myiopagis viridicta* |
| Yellow-bellied Elaenia | *Elaenia flavogaster* |
| Ochre-bellied Flycatcher | *Mionectes oleagineus* |
| Northern Bentbill | *Oncostoma cinereigulare* |
| Common Tody-Flycatcher | *Todirostrum cinereum* |
| Yellow-olive Flycatcher | *Tolmomyias suphurescens* |
| **FLUVICOLINE FLYCATCHERS - FLUVICOLINAE** | |
| Olive-sided Flycatcher (NT) | *Contopus cooperi* |
| Eastern Wood-Pewee | *Contopus virens* |
| Least Flycatcher | *Empidonax minimus* |
| Vermilion Flycatcher | *Pyrocephalus rubinus* |
| **TYRANNINE FLYCATCHERS - TYRANNINAE** | |
| Bright-rumped Attila | *Attila spadiceus* |
| Dusky-capped Flycatcher | *Myiarchus tuberculifer* |
| Great Crested Flycatcher | *Myiarchus crinitus* |
| Brown-crested Flycatcher | *Myiarchus tyrannulus* |

| **Bird Species of the Placencia Lagoon Area (R. Martinez, 2014 + additional literature records) / 5** | |
|---|---|
| **TYRANNINE FLYCATCHERS - TYRANNINAE** | |
| Great Kiskadee | *Pitangus sulphuratus* |
| Boat-billed Flycatcher | *Megarynchus pitangua* |
| Social Flycatcher | *Myiozetetes similes* |
| Tropical Kingbird | *Tyrannus melancholicus* |
| Couch's Kingbird | *Tyrannus couchii* |
| Eastern Kingbird | *Tyrannus tyrannus* |
| Fork-tailed Flycatcher | *Tyrannus savanna* |
| **MANAKINS -PIPRIDAE** | |
| White collared Manakin | *Manacus candei* |
| **VIREOS - VIREONIDAE** | |
| Mangrove Vireo | *Vireo pallens* |
| Yellow-throated Vireo | *Vireo flavifrons* |
| Red-eyed Vireo | *Vireo olivaceus* |
| Yellow-green Vireo | *Vireo flavoviridis* |
| Yucatan Vireo | *Vireo magister* |
| Rufous-browed Peppershrike | *Cyclarhis gujanensis* |
| **JAYS - CORVIDAE** | |
| Brown Jay | *Cyanocorax morio* |
| **SWALLOWS - HIRUNDINIDAE** | |
| Purple Martin | *Progne subis* |
| Gray-breasted Martin | *Progne chalybea* |
| Tree Swallow | *Trachycineta bicolor* |
| Mangrove Swallow | *Tachycineta albilinea* |
| Barn Swallow | *Hirundo rustica* |
| **WRENS - TROGLODYTIDAE** | |
| House Wren | *Troglodytes aedon* |
| Spot-breasted Wren | *Pheugopedius maculipectus* |
| **THRUSHES AND ALLIES - TURDIDAE** | |
| Gray-cheeked Thrush | *Catharus minimus* |
| Wood Thrush | *Hylocichla mustelina* |
| Clay-colored Thrush | *Turdus greyi* |
| **MOCKINGBIRDS AND ALLIES - MIMIDAE** | |
| Tropical Mockingbird | *Mimus gilvus* |
| **WOOD WARBLERS - PARULIDAE** | |
| Northern Parula | *Setophaga americana* |
| Yellow Warbler | *Setophaga petechia* |
| Chestnut-sided Warbler | *Setophaga pensylvanica* |
| Magnolia Warbler | *Setophaga magnolia* |
| Yellow-rumped Warbler | *Setophaga coronata* |
| Blackburnian Warbler | *Setophaga fusca* |
| Yellow-throated Warbler | *Setophaga dominica* |
| Grace's Warbler | *Setophaga graciae* |

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| Bird Species of the Placencia Lagoon Area (R. Martinez, 2014 + additional literature records) / 6 | |
|---|---|
| **WOOD WARBLERS - PARULIDAE** | |
| Prairie Warbler | *Setophaga discolor* |
| Black-and-white Warbler | *Mniotilta varia* |
| American Redstart | *Setophaga ruticilla* |
| Prothonotary Warbler | *Protonotaria citrea* |
| Worm-eating Warbler | *Helmitheros vermivorus* |
| Ovenbird | *Seiurus aurocapillus* |
| Northern Waterthrush | *Seiurus noveboracensis* |
| Mourning Warbler | *Geothlypis philadelphia* |
| Common Yellowthroat | *Geothlypis trichas* |
| Gray-crowned Yellowthroat | *Geothlypis poliocephala* |
| Hooded Warbler | *Wilsonia citrina* |
| Yellow-breasted Chat | *Icteria virens* |
| **TANAGERS - THRAUPIDAE** | |
| Blue-gray Tanager | *Thraupis episcopus* |
| Yellow-winged Tanager | *Thraupis abbas* |
| Yellow-throated Euphonia | *Euphonia hirundinacea* |
| **EMBERIZINES - EMBERIZIDAE** | |
| Blue-black Grassquit | *Volatinia jacarina* |
| White-collared Seedeater | *Sporophila torqueola* |
| Yellow-faced Grassquit | *Tiaris olivacea* |
| Grassland yellow finch* | *Sicalis luteola* |
| **EMBERIZINES - EMBERIZIDAE** | |
| Chipping Sparrow** | *Spizella passerina* |
| Grasshopper Sparrow | *Ammodramus savannarum* |
| **CARDINALS AND ALLIES - CARDINALINAE** | |
| Buff-throated Saltator | *Saltator maximus* |
| Blue-black Grosbeak | *Cyanocompsa cyanoides* |
| Rose-breasted Grosbeak | *Pheucticus ludovicianus* |
| Indigo Bunting | *Passerina cyanea* |
| Dickcissel | *Spiza americana* |
| **BLACKBIRDS AND ALLIES - ICTERIDAE** | |
| Eastern Meadowlark | *Sturnella magna* |
| Melodious Blackbird | *Dives dives* |
| Great-tailed Grackle | *Quiscalus mexicanus* |
| Bronzed Cowbird | *Molothrus aeneus* |
| Giant Cowbird | *Molothrus oryzivorus* |
| Black-cowled Oriole | *Icterus prosthemelas* |
| Orchard Oriole | *Icterus spurious* |
| Hooded Oriole | *Icterus cucullatus* |
| Yellow-backed Oriole | *Icterus chrysater* |
| Yellow-tailed Oriole | *Icterus mesomelas* |

| Bird Species of the Placencia Lagoon Area (R. Martinez, 2014 + additional literature records) / 7 | |
|---|---|
| **BLACKBIRDS AND ALLIES - ICTERIDAE** | |
| Baltimore Oriole | *Icterus glabula* |
| Yellow-billed Cacique | *Amblycercus holosericeus* |
| Montezuma Oropendola | *Psarocolius montezuma* |

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| **Fish Species of Placencia Lagoon** | |
|---|---|
| **ORECTOLOBIDAE** | |
| Nurse Shark | *Ginglymostoma cirratum* |
| **DASYATIDAE** | |
| Southern Stingray | *Dasyatis americana* |
| **RHINOPTERIDAE** | |
| Cow-nosed Ray | *Rhinoptera bonasus* |
| Longnose Stingrayay | *Dasyatis guttata* |
| **MYLIOBATIDAE** | |
| Spotted Eagle Ray | *Aetobatus narinari* |
| **ALBULIDAE** | |
| Bonefish | *Albula vulpes* |
| **MEGALOPIDAE** | |
| Tarpon | *Megalops atlanticus* |
| **PIMELODIDAE** | |
| Guatemalan chulin, Buttersea | *Rhamdia guatemalensis* |
| **CLUPEIDAE** | |
| Scaled sardine | *Harengula jaguar* |
| **ANGUILLIDAE** | |
| American Eel | *Anguilla rostrata* |
| **SYNBRANCHIDAE** | |
| Obscure Swamp Eel | *Ophisternon aenigmaticum* |
| **SERRANIDAE** | |
| Goliath grouper | *Epinephelus itajara* |
| **LUTANIDAE** | |
| Grey Snapper | *Lutjanus griseus* |
| Schoolmaster | *Lutjanus apodus* |
| Cubera Snapper | *Lutjanus cyanopterus* |
| Lane snapper | *Lutjanus synagris* |
| Mutton snapper | *Lutjanus analis* |
| Dog snapper | *Lutjanus jocu* |
| **CARANGIDAE** | |
| Horse-eye jack | *Caranx latus* |
| Crevalle jack | *Caranx hippos* |
| Blue runner | *Caranx crysos* |
| Permit | *Trachinotus falcatus* |
| Pompano | *Trachinotus carolinus* |

| **Fish Species of Placencia Lagoon** | |
|---|---|
| **HAEMULIDAE** | |
| Blue striped grunt | *Haemulon sciurus* |
| Caesar's grunt | *Haemulon carbonarium* |
| Burro grunt | *Pomadasys crocro* |
| **SPHYRAENIDAE** | |
| Great barracuda | *Sphyraena barracuda* |
| **MUGILIDAE** | |
| Striped mullet? | *Mugil cephalus* |
| **CENTROMOPIDAE** | |
| Common snook | *Centropomus undecimalis* |
| **BELONIDAE** | |
| Redfin needlefish | *Strongylura notata* |
| **CYPRINODONTIDAE** | |
| Pike killifish | *Belonesox belizanus* |
| **CHARACIDAE** | |
| Mexican tetra | *Astyanax aeneus* |
| Macabil | *Brycon guatemalensis* |
| Mayan tetra | *Hyphessobrycon compressus* |
| **ENGRAULIDAE** | |
| Key anchovy | *Anchoa cayorum* |
| **POECILIIDAE** | |
| Pike killifish | *Belonesox belizanus* |
| Sleek mosquitofish | *Gambusia luma* |
| Teardrop mosquitofish | *Gambusia sexradiata* |
| Nicaraguan mosquitofish | *Gambusia nicaraguensis* |
| Southern Yucatan mosquitofish | *Gambusia yucatana* |
| Twospot livebearer | *Heterandria bimaculata* |
| Shortfin molly | *Poecilia mexicana* |
| Mangrove molly | *Poecilia orri* |
| Green swordtail | *Xiphophorus helleri* |
| Southern platyfish | *Xiphophorus maculatus* |
| **RIVULIDAE** | |
| Dogtooth rivulus | *Rivulus tenuis* |
| **GERRIDAE** | |
| Striped mojarra? | *Eugerres plumieri* |
| Yellowfin mojarra? | *Gerres cinereus* |
| Flagfin mojarra | *Eucinostomus melanopterus* |

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| Fish Species of Placencia Lagoon | |
|---|---|
| **CICHLIDAE** | |
| False firemouth cichlid | *Amphilophus robertsoni* |
| Blue-eye cichlid | *Archocentrus spilurus* |
| Firemouth cichlid | *Thorichthys meeki* |
| Guapote, Musmus | *Cichlasoma friedrichsthali* |
| Jack Dempsey | *Cichlasoma octofasciatum* |
| False firemouth cichlid | *Cichlasoma robertsoni* |
| Yellowbelly cichlid | *Cichlasoma salvini* |
| Maya cichlid | *Cichlasoma uropthalmus* |
| Northern checkmark cichlid | *Vieja maculicauda* |
| Redhead cichlid | *Vieja synspila* |
| Bay snook | *Petenia splendida* |
| **ELEOTRIDAE** | |
| Large-scaled spinycheek sleeper | *Eleotris amblyopsis* |
| Spinycheek sleeper | *Eleotris pisonis* |
| Bigmouth sleeper | *Gobiomorus dormitor* |
| **GOBIIDAE** | |
| River goby | *Awaous banana* |
| **HEPTAPTERIDAE** | |
| Guatemalan chulin | *Rhamdia guatemalensis* |
| Filespine chulin | *Rhamdia laticauda* |
| **TETRADONTIDAE** | |
| Chequered pufferfish | *Sphoeroides testudineus* |

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BAL, 2014 (draft)
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