

**Gales Point Wildlife Sanctuary
And
Adjacent Areas
Biodiversity Assessment**



**For: Wildlife Trust &
Gales Point Wildlife Sanctuary Community Management
Committee**

2006



**OAK
FOUNDATION**

An Introduction to the Southern Lagoon Area

Southern Lagoon has long been recognized for its importance for the Antillean manatee (*Trichechus manatus*), being highlighted as an area with one of the highest populations of this species within Belize (O'Shea, 1989; Auil, 1998). As such, it was declared as the Gales Point (Antillean manatee) Wildlife Sanctuary by the Government of Belize in 1998 (SI 92 of 1998). Research by Wildlife Trust indicates that the manatee population may be in the region of 150 individuals in the Sanctuary, 89 of which have been marked to allow identification of individuals (by the end of 2006).

The brackish lagoon system (composed of a number of shallow lagoons and creeks) lies within the Manatee Special Development Area. This was established in 1992 (SI 162 of 92) to rationalize land use planning following the construction of the Coastal Road, which has provided easier access to the area, with the potential to lead to greater land use change. The Special Development Area (SDA) extends southwards from the Sibun River (north of Northern Lagoon), to just north of Mullins River, following the coast to the east and the Coastal Road to the west. The coastal ridge has been highlighted for its importance as a critical nesting site for Hawksbill Turtles, and has had community-driven active protective measures in place to prevent predation of the individual nests.

Within the coastal plain, behind the coastal ridge, this SDA area is characterized by flat pine savanna and steep limestone karst hills with broadleaf forest and cohune, with Southern Lagoon to the east, linked to the inner lagoon of the Mesoamerican Barrier Reef system by Bar River. Whilst being legislated, there is no evidence that this land-use tool has ever been used in land use planning for the area, or in decisions taken in the allocation of Government lands.

Gales Point Manatee, the primary stakeholder community of the protected area, is historically a small subsistence fishing, hunting and logging village with a population estimated at 500, located on a narrow peninsula that extends into Southern Lagoon and the Gales Point Wildlife Sanctuary. The Gales Point people are closely tied to the natural resources, and have made significant input into a number of conservation development initiatives over the years. There has been a growing tourism industry based on the traditional drumming, good fly fishing within the lagoon system, and on the presence of manatees.

This biodiversity assessment, requested by the community-based Gales Point Wildlife Sanctuary Management Committee and the international organisation Wildlife Trust, is the first step towards the development of a management plan for Gales Point Wildlife Sanctuary, providing background information on the natural resources and physical characteristics of the area, and placing it within the conservation context of the country. It also provides a biodiversity baseline, identifies critical threats, and will form the background for developing management strategies within the context of the sustainability of community livelihood.

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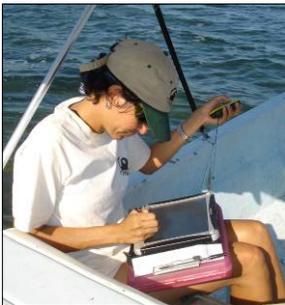
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1.0 Background

1.1 Location

Southern Lagoon is situated in the Manatee Special Development Area in Belize District, the most developed of the six districts of Belize. The focal area, a combination of national and private lands, lies approximately 30 km south-south west of Belize City (the largest population centre in Belize, with a population estimated at 59,400. (CSO, 2004)), and 34km north of Dangriga (the district capital of Stann Creek, with a population estimated at 10,400 (CSO, 2004)). One of two large lagoons on the central coastal plain, Southern Lagoon (designated as the Gales Point Wildlife Sanctuary) covers approximately 9,100 acres of brackish lagoons, creeks and mangroves. With rivers and creeks draining into the lagoon from the west, water then flows to the east, the lagoon being connected to the Caribbean Sea through Bar River, a channel that cuts through the coastal bar of the east coast of Belize (Map 1). Private land lines the majority of the shorelines of the lagoons and coast, except in the north west, where the Manatee Forest Reserve abuts the Wildlife Sanctuary. The surrounding coastal plain, a matrix of tropical broadleaf forest and short grass savanna, has very distinctive physical features – with tower karst limestone rising out of the flat coastal savanna, forming steep-sided hills, with cliffs and impressive cave structures.

The primary stakeholder community is Gales Point, with a population estimated at approximately 500 (Hoare, 2002), consisting of households lined along a narrow peninsular that juts northwards into the lagoon system. Other communities that also impact the area include Freetown Sibun, Belize City to the north, Dangriga, to the south, and even coastal communities of Honduras, primarily through fishing activities on the coastline by Bar Mouth.

1.2 Site Description

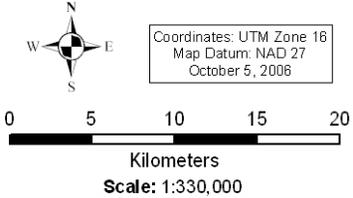
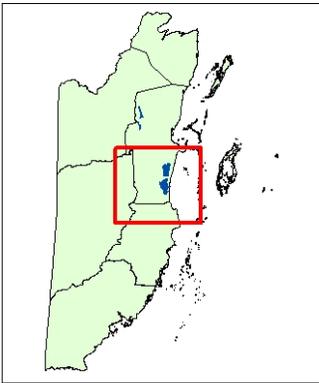
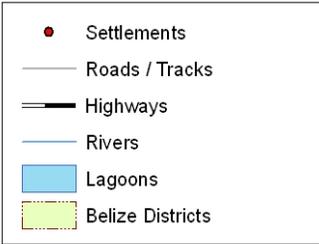
The Southern Lagoon project area encompasses both private and Government land, lying within the Manatee Special Development Area. Whilst the primary focus of the biodiversity assessment is the Southern Lagoon waterbody, first highlighted for its importance for manatees, the assessment has also included the surrounding terrestrial ecosystems and land use systems, as it is the status of the watershed that will have one of the greatest impacts on the health of the lagoon ecosystem.

Southern Lagoon itself was designated in 1998 as the Gales Point (West Indian Manatee) Wildlife Sanctuary (SI 92 of 1998), in recognition of its importance for the Antillean manatee (*Trichechus manatus*). The Wildlife Sanctuary is one of five distinct categories of protected areas under the National Parks System Act of 1981, each of which is protected by restrictions strictly defined by law. The Wildlife Sanctuary designation is for the protection of nationally significant species, biotic communities or physical features, and allows for research, tourism and education activities.

SI 92 of 1998:

All that body of water labelled as the Sapodilla Lagoon, the Western Lagoon, the greater Western Lagoon, the Southern Lagoon, the greater Southern Lagoon and the Quashie Trap Lagoon; including the Bar River and the Quashie Trap tributary; and also including a portion of the Manatee River commencing from its estuary for an approximate distance of 2,286 metres upriver to a point having a scaled UTM coordinate of 354350 East and 1904240 North, and also including that portion of Cornhouse Creek for an approximate distance of 1,287 metres up river from its confluence with the Manatee River to a point having a scaled UTM coordinate of 354110 East and 1905690 North, and including a sixty-six (66) feet strip from the high water mark all along the shoreline of the aforementioned lagoons but excluding Gales Point Peninsula.

Southern Lagoon: General Location

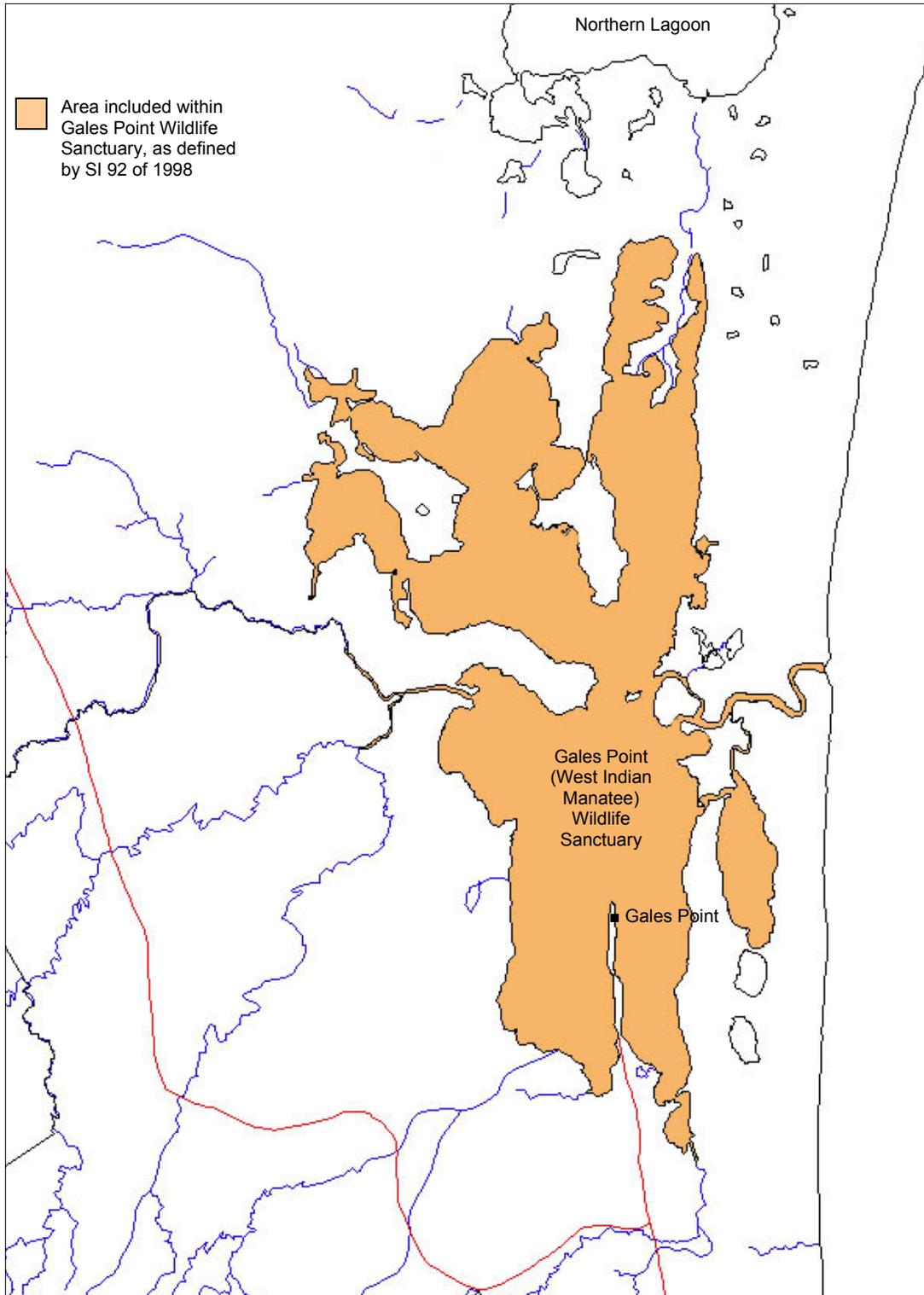


Map 1: Southern Lagoon: General Location

Mapping: A. Lloyd; Wildtracks

Southern Lagoon - Biodiversity Assessment..3

This protected area, an estimated 9,097 acres, consists of the Southern Lagoon system (including Quashie Trap Lagoon, Bar River and Quashie Trap tributary, 2.286km up the Manatee River, 1.287km up Cornhouse Creek), and also includes the 66' shoreline along all the lagoons (except for the shoreline of Gales Point peninsula) (Map 2).



Map 2: Gales Point (West Indian Manatee) Wildlife Sanctuary

Whilst originally designated as a Wildlife Sanctuary as a tool towards the continued conservation of the Antillean manatee in Belize, Southern Lagoon also provides an important habitat for a variety of fish and bird species, including the Critically Endangered goliath grouper (*Epinephelus itajara*). The lower reaches of the rivers and creeks, also within the protected area, are also important habitat for the Critically Endangered, regionally endemic Central American river turtle (*Dermatemys mawii*).

The terrestrial ecosystems surrounding the project area are a matrix of tropical broadleaf forest, short grass and pine savannah, fresh water creeks, swamp forest, and mangrove, sheltering a representative array of Belize's mammals, including jaguar, puma, paca, Baird's tapir, white tailed deer, red brocket deer, Yucatan howler monkey and the Central American spider monkey.

Throughout the karstic areas, caves exist with impressive stalactites and stalagmites. Reports suggest that at one time, these caves held Maya pottery offerings, as found to the north in the Sibun watershed by the Xibun Archaeology Research Project, with studies in adjacent areas indicating a Maya presence during the Terminal Classic period, between AD700 and AD1000, over 1000 years ago (McAnany and Thomas, 2003). Unfortunately, extensive looting in the Southern Lagoon area has removed much of the evidence of use of the caves. The general Southern Lagoon area has been used traditionally by the community of Gales Point for subsistence fishing, with hunting and logging in the adjacent short grass savanna and forest, and is now the focus of limited tourism activities.

Gales Point community wishes to further develop its established tourism base, relying on the lagoon, tropical forest savanna and the wildlife of the area, with the Antillean manatee as the prime focus. Tourism potential also relies on continued access to the many caves, broadleaf forests, and to the relatively undisturbed waters of the creeks and rivers that drain into the lagoon system. This has led to a wish to ensure the long-term protection of the area, putting in place the necessary infrastructure for sustainability, and developing and implementing conservation goals and actions that contribute to the long-term protection of the lagoon system and adjacent watershed, and to the national goals for biodiversity protection.

With the assistance of Wildlife Trust, the Gales Point Wildlife Sanctuary Community Management Committee is seeking a co-management agreement with the Ministry of Natural Resources to ensure the continued protection of the lagoon system for the benefit of the wildlife, the local community and future generations.

2.0 Conservation Importance of the Southern Lagoon Area

From a conservation standpoint, the Gales Point Wildlife Sanctuary's primary importance within Belize's protected areas system lies in the protection of the Antillean manatee (*Trichechus manatus*), a species listed as 'vulnerable' (IUCN, 2006) Belize has the Antillean subspecies (*T. manatus manatus*) which reside within the lagoon system. An ongoing long-term research project by Wildlife Trust is studying the manatee population within this lagoon system, the prime objective being to determine the habitat use, ranging patterns and health of individuals to implement conservation actions to safeguard species.

A second focal point of conservation interest lies to the east, outside the Wildlife Sanctuary, on the sand bar facing the Caribbean Sea. Originally identified as one of the most important nesting beaches within the Western Caribbean, the Critically Endangered hawksbill turtles (*Eretmochelys imbricata*) return here each year to nest.

Two other species of conservation importance have been recorded within the protected area. Both the goliath grouper (*Epinephelus itajara*), and the regionally endemic Central American river turtle (*Dermatemys mawii*) are considered Critically Endangered (IUCN, 2006).

2.1 Protection of Biodiversity

The biodiversity assessment of the Southern Lagoon area confirmed a representative mammal and bird population, though depressed by heavy hunting pressure. Data collection during the assessment demonstrated the presence of twenty-six species of international concern (IUCN, 2004). Three of these are considered Critically Endangered (CR), six are Endangered (EN), six are classed as Vulnerable (VU), and twelve are Near Threatened (NT) (though three of these require further confirmation of their presences) (Table 1). Four further species (red brocket deer (*Mazama americana*), Neotropical river otter (*Lontra longicauda*), the southern stingray (*Dasyatis americana*) and the spotted eagle ray (*Aetobatus narinari*)) are considered Data Deficient (DD) – being considered at risk, but with insufficient information available to give an accurate idea of their population status. Also recorded within the area is the regionally vulnerable sub-species of the Central American spider monkey (*Ateles geoffroyi yucatanensis*).

Also useful for highlighting threatened species is Appendix I of CITES (Convention on International Trade in Endangered Species, 2005). This listing reflects concerns over ensuring that international trade in specimens of wild animals and plants does not threaten their survival, and so concentrates more on species that have an internationally commercial value. The ocelot, margay, jaguarundi, jabiru and boa constrictor are the only six of these CITES listed species that do not occur also on the IUCN Red List (Table 2).

Table 1: Species of International Concern (IUCN: Red list 2006) of the Southern Lagoon Area		
Critically Endangered, CR	Central American River Turtle	<i>Dermatemys mawii</i>
	Hawksbill Turtle	<i>Eretmochelys imbricata</i>
	Goliath Grouper	<i>Epinephelus itajara</i>
Endangered, EN	Mexican Black Howler	<i>Alouatta pigra</i>
	Baird's Tapir	<i>Tapirus bairdii</i>
	Yellow-headed Parrot	<i>Amazona oratrix</i>
	Loggerhead Turtle	<i>Caretta caretta</i>
	Green Turtle	<i>Chelonia mydas</i>
	Yaxnik; Fiddlewood	<i>Vitex gaumeri</i>
Vulnerable, VU	Antillean Manatee	<i>Trichechus manatus</i>
	American Crocodile	<i>Crocodylus acutus</i>
	Cubera Snapper	<i>Lutjanus cyanopterus</i>
	Gaussia palm	<i>Gaussia maya</i>
	Spanish Cedar	<i>Cedrela odorata</i>
	Large-leaved Mahogany	<i>Swietenia macrophylla</i>
Near Threatened, NT	Jaguar	<i>Panthera onca</i>
	Puma	<i>Puma concolor</i>
	Great curassow	<i>Crax rubra</i>
	Water Opossum*	<i>Chironectes minimus</i>
	Morelet's Crocodile	<i>Crocodylus moreletii</i>
	Mexican Giant Musk Turtle	<i>Staurotypus triporcatus</i>
	Common Slider	<i>Trachemys scripta</i>
	Narrow-bridged Musk Turtle	<i>Claudius angustatus</i>
	Tabasco Mud Turtle*	<i>Kinosternon acutum</i>
	Lemon Shark *	<i>Negaprion brevirostris</i>
	Cownosed Ray*	<i>Rhinoptera bonasus</i>
	Cycad, Palmita	<i>Zamia polymorpha</i>
	* requires confirmation	

Future development and implementation of management planning for the Gales Point Wildlife Sanctuary will provide direct protection for eleven of these internationally important species, once enforcement is in place.

A further three less aquatic species benefit from the legal protection given to the 66 feet riverine vegetation within the Gales Point Wildlife Sanctuary, but require a greater area than is protected for the existence of viable populations.

Sixteen species of concern are present within the terrestrial portion of the Southern Lagoon watershed, but not in the protected area itself. The majority of these species, such as Jaguar and Great Curassow, will

Table 2: CITES Appendix One Species of Southern Lagoon Area	
Mammals	
<i>Alouatta pigra</i>	Yucatan Black Howler Monkey
<i>Lutra longicaudis</i>	Neotropical River Otter
<i>Herpailurus yaguarondi</i>	Jaguarundi
<i>Leopardus pardalis</i>	Ocelot
<i>Leopardus wiedii</i>	Margay
<i>Panthera onca</i>	Jaguar
<i>Trichechus manatus</i>	Antillean Manatee
<i>Tapirus bairdii</i>	Baird's Tapir
Birds	
<i>Jabiru mycteria</i>	Jabiru
Reptiles	
<i>Crocodylus moreletii</i>	Morelet's Crocodile
<i>Crocodylus acutus</i>	American Crocodile
<i>Boa constrictor</i>	Boa Constrictor

be present in Manatee Forest Reserve, but the lack of enforcement results in the level of protection within this reserve as very low (Table 3).

Table 3: Distribution of degree of legal protection for Species of Concern within the Southern Lagoon Area		
<i>Within the Gales Point Wildlife Sanctuary</i>	<i>Critically Endangered</i>	Hawksbill Turtle
		Goliath Grouper
		Central American River Turtle
	<i>Vulnerable</i>	Antillean Manatee
		American Crocodile
		Cubera Snapper
	<i>Near Threatened</i>	Morelet's Crocodile
		Southern Stingray
		Cownosed Ray
		Lemon Shark *
<i>CITES Appendix I</i>	Neotropical River Otter	
<i>Present in the riverine forest adjoining the Wildlife Sanctuary (but not directly protected unless within 66' of the water's edge)</i>	<i>Endangered</i>	Yucatan Howler
		Baird's Tapir
	<i>Near Threatened</i>	Water Opossum*
<i>Present within the general Southern Lagoon area, but outside protected area</i>	<i>Endangered</i>	Yellow-headed Parrot
		Yaxnik; Fiddlewood
	<i>Vulnerable</i>	Spanish Cedar
		Large-leaved Mahogany
	<i>Near Threatened</i>	Jaguar
		Puma
		Great Curassow
		Mexican Giant Musk Turtle
		Common Slider
		Narrow-bridged Musk Turtle
		Tabasco Mud Turtle
		Cycad, Palmita
	<i>CITES Appendix I</i>	Jaguarundi
Ocelot		
Margay		
Jabiru		

Gales Point Wildlife Sanctuary was created under the National Parks System Act (1981), which gives this lagoon system protected area status – ‘for the protection of nationally significant species, biotic communities or physical features’, with the stipulation that only research education and tourism activities are permitted – no extractive activities. The conservation framework of Belize also provides protection to the forest and wildlife under the Forest Act of 1990 and the Wildlife Protection Act of 1981, both administered under the Forest Department. The Fisheries Act of 1948 also provides a legal framework for the protection and harvesting of fish stocks in both the marine and freshwater environments, and for marine turtles and nesting sites.

The archaeological sites, including artifact found within caves, are protected under the Ancient Monuments and Antiquities Act of 1971.

2.2 Protection of Coastal Resources

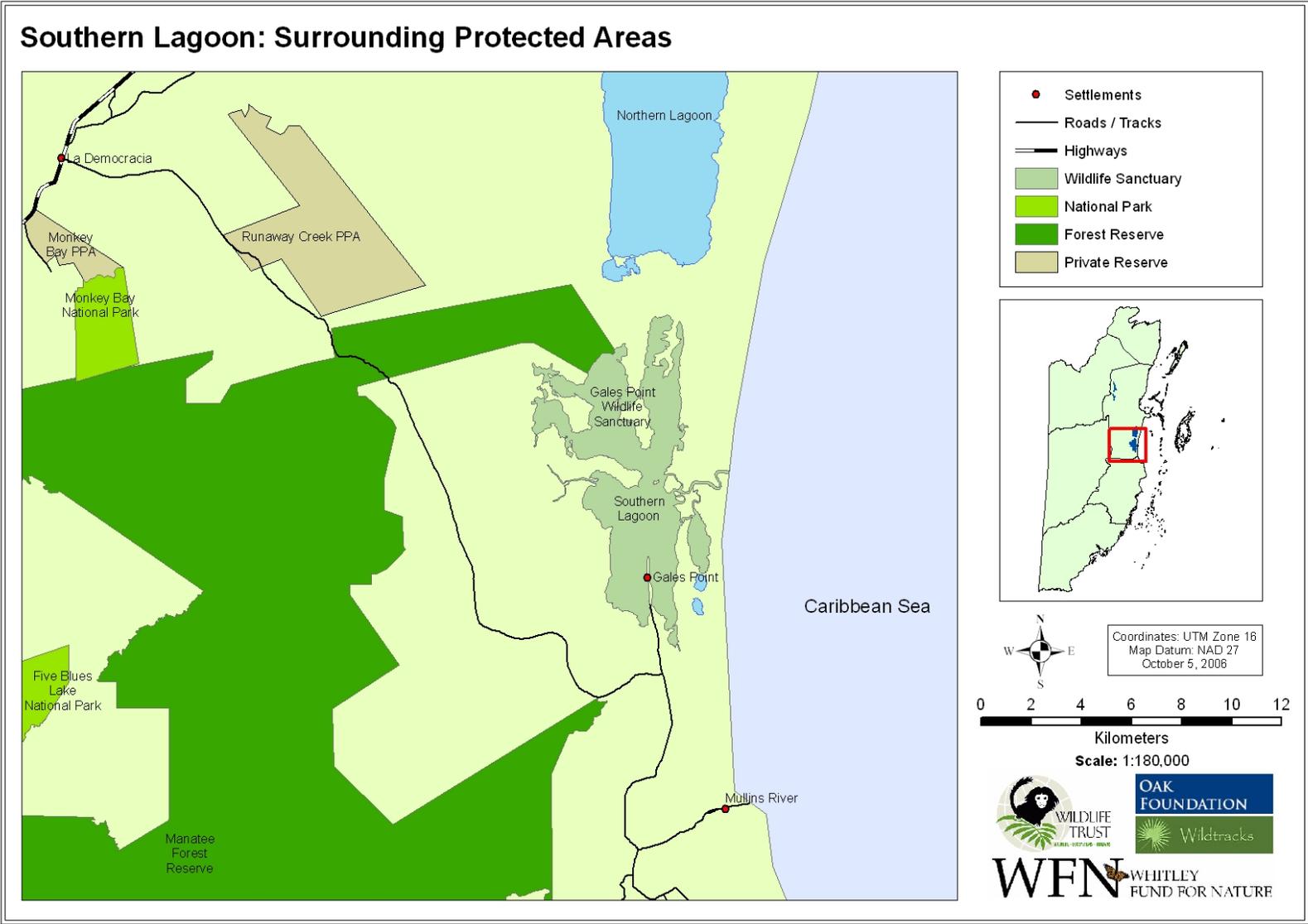
The Southern Lagoon system lies in the Central Coastal Plain, draining from the karstic hills to the west, and flowing to the east into the Caribbean Sea. The mangroves of the shallow lagoon system and adjacent coastal mangrove savannas provide an important filtration mechanism for water draining from the mainland, allowing settling of solids before the water empties into the Caribbean Sea. This maintains the natural processes of sedimentation, allows agricultural chemicals to settle out, and minimizes the associated impacts of these on the reef. The red mangrove roots also provide shelter and protection for juvenile populations of a number of important commercial fish species, ensuring continued resources for both traditional fishing by the Gales Point community, and by communities further south along the coastline.

The Gales Point Wildlife Sanctuary includes Sapodilla Lagoon, Western Lagoon, Southern Lagoon, and the Quashie Trap Lagoon (including the Bar River and the Quashie Trap tributary). It also includes a portion of the Manatee River, from its estuary upriver for an approximate distance of 2,286 metres, and including 1,287m of Cornhouse Creek up river from its confluence with the Manatee River (SI 92 of 1998). The inclusion of the 66 foot shoreline around the lagoons within the Wildlife Sanctuary is of significant importance to the maintenance of water quality within the system – and takes on greater meaning in light of the dereservation (in 2005) of significant areas of the Manatee Forest Reserve abutting the Wildlife Sanctuary: the 66' water-frontage buffer remains within the Sanctuary, and legally should therefore be maintained in pristine condition, though currently there is no enforcement to prevent land clearance.

2.3 Connectivity

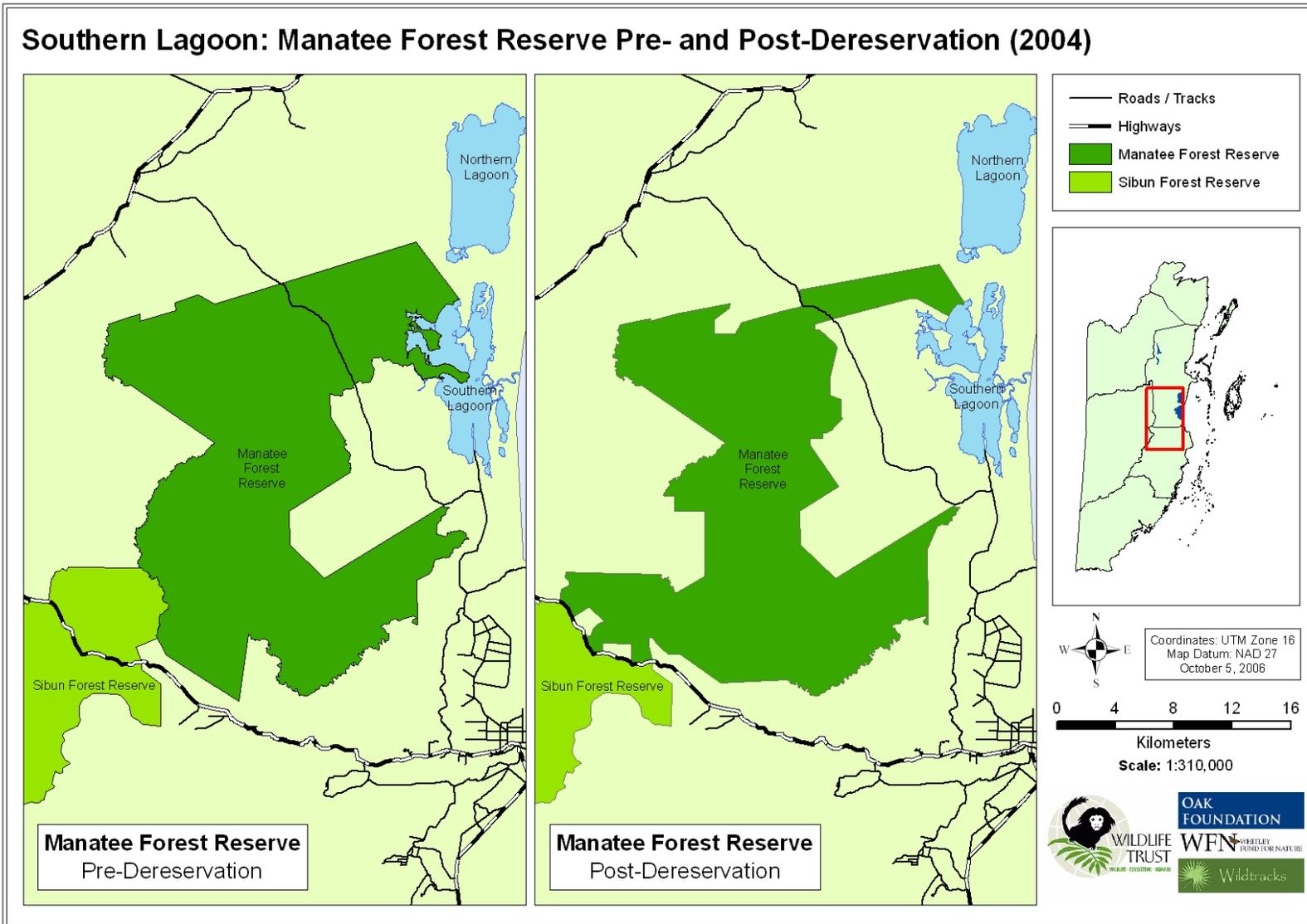
In terms of connectivity in the maintenance of biodiversity, there are several considerations regarding the role of the Southern Lagoon and Manatee Forest Reserve area:

- The Gales Point Wildlife Sanctuary provides direct aquatic connectivity between the marine coastal environment and the brackish lagoon systems (via the Bar River), and from there to a number of freshwater drainages. This connectivity is critical not only to the resident manatee population, but also to the maintenance of viable populations of many of the brackish water fish species – including several of great economic importance to the Gales Point Community.
- The 2005 dereservation of approximately 13,000 acres of the Manatee Forest Reserve has significantly reduced watershed integrity and biological connectivity between the Gales Point Wildlife Sanctuary and the broadleaf forest karst hills to the west. Most notably, the lower reaches of Mahogany Creek, along with Dew Creek, most of Cornhouse Creek, and other small drainages feeding into Western and Sapodilla Lagoons are no longer protected. With this dereservation, protected riparian vegetation connectivity has been lost for the Central American River Turtle (CR), the Yucatan Black Howler monkey (EN), the Central American Spider Monkey (VU) and, to a lesser extent, the Baird's Tapir (EN). Limited and tenuous terrestrial connectivity remains northwest of Western Lagoon, across the savannas north of the Ben Lomond area (Maps 3 and 4).
- Via this remaining narrow northern linkage of the Manatee Forest Reserve, limited biological connectivity remains between Gales Point Wildlife Sanctuary, the broadleaf forested karst hills to the west, and with the Runaway Creek Nature Preserve to the northwest - and from there into the national biological corridor system.
- Terrestrial connectivity still remains along the riverbanks, within the 66 foot reserve. Whilst not within the protected area, the use of this legislation can be used to ensure continued protection of this vegetation, reducing agricultural impacts on the system.



Map 3: Connectivity: Adjacent Protected Areas

Mapping: A. Lloyd; Wildtracks



Map 4: Manatee Forest Reserve Pre- and Post-Dereservation

Mapping: A. Lloyd; Wildtracks

2.4 Protection of Geological Features

The Wildlife Sanctuary encompasses a coastal lagoon system typical of the flat, Yucatan limestone platform on which it sits. In the adjacent Manatee Forest Reserve, and indeed throughout much of the land buffering the Sanctuary to the west, there is dramatic karstic landscape, with karstic towers rising sharply from the coastal plain. Caves with stalactites and stalagmites occur throughout the hills, though these now lie outside the protected areas; some (e.g. Ben Lomond's Cave) have been badly impacted by uncontrolled visitation. The recognition of the importance of karst landscapes as a conservation target by the IUCN World Commission on Protected Areas in 1997, and the increasing need for their protection, has led to an evaluation of karstic scenery and its protection throughout Central America (Kueny and Day, 2002). The region contains a significant proportion of the global karstic limestone, stretching from the Yucatan Peninsula to Panama, with 18% under some form of protection. Belize is highlighted as the country with the largest area of karst under protection (68% of the total karst landscape of the country falls within protected areas – pre-dereservation of the Manatee Forest Reserve area), however this is fast being eroded as the karst areas come under increasing pressure, with quarrying for limestone hardcore, and dereservation of forest reserves whittling away at the protected areas.

2.5 Protection of Cultural Heritage and Traditional Use

The Xibun Archaeological Research Project (XARP) has completed an initial investigation of the ancient Maya settlements, cave systems and associated Maya pottery of the Sibun-Manatee karst area, concentrating on the Sibun river valley, a few kilometers to the north of the Southern Lagoon area, indicating a Maya presence during the Terminal Classic period, between AD700 and AD1000, over 1000 years ago (McAnany and Thomas, 2003). Ceramic shards within caves adjacent to Southern Lagoon suggest that the karst areas in the immediate proximity were used in a similar way, though looting has removed the majority of the vessels that once existed from this era. There is no continuity of settlement between the Maya settlements and the present Gales Point community.

The cultural roots of the Gales Point community lie in Nigeria, the majority of the village being descended from members of the Eboe nation, brought to Belize as slaves during the days of the mahogany industry (Hoare, 2002). The large family units of several generations that belonged to the same master during the slave days, maintaining contact between great grandfather and great grandchild, is thought to have provided the opportunity for the African culture to have been passed from the original settlers to the present-day Creoles (Bolland, 1987). This was strengthened by the maintenance of tribal identities, and the congregation of tribes following emancipation. For this reason, the Gales Point community has maintained many of the cultural traditions to this day, such as the *sambai* dance, though some of the original meanings and reasons have been lost over time.

The Gales Point people are thought to have originated from a combination of the Maroon settlers (Hoare, 2002) (so called after similar communities in Jamaica – an independent community of runaway slaves, offering refuge to others escaping from slavery) and logging crews based south of Belize City during the early logging days. The Southern Lagoon and surrounding area has been important for these first settlers for small-scale milpa farming, hunting and fishing, and as a source of other forest products from that period onwards to the present day.

Land in the Soldier Creek area is known to have been allocated as land grants to members of the disbanded All Black 5th West India Regiment from Jamaica, in 1817, who established small farms along the creekside (from: Gales Point Manatee - Physical Analysis and Planning Guidelines, Date and author unknown).

By the 1840's, with increasing security of land tenureship, plantations stretched along the riverbanks, and through the forested karst, with names that reflect the origins of the owners -

such as Aberdeen Estate, Ben Lomond, and Cumberland Hall. These provided employment following the emancipation of slaves in 1833, and eventually resulted in the construction of the Burdon Canal in 1920, to provide an easier means of transporting crops to Belize City. Many of the older inhabitants of Gales Point remember descriptions of small holdings and the Government Landing community on the banks of the Manatee River, and of the move from there to Gales Point.

By 1950, the major industry in the area was once again logging, with the majority of men from Gales Point being employed logging and milling pine and mahogany, which was then carried to Belize by barge and lighters. During this period, employment opportunities in the logging industry were good, and people abandoned the traditional plantations as a source of income. With the eventual decline of the logging in the 1960's, and high unemployment in the area, seasonal work was located outside of the community – with many being seasonally employed by orange orchards in Florida during harvesting. This appears to have resulted in strong ties with the United States, with a high percentage of the younger generation moving away from the traditional subsistence lifestyle in favour of a less taxing existence in the United States, leading to significant social change in the community over the last sixty years.

In the last ten years or so, Gales Point has built on its cultural traditions and natural resources to create a small scale tourism base, and recognizes the need for active management of the Wildlife Sanctuary and adjacent natural areas and wildlife if this industry is to expand in the future. Without further tourism development, this small community and its rich culture will not be able to develop the economic base necessary for its survival.

3.0 Historical impacts that have shaped the Southern Lagoon area

3.1 Maya and Colonial Influences

Signs of Maya settlements can be found on the higher lands adjacent to Southern Lagoon, such as Tiger Point and Gales Point itself, as well as on the banks of the Manatee River. These communities appear to have been relatively small, and probably dependent on the river and lagoon resources.

Whilst little specific information appears to exist on Maya activity within the Southern Lagoon area, the Xibun Archaeological Research Project in the adjacent Sibun watershed area has developed an overview of land use over time using pollen core analysis. During the main period of Maya settlement (AD700 to AD1000), the presence of domesticated maize pollen and remnants of charcoal, and the relatively high levels of associated vegetation species composition, such as sapote (*Manilkara zapota*) and hogplum (*Spondias* sp.) suggest that the Sibun area itself was an open, cultivated river valley (Jones, 2003). This was followed by a period of naturally regenerating forest within the karstic areas, with small-scale milpas and a slightly elevated abundance of semi-cultivated tree species. Eventually, the area returned to its natural, heavily forested state, with a gradually increasing abundance of cohune (*Attalea cohune*) and other, non-economic species.

This reforestation stopped abruptly during colonial days, with pollen analysis indicating a shift from trees to pasture in the area being surveyed, suggesting the Sibun river valley was once again going through a period of intensive agriculture...this was reflected within the adjacent Manatee River flood plain as well, with large plantations being established along the Manatee River, Cornhouse Creek and Soldier (or Plantation) Creek.

These human influences have helped to shape the current forest structure throughout the watershed, and along the river banks, selecting for some more domesticated tree species (such as sapote), providing conditions suitable for the expansion of others such as cohune, and removing some tree species through over-harvesting.

3.2 Logging

Two concentrated periods of logging activity appear to have occurred in the Southern Lagoon / Manatee karst area. Significant logging based on mahogany and cedar occurred throughout the late eighteenth and early nineteenth century, with logs being transported by water to staging points down the Manatee River to Southern Lagoon, through Bar River and eventually to the sea, then northwards to Belize City for export. Logging, once again, became a locally important industry in the 1940's / 1950's, supporting the employment of many of the Gales Point inhabitants, with predominantly pine and some hardwoods from the Bocotura Pine Ride area being harvested, cut, and carried to Belize City by barge and lighters. It is believed that timber extraction from the forests to the west of Southern Lagoon was one of the driving forces behind the digging of Burdon Canal in 1920. Few mature timber resources remain in the area following this intensive logging activity and, more recently, the increased frequency of savanna fires is preventing regeneration of pine.

There are stretches of tropical broadleaf remaining within the area - as a hurricane-dependent forest, reliant upon periodic significant storm damage, it is possible that the Atlantic forest belt of Belize and neighbouring countries is more resilient to the long-term impacts of selective logging than more sheltered forest areas – whilst the relative abundance, and size distribution of a few commercial species may be reduced, overall forest structural integrity and species composition is

believed to be good. The depleted timber reserves evidently no longer support commercial extraction in lands immediately west of the Gales Point Wildlife Sanctuary.

3.3 Fire

Frequent anthropogenic fires on the pine savannas undoubtedly cause significant species shift and loss. There are two areas to consider in terms of fire:

Short-grass savanna

Most short-grass savannas in Belize are exposed to anthropogenic fires on an annual basis, sometimes even more frequently. In the Southern Lagoon area, fires are primarily started by hunters, aiming to attract white-tailed deer to the new shoots that rapidly emerge from the ashes of burnt savanna (though there are also reports of a cattle farmer in the Northern Lagoon area who burns the grass as well). Subjective perception is that these fires are becoming increasingly common in recent years – perhaps a reflection of increasing human population and increased mobility of hunters. Frequent fires have a pronounced impact on short-grass savannas, eradicating pine trees, and often the oaks and madre-de-cacao stands associated with the pine. These increasingly frequent fires reduce overall species richness – favouring the few species able to either withstand fire, or rapidly regenerate from fire events. As recently as 20 years ago, pine stands were far more extensive on the savannas than is now the case (community consultations, 2006). These fires also affect the bordering broadleaf shrublands and forest, with an overall trend of these forest margins being in retreat, with increasing fire damage in the transitional areas.

Hill-tops

Rising abruptly from the flat coastal plain, the karstic hills of the coastal plain are the first elevation features in the path of summer storms pushed by the trade winds. Not surprisingly therefore, the tops of the karst limestone towers are very vulnerable to lightning strikes, and resultant fires. The seasonally xeric conditions on these hilltops further enhance the likelihood of lightning strikes igniting isolated fires on these exposed localities. Anthropogenic fires on these hill-tops appear to be relatively rare (P. Walker pers. obs.)

3.4 Fishing

Fishing has been a traditional activity within the Southern Lagoon area, with both men and women being involved in providing fish and shrimp for the table. The general consensus during community consultations is that fish populations have declined significantly over recent years, with increasing seine net activity both within the lagoon and across the creek entrances. Quamina Creek, in particular, was highlighted during community consultations as having much lower fish populations than in past years.

Local fishing pressure is generally concentrated within Western Lagoon, though several community members also fish using handlines and cast nets at sea, beyond Bar Mouth. There is general consensus that there has been a general decline in the number and size of fish being caught - bonefish and barracuda in particular have been highlighted as having decreased in numbers over recent years. One species, the small tooth sawfish (*Pristis pectinata*) is now considered locally extinct, possibly throughout Belize, following extensive fishing of this species. This species used to be present in Southern Lagoon in shoals numbering a hundred or more. The last individual to be seen in the system was in the 1960's (E. A. Myers, pers. com.). Whilst the cause of the decline is almost certainly predominantly fishing, consultations also suggest that Hurricane Hattie had a major adverse effect on the population.

Fishing is not only affecting the larger, traditional fish species within the lagoon systems, but also the smaller *Astyanax aeneus* in Manatee River, Quamina and Soldier Creeks, with reports that both Central American immigrants and Chinese living within the Dangriga area catch these fish in large numbers as a supplemental food source (community consultations, 2006).

Recently, more active enforcement and awareness activities by Fisheries Dept. has reduced the use of 3" seine nets, and the practice of using nets over the creek mouths, which has resulted in an increase in numbers and size of commercial species such as the Goliath Grouper, though populations are still far below their original levels (community consultations, 2006). There is concern, however, over the effect the shrimp boats that fish in the coastal waters may have on recruitment of fish stocks to the lagoon system, and on the possible effect agricultural pollutants may have in the future, with the increase in the agriculture areas along the Coastal Road.

3.5 Hunting

All communities of the Manatee Special Development Area – Gales Point, La Democracia, Gracie Rock and Freetown Sibun, have traditionally hunted in the coastal broadleaf forests and savannas, both for the table and for commerce (Gales Point, Gracie Rock, community consultations). This constant pressure on the game populations has led to the local extinction of the white-lipped peccary, and to the current low population levels of the smaller collared peccary, paca, armadillo and great curassow.

Some species, such as Baird's tapir, were hunted in the past, but are now starting to recover, as increased awareness of the conservation status of this species, of the penalties should hunters be caught, and the decrease in the commercial market, have now afforded this species a measure of protection.

4.0 Review of Current Situation – Areas of Concern

Several areas of concern have been identified for Southern Lagoon and adjoining lands, both in previous reports (FAO, 1978; Horwich, undated; McGill, 1994; Manatee Advisory Team, 1992; Wilson, 1995; Zisman, 1996), and from community consultations. Recognition of the importance and fragility of the ecosystems resulted in the declaration of the area as the Manatee Special Development Area in 1992. This was designed to balance increasing human impacts with protection of the natural resources, and identified a number of ecologically sensitive and unique ecosystems, and highlighted concerns that would need to be addressed through land use planning. It also suggested zoning – for the protection of species, for the protection of natural scenic beauty, and for local development opportunities (particularly in tourism), in an effort to regulate appropriate development whilst still conserving key species of the area, and maintaining the protective coastal bar.

4.1 Southern Lagoon System

This extensive lagoon complex, including Quashie Trap, Buttonwood, Sapodilla and other small lagoons, has been highlighted for its importance for both Antillean manatee and goliath grouper, as well as fly fishing stocks and local commercial species. The system is shallow in depth, and therefore particularly sensitive to chemical runoff, siltation and changes in water quality. Water feeds into the lagoon system from three primary sources, dependent on tidal flows – from the rivers and creeks of the Manatee watershed, from Northern Lagoon through Main Creek, and from the Caribbean Sea, through Bar River. Land use change in any of these areas may disrupt the seagrass and mangroves on which many of the lagoon species are reliant.

Concerns that have been highlighted within this area include:

- Impacts of increasing boat traffic in active manatee travel routes and frequent congregation areas such as Tarpon Hole and Quashie Trap
- Seine nets across creek and river mouths – particularly Manatee, Main and Bar Rivers, preventing natural movement of fish through the lagoon system, reducing fish stocks, and a potential threat to manatee, crocodiles and Central America river turtles
- Mangrove clearance or filling for development, removing important juvenile fish habitat
- Development in pine savanna adjacent to Southern Lagoon
- Potential water contamination from septic tank waste, particularly during storm flood events or through poorly designed septic systems
- Potential water contamination from agricultural chemicals
- Dredging and canal digging activities within and adjacent to the lagoon area, potentially causing siltation of the seagrass beds
- Increasing number of fly-fishing guides using limited resources
- Impacts of speeding boats on bank erosion in Main Creek and Bar River, and increased potential for boat collisions
- Disturbance of nesting birds by inexperienced tour guides and increased boat traffic

4.2 Rivers and Creeks

Southern Lagoon is fed by a number of rivers and creeks the majority of which start in the karst hills, then drain the pine savannas, before emptying into the lagoon system.

Concerns that have been highlighted within this area include:

- Clearance of 66' buffer riparian vegetation, with associated bank erosion and problems of increased sediment load
- Agricultural runoff from farmland, particularly in Quamina Creek (which has at times been used for drinking water collection)
- Overfishing with seine nets (particularly by people from outside the area)

4.3 Coastal Lands

Whilst only Bar River and Bar Mouth are located within the Wildlife Sanctuary, approximately 21 miles of coast lie within the SDA, forming an important storm barrier, protecting the lagoon and Gales Point from the storm surges that have accompanied hurricanes in the past. This band of mangrove and swamp, stretching from one and a quarter to two and a half miles wide, also provides an important function in the filtration of sediment runoff before water from the Manatee Watershed reaches the sea and the reef.

Concerns that have been highlighted within this area include:

- Erosion rate of the beach was highlighted in consultations during the SDA development process
- The rate of sinking of the beach was highlighted during community consultations in 2006, resulting in overwash, causing mortality in the turtle eggs
- Potential and active development impacts in the coastal area, particularly in the Hawksbill nesting area, with associated mangrove clearance
- Predation of hawksbill turtle nests by both wild animals and dogs
- Artificial lights impacts on hatchling turtles
- Impact of shrimp boat activity offshore on the recruitment of fish to the lagoon system and the health of the turtle population
- Impact of potential dredging activities on seagrass beds
- Impacts of boat traffic on manatee – especially in the Bar River area
- Past fishing impacts by seine net fishermen from outside the Gales Point area (including Honduras)

4.4 Pine Savanna

The pine savannas that surround the lagoon system have been heavily logged historically. Whilst the ecosystem was once predominantly pine forest, it has degraded into an open, short-grass savanna with intermittent clusters of pine, black and white oak and pimenta. The open landscape is also interrupted at times by karst hills cloaked in broadleaf forest, and by *Eleocharis* swamp. The more open nature of the system, with increased fuel loads from the dead grass in dry season, and increased burning from hunting activity, has led to increased fire, further degrading the pine areas. The soil characteristics also lead to sheet soil erosion during the wet season.

Traditional activities within this area are confined primarily to hunting paca, armadillo, iguana and white-tailed deer, with some pimenta collection for construction.

Concerns that have been highlighted within this area include:

- Increasing frequency and severity of fires in the savanna areas, caused primarily by hunters
- Incursions into savanna area by hunters from Cayo, Belmopan and Belize City
- Declining wildlife – used to be known as one of the best jaguar areas in Belize, but prey base is now believed to be reduced
- Unsustainable and illegal logging practices

4.5 Karst Hills

The broadleaf forest-covered karst hills within the pine savanna areas add to the scenic beauty of the Southern Lagoon area, and provide forest 'islands' on which many species depend. Cave systems such as Ben Lomond, also add tourism value, providing an additional resource for the Gales Point community.

Concerns that have been highlighted within this area include:

- Forest fragmentation, with removal of pine forest vegetation corridors that have allowed movement of wildlife between karst hills in the past
- Inappropriate tourism development in privately held lands, removing broadleaf forest and causing soil erosion on the steep slopes, removing already fragmenting valuable wildlife habitat, and impacting scenic beauty
- Removal of archaeological artifacts from the cave systems, decreasing touristic value
- Fires set in cave systems, damaging stalactites and stalagmites and other cave formations
- Graffiti on cave walls reducing visitor appeal
- Uncontrolled visitor access damaging cave formations

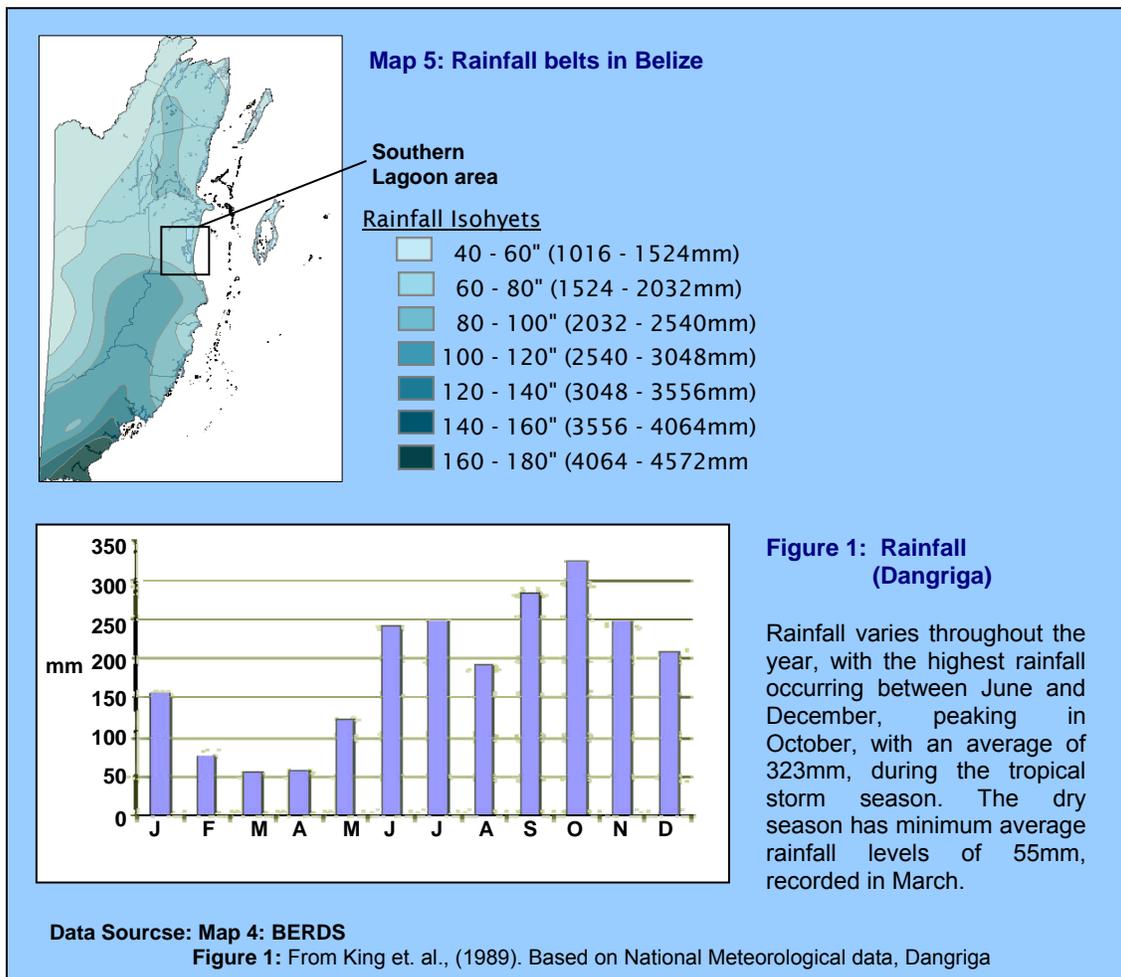
5.0 Physical Characteristics

5.1 Climate

Belize lies within the outer tropical geographical belt – with the relatively high temperature and rainfall patterns associated with the tropics being one of the factors that promote and sustain the high levels of biodiversity within the region. Prevailing winds are easterly from the Caribbean.

5.1.1 Rainfall Patterns

The Southern Lagoon area is situated on the central coastal lowland, an area defined climatically as sub-tropical, with distinct wet and dry seasons. It lies within the second driest rainfall belt in Belize, with an average annual rainfall of 228cm per annum (National Meteorological Service, 2005; Map 5).



There is a pronounced dry season stretching from February through to the end of May, with minimum monthly rainfall of as low as 55 mm in March, the driest month (Figure 1). The short grass savanna and associated pine also become parched, and as a result are prone to extensive seasonal wildfires, started by hunters seeking to attract game to the ash and regenerating grass shoots. The soil conditions in the limestone karst areas become increasingly xeric during these months.

The dry season is followed by a wetter season (June to December / January) with maximum rainfalls in the region of 280cm, punctuated by a mini dry season in August. The majority of the rain falls within the hurricane season, associated with passing tropical storms (particularly between September and November), resulting in sheet flow on the pine savanna, draining into the lagoon and inundation of the low-lying coastal mangrove. The annual fluctuations in the salinity of the lagoon system are dependent on the interaction between the seasonality of the rainfall, and the daily tidal movements.

5.1.2 Temperature

Lying within the subtropics, annual temperatures in the coastal area of central Belize (including the Southern Lagoon area) average approximately 26°C, with fluctuations throughout the year. Minimum mean temperatures of 19.5°C occur in January, during the cold fronts, whilst maximum mean temperatures of 31.8°C are recorded in May (Figure 2; Table 4; National Meteorological Service, 2005).

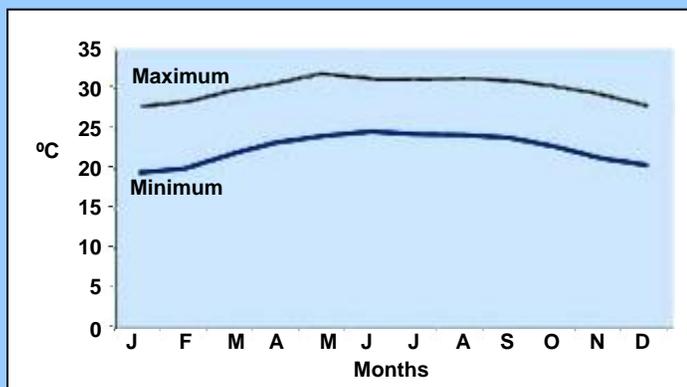


Figure 2: Temperature

Temperature

Air temperature in the Southern Lagoon area fluctuates throughout the year, dependent on the prevailing winds.

Month	Mean Temperature °C		Mean Total Rainfall (mm)	Mean Number of Rain Days
	Daily Minimum	Daily Maximum		
Jan	19.5	27.6	137.9	11.8
Feb	20.1	28.3	72.6	7.4
Mar	21.8	29.5	59.2	4.9
Apr	23.1	30.7	51.7	3.9
May	24.2	31.8	104.6	6.1
Jun	24.7	31.3	257.6	14.1
Jul	24.3	31.1	243.5	16.3
Aug	24.2	31.3	186.9	15.9
Sep	23.9	31.0	286.5	15.9
Oct	22.7	30.2	254.6	15.4
Nov	21.3	29.1	182.8	12.6
Dec	20.4	28.0	175.6	11.9

Table 4: Temperature and Rainfall

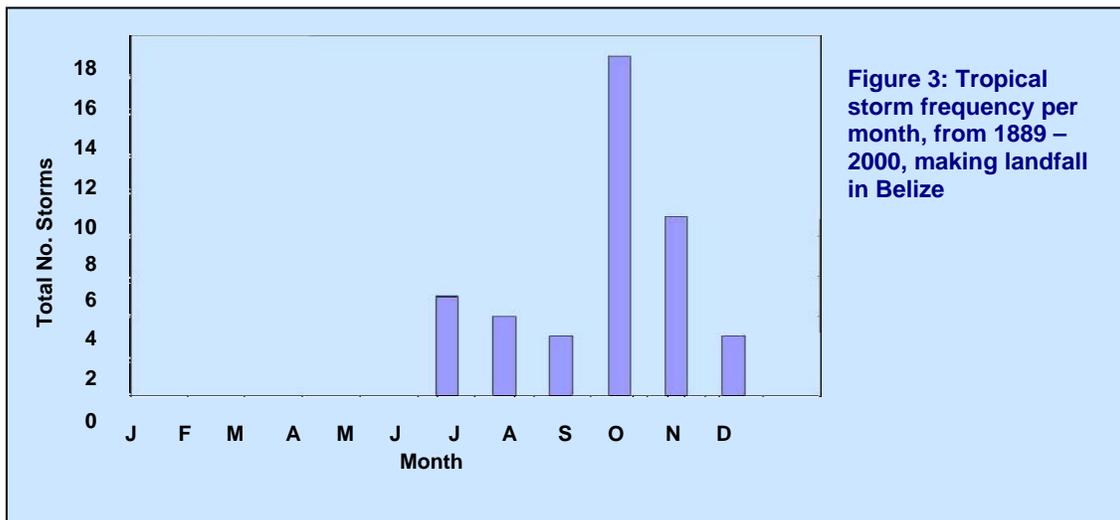
Data Source: Figure 2, Table 4: National Meteorological Service of Belize, 2005.

5.1.3 Weather Systems

Belize is affected by three very distinct seasonal weather systems - the Trade Winds (blowing from the east), tropical storms (occurring between June and November), and northers (occurring between October and April), all of which have an influence on the rainfall and temperature patterns.

Tropical Storms

Tropical storms form in the Atlantic Ocean over warm, tropical waters and are non-frontal, developing highly organized circulations. Ranging in scale from tropical depressions and storms (with sustained wind speeds of < 74 mph) to hurricanes (with sustained wind speed > 74 mph), these storms move westward towards the Caribbean, gathering strength until they hit land (Figure 3).



Hurricanes play a major role in the structural development of the coastal forests in Belize, including that of the karstic hills and riverine forest belts of the Southern Lagoon, reflecting the perturbation dependence of forests that lie within the Atlantic hurricane belt. This has resulted in the general term “hurricane climax forest”, with a species composition influenced by the cycle of natural disturbance from these tropical storms.

Clearance of land from the creek and river margins for agriculture and tourism development removes the protective vegetation buffer, resulting in the heavy rainfalls associated with hurricanes washing soil into the waterways, increasing sediment load in the creeks and rivers that flow into Southern Lagoon, whilst the strong storm waves during tropical storms alter the sediment distribution within the lagoon system.

The heavy rainfalls associated with these tropical storm events also cause increased river flow and a decrease of salinity within the lagoon system itself, resulting in changes in distribution of freshwater species such as the Central American river turtle (*Dermatemys mawii*), which is known to enter Western Lagoon at times of low salinity, as well as the composition and biomass of subaquatic vegetation (Wildlife Trust, unpublished data).

The Southern Lagoon area has been affected by a number of hurricanes in the recent past (Table 5) – with Hurricane Hattie in October 1961 being the most severe. This made landfall to the north east of the area, with hurricane force winds estimated at 150mph, and tides of 10 to 15 feet above normal, sweeping salt water many miles inland over the low coastal areas. Gales Point itself was protected from the worst of the storm surge by the coastal bar - though

the strong winds caused the destruction of the majority of the houses, flooding only occurred in the lowest areas of the peninsula.

Table 5: Hurricanes affecting the Southern Lagoon Area				
Year	Hurricane	Speed at Landfall	Date of Landfall	Notes
1961	Hattie	150mph	31/10/1961	Made landfall north east of the Gales Point area, with a tidal surge of between 10 and 15 ft on the coast, and inundation of the lower lying areas of the Gales Point peninsula.
1978	Greta	110mph	19/9/1978	Made landfall just north of Stann Creek, approx. 20km south of the Southern Lagoon area, resulting in a tidal surge of between 4 and 10ft in coastal areas.
2000	Keith	69mph	03/10/2000	Made landfall far north of the Southern Lagoon area, but caused heavy rainfall resulting in substantial flooding of the coastal savanna
Data Source: National Hurricane Centre				

More recently, Hurricane Keith, in October 2000, not only brought flooding, but also resulted in the denudation of the trees in the karst area to the west of Northern and Southern Lagoons (R. Gentle, pers.com.). These are reported to have re-leafed, suggesting that the storm was not as devastating as the more recent Hurricane Iris, which caused wholesale massive damage to forest structure in southern Belize in 2001. There was also substantial flooding of the area as a result of the heavy rainfall associated with the hurricane (32.67 inches being recorded at the Philip Goldson International Airport), causing significant amounts of flooding in riverine areas.

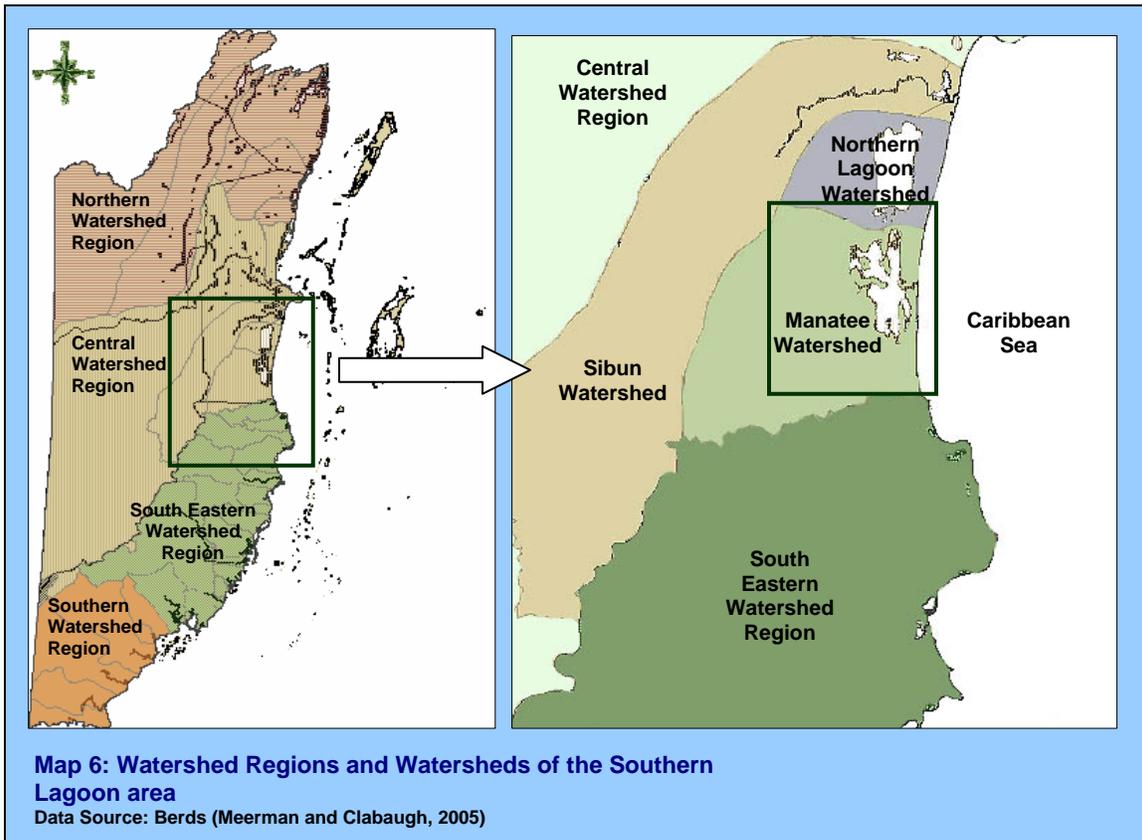
The landscape of the Southern Lagoon area, with caves, hills and sheltered valleys, ensures that the wildlife and forest structure is more sheltered, and better able to withstand hurricane force winds and flooding than in the non-karstic coastal plain broadleaf forest of Toledo, where recent biodiversity assessments indicate that some devastated areas of broadleaf forest now have extremely low vertebrate presence.

Northers

Northers affect the country from October through to April (with highest frequency in December, January and February). These cooler air masses move down from North America, bringing cooler temperatures and, on occasions, heavy rain and winds. These have little effect on the Southern Lagoon area other than the reduction in temperature, possibly reducing herptile activity during the coldest days and nights.

5.2 Hydrology of the Southern Lagoon Area

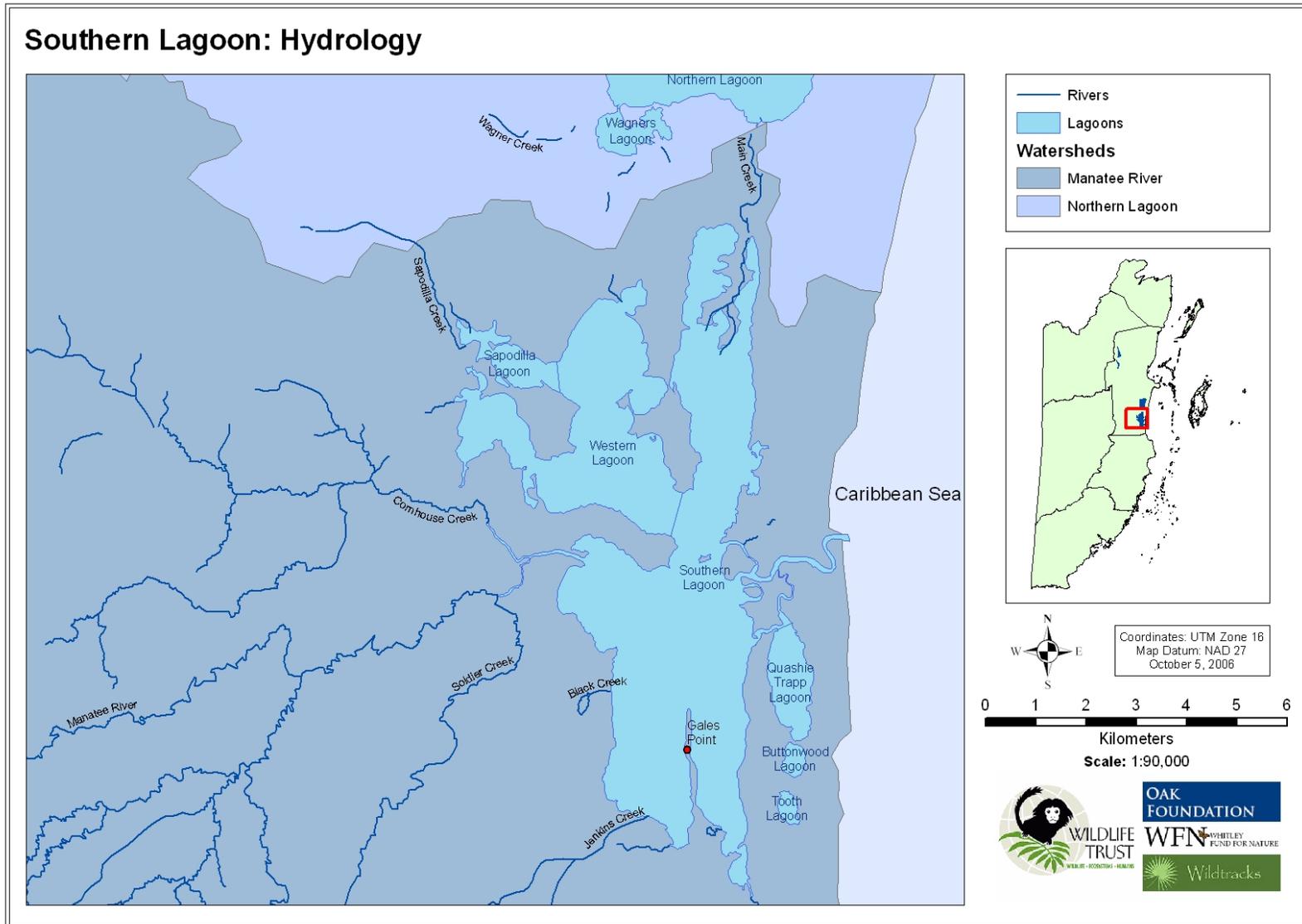
The Southern Lagoon area is located within the Manatee Watershed, which covers approximately 125,400 acres, and lying in the Central Watershed Region (Map 6; BERDS, 2005). Water drains from the surrounding savannas and karst hill slopes into the rivers and creeks that feed into the system – Manatee River, Black Creek, Cornhouse Creek, Sapodilla Creek, Soldier Creek, Jenkins Creek and Quamina Creek (Map 7). Water then flows from the lagoon out to the Caribbean Sea through Bar River, and out to Northern Lagoon through Main Creek.



The convoluted nature of the shoreline of Southern Lagoon has led to the naming of bays and bights within the system – Western Lagoon, Sapodilla Lagoon, and Southern Lagoon all being within the main water body of Gales Point Wildlife Sanctuary, whilst Quashie Trap Lagoon, Buttonwood Lagoon and Katy Pond lie to the east, separated from the main lagoon by an old coastal bar, and from the sea by the most recent beach deposits. These three smaller lagoons are linked north to south to each other, and flow northwards out through Quashie Trap Lagoon and tributary into Bar River to the north and Southern Lagoon to the west (Map 9).

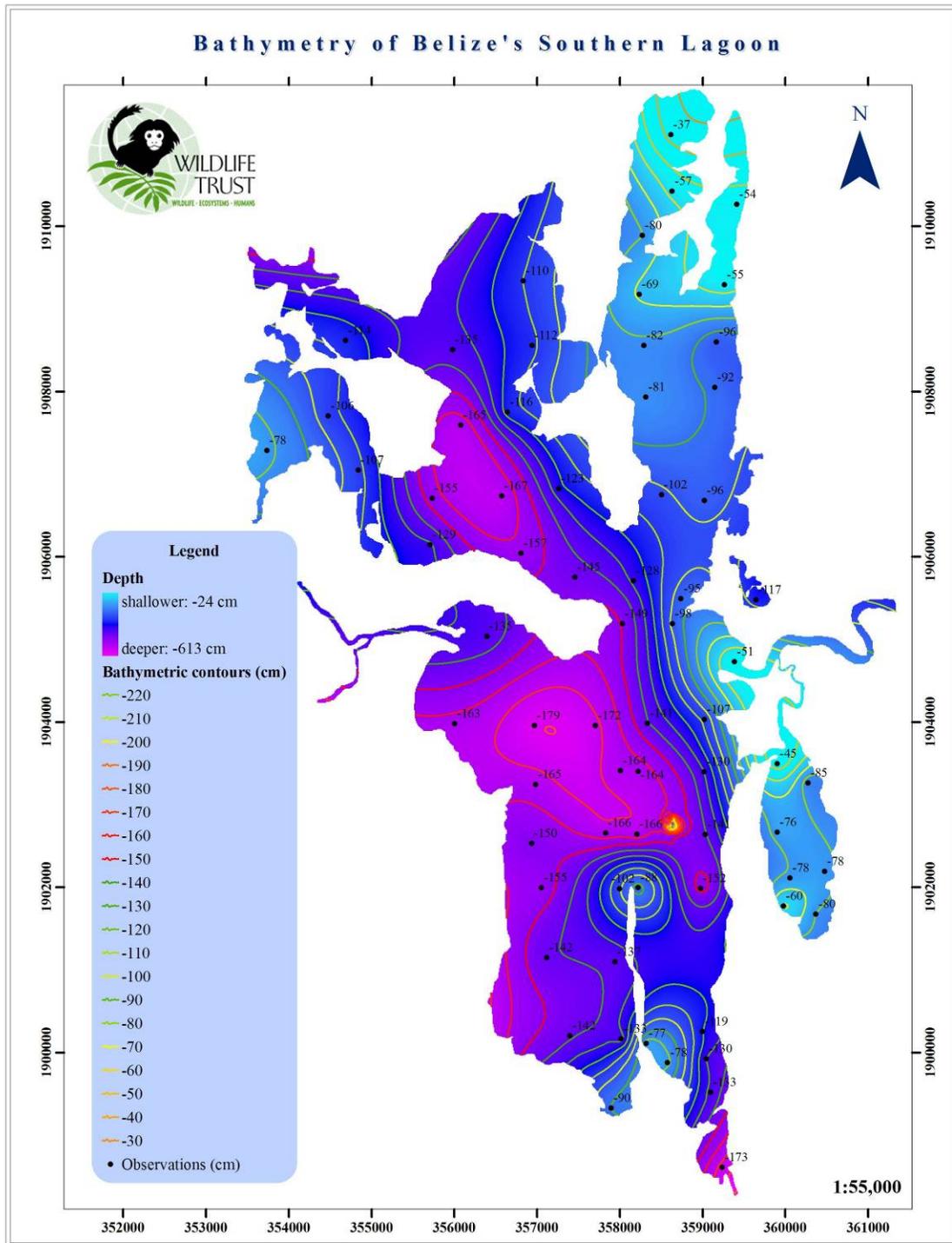
Direction of water flow through Main Creek and Bar River changes depending on the tides, whilst water level within the lagoon system, primarily influenced by tidal patterns (with a variation of water level of between 6 and 10 inches), is also affected by changing wind directions. As with many of the coastal lagoons in Belize, the water level drops with the strong north winds that blow from November to April, and increases later in the year with the strong easterly trade winds.

Bathymetry of the system has been mapped under the Wildlife Trust project (Map 8), and clearly highlights the shallow nature of the enclosed lagoon system, with deeper water to the western portion of the lagoon



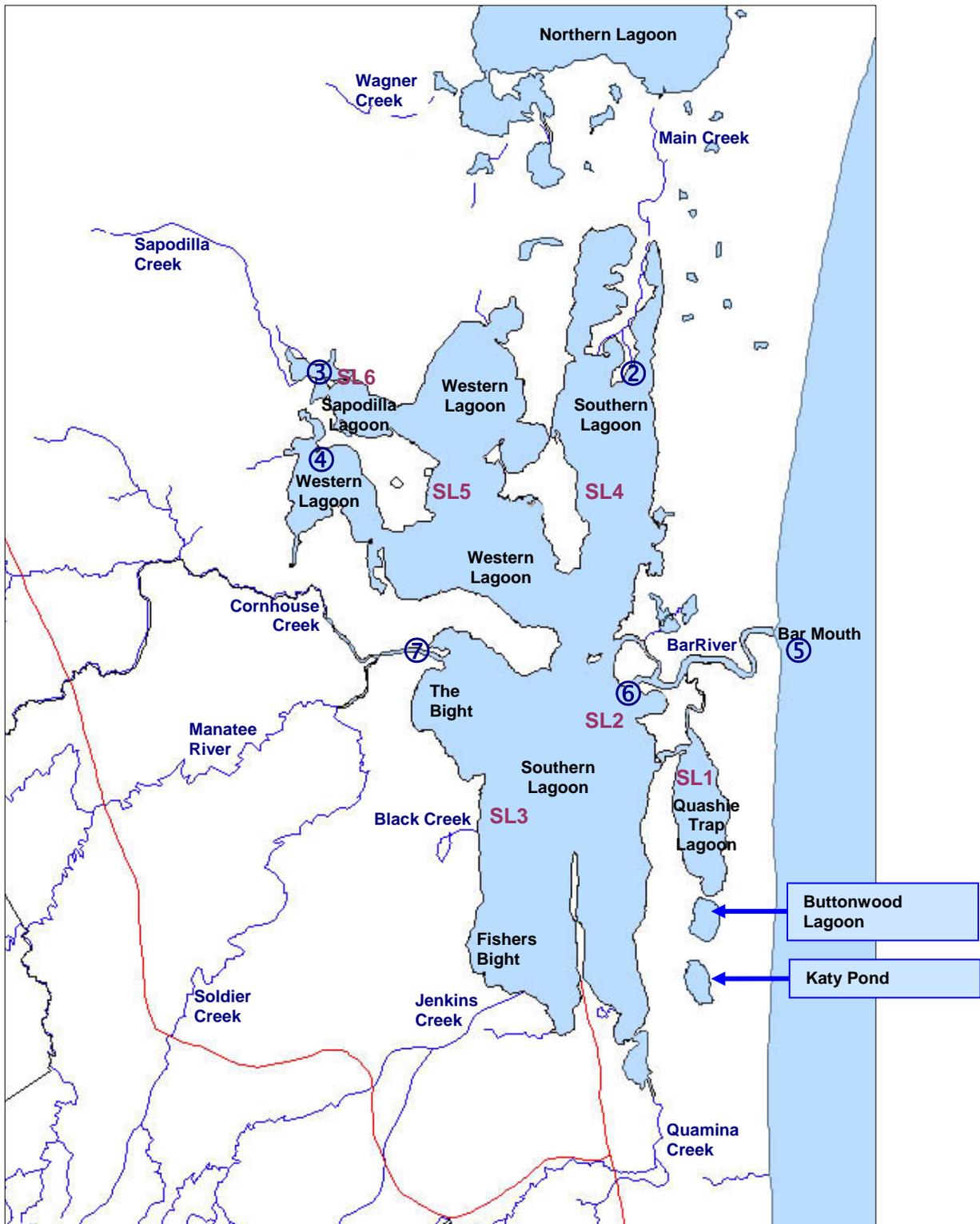
Map 7: Southern Lagoon: Hydrology

Mapping: A. Lloyd; Wildtracks



Map 8: Bathymetry of Southern Lagoon

Salinity within the lagoon system is moderated by the freshwater flowing into the system, and is highly variable throughout the system being impacted by surface run off and the reversal of several of the creeks with the tides. It also varies seasonally as rainfall and temperature vary throughout the year.



Map 9: The Southern Lagoon System: Water Sample Points

① Water sampling point for REA; SL1 Wildlife Trust vegetation sampling point

5.2.1 Southern Lagoon

Life in Gales Point centers on Southern Lagoon, the largest water body of the Southern Lagoon system (Photograph 1). The beauty and serenity of the lagoon draws tourism to the community, which sits on a narrow peninsula surrounded on three sides by water. Traditionally, fishing has figured prominently in the day to day lives of Gales Point residents. The extensive seagrass beds support a well studied population of Antillean manatees, and in the future, these manatee, the game fish – tarpon and permit among them, and the rich culture of the community – will be relied on to help Gales Point grow as a national tourism resource.



Photograph 1: Southern Lagoon

Most areas of the lagoon are shallow, ranging in depth from 50cm to 200cm (not including Manatee Hole which is deeper than 10m), with sediment composed predominantly of mud and very fine sand (or silt), with coarser sand, small shells and clay in places. Although turbidity is high throughout most of the lagoon system, the shallow depth means that light can penetrate to the bottom in most areas, enabling seagrass and other aquatic vegetation to grow.

Following concerns within the community over a marked decline in fish populations in the lagoon system, Fisheries Department have become more active within the area, enforcing regulations concerning seine nets, leading to a reduction in the level of netting within the lagoon system, and an overall increase in the fish populations – though still far below the original populations that used to support the community.

Active and Potential Impacts:

- Increasing land use change adjacent to the lagoon, with removal of vegetation within the 66' buffer, leading to increased beach erosion and run-off
- Poor sewage disposal, with leaching into the lagoon system, resulting in nutrient enrichment and eutrophication
- Increased boat traffic, with risk of manatee strikes
- Increased agricultural activity on creek and river banks, leading to escalating runoff of agrochemicals and problems of nutrient enrichment
- Seine net use both within the lagoon and across creek access points

Opportunities:

- Scenic vistas, wildlife, and local culture have the potential to attract tourism
- Potential for community management of fish stocks for sustainability
- Attraction of lagoon to researchers through the Wildlife Trust project

5.2.2 Main Creek

Main Creek has provided a transport link between Southern and Northern Lagoon since Europeans settled in the area (Photograph 2). It was important for the early logging industry in the late 1800's and 1900's, when logs and milled wood were floated to Belize City by barge and lighters through Northern Lagoon and then Burdon Canal. Overfishing in the last ten years has led to greater enforcement of fishing regulations by the Fisheries Department, and a decline in the practice of placing seine nets over the creek mouth. Fishermen commented that the reduction of seine netting over creek mouths has led to a noticeable increase in fish numbers (Gales Point community consultations, 2006).



Photograph 2: Main Creek

The increase in salinity in April / May, when the easterly trade winds start to blow and consequent running of the *Eugerres plumieri* in the hundreds is recognized by fishermen of Gales

Point, who time their cast net fishing activities to coincide with the large numbers at this time of year. This traditional haul is only sustainable if the seine net regulations are strictly enforced, particularly for the north and south Main Creek mouths.

Active and Potential Impacts:

- Threats to the creek include clearance of vegetation from the creek edges, resulting in increased sedimentation, destabilisation of the banks and removal of the mangrove roots, which are recognised as essential as nursery areas for juveniles of many of the commercial fish species.
- With the restricted width of the channel, there is also a significant risk of boat strikes on Antillean manatee, Morelet's and American crocodiles (*Crocodylus moreleti* and *C. acutus*), with past recommendations including creating a slow boat speed zone within the creek area.

5.2.3 Quamina Creek

Traditionally, Quamina Creek has been the drinking water source for the Gales Point community, with people using non-motorised dories to collect water from upstream. Whilst this use has become less viable with agricultural chemical use upstream, the creek is still used locally for a limited amount of fishing, and for hunting paca, armadillo and green iguana.



Photograph 3: Quamina Creek

Manatees enter the creek occasionally, and Morelet's crocodile is also known to inhabit the upper reaches. With its undisturbed swamp forest and mangrove covered banks, Quamina Creek has potential as a kayaking destination from Gales Point, if managed carefully (Photograph 3).

Active and Potential Impacts:

- Threats to this creek include citrus farming upriver, resulting in chemical herbicide and pesticide washing into the creek during heavy rainfall.
- Past impacts have also been from vehicles traveling on the Coastal Road, which crosses the creek south of the Gales Point junction – a major accidental spill from an oil tanker caused concern of large scale oil pollution in 2000, but was controlled by the Department of the Environment. Oil tanker traffic has increased significantly since then, with tankers transporting oil from Spanish Lookout to Big Creek.
- Past seine netting has reduced both the fish and turtle populations (including the Central American river turtle), but this activity has now been reduced within the Southern Lagoon generally following increased awareness and enforcement activities by Fisheries Department.

5.2.4 Manatee River

Whilst now used primarily for tourism, Manatee River was once important for the transportation of mahogany and cedar logs, floated in rafts downriver and eventually to Belize City (Photograph 4). It was also important for local transport, with many people living on the river bank in the Government Landing area, working river-side plantations and milpas. As the population of Gales Point grew, and that of Manatee River dwindled, the river's importance in the lives of people in the area also diminished. Now the primary use for the river is for fishing and tourism, with boat tours being offered from Belize City and Manatee Lodge. It is also the largest freshwater source for the lagoon system in the dry season, and is important for species reliant on fresh water such as manatees.



Photograph 4: Manatee River

Active and Potential Impacts:

- The biggest long term threat, both active and potential, to the health of the Manatee River is the clearance of the 66' river bank vegetation, the resulting increase in sedimentation levels,
- Potential threats from increased agricultural chemical use also exist, particularly in areas where bankside vegetation has been removed.
- In-stream sand and gravel mining is also a concern - this has taken place near Government Landing, leading to an increase in suspended sediment levels during mining operations.
- The increased tourism boat traffic may present an increased risk of collisions with manatees in the river, and increased erosion of river banks from boat wakes.

5.2.5 Sapodilla and Western Lagoon

It would appear that the majority of local seine net fishing occurs in the Western Lagoon area, with nets being stretched from Tiger Point across the entrance to this north western portion of the Southern Lagoon system. The area is also considered particularly good for fly-fishing, which is one of the potential alternative livelihood options for Gales Point Village tour guides. Tracking data also shows consistent use by female manatees and their offspring in this lagoon area.



Photograph 5: Sapodilla and Western Lagoon Area

Active and Potential Impacts:

- The biggest threat is that of overfishing, primarily through the use of seine nets within the lagoon system.
- Future fly fishing activities may also impact fish stocks if not carefully controlled

5.2.6 Bar River

Important in its function of linking Southern Lagoon with the sea and providing a continual tidal flow into and out of the lagoon system, Bar River is also critical in its role in maintaining local fish stocks (Photograph 6). The basin mangroves that line the river provide essential juvenile nursery areas, and the series of creeks and pools provide shelter for commercial species. This link with the Caribbean Sea is also critical for the manatees, which have been shown to move between the lagoon system and the coastal area.



Photograph 6: Bar River

Active and Potential Impacts:

- Community consultations suggest that past use of seine nets at the Bar Mouth have severely depleted fish stocks within the lagoon system itself
- Off shore shrimp fishing is also thought to be degrading the fish stocks and seagrass viability through trawling activities and poor management of by-catch
- Increasing boat traffic is increasing the risk of manatee strikes
- Poorly managed tourism has the potential to cause disturbance to manatee, nesting birds and other wildlife

5.2.7 Soldier Creek

Representative of the creeks that feed into the lagoon system, this creek supports a representative freshwater fish population, has high tourism value, for swimming, and for the natural beauty of the forest on its banks (Photograph 7).



Photograph 7: Soldier Creek

Active and Potential Impacts:

- Community consultations suggest that small mesh seine nets are being used by Chinese and Central Americans from Dangriga and adjacent communities to catch even the small *Astyanax fasciatus* to supplement diets
- The creek, like the majority of others in this area, are crossed by the Coastal Road, with the inherent dangers of passing vehicles and potential accidents, releasing fuel and oil into the water, and annual flooding undermining the road structure, causing increased sediment load
- Upstream, the creek passes through agricultural lands, at places with land clearance to the waters edge, with increased potential of agrochemical run-off and soil erosion
- Tourism impacts, with increased levels of garbage

5.2.8 Water Quality

Wildlife Trust monitored basic water parameters during intensive sampling periods in 2006, representing the dry (April) and wet (September) seasons (Figure 4).

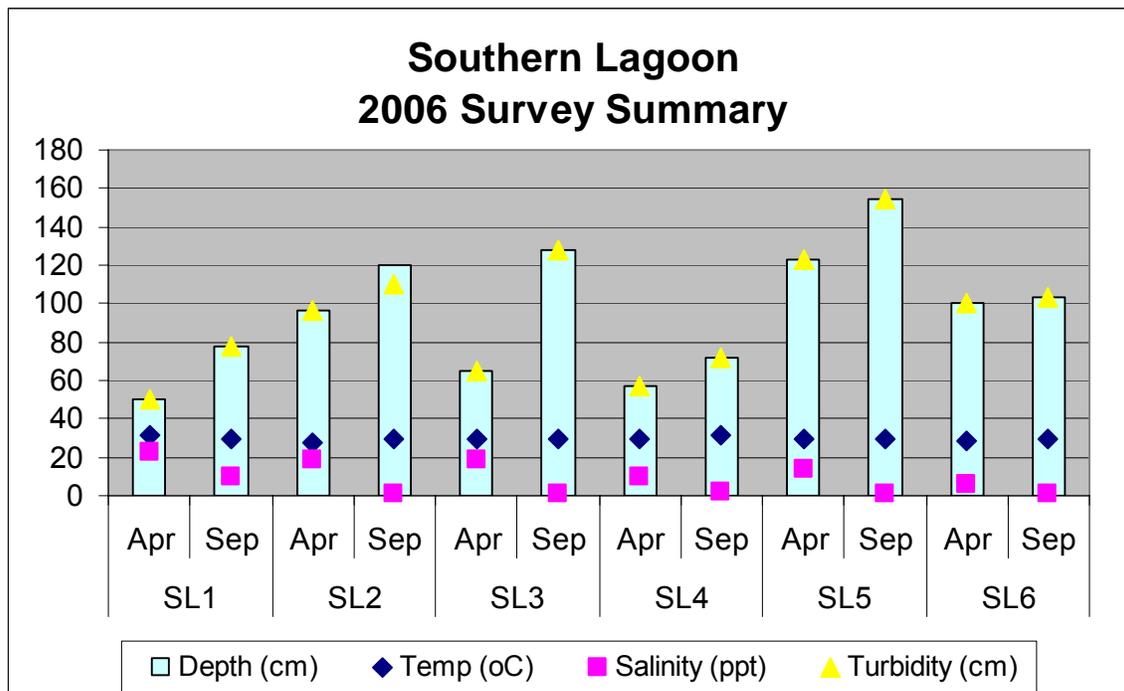


Figure 4: Physical parameters of Southern Lagoon: Collected during vegetation sampling in the dry (April) and wet (September) season for 2006. Depth (cm), temperature (celcius), salinity (parts per thousand) and turbidity (vertical visibility in centimeters) were recorded.

The depth measurements demonstrated that the deepest points in the lagoon system, excluding the ‘holes’ (depressions in the lagoon bed, found throughout the system) were no greater than 2000cm. During the wet season, water depth throughout the Southern Lagoon system averaged 27.3cm deeper than in the dry season. Water temperature remained relatively stable throughout the year, ranging from 28° to 31°C, with an annual average of 29.9°C (Wildlife Trust).

With water quality being crucial to the health of the lagoon ecosystem – especially to the viability of the seagrass on which the primary focal species, the Antillean manatee, is dependent - a series of water tests were also conducted during this assessment to provide information on basic water parameters for seven sample points (Table 6; Map 9). The samples were analyzed by Belize Water Services Limited, in January, 2006.

Table 6: Water Test Sample Points		
Sample Points		
Sample Point 1	Bird Isle, Northern Lagoon.	UTM Coordinates: 360572; 1918808 (not on map)
Sample Point 2	Main Creek Mouth (South).	UTM Coordinates: 359071; 1909067
Sample Point 3	Sapodilla Lagoon Creek.	UTM Coordinates: 353736; 1909751
Sample Point 4	Western Lagoon.	UTM Coordinates: 353773; 1908068
Sample Point 5	Bar River (Inner Mouth).	UTM Coordinates: 359152; 1904627
Sample Point 6	Bar River (Outer Mouth).	UTM Coordinates: 361383; 1905391
Sample Point 7	Manatee River.	UTM Coordinates: 355284; 1905113

Conductivity and Salinity

Conductivity (S/cm) and Salinity (ppt)							
Sample Point	1	2	3	4	5	6	7
Conductivity (S/cm)	8360	8710	17420	23600	25100	26800	330
Salinity (ppt)	4.7	4.9	10.3	14.3	15.5	16.5	0.2

Conductivity is a measure of the total concentration of dissolved inorganic salts in the water, through their ability to conduct electricity. It can provide an indication of whether the chemical nature of the aquatic ecosystem is being altered, providing a warning of potential loss of native biodiversity. Fish and other organisms of Southern Lagoon are primarily euryhaline, being adapted to rapid changes in salinity and conductivity with daily tidal patterns superimposed on freshwater flushing during wet season, and concentration of salts during dry season. Estuarine systems are considered to be stable if they show a 5% variation in conductivity from background levels over the year (ANZECC, 1992).

A series of samples were taken from throughout the lagoon system (Table 6), to provide a snapshot of conditions within the system. As expected, salinity (a more specific measure of chlorine ions) is greatest at Bar River mouth (16.5ppt), where the system empties into the Caribbean Sea and lowest at the mouth of the Manatee River (0.2ppt), with varying levels throughout the lagoon system. Year-long monitoring by Wildlife Trust also recorded highest salinity in the Quashie Trap mouth and Bar River at 35ppt in April-May; this consistently when salinity is highest through the system. Salinity within the open lagoons will vary dependent on the tide, increasing as salt water enters the lagoon through Bar River, as the tide comes in, then decreasing as the tide ebbs, and water flows out of Southern Lagoon. Salinity is also lower in Northern Lagoon, the reading for the southern mouth of Main Creek being 4.9ppt.

Moving up Manatee River, salinity decreases with increasing distance from the lagoon, this change also being indicated clearly by changes in the riverine vegetation from mangroves near the river mouth to the riparian forest on the non-saline, rich alluvial soils further upstream. A

similar change is also seen in Quamina Creek, where the mangrove gives way to swamp forest once salinity is 0.0ppt.

Salinity would also be expected to increase sharply during the first major rainfall of the wet season, which will wash salts concentrated in mangrove savanna areas during the dry season into the lagoon system. Increasing rainfall, and inflow from the watershed, will then start to dilute the system, reducing salinity. Another more sustained peak would be expected to occur at the start of the strong easterly trade winds, which will increase the flow of salt water into the lagoon system, resulting in seasonal movements of fish within the system, as seen with the congregation of large numbers of mojarra in Main Creek in April / May. The Central American river turtle also responds to changes in salinity, with local reports suggesting that this species, normally restricted to the freshwater creeks, will enter Sapodilla Lagoon to forage in the seagrass areas during peak wet season, when salinity is at its lowest.

Total Hardness (mg/L)

Hardness (mg/L)							
Sample Point	1	2	3	4	5	6	7
Hardness (mg/L)	931	953	2065	2796	2792	3120	158

Hardness in water is caused primarily by the presence of dissolved calcium and magnesium, derived from limestone (composed of calcium carbonate) and dolomite (composed of calcium carbonate and magnesium). Calcium carbonate sediment, originating in the karstic hill slopes, is carried by the rivers and creeks to the Southern Lagoon system, where it settles out and accumulates to form the lagoon substrate, resulting in all water samples taken within Southern Lagoon being considered hard to very hard (in drinking water, values of 200mg/L and above are considered 'hard'). The presence of *Chara* sp., with its characteristic calcium carbonate encrusted leaves, is considered indicative of the high level of hardness recorded from Southern Lagoon.

Nitrogen and Phosphorus

Nitrates and Phosphates (mg/L)							
Sample Point	1	2	3	4	5	6	7
Nitrates (mg/L)	3.54	4.43	4.87	4.43	5.31	8.87	5.31
Phosphates (mg/L)	0.12	0.12	0.11	0.15	0.11	0.08	0.07
N:P	30:1	37:1	44:1	30:1	48:1	111:1	76:1

Nitrogen and phosphorus (present primarily as nitrates and phosphates) are essential nutrients for both plants and animals within any water body, and cycle through the natural system. Availability of either one or the other of these compounds is thought to be a limiting factor for plant production in aquatic systems, and an increase in nutrient availability of either compound has the potential to upset the natural balance, resulting in algal blooms and eutrophication.

It is generally accepted that the majority of river systems are phosphorus-limited in the upper, freshwater areas, but become nitrogen-limited downstream in estuarine areas, where the water becomes brackish. This limitation, once thought to be related to salinity, is now considered to be directly related to the total nitrogen (TN) and total phosphorus (TP) concentrations in the water column, and the ratio between the two (TN:TP) (Guildford, 2000). It is generally considered that a TN:TP ratio <20 indicates a nitrogen limited system, whilst ratios > 50 indicate a phosphorus limited system. The majority of the readings lie between the two, suggesting (as with many estuarine systems) that either compound could be limiting dependent on conditions.

Two samples (6 and 7) show higher readings, suggesting phosphorus limitation to plant growth – this is not unexpected for Sample 6, the mouth of Bar River, where it meets the Caribbean Sea.

The reading for Sample 7, however, at the mouth of Manatee River, has a higher than expected ratio, possibly with elevated levels of nitrogen being carried as nitrate (NO_3) in the river from anthropogenic activities upstream.

Nitrate, a naturally occurring form of nitrogen, is normally present at minimal levels within any water body, being released as excreted ammonia or through decomposition, and is often the primary limiting nutrient in marine systems.

Naturally elevated levels of nitrate might be expected adjacent to active bird nesting or roosting sites (such as the two highlighted bird islands in Northern Lagoon), and in the first flush of nutrients leached from the savannas at the start of wet season.

Unnaturally high levels of nitrates may be attributable to agricultural chemicals (fertilizers, herbicides and insecticides) and septic system effluent leaching into the creeks and river system, and from there into Southern Lagoon, and can result in the increased incidence in algal blooms, in increased seagrass epiphyte load, and eventually a decline in the extent and health of seagrass beds within the lagoon system. Levels in Site 7 (Manatee River) are slightly elevated, possibly as a result of agricultural runoff, but do not approach the minimum levels for concern (acceptable nitrate (NO_3) levels in potable water, for example, are 45mg/L). Past research has shown that adverse effects from increased nitrogen loading through agricultural activities or poor sewage disposal have greater impact in areas such as Southern Lagoon, where there is restricted flushing.



Photograph 8: Green algal growth in Southern Lagoon

Phosphate is also a necessary nutritional component for plant and animal growth, and is considered a limiting factor to seagrass abundance and growth in freshwater systems, and in some estuarine and marine in-shore ecosystems (particularly those with carbonate sediments (Ferdie and Fourqurean, 2004)). As with nitrates, however, too much phosphate can cause excessive seagrass epiphyte growth, reducing light availability, and competition for nutrient availability.

The effects of excessive phosphorus are similar to those of nitrogen loading, also increasing the incidence of green algae, cyanobacteria, and phytoplankton in the water column, all reducing water transparency and the availability of light to seagrass, as well as competing with other organisms for oxygen – especially in such a shallow lagoon ecosystem (Photograph).

The recommended nitrogen concentration for rivers, streams and estuarine systems for avoidance of algal blooms is 0.1 to 1 mg/L, and 0.01 to 0.1 mg/L for phosphorus (a 10:1 ratio of N:P). Higher concentrations are recognised as supporting less diversity (NOAA/EPA, 1988). Any decrease in the distribution and abundance of seagrass within the Southern Lagoon ecosystem as a result in the change of nitrogen and phosphorus concentrations would be considered detrimental to the health of the ecosystem.

General Recommendations

It is important that a baseline of salinity, rainfall, temperature, turbidity and dissolved oxygen, gathered continuously and consistently over several years at pre-defined sample points in the lagoon, should be developed to provide greater understanding of the natural cycles against which changes are being monitored.

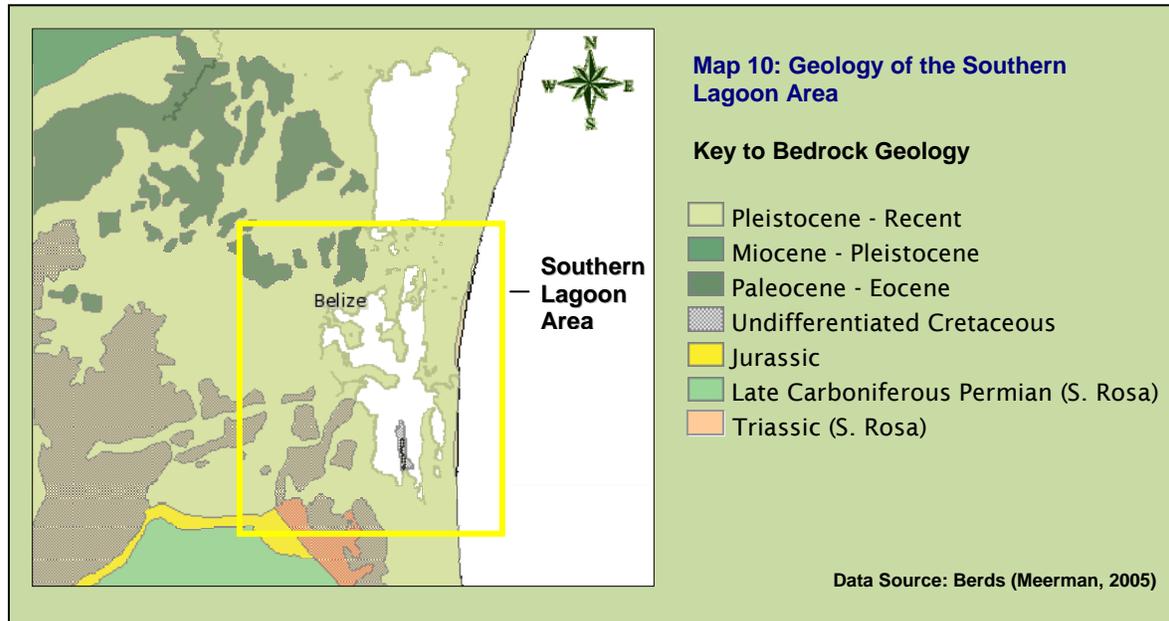
It is also recommended that this be integrated within a comprehensive water quality monitoring programme, with nutrient monitoring being targeted particularly at the creeks and river flowing

from the agricultural areas, and tied into monitoring of seagrass distribution and abundance in Southern Lagoon, and of algal blooms. Phytoplankton levels can be measured through monitoring of chlorophyll a concentrations, to give data on spatial variability and long term trends, for analysis of relationship to nitrate and phosphate levels.

Future water monitoring for nitrates and phosphates should continue, and also include the Manatee River and the major creeks (Quamina, Soldier, Jenkins and Cornhouse) both where they are crossed by the Coastal Road, and 300m upstream from where they enter Southern Lagoon. This is particularly important for Quamina Creek, which is occasionally used as a water source for Gales Point. It should be noted for both phosphate and nitrate monitoring, that the results, whilst useful in measuring and comparing levels of phosphate and nitrate over time, do not distinguish between nutrients that are available for uptake by plants, and those that aren't. Monitoring will also need to account for nutrients stored and released by the lagoon sediment.

5.3 Geology, Soils and Land Use

The Southern Lagoon area is characterized by two main geological features – the low to medium height karst hills formed from Cretaceous limestone rocks of the Campur formation (Miller, 1996), and those of the younger, low lying Pleistocene coastal plain (Maps 10 - 13).

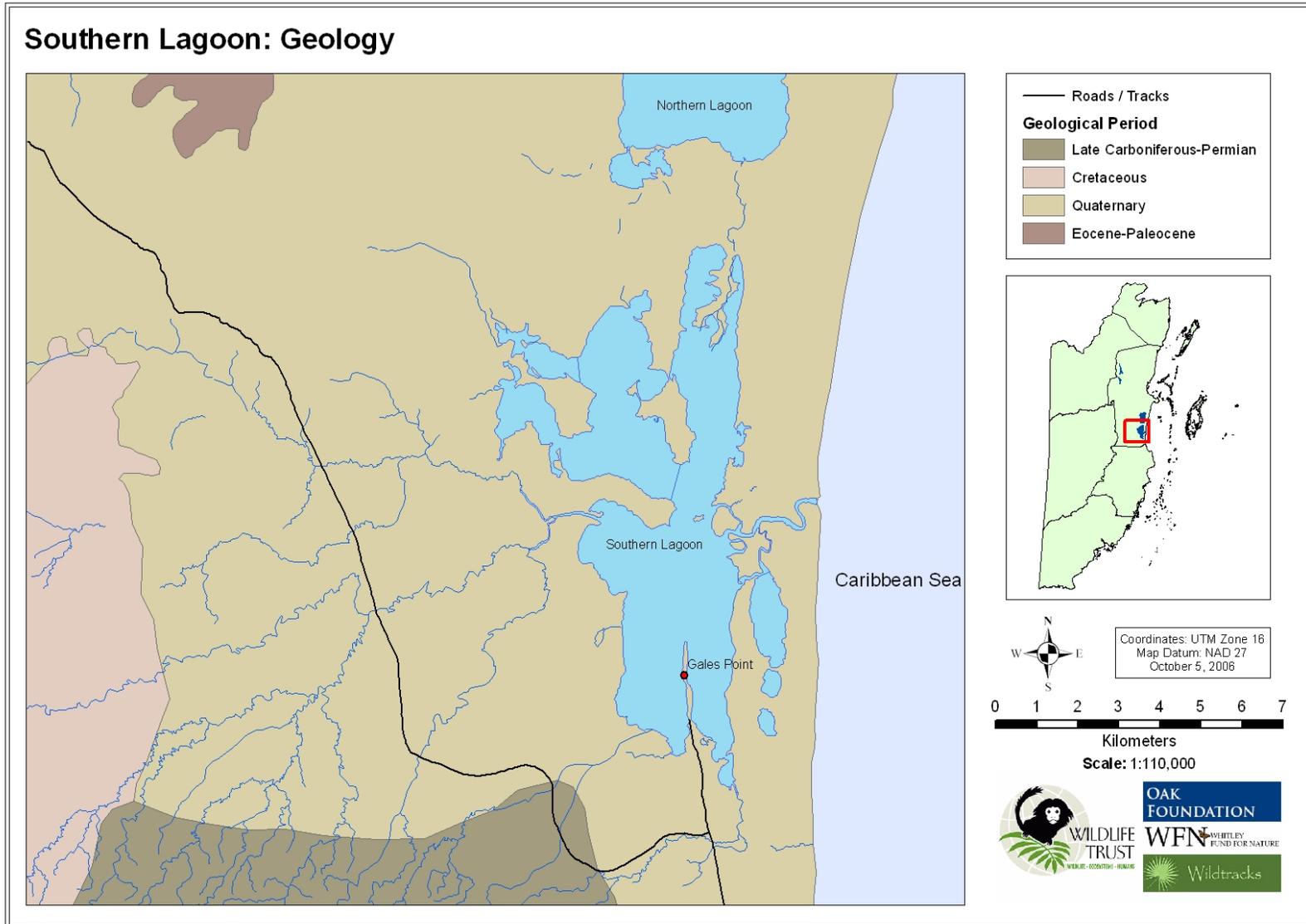


5.3.1 Karst Hills

The north west / west Southern Lagoon area is located in Sibun-Manatee karst region, the most northeasterly of the eight karst regions that have been identified in Belize (Miller, 1996). The area is considered to be an extension of the Boundary Fault region, estimated at 550km², with a maximum relief of 200m (Miller, 1996). Much of the area is tower karst – the final stage in the erosion of limestone deposited on the coastal plain 65 to 125 million years ago, and is indicative of the area being covered by a warm, shallow sea, with calcium carbonate deposition. As sea level dropped, the sedimented limestone bedrock became exposed, and was infiltrated by water, eroding to create sinkholes over time. These increased in size over time to gradually join together, leaving only the hardest remnants of the original Cretaceous limestone standing as tower karst, rising out of a flat valley floor. The recent nature of the landscape is indicated by the limited amount of colluvium at the base of the towers. Characteristic of this geology are the numerous caves found throughout the area, such as Ben Lomond to the north, as well as sinkholes and underground streams (Photograph 9).

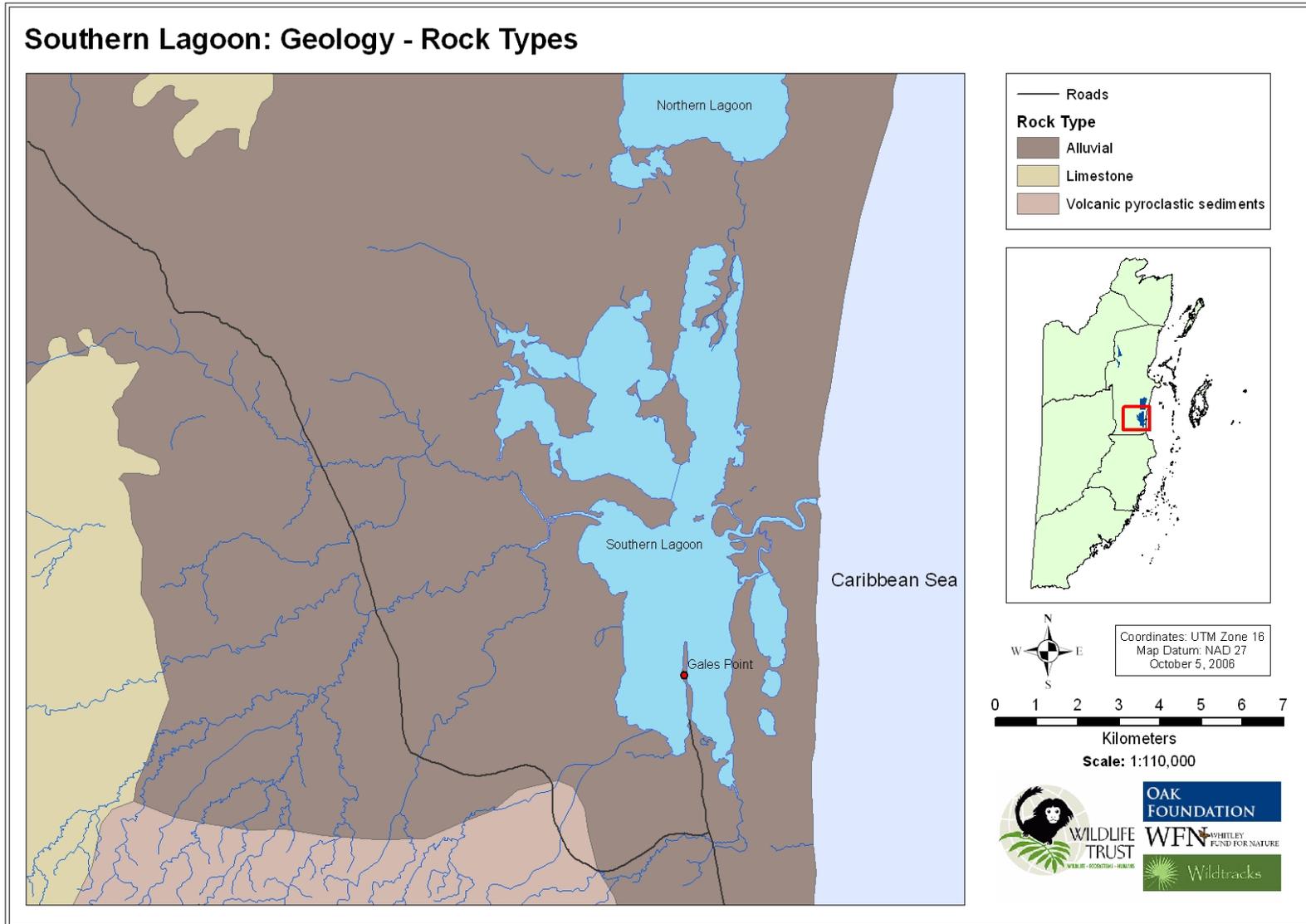


Photograph 9: Cave entrance in typical karst landscape



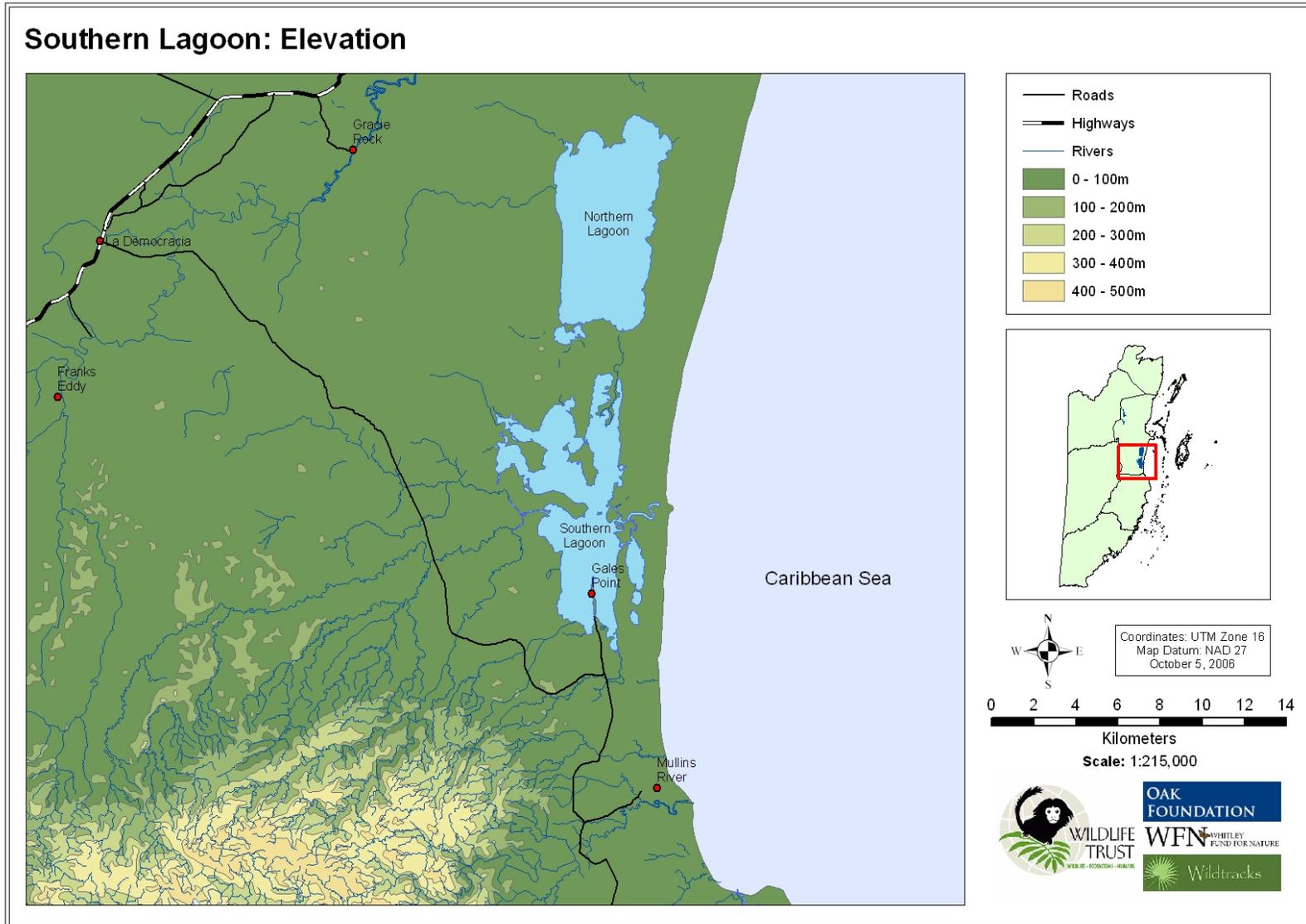
Map 11: Southern Lagoon: Geology (General)

Mapping: A. Lloyd; Wildtracks



Map 12: Southern Lagoon: Rock Types

Mapping: A. Lloyd; Wildtracks



Map 13: Southern Lagoon Area: Elevation

Mapping: A. Lloyd; Wildtracks

The more northerly Peccary Hills area has been described as Tertiary Dolomite (Miller 1996, quoting Cornec, 1986), suggesting it is not a continuation of the karst associated with the Maya Mountains, but a separate formation - this is, however, under debate, and there is little information on whether this is correct, or on how far south this dolomite stretches (whether it extends into the Ben Lomond area).

5.3.2 Pleistocene Plain

The Pleistocene limestone bedrock, deposited by shallow seas between 1.6 million and 8,000 years ago, forms a flat plain lying to the east of the karst hills, and supports a gradient from short grass savanna to open pine forest. It underlies sand-based alluvium deposits derived from the Maya Mountains. The red soils here are acidic, with a low nutrient content and extreme moisture regimes – being saturated in the wet season and droughty in the dry season. Soils are also affected by repeated burning, usually started by hunters during the dry season to attract deer to the ash and new growth. This has also resulted in maintaining the open character of this savanna, with limited regeneration of pine.

Moving north east from the Maya Mountains, across the coastal plain, the underlying limestone get progressively younger, and the neutral to alkaline soils are often very shallow. The youngest soils are found on the coastal deposits, overlying recently exposed coral beds (King et. al., 1993).

Two major soil and land use studies have taken place in Belize – the first a comprehensive study of the whole country by Wright et. al. (1959), looking at soils and associated vegetation assemblages in great detail. The second is a more recent series of studies by King et. al. (1986, 1989 and 1992), based on Wright, but using techniques such as satellite imagery to update the original report.

King et. al. demarcated a number of land regions and systems throughout Belize to classify different soil characteristics. Under this system, three Land Regions and ten Land Systems are recognized within the Southern Lagoon area.

5.3.3 Land Regions

Land Regions are broadscale divisions of the landscape into different units based primarily on topography. The three Land Regions identified within the Southern Lagoon area are the:

- Northern Coastal Plain
- Central Coastal Plain
- Central Foothills

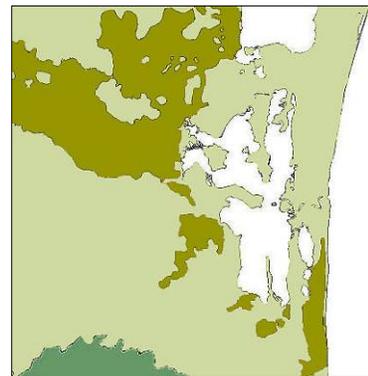
Northern Coastal Plain

The Northern Coastal Plain lies primarily to the north west and west of the Southern Lagoon system (Map 14), and is characterized by isolated karstic hills and valleys of the Paleocene – Eocene era, with shallow, stony, alkali soils, rising out of a flat Pleistocene plain with acidic pine ridge soils.

Northern Coastal Plain

Other Land Regions

Maya Mountain Massif



Map 14: Northern Coastal Plain

Central Coastal Plain

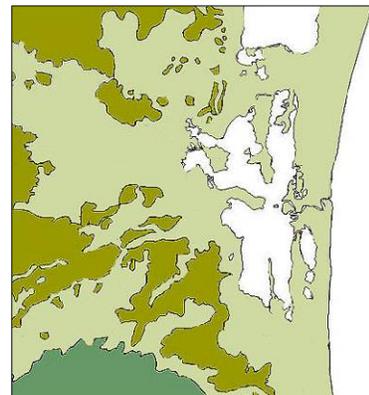
The Central Coastal Plain (Map 15) includes the majority of the land directly surrounding the Southern Lagoon system, stretching into the flood plains of the drainage system that flows into it. These are predominantly young soils – fertile river alluviums and less fertile beach deposits. The former provides good agricultural soils, whilst the latter supporting extensive areas of saline dwarf mangrove savanna.



Map 15: Central Coastal Plain

Central Foothills

The steep-sided karst slopes and alluvial plain on which they stand indicate the extent of the Cretaceous limestone that forms the foothills of the Maya Mountain block to the south, and extends into the Sibun-Manatee karst area (Map 16).



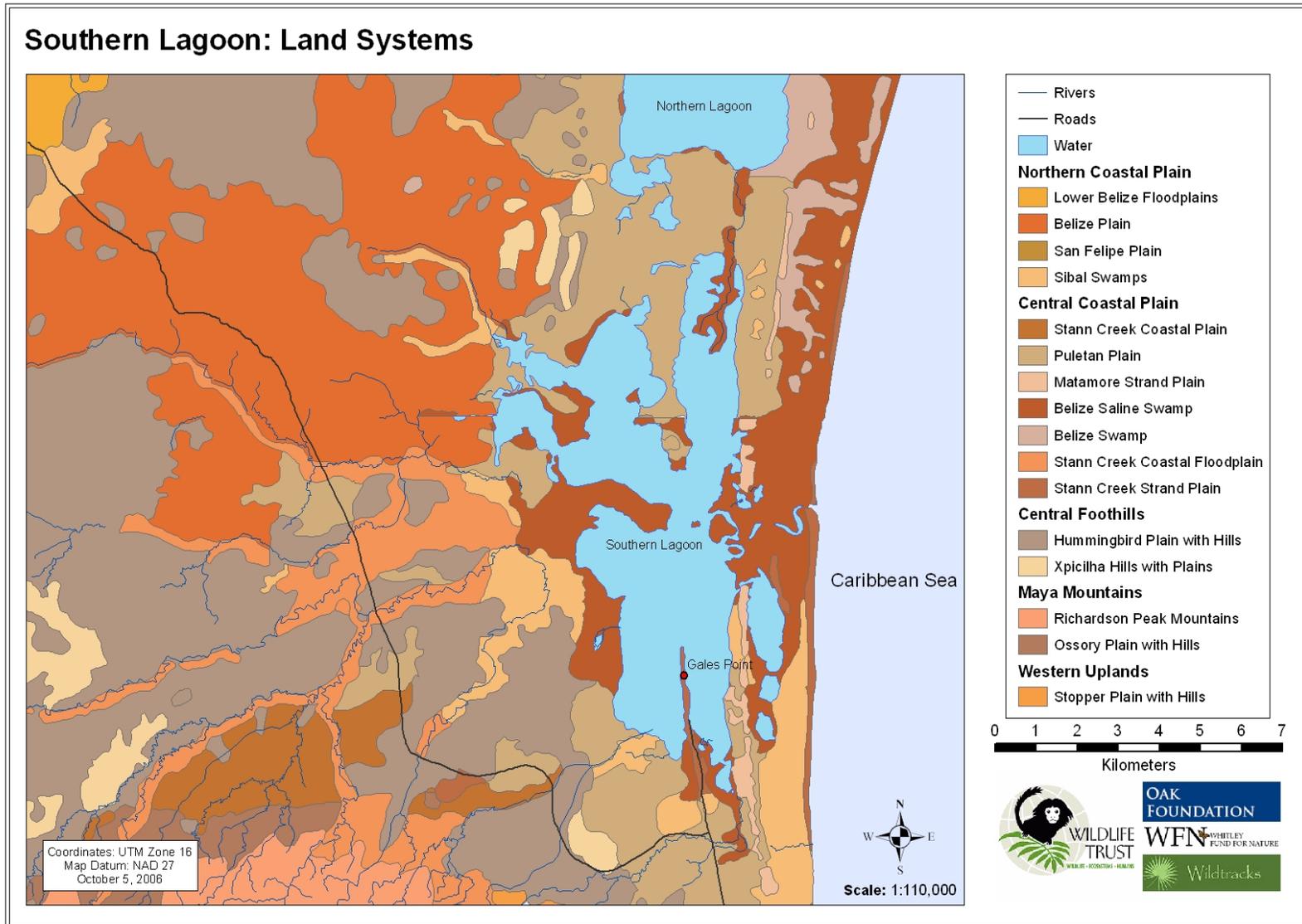
Map 16: Central Foothills

Maya Mountain Massif

Whilst not considered as within the Southern Lagoon area, the presence of the granitic Maya Mountains to the south has played a role in shaping the current land systems, providing alluvial material that is carried by rivers and deposited in the floodplain areas.

5.3.4 Land Systems

Within the Land Regions, classification of Land Systems and soil types are most heavily influenced by the geology and topography of the area, with the parent bedrock and steepness of the terrain playing an important part in soil characteristics. The Southern Lagoon area is categorized as being comprised of ten different Land Systems (Map 17; Table 7; King et. al., 1992).



Map 17: Southern Lagoon: Land Systems

Mapping: A. Lloyd; Wildtracks

Table 7: Land Regions, Land Systems and Soil Types within the Southern Lagoon area					
Land Region	Land System	Subunit	Soil Type Suite: Sub-suite	Characteristics	Location within the Southern Lagoon area
Northern Coastal Plain	Belize Plain (BP)	<i>Pitted Plain</i>	Puletan: *BV: Hattieville + Double Head Cabbage*	Moderately acidic, dry, sandy soils of the deeper deposits of siliceous old alluvium on the coastal plain, deposited in shallow water. Soils are heavily leached, and waterlog in wet weather, with flooding and surface wash occurring. Following heavy rain, sheet wash occurs, collecting in low areas to form temporary swamps and pools	Large expanse of low-lying short grass savanna to the west and north west of Western Lagoon, known as Bocotura Pine Ridge. Drains into Cornhouse Creek, the mid reaches of Manatee River, and Sapodilla Creek following heavy rains. Separated from the lagoon front itself by lower lying Puletan Plain. Also present to the west of Southern Lagoon, south of Horley Point, west of the low tidal flats.
		<i>Low Plain</i>	Puletan: Bocotura		
		<i>Braided Plain</i>	Puletan: Bocotura?		
	Sibal Swamp (SW)	<i>Savanna Plain</i>	Tintal: Sibal	Permanently waterlogged mineral and organic soils of freshwater swamps, with a wet peat surface extending to a depth of 50cm or more, overlying waterlogged mineral soils	The Savanna Plain subunit follows the course of the creeks draining into Sapodilla Lagoon and a small area adjacent to the confluence of Cornhouse Creek and Manatee River. The largest area of Herbaceous Swamp forms a broad north-south band to the east to the east and south of Buttonwood Lagoon and Katy Pond. Small patches also occur in low lying areas to the east of Main Creek. Marsh Forest Plain is located to the south of Manatee River, in the Black Creek area, and adjacent to the coast east of Buttonwood Lagoon and Katy Pond
		<i>Herbaceous Swamp</i>	Tintal: Sibal		
		<i>Marsh Forest Plain</i>	Tintal: Sibal		
Central Coastal Plain	Puletan Plain (TP)	<i>Flat Plain</i>	Puletan	Sandy topsoils occurring on old coastal deposits, with seasonal waterlogging. A wet peat surface extending to a depth of 50cm or more, overlying permanently waterlogged mineral soils	The most extensive area of Puletan Plain lies between Northern and Southern Lagoons, and includes both Flat Plain, to the west, and Saline Plain, to the east. To the south west and south east of Southern Lagoon, Saline Plain lies on the edge of the lagoon, giving way to Flat Plain with increasing distance from the water
		<i>Pitted Plain</i>	Puletan		
		<i>Very Poorly Drained Basin</i>	Tintal: Sibal		
	Stann Creek Coastal Floodplain (SF)	<i>Low floodplain bench</i>	Melinda: Monkey River	River alluvium with high silt and fine sand content. Soils with moderate nutrient fertility found on floodplain bench supporting riverine forest	This forms the floodplain of the Manatee River, following the course of Cornhouse Creek, Mangrove Creek, Manatee River, Big Creek and Soldier Creek, to the west of Southern Lagoon
	Matamore Strand Plain (SB)	<i>Slightly Undulating Plain</i>	Turneffe: Hopkins + Ycacos + Sibal	Gently undulating bars with poorly drained swales in-between. Deep, pale siliceous sand coastal deposits that are acidic, base deficient and droughty, and is a relic of past coastal strands	Located in the two coastal ridges – the present east coast beachline south of Bar River (and two areas to the north), and the old coastal ridge that forms the Gales Point peninsula
	Stann Creek Coastal Plain (SP)	<i>Slightly Undulating Plain</i>	Puletan Regalia + Serpon	Old Pleistocene(?) alluvium formed from a combination of coastal and alluvial deposits	Located to the south west of the Southern Lagoon area, adjacent to the Maya Mountains block
	Belize Swamps (BW)		Tintal: Ycacos	Permanent saline and brackish coastal swamps of gleys and peats, with extremely poor drainage, supporting mangrove forest and mangrove savanna	To the north east of Southern Lagoon, forming part of the coastal strip of land that separates Main Creek from the sea
	Belize Saline Swamps (TY)	<i>Low Tidal Flat</i>	Tintal: Ycacos	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.	Much of the coastal bar separating Southern Lagoon from the sea are low tidal flats, as are the low lying areas from Fisher's Bight north to the southern coast of Western Lagoon, and the Main Creek area. High tidal flats are found at Tiger Point, and along part of the north coast of Western Lagoon
<i>High Tidal Flat</i>		Tintal + Turneffe Ycacos + Hopkins			

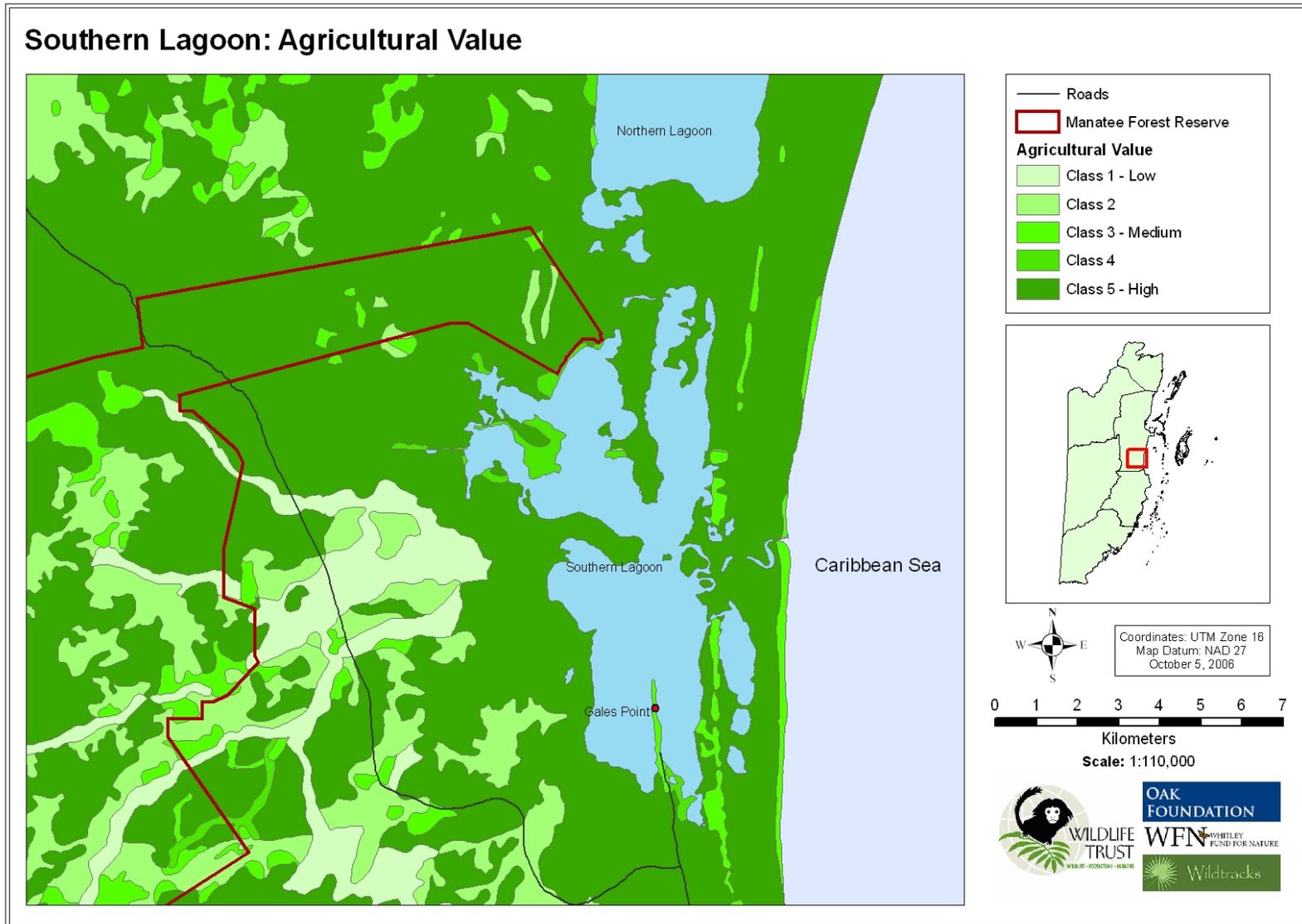
Table 7: Land Regions, Land Systems and Soil Types within the Southern Lagoon area (continued)					
Land Region	Land System	Subunit	Soil Type <i>Suite:</i> Sub-suite	Characteristics	Location within the Southern Lagoon area
Central Foothills	Hummingbird Plain with Hills (BX)	Medium Karst	Chacalte: Cabro > (Xpicilha + San Lucas + Quamina)	Chacalte soils are derived from the limestone karst, with a supply of bases from limestone offset by heavy leaching. Three main subunits are represented in the area – Cabro, Xpicilha and San Lucas. Cabro soils are the most common in the karst area, and are shallow and bouldery; Xpicilha soils are of moderate depth, found on lower slopes of the hills; San Lucas are the deepest, found at the base of the hills.	These soils are located in the karstic region of the Southern Lagoon area. *BV: Belize Valley Soils (Jenkins et. al. 1976) *SC: Stann Creek Soils (King et. al. 1989)
		Low Karst	Chacalte: Cabro + Quamina > (Xpicilha + San Lucas)		
		Slightly Undulating Plain	Chacalte: *SC:Regalia + Serpon > Quamina		
	Flat Alluvial Plain	Melinda: Quamina > (Puletan + Canquin)	Predominantly weakly developed river alluvium soils		
	Xpicilha Hills with Plains (TX)	High Karst Hills	Chacalte: Cabro	Shallow, stony, dark soils over steep cretaceous limestone karst. Well drained, droughty	Occupies a very small area on the high karstic hills in the Ben Lomond area, to the north of Western Lagoon
Maya Mountains	Richardson Peak Mountains (TR)	Hill Slope		This occurs outside the project area, forming a large escarpment south of the karstic hills, formed from uplifting of the granite bedrock.	

Based on: King et. al., 1993

5.3.5 Land Use

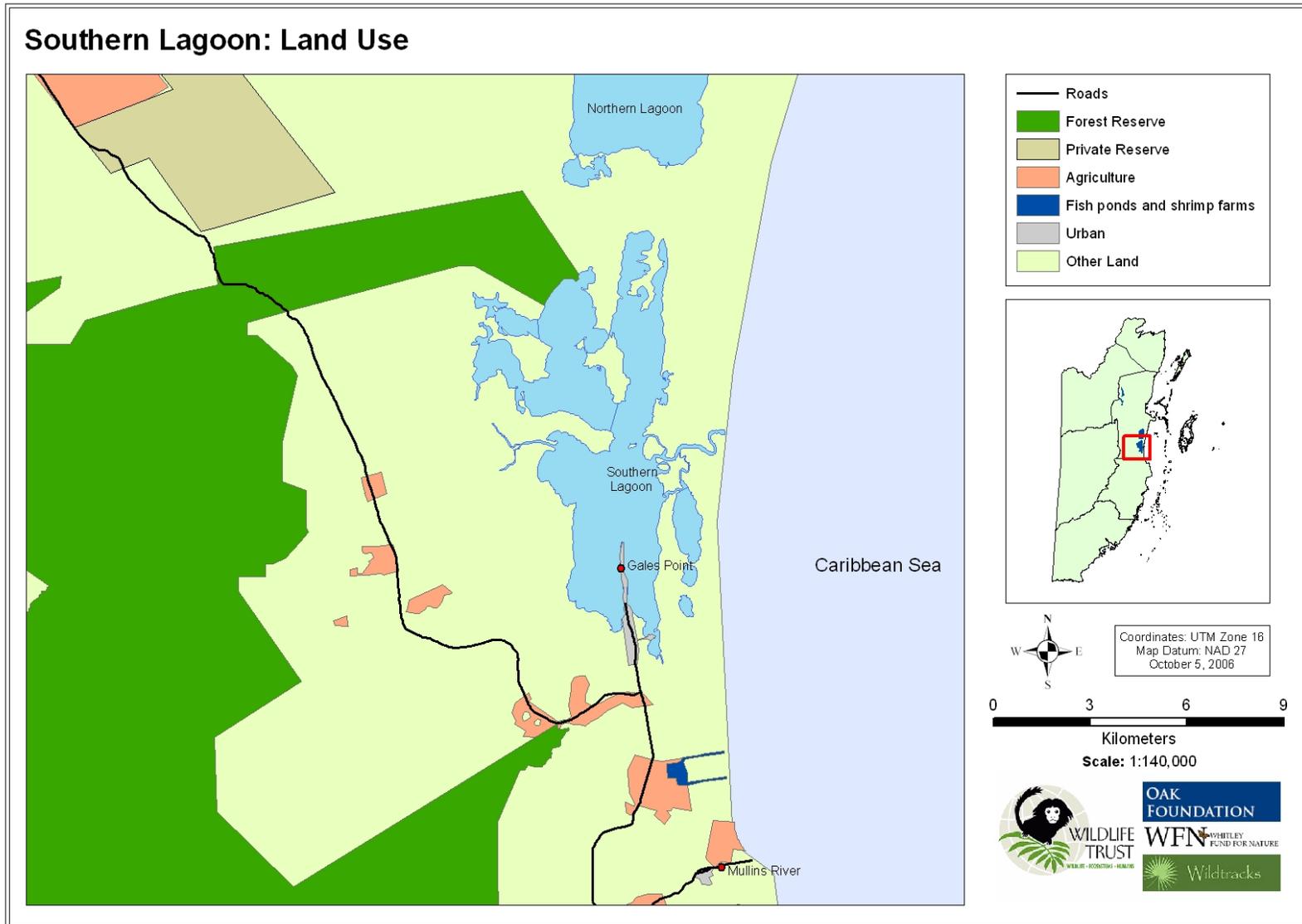
King et. al. (1993) also mapped potential land use, agricultural values and land use limitations within the project area (Table 8; Maps 18 and 19) – the majority of the coastal plain surrounding the lagoon system is of limited agricultural value, with low nutrient content, flooding in wet season and experiencing drought conditions in dry. The old coastal ridges to the east of Southern Lagoon (including Gales Point peninsula itself) form bars of more fertile soils, with recommended land use for citrus and bananas. The more fertile soils of the area lie further from the immediate coastal plain, in areas with alluvial or colluvial soils, along the middle reaches of the rivers and creeks, and in the valleys of the karstic hills. It is these areas that are being used for current agriculture – predominantly for citrus plantations along the Coastal Road.

Table 8: 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	Hunting, limited	Pine



Map 18: Agricultural Value within the Southern Lagoon Area

Mapping: A. Lloyd; Wildtracks



Map 19: Land Use within the Southern Lagoon Area

Mapping: A. Lloyd; Wildtracks

6.0 Biodiversity Assessment

6.1 Introduction

The conservation importance of an area is typically determined through an assessment of its biodiversity, achieved through recording the species presence, species distribution, condition and /or abundance of key species. Where a good baseline exists, a biodiversity assessment can concentrate on the latter, looking at species densities and abundance in different ecosystems, or comparisons with other areas of Belize or the region. In this instance, however, where little baseline data exists, the primary biodiversity assessment requirement is for data on species presence and distributions, to provide a baseline for future work on abundance during the development of a conservation plan.

Baseline data for Southern Lagoon itself is not well collated, with no central repository of information. Reports from the initial development of the Manatee Special Development Area, provided by the Gales Point Wildlife Sanctuary Community Management Committee, were invaluable for providing an overview of the biodiversity of the area, but are significantly outdated in view of the development that has taken place in the area over the last ten years. Data was also accessed from Environmental Impact Assessments conducted within the area, and from studies conducted by Wildlife Trust.

The aquatic component of the biodiversity assessment covered both the brackish lagoon systems and the freshwater streams and rivers in the immediate vicinity. As well as diurnal and nocturnal point observations in a wide variety of water bodies, and snorkel transects within Main Creek, Quamina Creek, Soldier Creek and Manatee River, data was also gathered from previous reports, from the local fishermen, from analysis of fish catch, and from sports fishermen using the area.

The terrestrial vegetation component of the current biological assessment of the Southern Lagoon area focused largely upon the collection of validated data on vegetation types, from transects, ground-truthing point surveys, aerial reconnaissance and photography, to determine the actual vegetation types, their location, and extent, and to generate an updated ecosystem map for the area. Predominant and / or characteristic species of flora, and relative abundances associated with each habitat were identified and listed where possible.

Preliminary site visits to each of the main habitat types within the area of interest highlighted by the Gales Point community participants were used to ground-truth existing ecosystem mapping (Meerman & Sabido, 2001 & 2004), and identify principal discrepancies, and develop preliminary lists of predominant plant species for each ecosystem. Resultant data was then used to re-evaluate the existing ecosystem map, and identify the locations for point stops where further ground-truthing would be required.

Point surveys were conducted within each of the identified ecosystems, and across ecoclines, noting habitat structure, predominant species, relative abundance, and drainage characteristics, to provide additional and broader coverage within the survey time available.

The major vertebrate groups were surveyed using a variety of techniques – a series of transects and point surveys were used to initiate a bird species list for the area, and data was also analyzed from field studies in the adjacent Runaway Creek private reserve. Mammals were recorded from opportunistic sightings, from signs of their presence (tracks and faeces), and from nocturnal surveys. Reliable local reports were also noted, as were past survey results (primarily Meerman, 1996; Greenlee, 1994; McAnanay and Thomas, 2003). Amphibians were surveyed

along nocturnal transects, and reptiles were surveyed largely opportunistically during ecosystem ground-truthing.



Photograph 10: Fish identification using dichotomous keys

Training for community members in the various field techniques was integrated into the biodiversity assessment framework, with community representatives taking part in all field surveys (Photograph 10).

This provided an opportunity to train community participants in the use of dichotomous keys, identification guides, and diurnal and nocturnal transects and point surveys, whilst also giving a forum for exchange of information, and full community input into the development of the biodiversity assessment, accessing the broad knowledge base of stakeholders such as Kevin Andrewin.

6.2 Ecoregions and Ecosystems of the Southern Lagoon Area

6.2.1 Ecoregions

Ecoregions are defined as “*large areas of relatively uniform climate that harbour a characteristic set of species and ecological communities*” (WWF Ecoregion Program, 2001), and are used to describe broad associations of ecosystems.

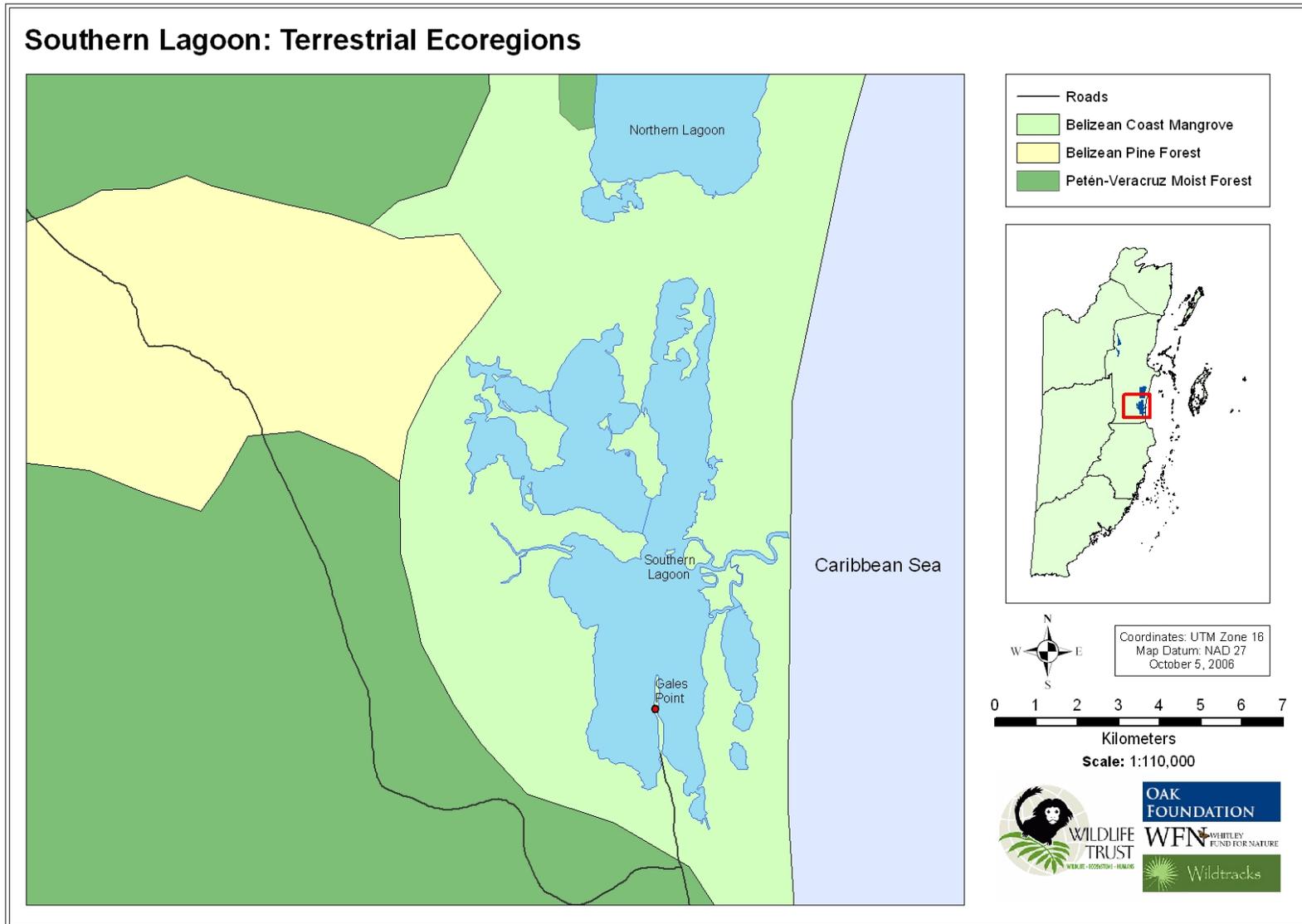


Photograph 11: Southern Lagoon

Southern Lagoon (Photograph 11), with its associated coastal wetlands, lagoons, seagrass beds and mangroves, lies within the **Mesoamerican Caribbean Reef** ecoregion (WWF 200 Ecoregion #235), one of four ecoregions defined within the Western Tropical Atlantic under the WWF 200 Ecoregion Programme). This ecoregion, stretching from the northern tip of the Yucatan Peninsula in Mexico to the Bay Islands in Honduras, provides critical habitat for many threatened species, including the Antillean manatee (*Trichechus manatus manatus*), and the critically endangered goliath grouper (*Epinephelus itajara*), Central American river turtle (*Dermatemys mawii*) and hawksbill turtle (*Eretmochelys imbricata*).

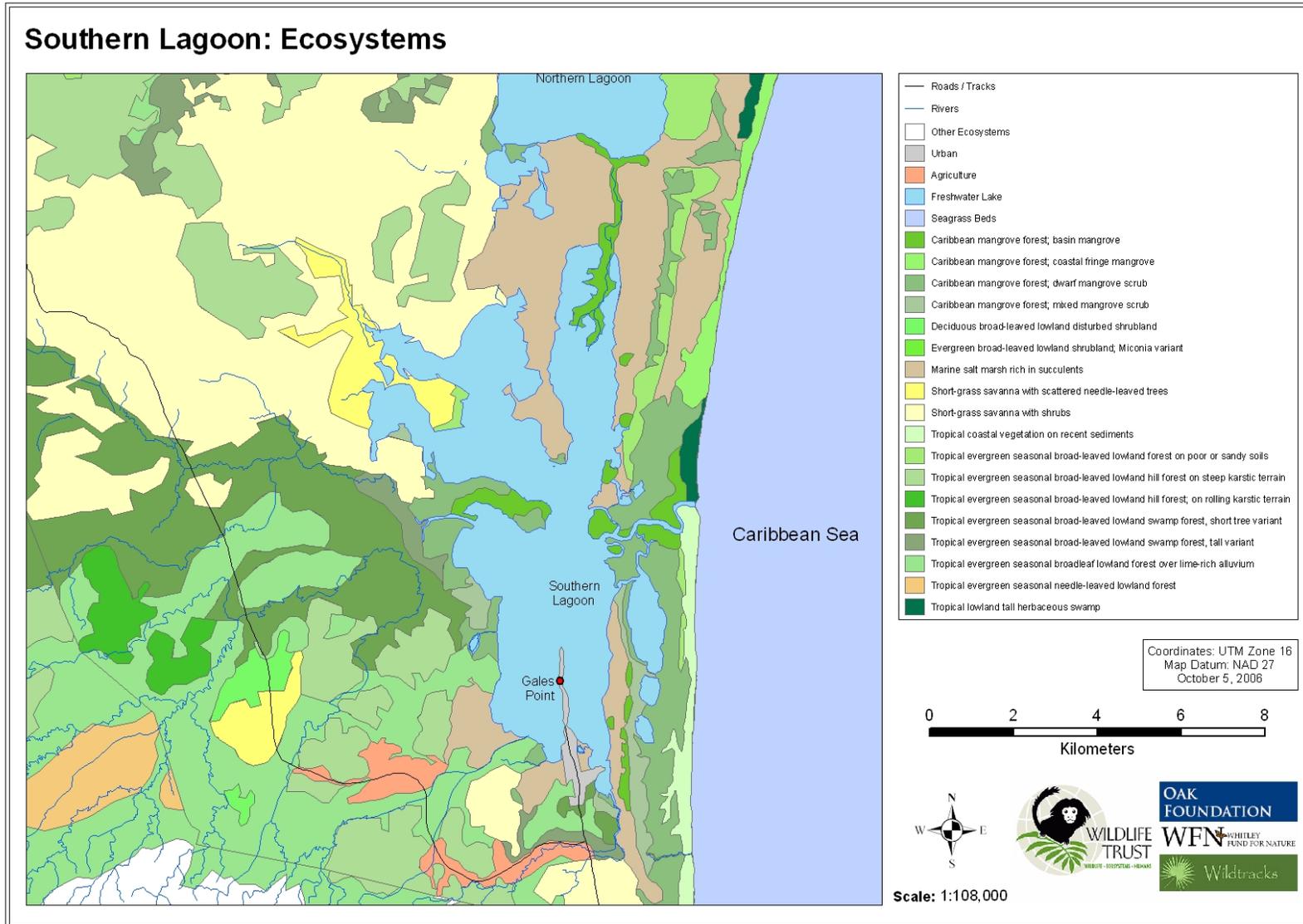
Within the Southern Lagoon system, the predominant vegetation is *Halodule*, an aquatic flowering plant that provides shelter and food resources for a large number of commercial marine fin-fish species (in the Gulf of Mexico, it is estimated that between 70 and 90 percent of commercial fish species spend some part of their life in the seagrass habitat (FDEP, 2001)).

Under the WWF Terrestrial Ecosystem initiative, the tropical and subtropical moist forest biome of the Neotropical biogeographic region is further subdivided into eighty Ecoregions, of which three are represented within the terrestrial component of the Southern Lagoon area – the **Petén-Veracruz Moist Forest**, the **Belizean Pine Savanna** and **Belize Coastal Mangrove** (Map 20). Gales Point Wildlife Sanctuary itself lies within the Belize Coastal Mangrove Ecoregion, with Belizean Pine Savanna and Petén-Veracruz Moist Forest to the west.



Map 20: Ecoregions (WWF)

Mapping: A. Lloyd; Wildtracks



Map 21: Southern Lagoon: Ecosystems (after Meerman, 2005)

Mapping: A. Lloyd; Wildtracks

6.2.2 Ecosystems

Twenty two ecosystems have been identified in the area under the UNESCO classification system – twenty terrestrial ecosystems and two aquatic systems (including a third, seagrass beds, as a nested system) (Map 21; Table 9).

Table 9: Terrestrial Ecosystems of the Southern Lagoon Area	
Legend	UNESCO classification
19	Tropical evergreen seasonal broadleaf lowland forest over rolling calcareous hills
20	Tropical evergreen seasonal broadleaf lowland forest over steep calcareous hills
28	Tropical evergreen seasonal broadleaf lowland forest over calcium-rich alluvium
29	Tropical evergreen seasonal broadleaf lowland forest over poor or sandy soils
42	Tropical evergreen seasonal broadleaf lowland swamp forest: high variant
43	Tropical evergreen seasonal broadleaf lowland swamp forest: low variant
47	Dwarf Mangrove Scrub
49	Caribbean mangrove forest: mixed mangrove scrub
50	Caribbean mangrove forest: coastal fringe mangrove
51	Caribbean mangrove forest: riverine mangrove
52	Caribbean mangrove forest: basin mangrove
56	Evergreen broad-leaved lowland shrubland: Miconia variant
58	Deciduous broad-leaved lowland disturbed shrubland
60	Deciduous lowland riparian shrubland of the plains
62	Short-grass savanna with scattered needle-leaved trees
63	Short-grass savanna with shrubs
65	Eleocharis marsh
66	Marine salt marsh rich in succulents
69	Tropical coastal vegetation on recent sediments
71	Tropical lowland tall herbaceous swamp
74	Rooted underwater communities of flowing water
761	Brackish / Saline Lagoon

Marine Ecosystems

The principle aquatic ecosystem of the project area – the brackish coastal lagoon - provides food resources and shelter for many plant and animal species, supporting complex food webs. This ecosystem, along with the associated estuarine and wetland areas, also provides important ecosystem services, such as providing sediment filtration and flood and erosion control.

- **Brackish / saline lagoon (UNESCO code 761)**

This ecosystem category encompasses Southern Lagoon and the associated water bodies in the area. In the estuarine system of Southern Lagoon, salinity varies daily and seasonally, with tidal and climatic influences – which impact flow rate and direction through the various creeks and channels, and the abundance of the seagrass and algae.

The lagoon supports a large biomass of aquatic vegetation, including sizeable areas of the predominant vegetation - shoal grass (*Halodule wrightii*), considered to be the primary

manatee food resource for these obligate grazers, the only herbivorous aquatic mammal within the lagoon. Shoal grass, a submerged flowering plant, is patchily distributed throughout the lagoon at all depths and is found in a range of salinities. It appears to be most abundant in the shallow waters of Quashie Trap Lagoon (Map 9; SL1), and almost absent from Sapodilla Lagoon. Grazing, boat propellers and other physical disturbance contribute to the patchiness of distribution – a typical feature of seagrass beds.



Photograph 12: Wigeon grass (*Ruppia maritima*)

A second seagrass species, Wigeon grass (*Ruppia maritima*), first identified by Wildlife Trust in 2005 (Auil, pers. com.) is also found in the lagoon and has been highlighted in the United States for its importance for waterfowl (Photograph 12). It is similar in appearance to shoal grass but is less widespread in this ecosystem. Patches of this species, also thought to be an important food plant for manatees, have been found close to Tiger Point in Western Lagoon (Auil, 2005). Both the seagrass species that inhabit the lagoon are euryhaline and eurythermal - capable of growing in shallow lagoon waters that may vary dramatically in salinity and temperature.

A number of species of algae also occur in the lagoon, including a filamentous green alga (*Chaetomorpha* sp.), present in Sapodilla Lagoon. This genus grows in mats, and is often found in high nutrient areas (such as around bird colony islands) – its presence in Sapodilla Lagoon, however, does not appear to be linked to such activity. *Chara* sp. (species unknown – likely more than one) is the second most common species, and is also abundant in Sapodilla lagoon, where seagrass is apparently absent – this lagoon has a very low salinity which, though not beyond the tolerance threshold of the seagrass species, may give the algae a competitive advantage.

Green algae of the Dasycladaceae family are found in Western Lagoon, near Tiger Point, and are also abundant on mangrove roots in Main Creek. Species such as *Bataphora* sp. grow on hard substrates, and were recorded in most areas where rocks were present in the lagoon. It is expected that further survey work in the area will show this species to be present wherever there is suitable substrate for its growth.

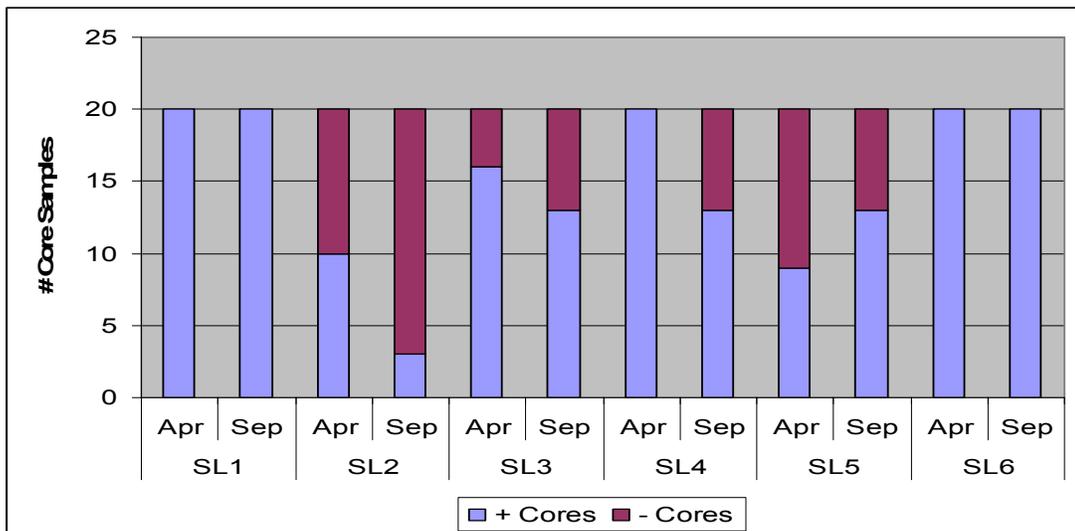


Figure 5: Vegetation Sampling Results: Number of core samples with vegetation (any species) during dry (April) and wet (September) vegetation sampling.

Southern Lagoon has more available food (in terms of types and biomass) for manatees than does the Northern Lagoon. As the water salinity decreases in the wet season, available vegetation decreases (Figure 5, September results) (though algae abundance in some sites does increase with increased rain / decreased salinity). With the excessive rainfall experienced in the latter part of 2006 and early 2007, vegetation was less abundant than expected from research in previous years, and the larger animals likely traveled outside of the lagoon system to forage on the *Thalassia*-rich seagrass beds located off-shore and south of the lagoon, near Mullin's River, where many manatees have been observed during aerial surveys.

Future analysis will be conducted looking at correlations between the physical water parameters with vegetation availability and changes in established, long-term manatee distribution patterns (N. Auil, pers. com.).

Terrestrial Ecosystems

In order to develop more extensive baseline data on the system as a whole, to assess the natural resources within each system, and to feed information into the proposed management planning and community tourism development planning processes, the terrestrial ecosystems in the focal area surrounding the Southern Lagoon complex, were included in this survey, at the request of the Wildlife Trust and the Gales Point Community.

The terminology of ecosystem classification used in the Belize Ecosystems Map (Meerman & Sabido, 2001; Meerman, 2004) has been applied in this assessment, to facilitate future assessment of conservation importance of the various ecosystems in this location (within the national context), and to help in the prioritization of research and conservation actions. Of the 18 ecosystems previously identified and mapped under the Central American Ecosystem Map (Meerman & Sabido, 2001; Meerman, 2004), one (tropical evergreen seasonal needle-leaved lowland forest) is now discounted. Three others (tropical evergreen seasonal broadleaf lowland swamp forest: tall tree variant; dwarf mangrove scrub, and *Eleocharis* marsh) were added during the current biodiversity assessment.

Previous ecosystem mapping exercises covering this project area include those of Wright et. al. (1959), Lyon et. al. (1999), Meerman & Sabido (2001) and Meerman (2004). Of these, the work of Lyon et. al. is the most accurate – being based on more extensive groundwork. All are incorporated to a greater or lesser extent within this updated assessment, errors are corrected where possible, and further ground-truthing was conducted to verify validity of the ecosystem characterizations and mapping. As the UNESCO ecosystem categories are generally at a finer scale than those of Lyon et. al., there is often no direct 'translation' from one to the other – though in fact the rather broader system used by Lyon et. al. may be rather more meaningful on the ground.

▪ **Tropical evergreen seasonal broad-leaf lowland forest over rolling calcareous hills (UNESCO code 19)**



This ecosystem occurs around the lower limits of some of the steep karst hills – generally in a narrow band of as little as 25-40m, ending abruptly as the steep limestone cliffs and rock outcrops emerge from the foothills (Photographs 13 and 14). The system is intermediate in terms of species composition and forest structure between that of the steep karst slopes and that of the alluvial plains. This habitat can be defined by its canopy height, with tree height higher than on the steeper slopes, with many trees up to 25m or more. It is also defined by the presence of *Dialium guianense* (largely absent from the flat alluvial plain), and by the absence of *Gaussia maya* and *Plumeria obtusa* (largely confined to the steep karst hills ecosystem). This ecosystem is considered to be significantly under-represented within the currently protected areas system of Belize (Meerman, 2005), with only



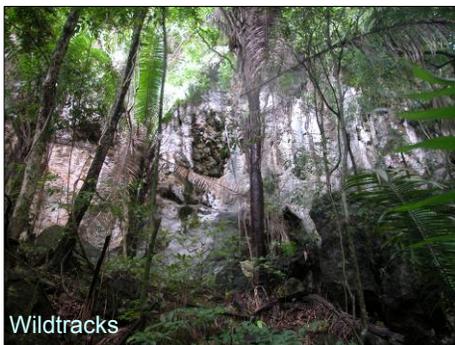
29,400 acres protected nationally – as compared with the national target of 55,500.

Tropical evergreen seasonal broad-leaf lowland forest over rolling calcareous hills

Photograph 13: (Above) The broadleaf forest on the karst hills west of GPWS has a mature stature, with open understory

Photograph 14: (Below) The vegetation of the short-grass savanna ends abruptly at the base of the karst hills.

▪ **Tropical evergreen seasonal broad-leaf lowland hill forest over steep calcareous hills (UNESCO code 20)**



Photograph 15: Lowland Hill Forest over steep calcareous hills, with limestone cliff face

Predominant or common species include: *Attalea cohune*, *Aspidosperma megalocarpon*, *Astronium graveolens*, *Bernoullia flammea*, *Brosimum alicastrum*, *Bursera simaruba*, *Caesalpinia gaumeri*, *Cecropia peltata*, *Ceiba pentandra*, *Chamaedorea neurochlamys*, *Coccoloba belizensis*, *Cordia alliodora*, *Cryosophila stauracantha*, *Cupania sp.*, *Desmoncus orthacanthos*, *Dialium guianense*, *Dracaena americana*, *Gaussia maya*, *Ficus sp.*, *Guazuma ulmifolia*, *Heliconia spissa*, *Manilkara staminodella*, *Metopium brownei*, *Pimenta dioica*, *Piper hispidum*, *Pouteria sp.*, *Protium copal*, *Sabal mauritiiformis*, *Schizolobium parahyba*, *Simarouba glauca*, *Spondias radlkoferi*, *Vitex gaumeri*, *Vitis*

tilliifolia, *Xylopia frutescens*, *Zamia polymorpha*, *Zanthoxylum sp.* and *Zuelania guidonia*. Ground cover plants include *Adiantum tenerum*, *Anthurium schlechtendalii*, *Begonia sericoneura*, *Tradescantia spathacea* and *Selaginella sp.*. Towards the tops of the hills, species such as *Lysiloma latisiliquum*, *Plumeria obtusa* and the orchids *Catasetum integerrimum*, *Encyclia cochleata* and *Myrmecophila tibicinis* become more abundant (Photograph 15).

▪ **Tropical evergreen seasonal broadleaf lowland forest over calcium-rich alluvium (UNESCO code 28)**



Photograph 16: Riparian forest - Broadleaf lowland forest over calcium rich alluvium, on the banks of the Manatee River

Located in the flat lowlands between the karst hills, to the west of the savannas, and along the rivers, this ecosystem shows significant variation in stature and species composition, reflecting variation in hydrology and past land use. Undisturbed areas have a very high canopy, with emergents reaching 30m in height – some of the tallest forest in Belize. Species richness is high. Forest on this soil-type is one of those most favoured for farming.

Species within this ecosystem include: *Acacia collinsii*, *Acacia dolichostachya*, *Acosmium panamense*, *Aechmea bracteata*, *Alibertia edulis*, *Anthurium sp.*, *Ardisia sp.*, *Aristolochia spp.*, *Aspidosperma megalocarpon*, *Attalea cohune*, *Bactris major*, *Bactris mexicana*, *Balizia leucocalyx*, *Bauhinia herrerae*, *Bauhinia jenningsii*, *Bromelia*

plumieri, *Brosimum alicastrum*, *Bucida buceras*, *Bursera simaruba*, *Caesalpinia gaumeri*, *Calophyllum brasiliense*, *Cassia grandis*, *Cecropia peltata*, *Cedrela odorata*, *Ceiba pentandra*, *Chrysophyllum mexicanum*, *Coccoloba barbadensis*, *Coccoloba belizensis*, *Cochlospermum vitifolium*, *Cojoba arborea*, *Costus pulverulentus*, *Cryosophila stauracantha*, *Cupania belizensis*, *Dalbergia stevensonii*, *Desmoncus orthacanthos*, *Dioscorea sp.*, *Encyclia cochleata*, *Epidendrum nocturnum*, *Epidendrum rigidum*, *Eugenia sp.*, *Ficus spp.*, *Gouania sp.*, *Guazuma ulmifolia*, *Guettarda combsii*, *Hampea trilobata*, *Helicteres guazumifolia*, *Inga pinetorum*, *Licania platypus*, *Lonchocarpus guatemalensis*, *Luehea speciosa*, *Manilkara staminodella*, *Manilkara zapota*, *Metopium brownei*, *Miconia argentea*, *Passiflora biflora*, *Passiflora coriacea*, *Philodendron spp.*, *Piper amalago*, *Piper auritum*, *Piper hispidum*, *Piper peltatum*, *Pimenta dioica*, *Piscidia piscipula*, *Pisonia aculeata*, *Pithocellobium sp.*, *Polypodium sp.*, *Pouteria campechiana*, *Protium copal*, *Psychotria poeppigiana*, *Quararibea funebris*, *Renealmia sp.*, *Roupala montana*, *Roystonea regia*, *Sabal mauritiiformis*, *Sapindus saponaria*, *Schizolobium parahyba*, *Selaginella sp.*, *Siparuna thecaphora*, *Spondias radlkoferi*, *Stemmadenia donnell-smithii*, *Swartzia cubensis*, *Swietenia macrophylla*, *Smilax sp.*, *Solanum sp.*, *Syngonium sp.*, *Tabebuia rosea*, *Tabernaemontana alba*, *Tabernaemontana arborea*, *Thevetia ahouai*, *Trichospermum grewiifolium*, *Trophis racemosa*, *Vanilla sp.*, *Viola koschnyi*, *Vismia camparaguey*, *Vitex gaumeri*, *Vitis tiliifolia*, *Zamia polymorpha*, *Zanthoxylum sp.* and *Zuelania guidoni*.

Regionally, this ecosystem has been greatly reduced from historical range – having greater agricultural potential than ecosystems occurring on many other soil types. In Belize, only 61% of the target of 33,670 acres is currently protected.

- **Tropical evergreen seasonal broad-leaf lowland forest on poor or sandy soils (UNESCO code 29)**

This ecosystem lies east of Southern Lagoon, but was not visited in the course of the current survey. Species likely to occur here include *Attalea cohune*, *Bactris mexicana*, *Bucida buceras*, *Calophyllum brasiliense*, *Coccoloba* spp., *Miconia* spp., *Simarouba glauca*, *Terminalia amazonia*, *Virola koschnyi*, *Vochysia hondurensis* and *Xylopia frutescens*. This is another ecosystem that is under-represented by 38% within the national protected areas system, with the target level of protection being approximately 33,000 acres.

- **Tropical evergreen seasonal broadleaf lowland swamp forest: high variant (UNESCO code 42)**



Photograph 17: Lowland swamp forest (high variant) lining Quamina Creek

The swamp forest in this locality grades from the low variant in a rather ill-defined ecocline. Predominant plant species include: *Bactris major*, *Bucida buceras*, *Calophyllum brasiliense*, *Coccoloba belizense*, *Cryosophila stauracantha*, *Desmoncus orthacanthos*, *Ficus* sp., *Metopium brownei*, *Pachira aquatica*, *Pterocarpus officinalis*, and *Swietenia macrophylla*. The ground is evidently flooded for several months of the year, with very extensive hog-wallow relief. Tracts of this forest type occur along the southern portions of Quamina Creek (Photograph 17).

- **Tropical evergreen seasonal broad-leaved lowland swamp forest: low variant (UNESCO code 43)**

Good examples of this ecosystem can be seen along and to the south of Manatee River and in the lower reaches of Soldier Creek. Species such as *Acoelorrhaphe wrightii*, *Bucida buceras*, *Cameraria latifolia*, *Chrysobalanus icaco* are common epiphytic *Aechmea* sp. and *Tillandsia* spp. bromeliads are locally common. *Pachira aquatica* is present in low densities, as is *Manilkara zapota*. *Coccoloba belizensis* and *Sabal mauritiformis* are present in the slightly less waterlogged areas. This ecosystem also occurs to the south of Southern Lagoon along portions of Quamina Creek, where it grades into tropical evergreen seasonal broadleaf lowland swamp forest: tall tree variant. Where these creeks and rivers meet the saline lagoon, a transition zone is indicated by the presence of red mangrove (Photograph 18).



Photograph 18: Lowland swamp forest (low variant) on Quamina

- **Dwarf mangrove scrub (UNESCO code 47)**

Extensive tracts of this ecosystem occur within the Southern Lagoon area - this ecosystem was identified with marine salt marsh rich in succulent plants in the Belize Ecosystems Map (Meerman & Sabido, 2001; Meerman 2004), from which it differs largely in having a much lower species richness. It tends to have a low and relatively uniform canopy of 1 – 1.5m, and characteristically occurs on saline mudflats. With a minimal increase in elevation (generally no more than 5-10cm), this system becomes more species rich and grades into the marine salt marsh (Photograph 19). The dominant species is *Rhizophora mangle*.



Photograph 19: Dwarf Mangrove Scrub

- **Caribbean mangrove forest: mixed mangrove scrub (UNESCO code 49)**

Often bordering dwarf mangrove scrub mudflats or marine salt marshes, this ecosystem has a rather higher canopy (2-6m), and has a greater diversity of woody species – including the three mangroves (*Avicennia germinans*, *Laguncularia racemosa* and *Rhizophora mangle*) as well as *Conocarpus erecta* and *Myrica cerifera*, usually with a dense ground cover of sedges and grasses.

- **Caribbean mangrove forest: coastal fringe mangrove (UNESCO code 50)**

Occurring along sections of the river near Bar Mouth, and along portions of the beach, this ecosystem is dominated by *Rhizophora mangle*, with looping stilt roots stretching out into the water.

- **Caribbean mangrove forest: riverine mangrove (UNESCO code 51)**

Occurring along lower portions of Manatee River, this ecosystem is dominated by *Rhizophora mangle*, with a canopy up to 15-18m, on permanently waterlogged soils. This ecosystem is severely under-represented within the protected areas of Belize, with only 16% of the 9,520 acres targeted for inclusion within the protected areas currently protected (Meerman, 2005).



Photograph 20: Riverine Mangrove lining Bar River

- **Caribbean mangrove forest: Basin mangrove (UNESCO code 52)**

This ecosystem occurs in low-lying depressions in several areas – and can be seen on the bar northeast of the mouth of Manatee River, and at the entrance to Bar River. Most stands are tall, with a canopy height of at least 10-15m, and are primarily dominated by *Rhizophora mangle*, interspersed with specimens of *Avicennia germinans*. Species predominance

appears to be dictated by the dynamics of seasonal flooding and by salinity. Structurally, this system differs little from riverine mangrove.

- **Evergreen broad-leaved lowland shrubland, *Miconia* variant (UNESCO code 56)**



Photograph 21: Lowland shrubland (*Miconia* variant)

This ecosystem characteristically occurs at the foot of karst hills bordering onto savanna habitats, with *Acoelorrhaphe wrightii*, *Bucida buceras*, *Chrysobalanus icaco*, *Eugenia* spp., *Miconia* spp., *Piper amalago* and *Xylopia frutescens* being abundant. *Symphonia globulifera* and *Terminalia amazonia* were recorded in the transition zone with the forest of the steep karstic hills. Small areas of this system do occur along the savanna margins – for example on the trail to Ben Lomond’s cave (Photograph 21). Only 47% of the

national target area for protection of this system is met by the current protected areas system.

- **Deciduous broad-leaved lowland disturbed shrubland (UNESCO code 58)**

An area of this system has been mapped along a section of the middle-reaches of Soldier Creek (Meerman, 2004) – this shrubland is in early successional regeneration from past farming activities. Much of the area has in fact now regenerated to a low forest (over 5m tall), such that the extent of disturbed shrubland is rather more limited than in the earlier mapping.

- **Deciduous lowland riparian shrubland of the plains (UNESCO code 60)**

Small patches of this ecosystem occur along the banks of Manatee River and Soldier Creek, and include a mosaic of tall reeds, rushes, grasses and sedges interspersed with shrubs. These areas are ones that have been exposed to past disturbances, with the vegetation including a high proportion of early colonizing species. Whilst some of these disturbances may have been natural – from riparian erosion, the majority lie within the areas once farmed by the inhabitants of Gales Point and demonstrate the relatively slow regeneration from anthropogenic clearance and fires in such conditions. The patches were too small to be mapped within the resolution of the current survey.

- **Short-grass savanna with scattered needle-leaved trees (UNESCO code 62)**

This open, grassland savanna is dominated by scattered, low-density *Pinus caribaea* and *Quercus oleoides*. The grasslands harbour quite a diverse assemblage of graminoids and herbaceous plants, with the terrestrial orchid *Bletia purpurea* and passionflower *Passiflora urbaniana* adding another highly visible component to the herbaceous ground-cover, along with the cycad *Zamia polymorpha*. Stands of *Acoelorrhaphe wrightii*, *Byrsonima crassifolia*, *Curatella americana* and *Gliricidia sepium* are interspersed amongst the pines and oaks. This ecosystem now covers an area that is evidently



Photograph 22: A stand of Caribbean pine within short grass savanna
Wildtracks...2006

significantly reduced from historical coverage, frequent anthropogenic fires having eradicated pine from areas where they occurred as recently as 20 years previously, leaving a 'short-grass savanna with shrubs'. With the degradation of this ecosystem in relatively recent history, and without significant fire management, and habitat replenishment, it is unlikely that this ecosystem will continue to support breeding populations of key species such as the endangered yellow-headed parrot.

A little under half the area of this ecosystem targeted for conservation management is met by the current protected areas system of Belize (Meerman, 2005). Additionally, another significant conservation concern regarding this ecosystem is the steady, almost annual degradation that is taking place – frequent anthropogenic fires push the system towards that of short-grass savanna with shrubs, as the populations of pine trees are unable to withstand the frequent fires.

- **Short grass savanna with shrubs (UNESCO code 63)**

Actual coverage of this ecosystem is dynamic, and is increasing over its historical extent as a result of anthropogenic fire, with pines previously occurring over a larger portion of the savanna habitat than is currently the case. Short-grass savanna with shrubs is a complex mosaic of species assemblages, each reflecting micro-topography, soil hydrology, soil acidity & nutrient availability, fire regime and seed source (Photograph 23). In this locality, much of the short-grass savanna is open grassland. *Cameraria latifolia*, *Chrysobalanus icaco*, *Curatella americana*,

Gliricidia sepium and *Quercus oleoides* occur at low density throughout much of the ecosystem, often as dwarfed specimens regenerating from past fires. Lower areas frequently support stands of *Acoelorrhaphe wrightii*, or *Eleocharis sp.*



Photograph 23: Short grass savanna with karst hills behind

- **Eleocharis marsh (UNESCO code 65)**

Previously unmapped within the project area, this ecosystem occurs predominantly in waterlogged or flooded hollows in the short-grass savanna. Generally, the extent of each patch is too small to be mapped at national scale (as was the case for the Belize Ecosystems Map). *Eleocharis* reeds form an almost mono-specific community, with only very low-density occurrence of other herbaceous species. Whilst these reed marshes are afforded their own categorization under the UNESCO classification species assemblage within the short-grass savanna ecosystem.



Photograph 24: Eleocharis marsh

- **Marine salt marsh rich in succulents
(UNESCO code 66)**

This ecosystem occurs in some areas between the dwarf mangrove scrub and the vegetation on slightly drier ground. Around Southern Lagoon, it tends to be dominated by stunted *Rhizophora mangle*, but has a significant ground cover of grasses and sedges and a variety of low succulent plants. It is interspersed with rather stunted *Conocarpus erecta*. Extent is significantly less than previously mapped by Meerman (2004), as much of that area is in fact dwarf mangrove scrub.

- **Tropical coastal vegetation on recent sediments
(UNESCO code 69)**



Photograph 25: Coastal Vegetation

This highly threatened ecosystem formerly occurred along several kilometers of coastal shoreline south of Bar Mouth, immediately behind the turtle-nesting beach (Photograph 25). Herbaceous beach vegetation is a highly threatened component of this ecosystem with less than 15% of the national target area for protection being met. It occurs on the seaward side of much of the coconut areas on Manatee Bar, this ecosystem is regenerating – but is negatively impacted by large amounts of sea-borne garbage. This habitat is essential for the continued nesting of the critically endangered hawksbill turtle. Whilst visited only briefly during the survey (being outside the Wildlife Sanctuary itself), it is clear that it

has suffered extensive and significant anthropogenic impacts. Historically, much of this area had been converted to coconut plantation, albeit with some degree of regeneration of littoral forest species, and the clearance for the construction of permanent buildings further down the coast poses a significant threat to nesting success of marine turtles unless development, light-management and domesticated animal guidelines are put in place and strictly adhered to.

- **Tropical lowland tall herbaceous swamp
(UNESCO code 71)**

This ecosystem occurs in a narrow belt on the coast north of Bar Mouth. Course graminoids form a dense ground-cover to approx 0.7m in height, with a relatively dense shrub component dominated by *Acoelorrhaphe wrightii*, *Crescentia cujete* and *Conocarpus erectus*.

6.3 Flora of the Southern Lagoon Area

Using data collected during fieldwork, and from other reports on plant species in the area (Lyon, 1994; Meerman, 1998), 246 plant species have been identified within the Southern Lagoon area (Table 11) Three species are considered to be of global concern, two of these being commercial timber species (cedar and mahogany) (Table 10)



Photograph 26: The insectivorous Sundew of the seasonally inundated short grass savanna

Table 10: Plant Species of National and International Concern of the Southern Lagoon area		
Vulnerable	Gaussia Palm	<i>Gaussia maya</i>
	Spanish cedar	<i>Cedrela odorata</i>
	Mahogany	<i>Swietenia macrophylla</i>
Near Threatened	Palmita	<i>Zamia polymorpha</i>

Table 11: Terrestrial Plants of the Southern Lagoon Area						
Family	Species	Common name	2006	1998	1994	IUCN
Acanthaceae	<i>Aphelandra scabra</i>			X	X	
Adiantaceae	<i>Acrostichum aureum</i>	Mangrove fern		X	X	
	<i>Adiantum tenerum</i>	Maidenhair fern	X			
Amaranthaceae	<i>Alternanthera flavescens</i>			X	X	
Amaryllidaceae	<i>Hymenocallis littoralis</i>	Spider lily	X	X	X	
Anacardiaceae	<i>Anacardium occidentale</i>	Cashew		X	X	
	<i>Astronium graveolens</i>	Jobillo, Glassy wood		X	X	
	<i>Mangifera indica</i>	Mango		X	X	
	<i>Metopium brownei</i>	Black Poisonwood, Chechem	X	X	X	
	<i>Spondias mombin</i>	Hogplum			X	
	<i>Spondias radlkoferi</i>	Hogplum	X	X		
Annonaceae	<i>Malmea depressa</i>	Elemui			X	
	<i>Xylopiya frutescens</i>	Polewood	X	X	X	
Apocynaceae	<i>Aspidosperma megalocarpon</i>	Mylady		X	X	
	<i>Cameraria latifolia</i>	White poisonwood	X	X	X	
	<i>Plumeria rubra</i>			X		
	<i>Stemmadenia donnell-smithii</i>	Cojeton	X		X	
	<i>Tabernaemontana alba</i>	Dog balls	X			
	<i>Tabernaemontana arborea</i>		X			
	<i>Thevetia ahouai</i>	Dog balls, Cojon de mico	X			

2006: Walker - fieldwork for this biodiversity assessment
1998: Meerman – species list for White Ridge area, BERDS
1994: Lyons – species list for Gales Point Natural Resource Project

Table 11: Terrestrial Plants of the Southern Lagoon Area (continued)						
Family	Species	Common name	2006	1998	1994	IUCN
Araceae	<i>Anthurium sp.</i>	Birds' nest 'fern'	X			
	<i>Anthurium schlechtendalii</i>	Pheasant's tail	X			
	<i>Montrichardia arborescens ?</i>	Upright riparian aroid	X			
	<i>Philodendron tripartitum</i>	Three-lobed philodendron	X			
	<i>Syngonium sp.</i>		X			
Araliaceae	<i>Dendropanax arboreus</i>	Mano de lion, White Chaca	X			
Arecaceae	<i>Acoelorrhaphe wrightii</i>	Tasiste, pimenta	X	X	X	
	<i>Acrocomia aculeata</i>	Supa palm, coco-yol		X		
	<i>Attalea cohune</i>	Cohune	X	X	X	
	<i>Bactris major</i>	Pokenoboy - black fruit	X			
	<i>Bactris mexicana</i>	Pokenoboy -red fruit	X			
	<i>Chamaedorea neurochlamys</i>	Monkey-tail	X			
	<i>Cocos nucifera</i>	Coconut	X		X	
	<i>Cryosophila stauracantha</i>	Escoba palm, Give-and-take	X	X	X	
	<i>Desmoncus orthacanthos</i>	Basket tie tie, stay-a-while	X	X	X	
	<i>Gaussia maya</i>	Palmasito, Gaussia palm	X			
	<i>Manicaria saccifera</i>	Confra			X	
	<i>Reinhardtia gracilis</i>	Jon-chib, fish-tail		X		
	<i>Roystonea regia</i>	Royal palm, Cabbage palm	X			
	<i>Sabal mauritiiiformis</i>	Bay-leaf, Botan	X	X	X	
	<i>Schippia concolor</i>	Mountain palmeto, Mis		X		
	<i>Thrinax radiata</i>	Chit	X		X	
	Aristolochiaceae	<i>Aristolochia sp.</i>	Contribo	X		
Asteraceae	<i>Ageratum littorale</i>			X	X	
	<i>Neurolaena lobata</i>	Jackass bitters	X			
	<i>Wedelia sp.</i>				X	
Begoniaceae	<i>Begonia sericoneura</i>	Begonia	X			
Bignoniaceae	<i>Amphitecna sp.</i>				X	
	<i>Anemopaegma chrysoleucum</i>			X	X	
	<i>Crescentia cujete</i>	Calabash	X	X	X	
	<i>Tabebuia rosea</i>	Mayflower	X	X	X	
Bixaceae	<i>Cochlospermum vitifolium</i>	Wild cotton, (yellow) cotton flower		X	X	
Bombacaceae	<i>Bernoullia flammea</i>	Mapola / Santo Domingo	X			
	<i>Ceiba pentandra</i>	Ceiba / cotton tree	X	X	X	
	<i>Ochroma pyramidale</i>	Balsa		X	X	
	<i>Pachira aquatica</i>	Provision bark, Santo domingo	X		X	
	<i>Quararibea funebris</i>	Coco mama	X			
Boraginaceae	<i>Cordia alliodora</i>	Salmwood, Samwood	X			
	<i>Tournefortia gnaphaloides</i>		X		X	

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Table 11: Terrestrial Plants of the Southern Lagoon Area (continued)						
Family	Species	Common name	2006	1998	1994	IUCN
Brassicaceae	<i>Cakile lanceolata</i>			X	X	
Bromeliaceae	<i>Aechmea bracteata</i>	Bromeliad (red-flowering)	X			
	<i>Aechmea magdalenae</i>		X	X		
	<i>Bromelia plumieri</i>		X			
	<i>Tillandsia bulbosa</i>		X			
	<i>Tillandsia spp.</i>	Air-plants	X			
Burseraceae	<i>Bursera simaruba</i>	Gumbo limbo	X	X	X	
	<i>Protium copal</i>	Copal	X	X	X	
Cactaceae	<i>Selenicereus testudo</i>	Devil's gut cactus	X			
Cannaceae	<i>Canna indica</i>	Canna	X			
Casuarinaceae	<i>Casuarina equisetifolia</i>	Casuarina	X	X	X	
Cecropiaceae	<i>Cecropia obtusifolia</i>	Trumpet	X			
	<i>Cecropia peltata</i>	Trumpet, Warumo	X	X	X	
Chrysobalanaceae	<i>Chrysobalanus icaco</i>	Cocoplum	X	X	X	
	<i>Hirtella americana (?)</i>	Pigeon plum		X	X	
	<i>Licania platypus</i>	Monkey apple	X			
Clethraceae	<i>Clethra occidentalis</i>			X		
Clusiaceae	<i>Calophyllum brasiliense</i>	Santa maria	X	X	X	
	<i>Clusia sp.</i>		X			
Clusiaceae	<i>Symphonia globulifera</i>	Waika chew-stick	X	X	X	
	<i>Vismia camparaguey</i>	Wild annato	X	X	X	
	<i>Vismia macrophylla</i>	Ringworm tree	X			
Combretaceae	<i>Bucida buceras</i>	Bullet Tree, Pucte	X		X	
	<i>Conocarpus erecta</i>	Buttonwood	X	X	X	
	<i>Laguncularia racemosa</i>	White Mangrove	X	X	X	
	<i>Terminalia amazonia</i>	Nargusta	X	X	X	
Commelinaceae	<i>Tradescantia spathacea</i>	Moses-in-a-basket	X			
Convolvulaceae	<i>Ipomoea alba</i>		X	X	X	
	<i>Jaquemontia havanensis</i>			X	X	
Costaceae	<i>Costus pulverulentus</i>	Costus	X			
Cyperaceae	<i>Cladium jamaicense</i>	Sawgrass	X			
	<i>Cyperus planifolius</i>				X	
	<i>Eleocharis sp.</i>	Freshwater reed	X			
<p>2006: Walker - fieldwork for this biodiversity assessment 1998: Meerman – species list for White Ridge area, BERDS 1994: Lyons – species list for Gales Point Natural Resource Project Nomenclature based on Balick et. al., 2000</p>						

Table 11: Terrestrial Plants of the Southern Lagoon Area (continued)

Family	Species	Common name	2006	1998	1994	IUCN	
Cyperaceae (cont.)	<i>Fimbristylis cymosa</i>			X	X		
	<i>Fimbristylis spadicea</i>			X	X		
	<i>Rhynchospora cephalotes</i>	Armadillo grass	X				
	<i>Scleria bracteata</i>	Cutting grass	X				
Dennstaedtiaceae	<i>Pteridium caudatum</i>	Pteridium, Bracken	X				
Dilleniaceae	<i>Curatella americana</i>	Yaha, Sandpaper tree	X	X	X		
	<i>Davilla kunthii</i>	Chaparro		X	X		
	<i>Davilla sp.</i>		X				
	<i>Tetracera volubilis</i>	Lavaplatos		X			
Dioscoreaceae	<i>Dioscorea sp.</i>	Chiny yam	X				
	<i>Dioscorea hondurensis</i>				X		
Dracaenaceae	<i>Dracaena americana</i>	Candlewood, Dracaena		X	X		
Droseraceae	<i>Drosera capillaris</i>	Red sundew	X				
Euphorbiaceae	<i>Alchornea latifolia</i>	Teem che		X			
	<i>Plukenetia penninervia</i>	Liana		X			
Fabaceae							
Caesalpinioideae	<i>Bauhinia herrerae</i>	Pata de Vaca, Bauhinia vine	X				
	<i>Bauhinia jenningsii</i>	Cow tongue	X				
	<i>Caesalpinia gaumeri</i>	Wareewood	X				
	<i>Cassia grandis</i>	Bukut	X				
	<i>Dialium guianense</i>	Ironwood	X		X		
	<i>Schizolobium parahyba</i>	Quamwood	X	X	X		
	<i>Senna papillosa</i>			X			
	<i>Senna spectabilis</i>	Pisabed	X				
	Mimosidae	<i>Acacia collinsii</i>	Subin	X			
		<i>Acacia cookii</i>				X	
<i>Acacia dolichostachya</i>		Wild tamarind	X				
<i>Acacia glomerosa (?)</i>		Subin-like Mimosoid			X		
<i>Balizia leucocalyx</i>		Wild tamarind	X				
<i>Cojoba arborea</i>		Barba jalote	X				
<i>Inga affinis</i>		Bri-bri	X		X		
<i>Inga pavoniana</i>				X	X		
<i>Inga pinetorum</i>		Tama-tama	X				
<i>Lysiloma latisiliquum</i>		Salam	X				
<i>Mimosa hondurana</i>	Dormilona, Sensitive weed		X	X			
<i>Mimosa watsonii</i>	Haulback	X	X				
<i>Pithecellobium sp.</i>		X					
<i>Pithecellobium winzerlingii</i>					X		

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Table 11: Terrestrial Plants of the Southern Lagoon Area (continued)						
Family	Species	Common name	2006	1998	1994	IUCN
Fabaceae (cont.)						
Mimosidae (cont.)	<i>Sphinga platyloba</i>	red fowl	X			
	<i>Zygia cognata</i>	Turtle-bone		X	X	
	<i>Zygia conzattii</i>	Turtle bone		X	X	
Papilionoideae	<i>Acosmium panamense</i>	Billy webb			X	
	<i>Andira inermis</i>	Bastard cabbage bark, carbon			X	
	<i>Dalbergia stevensonii</i>	Rosewood	X			
	<i>Gliricidia sepium</i>	Madre de Cacao	X		X	
	<i>Lonchocarpus castilloi</i>	Cabbage Bark, machich	X			
	<i>Lonchocarpus guatemalensis</i>	Dogwood, Turtle-bone		X	X	
	<i>Lonchocarpus hondurensis</i>	Turtle-bone, Swamp dogwood			X	
	<i>Mucuna sp.</i>	Deer eye, horse eye	X			
	<i>Piscidia piscipula</i>	Jabin, dogwood	X			
	<i>Pterocarpus officinalis</i>	Kaway	X	X	X	
	<i>Pterocarpus rohrii</i>	Mountain kaway	X			
	<i>Swartzia cubensis</i>	Lleurosangre	X			
	<i>Vigna luteola</i>			X	X	
Fagaceae	<i>Quercus insignis</i>			X	X	
	<i>Quercus elliptica</i>			X	X	
	<i>Quercus oleoides</i>	Oak, Live oak	X	X	X	
Flacourtiaceae	<i>Casaria arborea</i>				X	
	<i>Xylosma flexuosa</i>				X	
	<i>Zuelania guidonia</i>	Water Wood, Tamai, John Crow Wood			X	
Gleicheniaceae	<i>Dicranopteris pectinata</i>	Tiger fern		X		
Heliconiaceae	<i>Heliconia aurantiaca</i>			X		
	<i>Heliconia latispatha</i>	Platanillo,	X	X		
	<i>Heliconia spissa</i>					
	<i>Heliconia vaginalis</i>	Waha leaf, red	X			
Lamiaceae	<i>Hyptis verticillata</i>			X	X	
Lauraceae	<i>Cassytha filiformis</i>	Scorn de earth, jaundice tie-tie	X			
	<i>Siparuna thecaphora</i>	Wild coffee	X			
Malpighiaceae	<i>Bunchosia sp.</i>				X	
	<i>Byrsonima crassifolia</i>	Sacpa, Nancen	X	X	X	
	<i>Malpighia glabra</i>	Wild craboo		X	X	
Malvaceae	<i>Hampea trilobata</i>	Majua, salt water moho	X			
	<i>Hibiscus pernambucensis</i>			X	X	
	<i>Malvaviscus arboreus</i>	Turk's cap hibiscus	X			
	<i>Pavonia sp.</i>				X	
	<i>Sida acuta</i>			X	X	

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Table 11: Terrestrial Plants of the Southern Lagoon Area (continued)

Family	Species	Common name	2006	1998	1994	IUCN
Marantaceae	<i>Calathea sp.</i>	Waha leaf	X			
Melastomaceae	<i>Bellucia pentamera</i>	Maya			X	
	<i>Miconia albicans</i>	Pine ridge sirin		X		
	<i>Miconia argentea</i>	White Maya	X	X	X	
	<i>Miconia hondurensis</i>	Chigger nuts, blossom berry	X			
	<i>Miconia sp.</i>	Miconia	X			
	<i>Mouriri exilis</i>	Cacho venado embra		X	X	
	<i>Mouriri myrtilloides</i>	Granadillo		X	X	
Meliaceae	<i>Cedrela odorata</i>	Spanish cedar			X	VU
	<i>Guarea glabra</i>	Cramante			X	
	<i>Swietenia macrophylla</i>	Mahogany	X	X	X	VU
	<i>Trichilia havanensis</i>	Bastard lime			X	
	<i>Trichilia minutiflora</i>	Wild ime			X	
Moraceae	<i>Brosimum alicastrum</i>	Ramon, Breadnut	X	X	X	
	<i>Ficus sp.</i>	Fig	X			
	<i>Trophis racemosa</i>	Yaxox, Red breadnut, White ramon	X			
Myricaceae	<i>Myrica cerifera</i>	Tea bark, tea box	X	X	X	
Myristicaceae	<i>Virola koschnyi</i>	Banak			X	
Myrsinaceae	<i>Ardisia sp.</i>	Blossomberry	X			
Myrtaceae	<i>Eugenia sp.</i>	Eugenia	X			
Nyctaginaceae	<i>Neea psychotroides</i>			X	X	
	<i>Pisonia aculeata</i>	Tiger claw	X			
	<i>Pimenta dioica</i>	Allspice				
Nymphaeaceae	<i>Nymphaea sp.</i>	Water lily	X			
Orchidaceae	<i>Bletia purpurea</i>	Pink terrestrial orchid	X			
	<i>Brassavola nodosa</i>	orchid	X			
	<i>Catasetum integerrimum</i>		X			
	<i>Encyclia cochleata</i>		X			
	<i>Epidendrum nocturnum</i>		X			
	<i>Epidendrum rigidum</i>		X			
	<i>Myrmecophila tibicinis</i>	cow-horn orchid	X			
	<i>Nidema boothii</i>			X		
	<i>Rhyncholaela digbyana</i>	digbyana orchid	X			

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Table 11: Terrestrial Plants of the Southern Lagoon Area (continued)						
Family	Species	Common name	2006	1998	1994	IUCN
Passifloraceae	<i>Passiflora ambigua</i>	Granadillo		X		
	<i>Passiflora biflora</i>	Granadillo		X		
	<i>Passiflora coriacea</i>	Batwing	X			
	<i>Passiflora foetida</i>	Passionflower	X			
	<i>Passiflora lancetillensis</i>			X		
	<i>Passiflora urbaniana</i>		X	X		
	<i>Passiflora xiikzodz</i>	Narrow-leaved batwing		X		
Phytolaccaceae	<i>Rivina humilis</i>			X	X	
Pinaceae	<i>Pinus caribaea</i>	Caribbean pine	X	X	X	
Piperaceae	<i>Piper amalago</i>	Cordoncillo	X			
	<i>Piper auritum</i>	Cowfoot, Xmacolan	X	X	X	
	<i>Piper hispidum</i>	Cordoncillo	X			
	<i>Piper peltatum</i>	Santiago, Sweet cowfoot	X			
	<i>Piper schiedeianum</i>	Cordoncillo				
Poaceae	<i>Andropogon sp.</i>				X	
	<i>Bambusa vulgaris</i>	Cultivated bamboo	X			
	<i>Distichlis spicata</i>	Salt marsh grass		X	X	
	<i>Eragrostis ciliaris</i>				X	
	<i>Guadua longifolia</i>	Riparian bamboo	X			
	<i>Paspalum sp.</i>				X	
	<i>Spartina spartinae</i>	Swordgrass		X	X	
	<i>Sporobolus virginicus</i>			X	X	
Podocarpaceae	<i>Podocarpus guatemalensis</i>	Mountain cypress		X		
Polygonaceae	<i>Coccoloba barbadensis</i>	Wild grape	X	X	X	
	<i>Coccoloba belizensis</i>	Bob	X			
	<i>Coccoloba sp.</i>		X			
	<i>Coccoloba uvifera</i>	Sea-grape	X		X	
Polypodiaceae	<i>Polpodium sp.</i>	Fern	X			
Portulacaceae	<i>Protulaca oleracea</i>			X	X	
Proteaceae	<i>Roupala montana</i>			X		
Rhamnaceae	<i>Gouania sp.</i>		X			
Rhizophoraceae	<i>Rhizophora mangle</i>	Red Mangrove	X	X	X	
Rubiaceae	<i>Alibertia edulis</i>	Wild guava	X	X	X	
	<i>Alseis yucatanensis</i>	Cacao-che, Wild mamey		X	X	
	<i>Amaioua corymbosa</i>	Wild coffee	X			
	<i>Erithalis fruticosa</i>			X	X	

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1998: Meerman – species list for White Ridge area, BERDS
1994: Lyons – species list for Gales Point Natural Resource Project
 Nomenclature based on Balick et. al., 2000

Table 11: Terrestrial Plants of the Southern Lagoon Area (continued)

Family	Species	Common name	2006	1998	1994	IUCN
Rubiaceae (cont.)	<i>Ernodea littoralis</i>			X	X	
	<i>Guettarda combsii</i>	Glassy wood, tastab	X	X	X	
	<i>Guettarda elliptica</i>			X	X	
	<i>Hamelia patens</i>	Polly red head, Ixcanan		X	X	
	<i>Lindenia rivalis</i>			X		
	<i>Psychotria elata</i>			X		
	<i>Psychotria poeppigiana</i>	Hot lips	X	X		
	<i>Spermacoce assurgens</i>			X		
Rutaceae	<i>Zanthoxylum kellermanii</i>	Prickly yellow			X	
	<i>Zanthoxylum riedelianum</i>			X		
	<i>Zanthoxylum sp.</i>	Prickly yellow	X			
Sapindaceae	<i>Cupania belizensis</i>	Grande betty, palo carbon	X	X		
	<i>Sapindus saponaria</i>	Soap berry	X			
Sapotaceae	<i>Chrysophyllum mexicanum</i>	Chicheh	X			
	<i>Manilkara chicle</i>	Sapodilla macho		X	X	
	<i>Manilkara staminodella</i>	Chiquibul sapote	X			
	<i>Manilkara zapota</i>	Sapote	X			
	<i>Pouteria campechiana</i>	Mammee cerillo	X	X	X	
	<i>Pouteria sapota</i>	Mamey apple	X			
	<i>Pouteria sp.</i>		X			
	<i>Sideroxylon americanum</i>			X	X	
Selaginellaceae	<i>Selaginella sp.</i>	Selaginella	X			
Simaroubaceae	<i>Simarouba glauca</i>	Negrito	X	X	X	
Smilacaceae	<i>Smilax sp</i>	Chinee yam, Chinee root	X			
Solanaceae	<i>Solanum sp.</i>		X			
	<i>Solanum diphyllum</i>	Bocano		X	X	
Sterculiaceae	<i>Guazuma ulmifolia</i>	Bay cedar, pixoy	X	X	X	
	<i>Helicteres guazumifolia</i>		X			
Surianaceae	<i>Suriana maritima</i>			X	X	
Theophrastaceae	<i>Jaquinia macrocarpa</i>	Xcansic, Jaquinia	X			
Tiliaceae	<i>Luehea seemannii</i> (?)	Mapola	X			
	<i>Luehea speciosa</i>		X			
	<i>Trichospermum grewiifolium</i>	Balsa wood, Moho		X	X	
Turneraceae	<i>Erblichia odorata</i>			X	X	

2006: Walker - fieldwork for this biodiversity assessment

1998: Meerman – species list for White Ridge area, BERDS

1994: Lyons – species list for Gales Point Natural Resource Project

Nomenclature based on Balick et. al., 2000

Table 11: Terrestrial Plants of the Southern Lagoon Area (continued)

Family	Species	Common name	2006	1998	1994	IUCN
Ulmaceae	<i>Ampelocera hottlei</i>	Bullhoof		X		
Verbenaceae	<i>Aegiphila monstrosa</i>			X	X	
	<i>Avicennia germinans</i>	Black Mangrove	X	X	X	
	<i>Lantana involucrate</i>			X	X	
	<i>Vitex gaumeri</i>	Yaxnik	X			
Vitaceae	<i>Vitis tiliifolia</i>	Water vine		X	X	
Vochysiaceae	<i>Vochysia hondurensis</i>	Yemeri, San Juan	X	X	X	
Zamiaceae	<i>Zamia polymorpha</i>	Palmita	X	X		NT
Zingiberaceae	<i>Renealmia sp.</i>	Wild ginger sp.	X			

2006: Walker - fieldwork for this biodiversity assessment

1998: Meerman – species list for White Ridge area, BERDS

1994: Lyons – species list for Gales Point Natural Resource Project

Nomenclature based on Balick et. al., 2000

6.4 Fauna of the Southern Lagoon area

6.4.1 Mammals of the Southern Lagoon area

Mammals were recorded opportunistically throughout the survey period, during both diurnal and nocturnal transects, from sightings, tracks, calls, from local reports (confirmed and unconfirmed), and from previous survey work, both in the Southern Lagoon area and in adjacent areas (Greenlee, 1994; BERDS, 2006; Walker and Walker, 2005).

A total of twenty-five confirmed mammal species were recorded within the Southern Lagoon area (Table 13), with a species composition representative of the tropical broadleaf forests, savanna and coastal lagoon ecosystems of Belize.

- Four of these species were observed directly during the survey (Antillean manatee, nine banded armadillo, northern raccoon and grey fox)
- Four species were recorded during the survey from their tracks or calls (Common/Virginia opossum, paca, Baird's tapir, Yucatan black howler)
- Seventeen species were confirmed as present from previous survey work (Greenlee, 1994; BERDS, 2006)

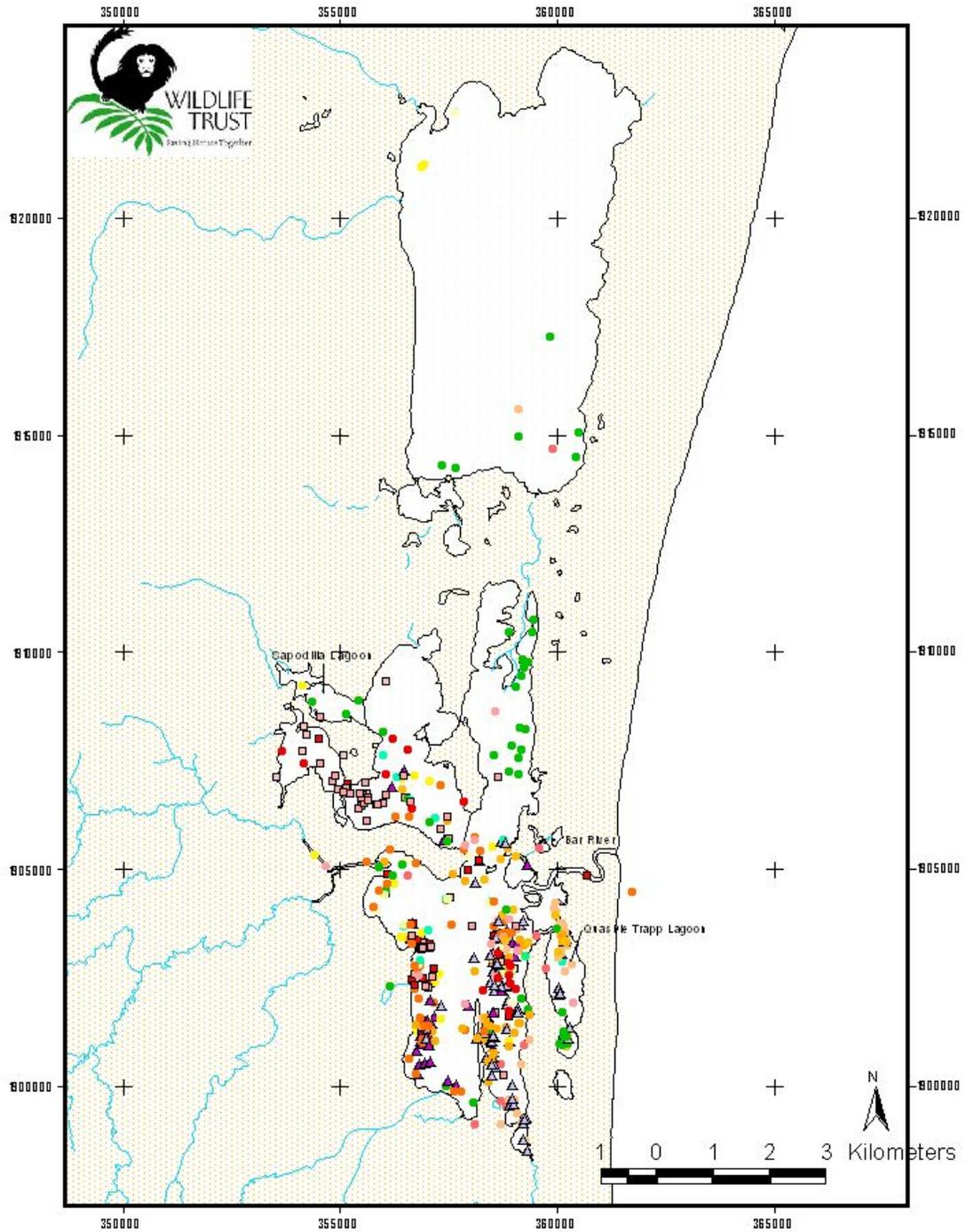
A further twelve species potentially occur within the area, based on information gathered from local reports, and Greenlee (1994). Three of these are also confirmed for the adjacent Peccary Hills area, but require verification for the Southern Lagoon area. Two further species are reported as present by local residents of Gales Point, but these reports also need confirmation.

Of the twenty-five confirmed species, five (20%) are considered to be species of international concern (Table 12), with two species, the Yucatan howler monkey and Baird's tapir, listed as Endangered (IUCN, 2006). One species is considered Vulnerable (the Antillean manatee), whilst one is classified as Near Threatened' (jaguar). One species, the Neotropical river otter, is listed as Data Deficient (IUCN, 2006) - potentially at risk, but for which there is insufficient data on abundance and/or distribution to allow an assessment of viability.

Three of the non-Red List species (jaguarundi, ocelot and margay) are listed in Appendix I of the Convention of International Trade in Endangered Species, with strict regulation of international trade, in recognition of their threatened populations. These three species are also highlighted in the provisional national list of critical species (Meerman, 2005).

There are three Yucatan endemics recorded within the area - the Yucatan and Deppe's squirrels, and the Yucatan black howler monkey, with ranges restricted to Mexico, Belize and Northern Guatemala. It is possible that further work on small mammals such as rodents and bats may show the presence of other regional endemics. The sub-species of Central American spider monkey (*Ateles geoffroyi yucatanensis*) is also restricted to this region, and is considered Vulnerable at sub-species level (IUCN, 2006).

Belize is particularly important for maintenance of viable populations of the Antillean manatee, having the largest population its range (Quintana-Rizzo and Reynolds, in review). The Antillean manatee is considered threatened throughout its range, and is listed as Vulnerable under the IUCN categories (IUCN 2006). Based on aerial survey counts and other surveys, Belize reportedly has the largest population of this subspecies within the Wider Caribbean (Auil 1998; Quintana-Rizzo & Reynolds in review), with an estimated population of about 1000 individuals (Auil, pers. com.). Within Belize, six sites have been identified as priorities for manatee conservation Belize, based on high probability of animal presence and favourable habitat. Southern Lagoon has been highlighted as one of six areas that has been



Map 22: Distribution of tracked Antillean Manatees in Southern Lagoon, 2003 - 2007

Each color represents one animal. Triangular points represent dame F02 (dark purple) and its calf F03 (light purple); square points represent dame F29 (red) and its calves F28 and F57 (shades of pink).

found to be consistently important to manatees (Auil, 1998; O'Shea and Salisbury 1991), with the availability of freshwater, seagrass and sheltered areas, with a resident population estimated at approximately 150 individuals (Auil, pers. com.). Comprehensive long term monitoring of the manatee populations within the lagoon system is being conducted by Wildlife Trust (Map 22), with a long-term research project which began in 1996 (the longest standing Antillean manatee research site in the Western Caribbean.)

In order to be able to manage the Southern Lagoon as an effective conservation area for manatees, it is important to collect information on how manatees use the lagoon system. Wildlife Trust has been recording data on 23 manatees tagged and tracked within the Southern Lagoon area, from January 21, 2003 to May 3, 2007. This includes 11 mother-calf pairs, and the location is considered to be preferred for calf rearing due to its availability of freshwater and vegetation, relatively low anthropogenic impacts (including pollution and boat traffic) and its protection from storms. Animals tracked show high site fidelity to Southern Lagoon and to a lesser extent, Northern Lagoon, although they are also known to travel less than 15km southward to Mullins River, probably to access the more abundant seagrass there.

The majority of sightings and tracking recordings within Southern Lagoon are made in the southeast portion, where the "Manatee Hole" is located. This depression in the lagoon floor is over 10m deep, with increasing salinity and temperature (to over 33°C) with increasing depth. Up to 20 animals have been seen aggregating in this resource site at any one time, usually when the water temperature drops below 26°C.

Tracking of mothers and calves has led to a better understanding of the behaviour of these mammals. The first mother / calf pair, F02 and calf F03 (triangles in Map 22), were captured and tagged in 1997, and tracked until 2004. During that time, they were most frequently recorded in the southeast area of the lagoon system. The calf, F03, remained with her mother for two years, until becoming fully weaned and independent. Even following weaning, however, the calf demonstrated similar habitat use as the mother, and continued to utilize the southeast portion of the lagoon.

This is in contrast to the movements observed between the second reproductive female, F29 and her calves (F28 and F57). F29 has been recorded utilizing primarily the southern portion of the lagoon, particularly the southwest region. Whilst her first calf, F28, was recorded moving with her in this area during his first two years, following weaning he displayed very different site specific preference, becoming a resident of the northwestern part of the lagoon. His sister, F57 (tagged in 2006), also seems to have adopted a similar residency pattern.

Long-distance travel has also been recorded, the first documentation of trans-boundary movement of a free-ranging Antillean manatee occurring in April 2006. Satellite data has indicated that four male manatees tagged in Mexico have traveled to Belize – two directly to the Southern Lagoon (~200km south from where they were tagged), one to Placencia, and one to the Belize City area. One of the largest males tagged in the Southern Lagoon has shown a similar pattern, traveling north of Belize City, then onward to Mexico, staying there for one month before returning to Belize waters. It is suspected that this may continue to be a common occurrence as manatee populations respond to changes in habitats and react to influences due to anthropomorphic threats.

Table 12: Mammal Species of National and International Concern of the Southern Lagoon area*			
Endangered	Yucatan Black Howler Monkey	<i>Alouatta pigra</i>	
	Baird's Tapir	<i>Tapirus bairdii</i>	
Vulnerable	Water Opossum	<i>Chironectes minimus</i>	
	Central American Woolly Opossum	<i>Caluromys derbianus</i>	
	Antillean Manatee	<i>Trichechus manatus manatus</i>	
Near Threatened	Jaguar	<i>Panthera onca</i>	
	Puma	<i>Puma concolor</i>	
Provisional Status in Belize (Meerman, 2005)			Criteria
Vulnerable	Central American Spider Monkey	<i>Ateles geoffroyi</i>	4
	Neotropical River Otter	<i>Lontra longicaudis</i>	5
	Ocelot	<i>Leopardus pardalis</i>	1,4,5
	Margay	<i>Leopardus weidii</i>	1,4,5
Least Concern	Jaguarundi	<i>Herpailurus yaguarondi</i>	5
IUCN Categories		Criteria for inclusion in provisional national critical species listing (Meerman, 2005)	
EN Endangered VU Vulnerable NT Near Threatened DD Data Deficient		1 Hunted - Fished 2 Colony breeder or restricted number of nesting locations 3 Specialized ecological requirements 4 Charismatic species drawing national and international attention 5 Persecuted as a perceived pest 6 Requires a large range 7 Genetically different from South American counterpart	
* Including Runaway Creek			

The majority of the terrestrial mammal species were recorded within the karstic broadleaf forest area.

Three species of Didelphidae have been listed as confirmed for the Southern Lagoon area. Tracks of either the Virginia opossum (*D. virginiana*) or common opossum (*D. marsupialis*) (or both) were observed in the broadleaf forest and short grass savanna areas, and previous work in the area (Greenlee, 1994) confirmed the presence of both species, as well as the gray four-eyed opossum (*Philander opossum*). The Near Threatened water opossum (*Chironectes minimus*) and the Central American woolly opossum (*Caluromys derbianus*), listed as Vulnerable (IUCN, 2006) have both been reported locally, though there is no confirmed sighting of this species to date within the area.

The smaller Mexican and Robinson's mouse opossums (*Marmosa mexicana* and *M. robinsoni*) are reported to potentially occur within the area (Greenlee, 1994), though their presence will probably not be confirmed until specific research techniques target the smaller non-volant mammals.

Two species of Edentata were recorded - the northern tamandua (*Tamandua mexicana*) during community consultations, and the nine-banded armadillo (*Dasypus novemcinctus*) confirmed through observation during fieldwork. *T. mexicana* is considered to be relatively common in the broadleaf forest areas, whilst *D. novemcinctus* is known to use both the forested areas and the more open savanna (Gales Point community consultations, 2006). The armadillo was highlighted as a favoured game species, with populations being heavily impacted by hunting pressure in the savanna areas, people from Gales Point hunting as far north as Freshwater and Tum Tum Creek (Gales Point community, pers. com.; Gracie Rock community, pers. com.). Both these species were also confirmed by past fieldwork (Greenlee, 1994).

Two species of primates are present in Belize, the Central American spider monkey (*Ateles geoffroyi*) and the Yucatan black howler (*Alouatta pigra*), and both were reported as present within the karst areas north west of Sapodilla and Western lagoons (community consultations, 2006), and the White Ridge area to the south (BERDS, 2006). The Yucatan howler monkey is restricted to the broadleaf forest, and shows a further preference for the forested river-edge vegetation within the Southern Lagoon area. The spider monkey, also found only within the broadleaf forest, was reported as being present throughout the more northern karst area.

Local reports indicate that both species experienced reduced populations during the yellow fever epidemic of 1956/57, and from the effects of Hurricane Hattie in 1961, but have recovered to some extent since then. During the fieldwork, the presence of the Yucatan black howler was established through its distinctive call, though the spider monkey was never confirmed visually during the survey, but was confirmed from previous reports (Augusta and Andrewin, 1993; Greenlee, 1994), from local consultations, and through fieldwork in the adjacent Peccary Hills area (Walker and Walker, 2005).

Ateles geoffroyi appears to be particularly vulnerable to human disturbance in Belize, requiring a large area of relatively undisturbed forest in order for viable populations to occur. This species is established within the karst hills of the Peccary Hills area, spreading into northern Manatee Forest Reserve and Runaway Creek (private reserve), and through the broadleaf forest areas of the Southern Lagoon watershed. Local reports suggest that there are small groups located along the banks of Cornhouse Creek, Manatee River and the lower reaches of Soldier Creek, as well as on the Ben Lomond karst outcrops.

Historically, large numbers of spider monkeys were known to have congregated north of the Manatee River, but currently numbers in the area are known to be much lower, with small, scattered groups, suggesting that populations are not yet fully recovered. Following recognition of increasing habitat fragmentation and loss, the regional subspecies (*A. g. yucatanensis*) has recently been upgraded to Vulnerable (IUCN, 2006), as the population is projected to decline by 35% over the next 30 years. This fragmentation is also affecting populations at the local level, especially with the increased scope and severity of fire on the savannas, reducing the vegetation to a low scrub with vast expanses of short grass, breaking any forest corridors that previously allowed these monkeys to move between the broadleaf forest of the isolated karst areas.

The Yucatan black howler monkey is a regional endemic, being found only in a relatively small area of Belize, Mexico and Guatemala. As with *Ateles geoffroyi*, the increasing rate of forest fragmentation, and the continued conversion of forest to agriculture, especially along the river and creek sides, is placing this species at increased risk of local extinction. Within the project area, howlers are reported to be present within most broadleaf forest fragments – both associated with karst outcrops, and with riverine vegetation. On balance, local consultations suggest that whilst both species of primate are found north of the Manatee River, only howler monkeys are considered to be in good numbers south of the river, with few reports of spider monkeys.

Whilst forest connectivity is of major concern for arboreal species such as these, *Alouatta pigra* (unlike *Ateles geoffroyi*) have been reported swimming across rivers in Belize, and have been observed crossing savannas with scattered pine trees in the Manatee Forest Reserve area (Gales Point resident, pers. com.). The construction of the Coastal Road and subsequent roadside development for agriculture has impacted connectivity for these primate populations between the Southern Lagoon area and the remaining western portion of the Manatee Forest Reserve.

Two species of squirrel - Deppe's and the Yucatan squirrel (*Sciurus deppei* and *Sciurus yucatanensis*) - are reported to be present within the Southern Lagoon area (local consultations, 2006; Greenlee, 1994). Throughout Belize, Deppe's squirrel appears to show a preference for cohune dominated areas of the broadleaf forest, and can therefore be expected to be primarily within the karst areas and river bank vegetation. The Yucatan squirrel does, however, appear to be much more of a generalist, utilizing a wide range of ecosystems within the Southern Lagoon area, including agricultural and broadleaf forest.

Three species of larger rodent are known to occur in the area – the paca (*Agouti paca*), Central American agouti (*Dasyprocta punctata*), and the Mexican porcupine (*Coendou mexicanus*). Paca tracks were recorded during the survey, and agouti and Mexican porcupine were confirmed as present in the adjacent Peccary Hills area, and through consultations in Gales Point. The Mexican porcupine and Central American agouti are reported to be present in the broadleaf forest areas, though the latter is considered to be in reduced numbers, a reflection of the hunting pressure within the area. The presence of caches of cohune nuts confirmed local reports that paca inhabit the numerous cave systems, and community consultations suggest that they are enthusiastically hunted along the creek and river edges (Gales Point community, 2006).

There has been no long term research to date on the small rodent species present within the Southern Lagoon area, but Greenlee confirmed the presence of the roof rat (*Rattus rattus*), a human commensal, within the area, and included the hispid cotton rat (*Sigmodon hispidus*) as potentially present, but requiring confirmation.

Based on local reports, present and past survey work, seven species of non-Felidae carnivores are considered to be present or potentially present within the Southern Lagoon area. The gray fox (*Urocyon cinereoargenteus*) was recorded during the fieldwork, as was the northern raccoon (*Procyon lotor*), which was sighted in the White Ridge area. Reports suggest that both these species are abundant within the area. White-nosed coati (*Nasua narica*) were reported during local consultations and confirmed by past survey work (Greenlee, 1994). They were also highlighted as predators of hawksbill turtle nests within the coastal area, as was the striped hog-nosed skunk (*Conepatus semistriatus*) (K. Andrewin, pers. com.). The kinkajou (*Potos flavus*) is reported to be present within the broadleaf forest, and has been confirmed in the adjacent Peccary Hills area (Walker and Walker, 2005). The Neotropical river otter (*Lutra longicaudis*) was recorded during the 1994 survey work, and its presence in the freshwater creeks and river was also confirmed during the community consultations, though it is suggested that densities are low.

All five of the cat species present in Belize have the potential to inhabit the Southern Lagoon area, with Greenlee confirming the presence of ocelot (*Leopardus pardalis*), jaguarundi (*Herpailurus yagouaroundi*) and jaguar (*Panthera onca*). Puma (*Puma concolor*) has been confirmed from surveys in the adjacent White Ridge and Peccary Hills areas (BERDS, 2006; Walker and Walker, 2005), and based on the minimum area required for a viable population, is considered to be present in the Southern Lagoon area as well.

Baird's tapir (*Tapirus bairdii*) is the largest herbivore present on the coastal plain, and tends to be associated with the creeks, freshwater inundation areas and riverside, where it grazes on the herbaceous vegetation. Whilst shy and infrequently seen, its tracks were recorded during the fieldwork on the savannah and broadleaf forest areas in the Ben Lomond area, in the White Ridge area (BERDS, 2006), and community consultations suggest that this species is found throughout the area. It is listed as Endangered (IUCN, 2004), but is thought to be widespread and relatively common in Belize, where it is seldom hunted. The main threat to this species is the increasing rate of habitat fragmentation and conversion to agriculture. The protection of significant tracts of unfragmented riparian vegetation and other suitable habitats (such as those adjacent to Manatee River and the numerous creeks), is a priority for its continued survival.

Of the two peccary species recorded in Belize, only the collared peccary (*Tayassu tajacu*) occurs within the Southern Lagoon area. White-lipped peccary (*Dicotyles pecari*) are reported to have occurred throughout the area until extensive flooding (following Hurricane Greta, in 1978) combined with intensive hunting pressure, is thought to have caused the local extinction of this species throughout the coastal savanna surrounding both Northern and Southern Lagoons, and the broadleaf forest areas of Manatee Forest Reserve, south to Gales Point. Coupled with the increasing fragmentation of forest habitat, the construction of the Coastal Road and the increased traffic, hunting and clearance associated with it, this species is unlikely to be able to recolonize the area without human intervention.

T. tajacu has been reported from both the broadleaf forest and short grass savanna areas. Local reports suggest that this species sometimes utilizes the caves of the karst slopes for shelter, though also that numbers are somewhat reduced. This is particularly so in the savanna areas, where it comes under pressure from hunters from Gales Point and La Democracia to the north, as well as hunting parties from Belize City, Belmopan and even San Ignacio, accessing the area from the Coastal Road during the dry season.

Two deer species are confirmed as present in the Southern Lagoon area. The larger of the two, the white-tailed deer (*Odocoileus virginianus*), is favoured by hunters, and comes under intense pressure during dry season. It prefers the savannah ecosystems, and is lured to newly burnt areas for the minerals in ash, and the new shoots, encouraging hunters to set fires throughout the coastal plain. The smaller red brockett (*Mazama americana*) was reported in the White Ridge area (BERDS, 2006), and is a forest species, rarely venturing into the open areas, so is confined to the broadleaf forest of the karst areas. .

Areas of Concern:

- Fragmentation of broadleaf forest areas through land clearance for agriculture and tourism development
- Increasing clearance of vegetation along creeks and rivers, removing connectivity of forest corridor – of particular importance to spider monkeys and howler monkeys
- Continued high scope and severity of fires on the savanna, reducing forest connectivity between broadleaf forest of karst areas, affecting many mammal species – especially Central American spider monkeys
- Increasing impact on water quality from agro-chemicals, potential oil spills, and increased sediment load affecting seagrass and reducing fish populations and impacting the Antillean manatee and Neotropical river otter
- High hunting pressure from both Gales Point and other communities, reducing viability of prey species
- Increased boat traffic in Southern Lagoon, Bar River and Main Creek, increasing probability of manatee strikes
- Threat of manatee drowning in seine nets – especially those placed across creeks and rivers with active manatee travel
- Unregulated tourism disturbing wildlife – particularly the Antillean manatee

Table 13: Mammals of the Southern Lagoon area

Common Name	Scientific Name	Walkers 2006	1998	1994	2005 Peccary Hills	Local reports	IUCN Status	CITES Status
Didelphimorphia								
Didelphidae								
Common Opossum	<i>Didelphis marsupialis</i>	T		x	x	x		
Virginia Opossum	<i>Didelphis virginiana</i>			x	x	x		
Grey Four-eyed Opossum	<i>Philander opossum</i>			x	x	x		
Water Opossum	<i>Chironectes minimus</i>			?	x	x	NT	
CA Woolly Opossum	<i>Caluromys derbianus</i>			?			VU	
Robinson's Mouse Opossum	<i>Marmosa robinsoni</i>			?				
Mexican Mouse Opossum	<i>Marmosa meicana</i>			?				
Edentata								
Myrmecophagidae								
Northern Tamandua	<i>Tamandua mexicana</i>			x	x	x		
Dasypodidae								
Nine-banded Armadillo	<i>Dasybus novemcinctus</i>	x		x	x	x		
Insectivora								
Soricidae								
Least Shrew	<i>Cryptotis parvis</i>			?				
Primates								
Cebidae								
Yucatan Black Howler	<i>Alouatta pigra</i>	H	x	x	x	x	EN	I
Central American Spider Monkey	<i>Ateles geoffroyi</i>		x	x	x	x		
Lagomorpha								
Leporidae								
Brazilian Rabbit	<i>Sylvilagus brasiliensis</i>			x				
Rodentia								
Sciuridae								
Yucatan Squirrel	<i>Sciurus yucatanensis</i>			x	x	x		
Deppe's Squirrel	<i>Sciurus deppei</i>			x	x	x		
Muridae								
Roof rat	<i>Rattus rattus</i>			x	x			
Hispid Cotton Rat	<i>Sigmodon hispidus</i>			?				
Erethizontidae								
Mexican Porcupine	<i>Coendou mexicanus</i>			?	x	x		
Dasyproctidae								
Central American Agouti	<i>Dasyprocta punctata</i>		x		x	x		
Agoutidae								
Paca	<i>Agouti paca</i>	T	x	x	x	x		

2005: Peccary Hills: Biodiversity Assessment (Walker and Walker, 2005)
1998: Data from BERDS, 2006; Meerman survey of White Ridge Farm area in 1998
1994: Data from Greenlee, 1994
H Heard; T Tracks
IUCN Status: CR Critically Endangered EN Endangered VU Vulnerable NT Near Threatened

Table 13: Mammals of the Southern Lagoon Area (continued)

Common Name	Scientific Name	Walkers 2006	1998	1994	2005 Peccary Hills	Local reports	IUCN Status	CITES Status
Carnivora								
Canidae								
Grey Fox	<i>Urocyon cinereoargenteus</i>	x		x	x	x		
Procyonidae								
Northern Raccoon	<i>Procyon lotor</i>	x		x	x	x		
White-nosed Coati	<i>Nasua narica</i>			x	x	x		
Kinkajou	<i>Potos flavus</i>			?	x			
Mustelidae								
Striped Hog-nosed Skunk	<i>Conepatus semistriatus</i>					x		
Spotted Skunk	<i>Spilogale putorius</i>					x		
Neotropical River Otter	<i>Lutra longicaudis</i>			x	x	x	DD	I
Tayra	<i>Eira barbara</i>			x		x		
Grison	<i>Galictis vittatus</i>			?				
Long-tailed weasel	<i>Mustela frenata</i>			?		x		
Felidae								
Ocelot	<i>Leopardus pardalis</i>			x	x	x		I
Margay	<i>Leopardus wiedii</i>			?		x		I
Jaguarundi	<i>Herpailurus yagouaroundi</i>			x		x		I
Puma	<i>Puma concolor</i>		x	?	x	x	NT	I
Jaguar	<i>Panthera onca</i>			x	x	x	NT	I
Perissodactyla								
Tapiridae								
Baird's tapir	<i>Tapirus bairdii</i>	T	x	x	x	x	EN	I
Artiodactyla								
Tayassuidae								
Collard Peccary	<i>Tayassu tajacu</i>			x	x	x		
Cervidae								
White-tailed Deer	<i>Odocoileus virginianus</i>			x	x	x		
Red brocket Deer	<i>Mazama americana</i>		x	x	x	x		
Sirenia								
Trichechidae								
Antillean manatee	<i>Trichechus manatus</i>	x	x	x	x	x	VU	I

2005: Peccary Hills: Biodiversity Assessment (Walker and Walker, 2005)

1998: Data from BERDS, 2006; Meerman survey of White Ridge Farm area in 1998

1994: Data from Greenlee, 1994

H Heard; T Tracks

IUCN Status: CR Critically Endangered EN Endangered VU Vulnerable NT Near Threatened

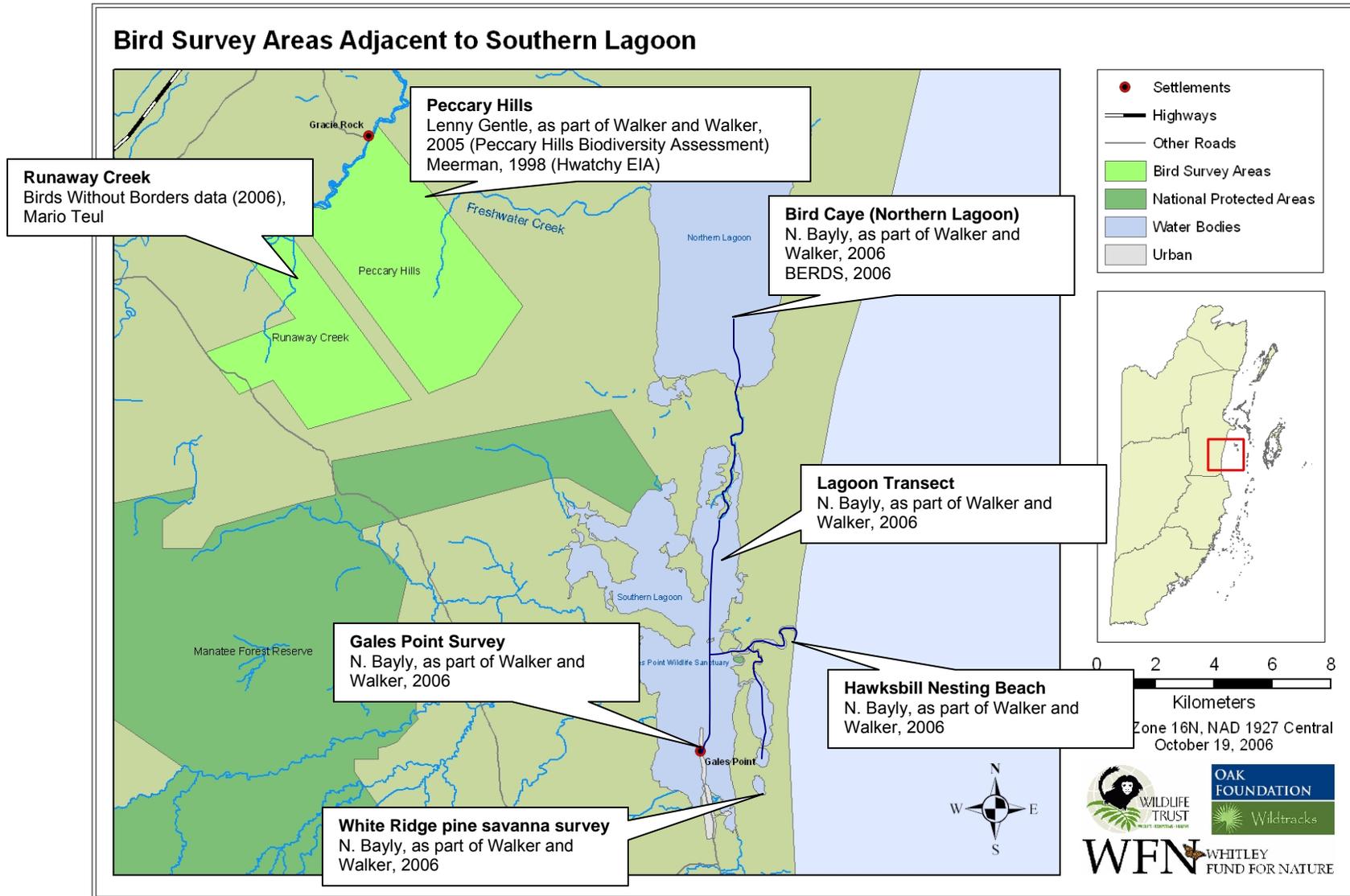
6.4.2 Birds

A total of 315 species of birds have been listed for the Southern Lagoon watershed and adjacent area, 73% of these (230 species) are considered permanent residents (Table 15; Jones, 2003). Birds were surveyed using both lagoon and terrestrial transects and point surveys, with recordings of opportunistic sightings by all members of the fieldwork team, and input from community consultations (Map 23). Data was also analyzed from adjacent areas – particularly from Runaway Creek Nature Preserve to the north, where Birds without Borders (a project of the Zoological Society of Milwaukee), has been conducting a long-term survey of resident and migratory bird species, between 1999 and 2002. Using mist netting and banding both in the karst and savanna, this study has provided significant data on the bird species that use the area. With the similarities in ecosystem types and proximity of sites, there is expected to be complete overlap between the bird fauna with that of the western pine savanna and karst to the west of Southern Lagoon. Data has also been available from surveys within the Peccary Hills area immediately to the north (BERDS, 2006; Walker and Walker, 2005) (Map 23).

Five bird species (the yellow-headed parrot (*Amazona oratrix*), cerulean warbler (*Dendroica cerulean*), great curassow (*Crax rubra*), black catbird (*Melanoptila glabirostris*) and painted bunting (*Passerina ciris*)) have been highlighted for their status as species of international concern (Table 14; IUCN, 2006).

Table 14: Bird Species of National and International Concern of the Southern Lagoon area*			
Endangered	Yellow-headed Parrot	<i>Amazona oratrix</i>	
Vulnerable	Cerulean Warbler	<i>Dendroica cerulea</i>	
Near Threatened	Great Curassow	<i>Crax rubra</i>	
	Black Catbird	<i>Melanoptila glabirostris</i>	
	Painted Bunting	<i>Passerina ciris</i>	
Provisional Status in Belize (Meerman, 2005)			Criteria
Vulnerable	Agami Heron	<i>Agamia agami</i>	2,3
	Yellow-lored Parrot	<i>Amazona xanthlora</i>	5
	Great Blue Heron	<i>Ardea herodias</i>	1,5
	Muscovy Duck	<i>Cairina moschata</i>	1
	Black-bellied Whistling-Duck	<i>Dendrocygna autumnalis</i>	1,5
	Snowy Egret	<i>Egretta thula</i>	2,5
	Tricolored Heron	<i>Egretta tricolor</i>	2,5
	White Ibis	<i>Eudocimus albus</i>	2
	Magnificent Frigatebird	<i>Fregata magnificens</i>	2
	Jabiru	<i>Jabiru mycteria</i>	1,4,5,6,7
	Wood Stork	<i>Mycteria Americana</i>	1,2,5
	Yellow-crowned Night-Heron	<i>Nyctanassa violacea</i>	2
	Black-crowned Night-Heron	<i>Nycticorax nycticorax</i>	2
	Brown Pelican	<i>Pelecanus occidentalis</i>	2,5
	Crested Guan	<i>Penelope purpurascens</i>	1
Neotropic Cormorant	<i>Phalacrocorax brasilianus</i>	1,2,5	
King Vulture	<i>Sarcoramphus papa</i>	3,4,6	
IUCN Categories		Criteria for inclusion in provisional national critical species listing (Meerman, 2005)	
EN Endangered		1 Hunted - Fished	
VU Vulnerable		2 Colony breeder or restricted number of nesting locations	
NT Near Threatened		3 Specialized ecological requirements	
DD Data Deficient		4 Charismatic species drawing national and international attention	
		5 Persecuted as a perceived pest	
		6 Requires a large range	
		7 Genetically different from South American counterpart	
* Including Runaway Creek			

Bird Survey Areas Adjacent to Southern Lagoon



Map 23: Bird Survey Locations of the Southern Lagoon Area

Mapping: A. Lloyd; Wildtracks

A further species, the jabiru stork (*Jabiru mycteria*), has also been highlighted through its listing in CITES Appendix I. On the national level, a provisional list of 46 critical bird species has been generated (Meerman, 2005), of which twenty three (50%) have been recorded within the Southern Lagoon / Runaway Creek / Peccary Hills area.

The Southern Lagoon system, with its complex mosaic of creeks, lagoons and large expanses of red mangrove, provides a wilderness with a wide range of foraging habitats available to water birds (shallow water, shaded creeks, inundated mangrove flats and riverine edge) resulting in a rich and varied water bird population. The basin mangrove lining Bar River, and the isolated mangrove cayes, provide an excellent structure for nesting birds such as night herons and tiger herons, and refuge for kingfishers and green herons.

The black catbird (*Melanoptila gabrirostris*), listed as Near Threatened (IUCN, 2006), is a Yucatan endemic, restricted to the scrubby woodlands and mangrove of the Yucatan and north east Belize. Whilst the Southern Lagoon area is considered beyond the southern-most range of this species within Belize, this species has been recorded further south in Paynes Creek, Toledo, and both the numbers and the southward range are thought to be increasing (Jones, 2003), despite the rate of land use change for coastal development. This species, whilst not recorded during the survey, is considered likely to be present.

This focus on coastal development has also increased the risk to colony nesting birds, highlighted as national critical species. Many of these species use mangrove cayes, such as the two bird sanctuaries in Northern Lagoon, for colonial nesting, concentrating populations within a small area during nesting season. The increased clearance, human presence, and disturbance from boat activity has the potential to have a negative impact on these species unless mitigation measures are put in place.



Photograph 27:
Boat-billed heron
(*Cochlearius cochlearius*)

The bird cayes of Northern Lagoon was one of five bird nesting cayes designated as crown reserves in 1977, under the Crown Lands Ordinance (1926), and has been included within the survey, at the request of the Gales Point community and Wildlife Trust. Its inclusion in this protected area category is a reflection of its value as a nesting colony site for magnificent frigatebirds (*Fregata magnificens*), great egrets (*Ardea alba*), boat billed herons (*Cochlearius cochlearius*), white ibis (*Eudocimus albus*), cattle egrets (*Bubulcus ibis*) and cormorants (*Phalacrocorax purpurascens*).

Whilst Southern Lagoon itself is important for many waterbirds, the surrounding savannas and broadleaf forests also provide a critical mosaic of habitat for other species.

One bird of the coastal pine savanna areas adjacent to Southern Lagoon is the yellow headed parrot (*Amazona oratrix*), classified globally as Endangered following a rapid population decline of 90% throughout its range since the 1970's. An estimated 7,000 individuals remained in the region in 1994 (Birdlife, 2005 IUCN, 2006), and in the last ten years alone, the population is thought to have declined by a further 68%. Significant rates of decline are expected in the future, with increased habitat destruction for development, increased man-made fires over the pine savanna areas, and the theft of nestlings for the pet trade.

The sub-species *Amazona oratrix belizensis* is restricted to the pine savanna of Belize and northern Honduras, and has been recorded within the Runaway Creek area. Once common throughout the coastal savannas of Belize, the range of this species has contracted to small, fragmented pockets, primarily in north west Belize and the Paynes Creek area in the south. Local reports from Gales Point suggest that this species has always been scarce within the

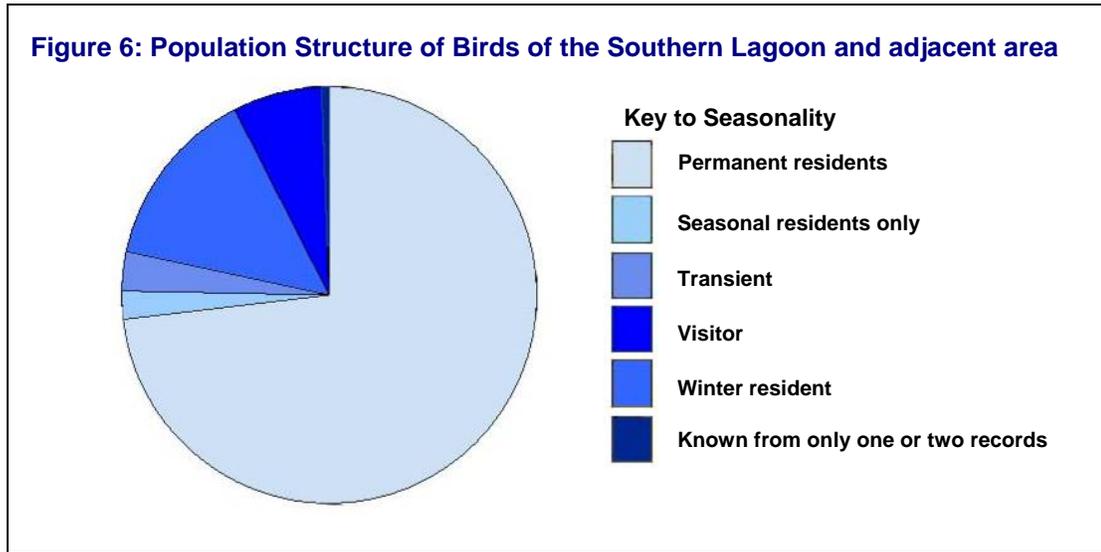
area, though there is general agreement that it is still present within the pine savanna areas south of Gales Point. The degradation of the pine savanna through increased frequency of fires may well have been the primary threat responsible for the decline of this species in the area in the past, removing the majority of large pine trees used by the parrots for nesting. Harvesting of nestlings as pets and for the local pet trade, has also been responsible for reductions in the population (N. Auil, pers. com.). Without strategies in place to prevent further such impacts, there is nothing to prevent further decline of this species, and local extinction.

The threat of increasing frequency of fire in the savanna areas faces not only the yellow-headed parrots, but other savanna specialists too – such as the aplomado falcon, and fork-tailed flycatcher, black-throated bobwhite, and savanna sparrows – species that nest low down within the grass layer. Another bird that has been observed frequenting the savanna and is known to nest within the Southern Lagoon area is the jabiru stork, listed as a CITES Appendix I species, and considered to be genetically isolated from that of South America, resulting in a limited gene pool available for viability (Figueroa, 2005). However the jabiru relies on tall trees, generally located on or adjacent to savanna, to provide safe nesting sites – trees that are becoming increasingly scarce with past and present logging pressure, and the increased scope and severity of fire.

The broadleaf forests of the karst hills and river and creek banks provide an ecosystem that is important for many species. The great curassow (*Crax rubra*), highlighted as a high global priority in the Cracid Action Plan, 2000 – 2004 (Brooks and Strahl, 2000), has a wide regional distribution, stretching from Mexico southwards to Ecuador, though it is restricted to broadleaf forest areas. This species is found in the karst areas of the Southern Lagoon area. This species is becoming uncommon to rare through much of its range, and in parts, locally extinct (Birdlife, 2005). Throughout the Neotropics, great curassow are heavily persecuted as game species, and populations in Belize are no exception, coming under serious hunting pressure (Belize is highlighted within the Cracid Action Plan (Brooks et. al. 2000) as one of the few countries where hunting of this species is still legal). Within the broadleaf forests of the Southern Lagoon area, populations are considered to be seriously reduced, with heavy hunting pressure from Gales Point, and also from hunting parties originating from Dangriga, Belmopan, Belize City and even San Ignacio. Community consultations suggest that this species is no longer as common as it was twenty years ago.

The second large gamebird species in the area, the crested guan (*Penelope purpurascens*), is also declining in numbers and range in Belize generally, and is unlikely to recover in the Southern Lagoon area unless there is serious control of hunting. This species is considered of intermediate priority in the Cracid Action Plan, with recommendations for additional fieldwork to determine the status and monitor population numbers.

The Southern Lagoon area is also important for migratory birds, with winter residents and transients comprising 21% of the recorded species (Figure 6). This is increasingly true with the high rates of deforestation further inland, reducing the area of quality stopping points for migrants heading further south, and with the movement of transient birds following the coastline.



Areas of Concern:

- Fragmentation of broadleaf forest areas through land clearance for agriculture and tourism development
- Increasing clearance of vegetation along creeks and rivers, removing connectivity of forest corridor – of particular importance to riparian specialists such as the shy agami heron (*Agami agami*) and muscovy duck (*Cairina moschata*)
- Continued high scope and severity of fires on the savanna, reducing forest connectivity between broadleaf forest of karst areas, and reducing nesting viability of savanna specialists – including the ‘endangered’ yellow-headed parrot (*Amazona oratrix*) and the jabiru (*Jabiru mycteria*)
- High hunting pressure from both Gales Point and other communities, reducing viability of prey species such as the ‘near threatened’ great curassow (*Crax rubra*), and the crested guan (*Penelope purpurascens*)
- Unregulated tourism disturbing wildlife – particularly of bird nesting colonies on the mangrove cayes

Table 15: Birds of the Southern Lagoon Area

Species		Status	Habitats	Southern Lagoon	Peccary Hills	Runaway Creek	IUCN
Great Tinamou	<i>Tinamus major</i>	fP	BFL			x	
Little Tinamou	<i>Crypturellus soui</i>	fP	SC		x	x	
Thicket Tinamou	<i>Crypturellus cinnamomeus</i>	IP	BFL			x	
Slaty-breasted Tinamou	<i>Crypturellus boucardi</i>	fP	BFL			x	
Least Grebe	<i>Tachybaptus dominicus</i>	IP	WL,LA			x	
Brown Pelican	<i>Pelecanus occidentalis</i>	vV	O	x		x	
Neotropic Cormorant	<i>Phalacrocorax brasilianus</i>	oV	LA	x		x	
Anhinga	<i>Anhinga anhinga</i>	fP	LA	x	x	x	
Magnificent Frigatebird	<i>Fregata magnificens</i>	vP	O	x		x	
Bare-throated Tiger-Heron	<i>Tigrisoma mexicanum</i>	uP	WL,LA			x	
Great Blue Heron	<i>Ardea herodias</i>	cV	WL, LA	x		X	
Great Egret	<i>Ardea alba</i>	vP	LA	x	x	x	
Snowy Egret	<i>Egretta thula</i>	oV	WL,LA	x		x	
Little Blue Heron	<i>Egretta caerulea</i>	vV	WL,LA	x	x	x	
Tricolored Heron	<i>Egretta tricolor</i>	cV	LA	x	x		
Cattle Egret	<i>Bubulcus ibis</i>	fV	SC	x		x	
Green Heron	<i>Butorides virescens</i>	cP	LA	x	x	x	
Agami Heron	<i>Agamia agami</i>	uV	LA			x	
Black-crowned Night-Heron	<i>Nycticorax nycticorax</i>	fW	LA		x	x	
Yellow-crowned Night-Heron	<i>Nyctanassa violacea</i>	IP	LA	x		x	
Boat-billed Heron	<i>Cochlearius cochlearius</i>	IP	LA	x	x	x	
White Ibis	<i>Eudocimus albus</i>	cP	MF, LA	x			
Limpkin	<i>Aramus guarana</i>	cP	LA		x	x	
Jabiru	<i>Jabiru mycteria</i>	IP	SA			x	
Wood Stork	<i>Mycteria americana</i>	fV	LA			x	
Black Vulture	<i>Coragyps atratus</i>	vP	SA,O	x ¹	x	x	
Turkey Vulture	<i>Cathartes aura</i>	vP	SA,O	x ¹	x	x	
Lesser Yellowheaded Vulture	<i>Cathartes burrovianus</i>	fP	SA	x		x	
King Vulture	<i>Sarcoramphus papa</i>	uP	O		x	x	
Black-bellied Whistling-Duck	<i>Dendrocygna bicolor</i>	cP	WL			x	
Muscovy Duck	<i>Cairina moschata</i>	uP	LA			x	
Osprey	<i>Pandion haliaetus</i>	fP	MF, LA	x	x	x	
Gray-headed Kite	<i>Leptodon cayanensis</i>	uP	BFL			x	
Swallow-tailed Kite	<i>Elanoides forficatus</i>	uS	BFL,O			x	
White-tailed Kite	<i>Elanus leucurus</i>	uP	WL,SC			x	
Snail Kite	<i>Rostrhamus sociabilis</i>	fP	WL, LA	x		x	
Double-toothed Kite	<i>Harpagus bidentatus</i>	uP	BFL			x	
Plumbeous Kite	<i>Ictinia plumbea</i>	uS	BFL,O			x	
Black-collared Hawk	<i>Busarellus nigricollis</i>	uP	LA			x	
White Hawk	<i>Leucopternis albicollis</i>	uP	BFL,O			x	
Gray Hawk	<i>Asturina nitida</i>	fP	BFL,SC,O			x	
Common Black-Hawk	<i>Buteogallus anthracinus</i>	uP	SC,O	x		x	
Great Black-Hawk	<i>Buteogallus urubitinga</i>	uP	BFL,O	¹		x	
Roadside Hawk	<i>Buteo magnirostris</i>	cP	SC,SA,O	x ¹	x	x	

Table 15: Birds of the Southern Lagoon Area (continued)

Species		Status	Habitats	Southern Lagoon	Peccary Hills	Runaway Creek	IUCN
White-tailed Hawk	<i>Buteo albicaudatus</i>	uP	uP	x		x	
Zone-tailed Hawk	<i>Buteo albonotatus</i>	oW	oW			x	
Black Hawk-Eagle	<i>Spizaetus tyrannus</i>	uP	BFL,O	1		x	
Ornate Hawk-Eagle	<i>Spizaetus ornatus</i>	rP	BFL,O			x	
Barred Forest-Falcon	<i>Micrastur ruficollis</i>	uP	BFL			x	
Collared Forest-Falcom	<i>Micrastur semitorquatus</i>	uP	BFL			x	
Laughing Falcon	<i>Herpetotheres cachinnans</i>	fP	SC,SA		x	x	
Bat Falcon	<i>Falco ruficularis</i>	fP	SC,O		x	x	
Aplomado Falcon	<i>Falco femoralis</i>	uP	SA		x	x	
Plain Chachalaca	<i>Ortalis vetula</i>	cP	BFL, SC		x	x	
Crested Guan	<i>Penelope purpurascens</i>	IP	BFL		x	x	
Great curassow	<i>Crax rubra</i>	IP	BFL		x	x	NT
Black-throated Bobwhite	<i>Colinus nigrogularis</i>	IP	SA		x	x	
Spotted Wood-Quail	<i>Odontophorus guttatus</i>	uP	BFL			x	
Ruddy Crake	<i>Laterallus ruber</i>	IP	SC			x	
Gray-necked Woodrail	<i>Aramides cajanea</i>	fP	LA		x	x	
Sungrebe	<i>Heliornis fulica</i>	IP	LA			x	
Limpkin	<i>Aramus guarauna</i>	IP	WL,LA			x	
Black-bellied Plover	<i>Pluvialis squatarola</i>	fW	LA	x			
Semi-palmated Plover	<i>Charadrius semipalmatus</i>	fW	LA	x			
Killdeer	<i>Charadrius vociferus</i>	fW	WL			x	
Northern Jacana	<i>Jacana spinosa</i>	cP	LA		x	x	
Solitary Sandpiper	<i>Tringa solitaria</i>	fW	WL		x	x	
Spotted Sandpiper	<i>Actitis macularia</i>	fW	LA			x	
Least Sandpiper	<i>Calidris minutilla</i>	vW	LA	x			
Wilson's Snipe	<i>Gallinago gallinago</i>	x	SA	x			
Royal Tern	<i>Sterna maxima</i>	cV	LA	x			
Pale-vented Pigeon	<i>Columba cayennensis</i>	vP	BFL, PFL, MF		x	x	
Scaled Pigeon	<i>Columba speciosa</i>	uP	BFL			x	
Short-billed Pigeon	<i>Columba nigrirostris</i>	vP	BFL		x	x	
Red-billed Pigeon	<i>Columba flavirostris</i>	uP	BFL	x	x	x	
Plain-breasted Ground-Dove	<i>Columbina minuta</i>	cP	SA	x		x	
Ruddy Ground-Dove	<i>Columbina talpacoti</i>	vP	SC	x	x	x	
Blue Ground-Dove	<i>Claravis pretiosa</i>	uP	BFL		x	x	
White-tipped Dove	<i>Leptotila verreauxi</i>	cP	BFL		x	x	
Gray-fronted Dove	<i>Leptotila rufaxilla</i>	cP	BFL			x	
Gray-chested Dove	<i>Leptotila cassini</i>	mP	BFL			x	
Ruddy Quail-Dove	<i>Geotrygon montana</i>	uP	BFL			x	
Olive-throated Parakeet	<i>Aratinga nana</i>	vP	BFL,SC	x ¹	x	x	
Brown-hooded Parrot	<i>Pionopsitta haematotis</i>	cP	BF			x	
White-crowned Parrot	<i>Pionus senilis</i>	cP	BFL		x	x	
White-fronted Parrot	<i>Amazona albifrons</i>	vP	BFL,SA	x	x	x	
Yellow-lored Parrot	<i>Amazona xantholora</i>	fP	BFL, SA			x	
Red-lored Parrot	<i>Amazona autumnalis</i>	vP	BFL		x	x	
Mealy Parrot	<i>Amazona farinosa</i>	IP	BFL		x	x	

Table 15: Birds of the Southern Lagoon Area (continued)

Species		Status	Habitats	Southern Lagoon	Peccary Hills	Runaway Creek	IUCN
Yellow-headed Parrot	<i>Amazona oratrix</i>	fP	PFL, SA			x	EN
Yellow-billed Cuckoo	<i>Coccyzus americanus</i>	uT	BFL, MF			x	
Squirrel Cuckoo	<i>Piaya cayana</i>	cP	BFL		x	x	
Striped Cuckoo	<i>Tapera naevia</i>	uP	SC			x	
Pheasant Cuckoo	<i>Dromococcyx phasianellus</i>	rP	BFL,SC			x	
Groove-billed Ani	<i>Crotophaga sulcirostris</i>	vP	SC	x	x	x	
Vermiculated Screech-Owl	<i>Otus guatemalae</i>	uP	BFL			x	
Ferruginous Pygmy-Owl	<i>Glaucidium brasilianum</i>	IP	BFL,SC			x	
Mottled Owl	<i>Ciccaba virgata</i>	cP	BFL			x	
Striped Owl	<i>Pseudoscops clamator</i>	uP	SA			x	
Common Pauraque	<i>Nyctidromus albicollis</i>	cP	BFL	x	x	x	
Common Nighthawk	<i>Chordeiles minor</i>	oT	SA,O			x	
Lesser Nighthawk	<i>Chordeiles acutipennis</i>	fP	SA		x	x	
Northern Potoo	<i>Nyctibius jamaicensis</i>	uP	SA	x			
White-collared Swift	<i>Streptoprocne zonaris</i>	fP	O			x	
Vaux's Swift	<i>Chaetura vauxi</i>	cP	O			x	
Lesser Swallow-tailed Swift	<i>Panyptila cayennensis</i>	uP	O		x	x	
Long-tailed Hermit	<i>Phaethornis superciliosus</i>	uP	BFL, SC		x	x	
Little Hermit	<i>Phaethornis longuemareus</i>	fP	BFL		x	x	
Scaly-breasted Hummingbird	<i>Phaeochroa cuvieri</i>	uP	BFL			x	
Wedge-tailed Sabrewing	<i>Campylopterus curvipennis</i>	cP	BFL			x	
White-necked Jacobin	<i>Florisuga mellivora</i>	fP	BFL,LA			x	
Green-breasted Mango	<i>Anthracothorax prevostii</i>	uP	SC			x	
Canivet's Emerald	<i>Chlorostilbon canivetii</i>	uP	SA,SC	x		x	
White-bellied Emerald	<i>Amazilia candida</i>	fP	BFL		x	x	
Azure-crowned Hummingbird	<i>Amazilia cyanocephala</i>	vP	PFL		x	x	
Rufous-tailed Hummingbird	<i>Amazilia tzacatl</i>	cP	SC,SA	1		x	
Buff-bellied Hummingbird	<i>Amazilia yucatanensis</i>	IP	SC,SA			x	
Cinnamon Hummingbird	<i>Amazilia rutila</i>	IP	MF	x		x	
Purple-crowned Fairy	<i>Heliothryx barroti</i>	mP	BFL			x	
Long-billed Starthroat	<i>Heliomaster longirostris</i>	x	SC			x	
Ruby-throated Hummingbird	<i>Archilochus colibris</i>	uW	SC			x	
Black-headed Trogon	<i>Trogon melanocephalus</i>	cP	BFL. PFL		x	x	
Violaceous Trogon	<i>Trogon violaceus</i>	cP	,BFL		x	x	
Slaty-tailed Trogon	<i>Trogon massena</i>	cP	,BFL		x	x	
Tody Motmot	<i>Hylomanes momotula</i>	?P	BFL			x	
Blue-crowned Motmot	<i>Momotus momota</i>	cP	BFL	1	x	x	
Ringed Kingfisher	<i>Ceryle torquata</i>	IP	LA	x		x	
Belted Kingfisher	<i>Ceryle alcyon</i>	fW	LA	x		x	
Amazon Kingfisher	<i>Chloroceryle amazona</i>	cP	LA		x	x	
Green Kingfisher	<i>Chloroceryle americana</i>	cP	LA	x	x		
American Pygmy Kingfisher	<i>Chloroceryle aenea</i>	cP	LA	x	x	x	
White-necked Puffbird	<i>Notharchus macrorhynchos</i>	uP	SC			x	
Rufous-tailed Jacamar	<i>Galbula ruficauda</i>	fP	BFL			x	
Collared Aracari	<i>Pteroglossus torquatus</i>	cP	BFL		x	x	

Table 15: Birds of the Southern Lagoon Area (continued)

Species		Status	Habitats	Southern Lagoon	Peccary Hills	Runaway Creek	IUCN
Keel-billed Toucan	<i>Ramphastos sulfuratus</i>	cP	BFL	x ¹	x	x	
Acorn Woodpecker	<i>Melanerpes formicivorus</i>	cP	PFL	x	x	x	
Black-cheeked Woodpecker	<i>Melanerpes pucherani</i>	cP	BFL			x	
Red-vented Woodpecker	<i>Melanerpes pygmaeus</i>	fP	BFL			x	
Golden-fronted Woodpecker	<i>Melanerpes aurifrons</i>	cP	SC		x	x	
Yellow-bellied Sapsucker	<i>Sphyrapicus varius</i>	uW	BFL			x	
Ladder-backed Woodpecker	<i>Picoides sclaris</i>	fP	PFL			x	
Smoky-brown Woodpecker	<i>Veniliornis fumigatus</i>	fP	BFL			x	
Golden-olive Woodpecker	<i>Piculus rubiginosus</i>	fP	BFL			x	
Chestnut-colored Woodpecker	<i>Celeus castaneus</i>	uP	BFL			x	
Lineated Woodpecker	<i>Dryocopus lineatus</i>	cP	BFL		x	x	
Pale-billed Woodpecker	<i>Campephilus guatemalensis</i>	cP	BFL		x	x	
Rufous breasted Spinetail	<i>Synallaxis erythrothorax</i>	fP	SC		x	x	
Plain Xenops	<i>Xenops minutus</i>	fP	BFL		x	x	
Scaly-throated Leaf-tosser	<i>Sclerurus guatemalensis</i>	uP	FM,BFL			x	
Tawny-winged Woodcreeper	<i>Dendrocincla anabatina</i>	fP	BFL		x	x	
Ruddy Woodcreeper	<i>Dendrocincla homochroa</i>	uP	BFL		x	x	
Olivaceous Woodcreeper	<i>Sittasomus griseicapillus</i>	fP	BFL		x	x	
Wedge-billed Woodcreeper	<i>Glyphorhynchus spirurus</i>	fP	BFL			x	
Northern Barred-Woodcreeper	<i>Dendrocolaptes sanctithomae</i>	fP	BFL, PFL			x	
Ivory-billed Woodcreeper	<i>Xiphorhynchus flavigaster</i>	cP	BFL			x	
Streak-headed Woodcreeper	<i>Lepidocolaptes souleyetii</i>	uP	BFL		x	x	
Great Antshrike	<i>Taraba major</i>	IP	SC			x	
Barred Antshrike	<i>Thamnophilus doliatus</i>	cP	SC		x	x	
Dot-winged Antwren	<i>Microrhophias quixensis</i>	cP	BFL		x	x	
Dusky Antbird	<i>Cercomacra tyrannina</i>	cP	SC			x	
Black-faced Antthrush	<i>Formicarius analis</i>	cP	BFL		x	x	
Yellow-bellied Tyrannulet	<i>Ornithion semiflavum</i>	fP	BFL			x	
Northern Beardless Tyrannulet	<i>Camptostoma imberbe</i>	fP	PFL, SC, SA	x		x	
Greenish Elaenia	<i>Myiopagis viridicta</i>	fP	BFL		x	x	
Yellow-bellied Elaenia	<i>Elaenia flavogaster</i>	vP	PFL,SA	x	x	x	
Ochre-bellied Flycatcher	<i>Mionectes oleagineus</i>	cP	BFL			x	
Sepia-capped Flycatcher	<i>Leptopogon amaurocephalus</i>	fP	BFL			x	
Northern Bentbill	<i>Oncostoma cinereigulare</i>	cP	BFL			x	
Slate-headed Tody-Flycatcher	<i>Poecilatriccus sylvia</i>	uP	SC			x	
Common Tody-Flycatcher	<i>Todirostrum cinereum</i>	cP	SC,SA	x		x	
Eye-ringed Flatbill	<i>Rhynchocyclus brevirostris</i>	uP	BFL			x	
Yellow-olive Flycatcher	<i>Tolmomyias suphurescens</i>	cP	BFL			x	
Stub-tailed Spadebill	<i>Platyrinchus cancrominus</i>	fP	BFL		x	x	
Royal Flycatcher	<i>Onychorhynchus coronatus</i>	uP	BFL			x	
Sulphur-rumped Flycatcher	<i>Myiobius sulphureipygius</i>	cP	BFL			x	
Eastern Wood-Pewee	<i>Contopus virens</i>	cT	BFL			x	
Tropical Pewee	<i>Contopus cinereus</i>	fP	BFL			x	
Yellow-bellied Flycatcher	<i>Empidonax flaviventris</i>	fW	BFL			x	
Least Flycatcher	<i>Empidonax minimus</i>	fW	SC			x	

Table 15: Birds of the Southern Lagoon Area (continued)

Species		Status	Habitats	Southern Lagoon	Peccary Hills	Runaway Creek	IUCN
Black Phoebe	<i>Sayornis nigricans</i>	IP	LA			x	
Vermilion Flycatcher	<i>Pyrocephalus rubinus</i>	IP	SA,SC			x	
Bright-rumped Attila	<i>Attila spadiceus</i>	IP	BFL		x	x	
Yucatan Flycatcher	<i>Myiarchus yucatanensis</i>	uP	BFL, SC			x	
Dusky-capped Flycatcher	<i>Myiarchus tuberculifer</i>	cP	BFL	x	x	x	
Great Crested Flycatcher	<i>Myiarchus crinitus</i>	fW	BFL			x	
Brown-crested Flycatcher	<i>Myiarchus tyrannulus</i>	cS	BFL,PFL			x	
Great Kiskadee	<i>Pitangus sulphuratus</i>	vP	SC	x ¹	x	x	
Boat-billed Flycatcher	<i>Megarynchus pitangua</i>	cP	BFL			x	
Social Flycatcher	<i>Myiozetetes similis</i>	vP	SC	x	x	x	
Sulphur-bellied Flycatcher	<i>Myiodynastes luteiventris</i>	cS	BFL		x	x	
Piratic Flycatcher	<i>Legatus leucophaeus</i>	cS	BFL			x	
Tropical Kingbird	<i>Tyrannus melancholicus</i>	vP	PFL,SA	x	x	x	
Couch's Kingbird	<i>Tyrannus couchii</i>	cP	PFL,SA	?		x	
Eastern Kingbird	<i>Tyrannus tyrannus</i>	vT	BFL	x	x	x	
Fork-tailed Flycatcher	<i>Tyrannus savanna</i>	cP	SA	x	x	x	
Thrushlike Schiffornis	<i>Schiffornis turdinus</i>	cP	BFL		x	x	
White-winged Becard	<i>Pachyramphus polychopterus</i>	uP	SC			x	
Gray-collared Becard	<i>Pachyramphus major</i>	rP	BFL			x	
Rose-throated Becard	<i>Pachyramphus aglaiae</i>	uP	BFL,PFL			x	
Masked Tityra	<i>Tityra semifasciata</i>	cP	BFL		x	x	
White-collared Manakin	<i>Manacus candei</i>	cP	BFL		x	x	
Red-capped Manakin	<i>Pipra mentalis</i>	fP	BFL		x	x	
White-eyed Vireo	<i>Vireo griseus</i>	cW	SC		x	x	
Mangrove Vireo	<i>Vireo pallens</i>	cP	SC	x		x	
Yellow-throated Vireo	<i>Vireo flavifrons</i>	fW	BFL		x	x	
Red-eyed Vireo	<i>Vireo olivaceus</i>	cT	BFL			x	
Yellow-green Vireo	<i>Vireo flavoviridis</i>	cS	BFL		x	x	
Tawny-crowned Greenlet	<i>Hylophilus ochraceiceps</i>	cP	BFL			x	
Lesser Greenlet	<i>Hylophilus decurtatus</i>	vP	BFL		x	x	
Rufous-browed Peppershrike	<i>Cyclarhis gujanensis</i>	cP	SA,SC	x		x	
Green Jay	<i>Cyanocorax yncas</i>	uP	BFL,PFL			x	
Brown Jay	<i>Cyanocorax morio</i>	vP	BFL,PFL	x ¹	x	x	
Yucatan Jay	<i>Cyanocorax yucatanicus</i>	IP	BFL, PFL	x		x	
Purple Martin	<i>Progne subis</i>	cT	O			x	
Gray-breasted Martin	<i>Progne chalybea</i>	cS	O			x	
Tree Swallow	<i>Tachycineta bicolor</i>	oW	LA			x	
Mangrove Swallow	<i>Tachycineta albilinea</i>	cP	LA	x	x	x	
Northern Rough-winged Swallow	<i>Steigidopteryx serripennis</i>	cW	BFL,SA		x	x	
Ridgways Rough-winged Swallow	<i>Steigidopteryx ridgwayi</i>	cW	BFL, PFL,SA				
Barn Swallow	<i>Hirundo rustica</i>	vT	SA,WL,LA	x		x	
Spot-breasted Wren	<i>Thryothorus maculipectus</i>	vP	BFL		x	x	
House Wren	<i>Troglodytes aedon</i>	cP	SC			x	
White-bellied Wren	<i>Uropsila leucogastra</i>	fP	BFL, PFL			x	
White-breasted Wood-Wren	<i>Henicorhina leucosticta</i>	cP	BFL		x	x	

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Table 15: Birds of the Southern Lagoon Area (continued)							
Species		Status	Habitats	Southern Lagoon	Peccary Hills	Runaway Creek	IUNN
Long-billed Gnatwren	<i>Pamphocaenus melanurus</i>	fP	BFL			x	
Blue-grey Gnatcatcher	<i>Polioptila caerulea</i>	cP	SC	x	x	x	
Tropical Gnatcatcher	<i>Polioptila plumbea</i>	uP	BFL			x	
Veery	<i>Catharus fuscescens</i>	oT	BFL			x	
Gray-cheeked Thrush	<i>Catharus minimus</i>	uT	BFL			x	
Swainson's Thrush	<i>Catharus ustulatus</i>	uT	BFL			x	
Wood Thrush	<i>Hylocichla mustelina</i>	cW	BFL			x	
Clay-colored Robin	<i>Turdus grayi</i>	cP	BFL,SC		x	x	
White-throated Robin	<i>Turdus assimilis</i>	cP	BFL			x	
Gray Catbird	<i>Dumetella carolinensis</i>	cW	BFL, PFL	x		x	
Black Catbird	<i>Melanoptila glabirostris</i>	IP	MF			x	NT
Tropical Mockingbird	<i>Mimus gilvus</i>	vP	SA	x ¹	x	x	
Blue-winged Warbler	<i>Vermivora pinus</i>	uW	BFL,SC			x	
Tennessee Warbler	<i>Vermivora peregrina</i>	cT	BFL,SC			x	
Orange-crowned Warbler	<i>Vermivora celata</i>	?W	BFL, SC			x	
Northern Parula	<i>Parula americana</i>	oT	BFL,PFL	x		x	
Yellow Warbler	<i>Dendroica petechia</i>	cW	SC	x	x	x	
Chestnut-sided Warbler	<i>Dendroica pensylvanica</i>	cW	BFL,SC			x	
Magnolia Warbler	<i>Dendroica magnolia</i>	cW	BFL,SC	x		x	
Black-throated Green Warbler	<i>Dendroica virens</i>	fW	PFL,SC		x	x	
Yellow-rumped Warbler	<i>Dendroica coronata</i>	fW	PFL,SA	x			
Blackburnian Warbler	<i>Dendroica fusca</i>	uT	BFL			x	
Yellow-throated Warbler	<i>Dendroica dominica</i>	fW	BFL,PFL	x		x	
Grace's Warbler	<i>Dendroica graciae</i>	IP	PFL			x	
Bay-breasted Warbler	<i>Dendroica castanea</i>	uT	BFL			x	
Cerulean Warbler	<i>Dendroica cerulea</i>	uT	BFL			x	VU
Black-and-white Warbler	<i>Mniotilta varia</i>	cW	BFL	x	x	x	
American Redstart	<i>Setophaga ruticilla</i>	cW	SA	x			
Prothonotary Warbler	<i>Protonotaria citrea</i>	uT	BFL,LA			x	
Worm-eating Warbler	<i>Helmitheros vermivorus</i>	uW	BFL			x	
Swainson's Warbler	<i>Limnithlypis swainsonii</i>	rW	BFL			x	
Ovenbird	<i>Seiurus aurocapillus</i>	fW	BFL			x	
Northern Waterthrush	<i>Seiurus noveboracensis</i>	cW	LA	x	x	x	
Louisiana Waterthrush	<i>Seiurus motacilla</i>	uW	LA			x	
Kentucky Warbler	<i>Oporornis formosus</i>	cW	BFL			x	
Common Yellowthroat	<i>Geothlypis trichas</i>	cW	SC	x		x	
Gray-crowned Yellowthroat	<i>Geothlypis poliocephala</i>	IP	PFL,SA			x	
Hooded Warbler	<i>Wilsonia citrina</i>	cW	BFL	x	x	x	
Golden-crowned Warbler	<i>Basileuterus culicivorus</i>	cP	BFL			x	
Yellow-breasted Chat	<i>Icteria virens</i>	uW	SC			x	
Gray-throated Chat	<i>Granatellus sallaei</i>	uP	BFL			x	
Gray-headed Tanager	<i>Eucometis penicillata</i>	fP	BFL			x	
Black-throated Shrike-Tanager	<i>Lanio aurantius</i>	uP	BFL			x	
Red-crowned Ant-Tanager	<i>Habia rubica</i>	cP	BFL			x	
Red-throated Ant-Tanager	<i>Habia fuscicauda</i>	vP	BFL		x	x	

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Table 15: Birds of the Southern Lagoon Area (continued)							
Species		Status	Habitats	Southern Lagoon	Peccary Hills	Runaway Creek	IUCN
Rose-throated Tanager	<i>Piranga roseogularis</i>	IP	BFL			x	
Hepatic Tanager	<i>Piranga flava</i>	IP	PFL	x		x	
Summer Tanager	<i>Piranga rubra</i>	cW	BFL	x		x	
Scarlet Tanager	<i>Piranga olivacea</i>	fT	BFL			x	
Crimson-collared Tanager	<i>Ramphocelus sanguinolentus</i>	fP	SC			x	
Passerini's Tanager	<i>Ramphocelus passerinii</i>	fP	SC			x	
Blue-gray Tanager	<i>Thraupis episcopus</i>	cP	BFL,PFL	x		x	
Yellow-winged Tanager	<i>Thraupis abbas</i>	cP	BFL			x	
Scrub Euphonia	<i>Euphonia affinis</i>	fP	SC		x	x	
Yellow-throated Euphonia	<i>Euphonia hirundinacea</i>	cP	BFL	x	x	x	
Olive-backed Euphonia	<i>Euphonia gouldi</i>	cP	BFL			x	
Red-legged Honeycreeper	<i>Cyanerpes cyaneus</i>	cP	BFL			x	
Blue-black Grassquit	<i>Volatinia jacarina</i>	vP	SC		x	x	
Variable Seedeater	<i>Sporophila americana</i>	cP	SC,SA			x	
White-collared Seedeater	<i>Sporophila torqueola</i>	cP	SC	x	x	x	
Thick-billed Seed-Finch	<i>Oryzoborus funereus</i>	fP	PFL,SC,SA			x	
Blue Seedeater	<i>Amaurospiza concolor</i>	IP	SC			x	
Yellow-faced Grassquit	<i>Tiaris olivacea</i>	IP	SC			x	
Olive Sparrow	<i>Arremonops chloronotus</i>	cP	PFL, SA			x	
Green-backed Sparrow	<i>Arremonops chloronotus</i>	cP	BFL,SC		x	x	
Chipping Sparrow	<i>Spizella passerina</i>	fP	PFL	1		x	
Savanna Sparrow	<i>Passerculus sandwichensis</i>	oW	SA			x	
Grasshopper Sparrow	<i>Ammodramus savannarum</i>	cP	SA			x	
Grayish Saltator	<i>Saltator coerulescens</i>	cP	SC			x	
Buff-throated Saltator	<i>Saltator maximus</i>	fP	BFL			x	
Black-headed Saltator	<i>Saltator atriceps</i>	cP	BFL	x	x	x	
Black-faced Grosbeak	<i>Caryothraustes polioogaster</i>	cP	BFL			x	
Northern Cardinal	<i>Cardinalis cardinalis</i>	fP	PFL, SC			x	
Rose-breasted Grosbeak	<i>Pheucticus ludovicianus</i>	cT	BFL			x	
Blue-black Grosbeak	<i>Cyanocompsa cyanooides</i>	cP	BFL			x	
Blue Bunting	<i>Cyanocompsa parellina</i>	fP	fP			x	
Blue Grosbeak	<i>Passerina caerulea</i>	cT	SC			x	
Indigo Bunting	<i>Passerina cyanea</i>	cT	SC			x	
Painted Bunting	<i>Passerina ciris</i>	oT	SC			x	NT
Dickcissel	<i>Spiza americana</i>	uT	SC,WL			x	
Eastern Meadowlark	<i>Sturnella magna</i>	cP	SA			x	
Melodious Blackbird	<i>Dives dives</i>	vP	SC	x	x	x	
Great-tailed Grackle	<i>Quiscalus mexicanus</i>	vP	WL	x		x	
Giant Cowbird	<i>Molothrus oryzivorus</i>	uP	SC			x	
Black-cowled Oriole	<i>Icterus prosthelas</i>	cP	BFL, PFL,SA	x		x	
Orchard Oriole	<i>Icterus spurius</i>	cW	SC, WL			x	
Yellow-backed Oriole	<i>Icterus chrysater</i>	fP	PFL	x		x	
Yellow-tailed Oriole	<i>Icterus mesomelas</i>	fP	LA			x	
Baltimore Oriole	<i>Icterus glabula</i>	cW	BFL	x		x	
Yellow-billed Caticue	<i>Amblycercus holosericeus</i>	cP	BFL,PFL		x	x	

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Table 15: Birds of the Southern Lagoon Area (continued)							
Species		Status	Habitats	Southern Lagoon	Peccary Hills	Runaway Creek	IUCN
Montezuma Oropendola	<i>Psarocolius montezuma</i>	cP	BFL	x	x	x	
<p>Southern Lagoon: Dr. Nick Bayly, 2006, with sightings added by other field team members ¹ BERDS species records for White Ridge, from survey by Meerman, 1998</p> <p>Peccary Hills: Lenny Gentle, 2005 (Peccary Hills Biodiversity Assessment) and Jan Meerman, 1996 (Hwatschy Property EIA)</p> <p>Runaway Creek: Birds Without Borders ringing data, Mario Teul (2005)</p>							
Status				Habitat Preferences			
Legend		Legend (Adapted from Jones and Vallely, 2001)					
v = very common	P = permanent resident	BFL Lowland broadleaf forest	O Overhead/aerial				
c = common	S = seasonal resident	PFL Lowland pine forest					
f = fairly common	V = visitor	SC Scrub, low second growth					
u = uncommon	T = transient (migrant)	SA Savanna					
o = occasional	W = winter resident	WL Wetland habitats with emergent vegetation					
l = local	X = one or two records only	LA Lagoons, ponds, rivers, streams					

6.4.3 Amphibians and Reptiles

Twenty-nine species of reptile and amphibian were recorded during this survey – either as direct observations or as reliable local reports (Table 17). A further 24 species not encountered in the survey have previously been collected within the survey area, and are known from museum records (Lee, 1996) – giving a known herpetofauna to date of 53 species, approximately half of the likely total. The total number of species that can reasonably be predicted to occur within the immediate environs of the Gales Point Wildlife Sanctuary and adjacent broadleaf-forests of the karst hills and coastal beaches, is up to 103, based on existing ground surveys and known species distributions and habitat requirements (Table 18). An additional 11 species are not predicted to occur within the area from current mapping efforts, but have ranges that are close – these would not be entirely unexpected as range extensions.

Of the 103 species likely to occur in the area, 17 are amphibians, 2 are crocodylians, 3 are sea turtles, 8 are freshwater turtles, 30 are lizards and 43 are snakes. This high herpetofaunal species diversity is largely a reflection of the inclusion of the 66' lacustrine and riparian buffer area, and adjacent short grass savanna and karst hillslopes, without which the herpetofauna of the Gales Point Wildlife Sanctuary would be very much lower indeed.

In the context of herpetofauna, it is necessary to examine the Gales Point Wildlife Sanctuary and adjacent area at three levels in terms of the herpetofaunal habitat potential:

- The brackish Southern Lagoon system, Bar River and associated tributaries, the approximately 3.6km of Manatee River and Cornhouse Creek within the Sanctuary boundaries, as well as the 66' terrestrial element of the Sanctuary surrounding the lagoons.
- Adjacent turtle nesting beaches south of the Bar River mouth – the protection of which is provided also by villagers from Gales Point with the support of the Wildlife Trust.
- Connectivity with the surrounding ecosystems, beyond the 66' terrestrial portion, including those within the Manatee Forest Reserve.

Approximately 10% of the likely overall herpetofauna of the Southern Lagoon area is considered threatened (IUCN, 2006). Of these 10 threatened species, 8 are turtles and 2 are crocodylians, none of the snake, lizard or amphibian species of this area are considered at risk, though the boa is CITES listed (limiting its international trade). Of the threatened species, two are Critically Endangered (hawksbill turtle (*Eretmochelys imbricata*) and Central American river turtle or 'hicatee' (*Dermatemys mawii*)) and two are Endangered (loggerhead turtle (*Caretta caretta*) and green turtle (*Chelonia mydas*)) (Table 16).

Table 16: Herptile Species of Concern for the Southern Lagoon Area		
Critically Endangered	<i>Eretmochelys imbricata</i>	Hawksbill Turtle
	<i>Dermatemys mawii</i>	Central American River Turtle
Endangered	<i>Caretta caretta</i>	Loggerhead Turtle
	<i>Chelonia mydas</i>	Green Turtle
Vulnerable	<i>Crocodylus acutus</i>	American Crocodile
Lower Risk	<i>Claudius angustatus</i>	Narrowbridge Musk Turtle
	<i>Staurotypus triporcatus</i>	Mexican Giant Musk Turtle
	<i>Kinosternon acutum</i>	Tabasco Mud turtle
	<i>Trachemys scripta</i>	Slider
	<i>Crocodylus moreletii</i>	Morelet's Crocodile

Regarding overall herpetofaunal considerations, by far the most important national and regional function of the Gales Point Wildlife Sanctuary and its immediate environs is its role in assisting

the regional conservation of two critically endangered turtles: the marine hawksbill turtle, and the freshwater Central American River Turtle.

Manatee Bar, immediately south of the mouth of Bar River, is one of the six most important nesting beaches in the Caribbean for the hawksbill turtle (Smith, et al., 1992), with over 100 active nests having been recorded there in a single year. Recorded nests have however dropped by over 50% in the last ten years (Majil, 2005). With very high nesting beach fidelity, and extremely limited migration between Caribbean populations, the population of hawksbills nesting on Manatee Bar appears to be in sharp decline and is clearly in immediate need of highly effective conservation measures to address and reverse the current trend if this regionally important population is not to be lost permanently within the next 10-20 years.



Manatee Bar is also recognized as an important nesting site of loggerhead turtles (Majil, 2005), though numbers are far smaller. Whilst not noted as an important nesting site for green turtles, this species is listed as being exposed to nest depredation at this site (Majil, 2005), the implication being that the species does nest there but not in nationally important numbers.

Whilst the Manatee Bar turtle nesting beach has received significant conservation attention (initiated by Greg Smith, Kevin Andrewin and Lincoln McSweeney), and sporadic support from a number of national and international conservation agencies, nesting success remains low, with very low recruitment even into the juvenile population. Nest predation by raccoons, skunks and possibly coatis, and periodic over-washing (resulting in chilled and/or drowned eggs) have been identified as the primary causes of low nesting success (K. Andrewin, pers. com.). There is a need for conservation management planning for the Gales Point Wildlife Sanctuary and its immediate environs, to highlight the urgency of re-inforcing the ongoing sea turtle work being undertaken by the Gales Point Community and its conservation partners, and build the capacity, infrastructure and finance to be able to more comprehensively implement identified conservation actions, determine if additional measures are needed, and to implement them. Current measures are very positive, but need to be reviewed in terms of setting and reaching goals for increased nesting success – to increase recruitment into the turtle population. Wildlife Trust is taking a lead role in formally monitoring and managing the data for the nesting beach, in collaboration with the Community.



Photograph 28 (Above):
Hatchling hawksbill turtle
Photograph 29 (Below)
Surveying hatching success

The 2006 beach surveys, conducted between June and October, resulted in the protection of 32 nests, with an additional 33 nests reported as destroyed by predators. The majority (65%) of the eggs from within protected nests hatched successfully; although about a quarter (23%) were depredated (physically destroyed.) A smaller number were either dead hatchlings (those that emerged from the egg but died before reaching the sea), or developed eggs (developed hatchlings that did not emerge successfully from their eggs) or undeveloped (eggs which did not develop into hatchlings.) A species identification was not confirmed for all protected nests, but most nests were likely laid by hawksbill turtles. With 65 total nests recorded, given a nest frequency of about 4 per season per species (hawksbill or loggerhead), the 6-mile beach likely supports less than 20 females.

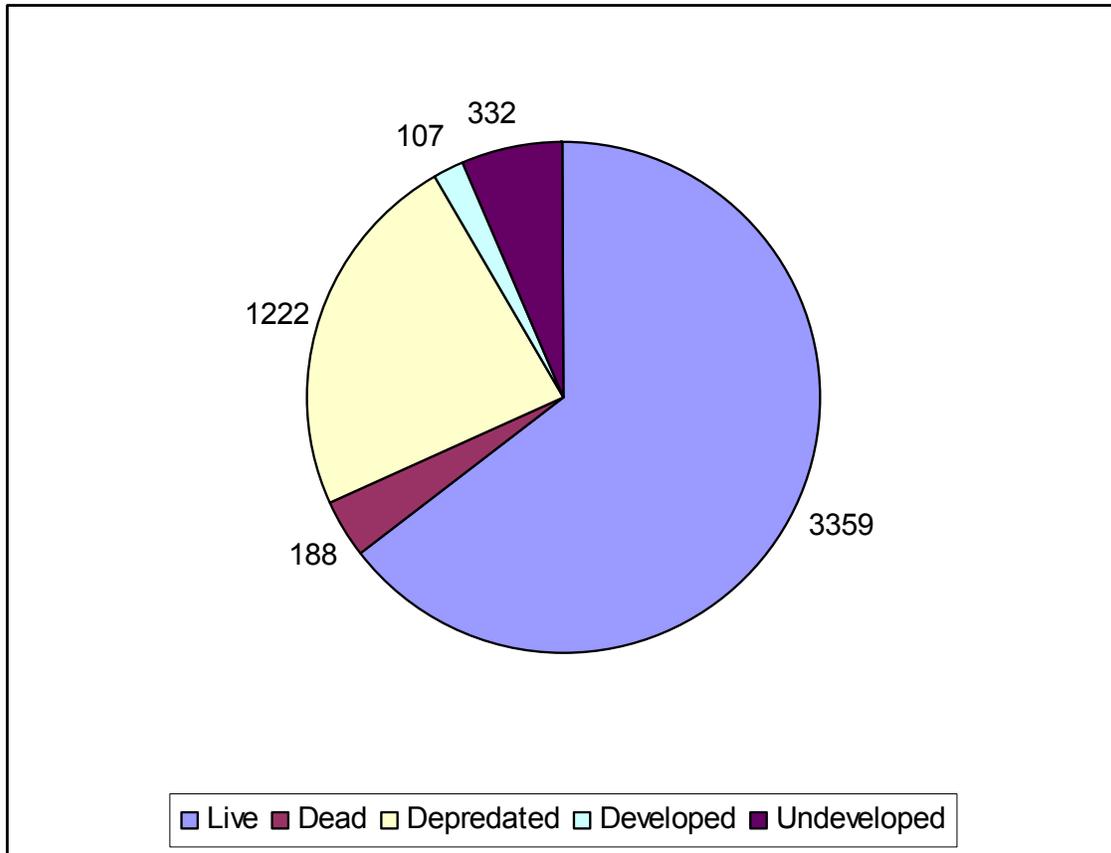


Figure 7: Hatchling success for 2006: 6 miles of beach south of Manatee Bar mouth.

The global conservation status of the Central American River Turtle has recently been upgraded from Endangered to Critically Endangered following a recent assessment of distribution and abundance (IUCN, 2006), in recognition of the plummeting populations, and broadscale local extinctions. Whilst isolated remnant populations have recently been discovered in the Peten, it is believed that few viable populations exist outside Belize. Within Belize however, the Central American River Turtle is also in sharp decline, with many areas having been effectively hunted out in recent years (Walker, P. pers. obs.). The remaining populations of this species within the Manatee River, Cornhouse Creek, Soldier Creek and the western drainage of Sapodilla Lagoon should figure prominently in national and regional initiatives to prevent the extinction of this species. Numbers within these creeks are reported to have declined significantly in recent years by local hunters and fishermen – but populations apparently remain viable to date.

The American Crocodile (IUCN: Vulnerable) is known to nest on the Manatee Bar north of the Bar River (Platt & Thorbjarnarson, 1997; K. Andrewin, pers. com.). This is one of the few nesting beaches known for this species on the Belize mainland, and will become increasingly important for this species nationally as preferred beaches on the offshore cayes are increasingly developed for tourism.

Gales Point Wildlife Sanctuary itself encompasses critical areas for the conservation of the Central American river turtle, and the adjacent coastal beach (lying outside the Sanctuary) is of regional importance in the conservation of the marine hawksbill turtle. Additionally, the importance of these two areas should not be under-estimated in terms of the conservation of Belize's two crocodylians. If effective management and adequate enforcement of the protected area legislation can be initiated and maintained, then the value of the Sanctuary on a national scale would take on greater meaning for a far broader herpetofaunal community. Full protection

and management of the 66' lagoon shore and riparian terrestrial components of the Sanctuary potentially provide the habitat connectivity that will be critical to the long-term survival of the 100+ herptiles likely to exist in the area. The 2005 de-reservation of a significant portion of the Manatee Forest Reserve will result in a significant decrease in this core conservation area of the coastal plain and abutting karst hills: the need for the connectivity of the terrestrial component of the Gales Point Wildlife Sanctuary is therefore accentuated in helping mitigate imminent habitat fragmentation. The Sanctuary itself does not include sufficient terrestrial habitat to maintain viable populations of the diverse herpetofauna found there, but if connectivity is maintained both within this narrow strip of vegetation and with that of the Manatee Forest Reserve and that within the lands of environmentally-sensitive landowners, then long-term viability may be maintained.

Areas of Concern:

- Land-use change (and associated impacts) in areas adjacent to marine turtle and American crocodile nesting beach areas
- Current poor nesting success and population recruitment of marine turtles, especially the critically endangered hawksbill turtle
- High hunting pressure from both Gales Point and other communities, reducing viability of prey species – including the critically endangered Central American river turtle, the lower risk Mexican giant musk turtle (also known as the freshwater loggerhead), the lower risk slider, as well as the green iguana
- Fragmentation of broadleaf forest areas through land clearance for agriculture and tourism development
- Increasing clearance of vegetation along creeks and rivers, removing connectivity of forest corridor
- Continued high scope and severity of fires on the savanna, reducing forest connectivity between broadleaf forest of karst areas, affecting both savanna and broadleaf species
- Increasing impact on water quality from agro-chemicals, potential oil spills
- Potential direct kills of amphibians from agro-chemical pollution, as well as potential feminizing of males by atrazine-based herbicides
- Threat of crocodile and turtle drowning in seine nets – especially those placed across creeks and rivers
- Unregulated tourism disturbing wildlife – particularly the Central American river turtle

Table 17: Amphibians and Reptiles of the Southern Lagoon Area					
Family	Species		Observed	Reported	IUCN
Plethodontidae	<i>Bolitoglossa Mexicana</i>	Mexican Mushroomtongue Salamander		x	
Leptodactylidae	<i>Leptodactylus melanonotus</i>	Sabinal Frog	x		
	<i>Leptodactylus fragilis</i>	White-lipped Frog	x		
Bufo	<i>Bufo marinus</i>	Cane Toad	x	x	
	<i>Bufo valliceps</i>	Gulf Coast Toad	x		
Hylidae	<i>Agalychnis callidryas</i>	Red-eyed Treefrog	x	x	
	<i>Dendropsophus microcephala</i>	Yellow Treefrog	x		
	<i>Trachycephalus venulosa</i>	Veined Treefrog	x		
	<i>Scinax staufferi</i>	Stauffer's Treefrog	x		
	<i>Smilisca baudinii</i>	Common Mexican Treefrog	x	x	
Crocodylidae	<i>Crocodylus moreletii</i>	Morelet's Crocodile	x	x	NT
	<i>Crocodylus acutus</i>	American Crocodile	x		VU
Cheloniidae	<i>Caretta caretta</i>	Loggerhead Turtle		x	EN
	<i>Chelonia mydas</i>	Green Turtle		x	EN
	<i>Eretmochelys imbricata</i>	Hawksbill Turtle	x	x	CR
Dermatemydidae	<i>Dermatemys mawii</i>	Central American River Turtle	x	x	CR
Chelydridae	<i>Claudius angustatus</i>	Narrowbridge Musk Turtle	x	x	LR
	<i>Staurotypus triporcatus</i>	Mexican Giant Musk Turtle		x	LR
Kinosternidae	<i>Rhinoclemmys areolata</i>	Furrowed Turtle	x		
	<i>Trachemys scripta</i>	Slider	x		LR
Eublepharidae	<i>Coleonyx elegans</i>	Yucatan Banded Gecko	x	x	
Gekkonidae	<i>Sphaerodactylus glaucus</i>	Dwarf Gecko		x	
	<i>Sphaerodactylus millepunctatus</i>	Spotted Dwarf Gecko		x	
	<i>Hemidactylus frenatus</i>	House Gecko	x		
Corytophanidae	<i>Basiliscus vittatus</i>	Brown Basilisk	x	x	
	<i>Corytophanes cristatus</i>	Smoothhead Helmeted Basilisk		x	
Iguanidae	<i>Ctenosaura similis</i>	Black Iguana	x	x	
	<i>Iguana iguana</i>	Green Iguana	x	x	
<p>Reports include: Lee, 1996; BERDS (Meerman, 1998); Community consultations</p> <p>IUCN Status: CR Critically Endangered EN Endangered VU Vulnerable NT Near Threatened DD Data Deficient</p>					

Table 17: Amphibians and Reptiles of the Southern Lagoon Area (continued)					
Family	Species		Observed	Reported	IUCN
Polychrotidae	<i>Anolis capito</i>	Bighead Anole	x	x	
	<i>Anolis lemurinus</i>	Ghost Anole	x		
	<i>Anolis sagrei</i>	Brown Anole	x		
	<i>Anolis tropidonotus</i>	Greater Scaley Anole		x	
	<i>Anolis rodriguezii</i>	Smooth Anole	x		
Teiidae	<i>Ameiva undulata</i>	Rainbow Ameiva	x	x	
	<i>Cnemidophorus angusticeps</i>	Yucatan Whiptail	x		
	<i>Cnemidophorus cozumela</i>	Cozumel Whiptail		x	
Boidae	<i>Boa constrictor</i>	Boa Constrictor	x	x	
Colubridae	<i>Coniophanes fissidens</i>	White-lipped Spotbelly Snake		x	
	<i>Drymarchon corais</i>	Indigo Snake		x	
	<i>Drymobius margaritiferus</i>	Speckled Racer		x	
	<i>Imantodes cenchoa</i>	Blunthead Tree Snake		x	
	<i>Lampropeltis triangulum</i>	Milk Snake		x	
	<i>Leptodeira frenata</i>	Rain Forest Cat-eyed Snake		x	
	<i>Leptodeira septentrionalis</i>	Northern Cat-eyed Snake		x	
	<i>Leptophis ahaetulla</i>	Parrot Snake		x	
	<i>Leptophis mexicanus</i>	Mexican Parrot Snake		x	
	<i>Ninia sebae</i>	Redback Coffee Snake		x	
	<i>Oxybelis aeneus</i>	Mexican Vine Snake		x	
	<i>Oxybelis fulgidus</i>	Green Vine Snake		x	
	<i>Spilotes pullatus</i>	Tiger Tree Snake		x	
	Elapidae	<i>Micrurus diastema</i>	Variable Coral Snake	x	x
Viperidae	<i>Bothrops asper</i>	Fer-de-Lance		x	
	<i>Crotalus durissus</i>	Neotropical Rattlesnake		x	
<p>Reports include: Lee, 1996; BERDS (Meerman, 1998); Community consultations</p> <p>IUCN Status: CR Critically Endangered EN Endangered VU Vulnerable NT Near Threatened DD Data Deficient</p>					

Table 18: Potential Herptile Species of the Southern Lagoon Area

Family	Species		IUCN
Rhinophrynidae	<i>Rhinophrynus dorsalis</i>	Burrowing Toad	
Leptodactylidae	<i>Craugastor loki</i>	Polymorphic Robber Rainfrog	
Hylidae	<i>Tlalohyla loquax</i>	Mahogany Treefrog	
	<i>Tlalohyla picta</i>	Painted Treefrog	
Microhylidae	<i>Gastrophryne elegans</i>	Elegant Narrowmouth Frog	
Ranidae	<i>Rana berlandieri</i>	Rio Grande Leopard Frog	
	<i>Rana vaillanti (palmipes)</i>	Rainforest Frog	
Kinosternidae	<i>Kinosternon acutum</i>	Tabasco Mud turtle	LR
	<i>Kinosternon leucostomum</i>	White-lipped Mud Turtle	
	<i>Kinosternon scorioides</i>	Scorpion Mud Turtle	
Gekkonidae	<i>Aristelliger georgeensis</i>	St. George Island Gecko	
	<i>Hemidactylus frenatus</i>	House Gecko	
	<i>Phyllodactylus tuberculatus</i>	Tuberculate Leaf-toed Gecko	
	<i>Thecadactylus rapicauda</i>	Turnip Tail Gecko	
Corytophanidae	<i>Corytophanes hernandezii</i>	Hernandez's Helmeted Basilisk	
	<i>Laemantus longipes</i>	Eastern Casquehead Iguana	
Phrynosomatidae	<i>Sceplorus chrysostictus</i>	Yucatan Spiny Lizard	
	<i>Sceloporus lundelli</i>	Lundell's Spiny Lizard	
	<i>Sceloporus variabilis</i>	Rosebelly Lizard	
Polychrotidae	<i>Anolis biporcatus</i>	Neotropical Green Anole	
	<i>Anolis pentaprion</i>	Lichen Anole	
	<i>Anolis rodriguezii</i>	Smooth Anole	
	<i>Anolis sericeus</i>	Silky Anole	
	<i>Anolis uniformis</i>	Lesser Scaly Anole	
Scincidae	<i>Eumeces schwartzei</i>	Schwartz's Skink	
	<i>Eumeces sumichrasti</i>	Sumichrast's Skink	
	<i>Mabuya unimarginata</i>	Central American Mabuya	
	<i>Sphenomorphus cherriei</i>	Brown Forest Skink	
Teiidae	<i>Ameiva festiva</i>	Middle American Ameiva	
	<i>Cnemidophorus maslini</i>	Maslin's Whiptail	
Xantusiidae	<i>Lepidophryma flavimaculatum</i>	Yellow-spotted Night Lizard	
Anguidae	<i>Celestus rozellae</i>	Rozella's Lesser Galliwasp	
Typhlopidae	<i>Typhlops microstomas</i>	Yucatan Blind Snake	
	<i>Amastridium veliferum</i>	Rustyhead Snake	
	<i>Clelia clelia</i>	Mussurana	
	<i>Coluber constrictor</i>	Racer	
	<i>Coniophanes bipunctatus</i>	Two-spotted Snake	
	<i>Coniophanes imperialis</i>	Black-striped Snake	
	<i>Conopsis lineatus</i>	Road Guarder	
	<i>Dipsas brevifacies</i>	Snail-eating Thirst Snake	
	<i>Dryadophis melanolomus</i>	Lizard Eater	
	<i>Elaphe flavirufa</i>	Tropical Rat Snake	
	<i>Ficimia publia</i>	Blotched Hook-nosed Snake	
	<i>Masticophis mentovarius</i>	Neotropical Whipsnake	

Table 18: Potential Herptile Species of the Southern Lagoon Area (continued)

Family	Species	IUCN
Typhlopidae	<i>Oxyrhopus petola</i>	Calico False Coral Snake
	<i>Scaphiodontophis annulatus</i>	Guatemalan Neckband Snake
	<i>Senticolis triaspis</i>	Peninsular Rat Snake
	<i>Sibon nebulata</i>	Cloudy Snail Sucker
	<i>Sibon sanniola</i>	Pygmy Snail Sucker
	<i>Sibon sartorii</i>	Terrestrial Snail Sucker
	<i>Tantilla schistosa</i>	Red Earth Centipede Snake
	<i>Tantillita canula</i>	Yucatan Dwarf Short-tailed Snake
	<i>Thamnophis marcianus</i>	Checkered Garter Snake
	<i>Thamnophis proximus</i>	Western Ribbon Snake
	<i>Tretanorhinus nigroluteus</i>	Orangebelly Swamp Snake
	<i>Urotheca elapoides</i>	False Coral Snake
	<i>Xenodon rhabdocephalus</i>	False Fer-De-Lance
	Elapidae	<i>Micrurus hippocrepis</i>
<i>Micrurus nigrocinctus</i>		C. American Coral Snake
Viperidae	<i>Atropoides nummifer</i>	Jumping Pitviper
IUCN Status: CR Critically Endangered EN Endangered VU Vulnerable NT Near Threatened DD Data Deficient		

6.4.4 Fish Fauna of Southern Lagoon

A total of seventy two species of fish have been recorded both during the fieldwork and through analysis of previous reports (Table 19; Greenfield and Thomerson, 1997; BERDS, 2006; Walker and Walker, 2005).

The Southern Lagoon area has a number of freshwater rivers and creeks that drain into the lagoon from the south, north and west. Salinity increases towards the east, where Bar River empties into the sea. The Bar River area includes a complex of mangrove-lined creeks that drain the saline mangrove savannas. The flooded coastal *Eleocharis* swamp areas to the south provide another freshwater ecosystem that supports freshwater fish.

Eight specific water bodies were identified for investigation (Map 9):

- Southern Lagoon
- Sapodilla / Western Lagoons
- Main Creek
- Bar River
- Manatee River
- Quamina Creek
- Soldier Creek
- *Eleocharis* swamp (White Ridge)



Local commercial fish catch was also investigated

Photograph 30: Commercial fish catch from Southern Lagoon

Southern Lagoon

The fish species assemblage in the lagoon itself is predominantly of euryhaline species, which are able to withstand the daily and seasonal shifts in salinity. A number of the more saline-tolerant freshwater species are present in areas of lower salinity where rivers and creeks enter the system.

The goliath grouper (*Epinephelus itajara*), found in saline and brackish areas of the Southern Lagoon system, is a species of international concern, being considered critically endangered on a global scale (IUCN, 2006). This species has traditionally been fished in the lagoon system, with the result that both the individual size and the numbers of fish caught has decreased, indicating that the population is showing significant decline over the last decade, as seine net activity increased. Following intervention by Gales Point community

Fish Species of Southern Lagoon, January 2006	
Tarpon	<i>Megalops atlanticus</i>
Redfin needlefish	<i>Strongylura notata</i>
Ocellated killifish	<i>Floridichthys polyommus</i>
Yucatan mosquitofish	<i>Gambusia yucata</i>
Common snook	<i>Centropomus undecimalis</i>
Goliath grouper	<i>Epinephelus itajara</i>
Striped Mullet	<i>Mugil cephalus</i>
Crevalle Jack	<i>Caranx hippos</i>
Grey snapper	<i>Lutjanus griseus</i>
Lookdown	<i>Selene vomer</i>
Bonefish	<i>Albula vulpes</i>
Great barracuda	<i>Sphyraena barracuda</i>
Southern Sheepshead	<i>Archosargus probatocephalus</i>
Maya cichlid	<i>Cichlasoma urophthalmus</i>
Tilapia sp.	<i>Tilapia sp.</i>
Opossum pipefish	<i>Microphis brachyurus</i>
Southern stingray	<i>Dasyatis americana</i>
Green moray eel	<i>Gymnothorax funebris</i>
Chequered pufferfish	<i>Sphoeroides testudinum</i>

and Fisheries Department, and the subsequent regulation of seine net types and use, numbers have started to increase again, as has the average size of the individuals caught, suggesting that the population may be starting to recover. This pattern has also been seen in many of the other commercial fish species – the snook, for example – especially towards Christmas, when people travel to Gales Point from Dangriga and Belize City to supplement their income.

The Manatee Hole, and area of deeper water in front of Gales Point, attracts a number of fish, including the tarpon (*Megalops atlanticus*) – the area was once known as Tarpon Hole. Whitefin sharksuckers (*Echeneis neucratoides*) can also be seen here, attached as commensals to Antillean manatee.

Local reports suggest that cow-nosed rays (*Rhinoptera bonasus*) form mating congregations seasonally in the shallow waters, between the months of February and April - this species still needs to be confirmed, but has been noted in Payne’s Creek, and reports suggest that it may also utilize Northern Lagoon.



Photograph 31: Smalltooth Sawfish blade – the last sawfish seen in Southern Lagoon was in the 1960’s (D. Myers, pers. com.)

The smalltooth sawfish (*Pristis pectinata*), restricted to shallow coastal lagoons such as Southern Lagoon, was once present in large numbers, but was extensively fished to the point of becoming locally extinct in Southern Lagoon in the early 1960’s (D. Myers, pers. com.). This species, which is considered ‘endangered’ (IUCN, 2006), has since 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 (Photograph 31; Z. Walker, per. obs.; R. Graham, pers. com.).

Main Creek

Main Creek, linking Northern Lagoon with Southern Lagoon, is lined with red mangrove, the stilt roots extending into the water and providing a sheltered habitat for species such as the juvenile schoolmaster (*Lutjanus apodus*) and the Maya cichlid (*Cichlasoma urophthalmus*). Draining in from either side are shallow lagoons with dwarf mangrove, with ocellated killifish (*Floridichthys polyommus*) and chequered pufferfish (*Sphoeroides testudinum*).

Fish Species of Main Creek, January 2006	
Tarpon	<i>Megalops atlanticus</i>
Central Tetra	<i>Astyanax aeneus</i>
Redfin Needlefish	<i>Strongylura notata</i>
Ocellated Killifish	<i>Floridichthys polyommus</i>
Mangrove Molly	<i>Poecilia orri</i>
Common Snook	<i>Centropomus undecimalis</i>
Crevalle Jack	<i>Caranx hippos</i>
Grey snapper	<i>Lutjanus griseus</i>
Schoolmaster	<i>Lutjanus apodus</i>
Great barracuda	<i>Sphyaena barracuda</i>
Striped mojarra	<i>Eugerres plumieri</i>
Brazilian mojarra	<i>Eugerres brasiliensis</i>
Yellowfin mojarra	<i>Gerres cinereus</i>
Southern Sheepshead	<i>Archosargus probatocephalus</i>
Maya cichlid	<i>Cichlasoma urophthalmus</i>
Chequered pufferfish	<i>Sphoeroides testudinum</i>

Many of the sixteen species recorded were of the snapper (Lutjanidae) and mojarra (Gerridae) families, both of which are saline tolerant. However, the presence of *Astyanax aeneus* and *Cichlasoma synspilum* indicate that salinity is low (being recorded as 4ppt at the northern end of the creek, and 3 ppt at the point to entry to Southern Lagoon). Local reports suggest that the strong east trade winds in April and May increase water depth and salinity, resulting in a change

in the species composition, with the appearance of large numbers (hundreds) of striped mojarra (*Eugerres plumieri*) (community consultations, 2006). This influx has been traditionally been targeted by local fishermen, using cast nets. There is a valid concern among Gales Point fishermen that illegal seine net activity could rapidly deplete these seasonal congregations.

Quamina Creek

Quamina Creek enters Southern Lagoon from the south. At its mouth, the creek has a salinity of 2ppt. This gradually decreases to 0ppt with increasing distance from the lagoon, indicated by a significant change in creekside vegetation from mangrove-dominated forest to kaway swamp. Fish distribution and species composition is related to this salinity gradient, freshwater species such as the bay snook (*Petenia splendida*) and Central American tetra (*Astyanax aeneus*) only being observed in the more southerly, freshwater reaches of the creek, with a salinity of 0ppt. Towards the more saline creek mouth, species such as yellowfin mojarra (*Gerres cinereus*), grey snapper (*Lutjanus griseus*) and crevalle jack (*Caranax hippos*) occur.

Fish Species of Quamina Creek, January 2006	
Tarpon	<i>Megalops atlanticus</i>
Central Tetra	<i>Astyanax aeneus</i>
Sleek Mosquitofish	<i>Gambusia luma</i>
Southern Yucatan mosquitofish	<i>Gambusia yucatanana</i>
Common Snook	<i>Centropomus undecimalis</i>
Goliath grouper	<i>Epinephelus itajara</i>
Striped Mullet	<i>Mugil cephalus</i>
Crevalle Jack	<i>Caranax hippos</i>
Grey snapper	<i>Lutjanus griseus</i>
Yellowfin mojarra	<i>Gerres cinereus</i>
Southern Sheepshead	<i>Archosargus probatocephalus</i>
Firemouth Cichlid	<i>Cichlasoma meeki</i>
Musmus	<i>Cichlasoma friedrichsthalii</i>
Redhead cichlid	<i>Cichlasoma synspilum</i>
Maya cichlid	<i>Cichlasoma urophthalmus</i>
Bay snook	<i>Petenia splendida</i>
Southern stingray	<i>Dasyatis americana</i>

Manatee River

Manatee River, the largest river flowing into the Southern Lagoon, provides a constant source of freshwater to the Southern Lagoon system. The Manatee River watershed drains an area estimated at 480km² (BERDS, 2005), consisting of very steep, fast moving tributaries over older granite rocks in the southern area of the watershed, that then slow to flow northwards then east across the flat coastal savanna. The freshwater conditions in the upper stretches, and brackish water in lower, and is thought to have a relatively healthy fish fauna representative of freshwater and brackish water conditions (consultations, Gales Point, 2005). The low number of fish species recorded is a reflection of the turbidity of the water at the time surveying took place.

Fish Species of Manatee River, January 2006	
Central tetra	<i>Astyanax aeneus</i>
Grey snapper	<i>Lutjanus griseus</i>
Redhead cichlid	<i>Cichlasoma synspilum</i>
Opossum pipefish	<i>Microphis brachyurus</i>

Sapodilla and Western Lagoons

Sapodilla and Western lagoons lie in the north west of the Southern Lagoon system, and are fed primarily by Sapodilla Creek, and by sheet run off from the adjacent short grass savanna and low-lying dwarf mangroves. Western Lagoon in particular is favoured by local fishermen, who use hand lines, cast nets, and occasionally set-lines. Seine nets stretching from Tiger Point across the entrance to the lagoon are used by commercial fishermen. During the fieldwork, it was noted that this part of the lagoon had the greatest algal growth, with *Dasycladaceae* and other algae growing on the majority of the exposed stones, providing much greater cover and habitat complexity than other more open areas of the lagoon, with a corresponding apparent increase in fish diversity and abundance.

Fish Species of Sapodilla and Western Lagoons	
Tarpon	<i>Megalops atlanticus</i>
Redfin Needlefish	<i>Strongylura notata</i>
Yucatan Mosquitofish	<i>Gambusia yucatanana</i>
Ocellated Killifish	<i>Floridichthys polyommus</i>
Crevalle Jack	<i>Caranx hippos</i>
Permit	<i>Trachinotus falcatus</i>
Grey snapper	<i>Lutjanus griseus</i>
Schoolmaster	<i>Lutjanus apodus</i>
Bonefish	<i>Albula vulpes</i>
Great barracuda	<i>Sphyraena barracuda</i>
Striped mojarra	<i>Eugerres plumieri</i>
Yellowfin mojarra	<i>Gerres cinereus</i>
Southern Sheepshead	<i>Archosargus probatocephalus</i>
Red-head cichlid	<i>Cichlasoma synspilum</i>
Southern stingray	<i>Dasyatis americana</i>

Permit are considered common in Western and Northern Lagoon, however community consultations suggest that the use of seine nets in the area is causing a population decline. With the need for Gales Point to ensure the viability of its resources if the community wishes to focus on tourism and fly fishing as a means to elevate the standard of living within the community, the current decline is a cause for concern.

Soldier Creek

Diurnal and nocturnal sampling of the fish populations of Soldier Creek took place during the fieldwork, with results showing that species at both sample sites were typical of freshwater ecosystems of the coastal plain in Belize.

Fish Species of Soldier Creek, January 2006	
Central tetra	<i>Astyanax aeneus</i>
Maya cichlid	<i>Cichlasoma urophthalmus</i>
Red head cichlid	<i>Cichlasoma synspilum</i>
Yellowbelly Cichlid	<i>Cichlasoma salvini</i>
Blue-eyed Cichlid	<i>Cichlasoma spilurum</i>

White Ridge Ponds

Sampling was also conducted in the Eleocharis swamp in the White Ridge property. The freshwater swamp and drainage ditches were reportedly the result of road construction on the property, and hold a diverse and seemingly abundant fish population.

Several species of cichlid were observed, including the predatory bay snook (*Petenis splendida*), as well as other typically freshwater species such

Fish Species of White Ridge Eleocharis swamp	
Firemouth cichlid	<i>Cichlasoma meeki</i>
Maya cichlid	<i>Cichlasoma urophthalmus</i>
Bay Snook	<i>Petenis splendida</i>
Yucatan Mosquitofish	<i>Gambusia yucatanana</i>
Mayan tetra	<i>Hyphessobrycon compressus</i>
Central tetra	<i>Astyanax aeneus</i>
Green swordtail	<i>Xiphophorus helleri</i>
Mangrove molly	<i>Poecilia orri</i>
Buttersea	<i>Rhamdia sp.</i>
Fat sleeper	<i>Dormitator maculatus</i>

as the Mayan tetra (*Hyphessobrycon compressus*) and the green swordtail (*Xiphophorus helleri*).

Areas of Concern:

- Seine net fishing within the lagoon system and over creek mouths, reducing the viability of fish populations
- Increasing impact on water quality from agro-chemicals, potential oil spills, and increased sediment load, affecting seagrass and reducing viability of fish populations
- Unregulated fly-fishing by people from outside of the community may have the potential to affect the value of Southern Lagoon area for fly-fishing as an alternative income

Table 19: Fish of the Southern Lagoon Area

Species		Southern Lagoon	Sapodilla and Western Lag	Main Creek	Bar River / Coastal Water	Quamina Creek	Manatee River	Soldier Creek	White Ridge Ponds	White Ridge Meerman 1998	Greenfield and Thomerson
Orectolobidae											
Nurse Shark	<i>Ginglymostoma cirratum</i>				X						
Carcharhinidae											
Bull Shark	<i>Carcharinus leucas</i>				X					X	
Blacktip Shark	<i>Carcharinus limbatus</i>				X					X	
Lemon Shark	<i>Negaprion brevirostris</i>				X						
Dasyatidae											
Southern Stingray	<i>Dasyatis americana</i>	X	X		X	X					
Rhinopteraidae											
Cow-nosed Ray	<i>Rhinoptera bonasus</i>	?									
Myliobatidae											
Spotted Eagle Ray	<i>Aetobatus narinari</i>				X					X	
Albulidae											
Bonefish	<i>Albula vulpes</i>	X	X		X						
Megalopidae											
Tarpon	<i>Megalops atlanticus</i>	X	X	X	X	X	X		X	X	X
Muraenidae											
Green Moray Eel	<i>Gymnothorax funebris</i>	X			X						
Arridae											
Bagre, Catfish	<i>Bagre marinus</i>				X					X	
Pimelodidae											
Guatemalan chulin, Buttersea	<i>Rhamdia guatemalensis</i>								X	X	X
Filespin chulin	<i>Rhamdia laticauda</i>									X	
Batrachoididae											
Central American Toadfish	<i>Batrachoides gilberti</i>										X
Tetraodontidae											
Chequered Pufferfish	<i>Sphoeroides testudinum</i>	X	X		X						
Serranidae											
Goliath grouper	<i>Epinephelus itajara</i>	X				X					

Table 19: Fish of the Southern Lagoon Area (continued)

Species		Southern Lagoon	Sapodilla and Western Lag	Main Creek	Bar River / Coastal Water	Quamina Creek	Manatee River	Soldier Creek	White Ridge Ponds	White Ridge Meerman 1998	Greenfield and Thomerson
Sparidae											
Southern Sheepshead	<i>Archosargus probatocephalus</i>	X	X			X					
Scombridae											
Cero	<i>Scomberomorus regalis</i>				X						
Spanish Mackerel	<i>Scomberomorus maculatus</i>				X						
Lutanidae											
Grey Snapper	<i>Lutjanus griseus</i>	X	X	X	X	X	X				X
Schoolmaster	<i>Lutjanus apodus</i>			X							
Cubera Snapper	<i>Lutjanus cyanopterus</i>			X						X	
Carangidae											
Crevalle Jack	<i>Caranx hippos</i>	X		X	X	X					
Horse-eye Jack	<i>Caranx latus</i>	X				X	X				
Permit	<i>Trachinotus falcatus</i>	X	X								
Pompano	<i>Trachinotus carolinus</i>	X									
Leatherjacket	<i>Oligoplites saurus</i>									X	
Lookdown	<i>Selene vomer</i>	X	X		X						
Sphyraenidae											
Great Barracuda	<i>Sphyraena barracuda</i>	X	X	X	X						
Mugilidae											
Mountain Mullet	<i>Agnostomus monitcola</i>						X				
Striped Mullet	<i>Mugil cephalus</i>	X	X		X	X					
White Mullet	<i>Mugil curema</i>									X	
Lobotidae											
Tripletail	<i>Lobotes surinamensis</i>										X ¹
Centromopidae											
Common Snook	<i>Centropomus undecimalis</i>	X		X	X	X	X			X	
Tarpon Snook	<i>Centropomus pectinatus</i>									X	
Belonidae											
Redfin needlefish	<i>Strongylura notata</i>	X		X	X	X			X	X	
Rivulidae											
Ocellated killifish	<i>Foridichthys polyommus</i>	X		X						X	X
Cyprinodontidae											
Orange flagfish	<i>Jordanella pulchra</i>		X								X
Pike killifish	<i>Belonesox belizanus</i>								X	X	X

Table 19: Fish of the Southern Lagoon Area (continued)											
Species		Southern Lagoon	Sapodilla and Western Lag	Main Creek	Bar River / Coastal Water	Quamina Creek	Manatee River	Soldier Creek	White Ridge Ponds	White Ridge Meerman 1998	Greenfield and Thomerson
Characidae											
Central tetra	<i>Astyanax aeneus</i>			X		X	X				X
Mayan tetra	<i>Hyphessobrycon compressus</i>								X	X	X
Poeciliidae											
Sleek mosquitofish	<i>Gambusia luma</i>					X				X	X
Teardrop mosquitofish	<i>Gambusia sexradiata</i>										X
Southern Yucatan mosquitofish	<i>Gambusia yucatanana</i>	X				X			X	X	X
Twospot livebearer	<i>Heterandria bimaculata</i>									X	X
Shortfin molly	<i>Poecilia mexicana</i>									X	X
Mangrove molly	<i>Poecilia orri</i>			X					X		X
Green swordtail	<i>Xiphophorus helleri</i>								X	X	X
Sygnathidae											
Opossum pipefish	<i>Microphis brachyurus</i>	X					X				
Scianidae											
Ground Croaker	<i>Bairdiella ronchus</i>									X	
Gerridae											
Silver Mojarra	<i>Eucinostomus argenteus</i>									X	
Slender Mojarra	<i>Eucinostomus jonesi</i>									X	
Flagfin Mojarra	<i>Eucinostomus melanopterus</i>	X	X	X		X				X	
Striped Mojarra	<i>Eugerres plumieri</i>			X							
Brazilian Mojarra	<i>Eugerres brasiliensis</i>			X							
Yellowfin Mojarra	<i>Gerres cinereus</i>			X		X					
Ephippidae											
Atlantic Spadefish	<i>Chaetodipterus faber</i>				X						
Cichlidae											
Guapote, Musmus	<i>Cichlasoma friedrichsthalii</i>					X				X	
Firemouth cichlid	<i>Cichlasoma meeki</i>					X				X	X
Jack Dempsey	<i>Cichlasoma octofasciatum</i>									X	
Yellowbelly cichlid	<i>Cichlasoma salvini</i>							X			
Redhead cichlid	<i>Cichlasoma synspilum</i>					X	X				
Maya cichlid	<i>Cichlasoma urophthalmus</i>	X		X		X		X			
Blue-eyed Cichlid	<i>Cichlasoma spilurum</i>		?					X	X		
Bay snook	<i>Petenia splendida</i>					X		X	X		
Tilapia	<i>Tilapia sp.</i>		X								
Belontiidae											
Mangrove Blenny	<i>Lupinoblennius dispar</i>									X	

Table 19: Fish of the Southern Lagoon Area (continued)

Species		Southern Lagoon	Sapodilla and Western Lag	Main Creek	Bar River / Coastal Water	Quamina Creek	Manatee River	Soldier Creek	White Ridge Ponds	White Ridge Meerman 1998	Greenfield and Thomerson
Eleotridae											
Fat sleeper	<i>Dormitator maculatus</i>								x		
Large-scaled Spinycheek Sleeper	<i>Eleotris amblyopsis</i>									x	
Gobiidae											
Emerald Goby	<i>Ctenogobius smaragdus</i>									x	
Yucatan Goby	<i>Gobiosoma yucatanum</i>									x	
Whitfin Sharksucker ²	<i>Echeneis neucratoides</i>	x	x	x	x	x	x				
¹ From Northern Lagoon ² Manatee commensal											

6.5 Past and Present Research in the Southern Lagoon Area

Southern Lagoon was first highlighted as of conservation interest for its high Antillean manatee population by first **Bengston and Magor (1979)**, then later by **O'Shea and Salisbury (1991)**.

A series of baseline research activities then took place in 1994, as part of the Gales Point Natural Resources Project, to provide background for the designation of the area as a Special Development Area

- During the 1994 vegetation inventory of the Manatee Special Development Area (**Lyon, 1994**), a series of 12 permanent vegetation plots were established throughout the Southern Lagoon area, with a summary report on the vegetation of the area. Unfortunately, these plots have not been maintained, and when revisited, the plot markers could not be located.
- **Augusta and Adrewin (1993)** conducted a preliminary survey of the primates of the area – the Central American spider monkey and Yucatan howler monkey, and **Augusta** then went on to provide an overview of the Antillean manatee population within Southern Lagoon, and developed a set of conservation recommendations.
- A brief survey by **Greenlee (1994)** established the initial mammal species list for the area, in collaboration with the hunters, concentrating on the terrestrial mammal species, and **Smith et al. (1995)** completed an overview of turtle nesting activity.

A brief survey of the lagoon system was completed by **Platt and Thorbjarnason (1997)** as part of a country wide survey on the distribution of American Crocodiles in Belize.

Since 1996, **Wildlife Trust** has been engaged in the long-term conservation of the manatee (*Trichechus manatus manatus*) in Belize, through a combination of scientific research, professional training, and public education focusing on manatees that reside or use the Southern and Northern Lagoons.

Telemetry tagging is being used to observe manatee movements both within the lagoon system and adjacent waters, and has highlighted several examples of long-distance movement, especially in males. Analysis of data will help determine which social class of manatees (e.g. males, females, juveniles, lactating females) are seasonally or permanently resident in Southern Lagoon, and how distribution within the lagoon system corresponds to available resources – seagrass, freshwater etc.

The objectives of this long-term project are:

- to determine the ranging patterns, threats, and health of manatees in the Southern Lagoon area (near Gales Point, Belize), to assess the conservation status of this manatee population;
- to provide information and advice to the Gales Point community and government bodies on how to best observe manatees with minimal impact;
- to provide ecological information to various organizations that can be used for the development of a conservation management plan for Belizean manatees.

The project also serves as a valuable training site for marine mammal conservation scientists from around the world; students from Cuba, Guatemala, Ivory Coast, and USA have completed internships at the site.

Integrated into the overall programme is assessment and monitoring of the seagrass within the lagoon system, in partnership with the Meso-American Barrier Reef System project, which has provided training, providing further information on the Southern Lagoon ecosystem.

7.0 Research Priorities

The following areas have been highlighted as research priorities for the conservation and sustainable use of the Southern Lagoon area. It is recommended that they be incorporated into an overall Research and Monitoring Programme, within a structured management plan

7.1 Species of concern

- **Antillean manatee (*Trichechus trichechus*)** – It is important that there is a continuation of the long term Wildlife Trust research, including:
 - ongoing monitoring of population size and health within the system
 - movements (within and outside the system)
 - mapping of feeding areas
 - estimate of biomass consumption
 - the role of the manatee in maintenance of seagrass beds
 - nutrient cycling
 - behaviour (including anthropogenic impacts)
 - mapped boat impact risk assessment
 - monitoring of scarring

- **Hawksbill turtle (*Eretmochelys imbricata*)** – a continuation of, and greater support for, local efforts to monitor nesting/hatching success, with:
 - ongoing assessment of the no. of nests, eggs per nest
 - hatch-rate
 - causes of mortality
 - options for increasing nest success
 - threat mitigation, including beach sinkage and the potential for replenishment
 - location of project partner to support local community conservation efforts

- **Central American river turtle (*Dermatemys mawii*)** -
 - population survey: density and distribution, age class distribution
 - habitat preferences & seasonality
 - harvest data
 - population modeling
 - assessment of the population status, and development of a species recovery plan for the area

- **Fish** – with the traditional importance of fishing to the local community, and the need to manage Southern Lagoon as a Wildlife Sanctuary, there needs to be research into the current level of fish stocks, and management requirements for ensuring sustainable use:
 - collection and analysis of fish catch data
 - assessment of the commercial fish species populations within the lagoon system (population size, distribution, seasonality, individual size, health)
 - assessment of the population status of the critically endangered goliath grouper (*Epinephelus itajara*), and development of a species recovery plan for the area
 - assessment of threats to fish stocks within the area
 - primary productivity of the Southern Lagoon system

- **American crocodile (*Crocodylus actutus*)**
 - assessment of size of population around Bar River, Bar Mouth, and adjacent beaches
 - determination of extent of movements into the lagoon system
 - interaction with Morelet's crocodile
 - monitor nests on beach, no. eggs per nest, hatch-rates, hatchling dispersal & habitat preferences
 - accidental kills in fishing nets

7.2 Other concerns

Ecosystems:

- **Seagrass beds**
 - mapping,
 - primary productivity,
 - consumption rates (by manatee),
 - threat assessment
 - epiphyte load

- **66' terrestrial component**
 - detailed baseline mapping for monitoring of land use change and enforcement activities,
 - risk assessment and mapping of land-use change threats,
 - identification of key areas for connectivity,
 - water-quality protection functionality,
 - identification of scale of fin-fish nursery functionality of buffer vegetation

Systems:

- **Hydrology**
 - watershed dynamics and modelling,
 - water flow,
 - water quality,
 - temperature,
 - water depth,

- **Land-use change** - monitoring, and impacts
- **Socio-economics** (Gales Point)
 - determination of scale of economic benefits derived from both fishing (subsistence, commercial and sports) and from tourism within the Sanctuary, and in adjacent areas,
 - determination of role of the Wildlife Sanctuary in maintaining these livelihoods,
 - determination of sustainability;
 - identification of degree of dependency on forest products from surrounding areas,
 - identification of relative scale of income generated from outside the Village and its immediate surroundings

References

- Auil, N. E. (1998).** Belize Manatee Recovery Plan. UNDP/GEF Coastal Zone Management Project, BZE/92/G31, Belize / UNEP Caribbean Environment Programme, Kingston Jamaica. 67pp.
- Auil N. (2006).** Strengthening the Recovery of the Antillean Manatee in Belize Through Building Local Management Capacity and Research Activities
- Augusta C. and A. Andrewin (1993).** Preliminary Spider and Howler Monkey Survey of Southern Lagoon Watershed. Unpublished
- Augusta C. (Undated).** Manatee Special Development Area - Overview of manatee population and preliminary recommendations. Unpublished.
- Australian and New Zealand Environment and Conservation Council (1992),** Australian Water Quality Guidelines for Fresh and Marine Waters, National Water Quality Management Strategy, Australian and New Zealand Environment and Conservation Council, Canberra
- Balick M. J., Nee M. H. and D.E. Atha (2000).** Checklist of the vascular plants of Belize with common names and uses. *Memoirs of the New York Botanical Garden*, Volume 85. New York Botanical Garden Press. ISBN: 0-89327-440-2
- Belize Biodiversity Information System (Downloaded 2006)**
- Bengston J. L. and D. Magor (1979).** A survey of manatees in Belize. *Journal of Mammalogy*, 60(1):230-232.
- BERDS (Meerman, J. C. and J. Clabaugh (ed.) 2005).** Biodiversity and Environmental Resource Data System of Belize. Internet address: <http://www.biodiversity.bz>
- BirdLife International (2005).** Species factsheet: *Crax rubra*. Downloaded from <http://www.birdlife.org> on 8/20/2005
- Bolland, O. Nigel (1987).** "Race Ethnicity and National Integration in Belize", in *Belize Ethnicity and Development*, paper presented at the First Annual Studies on Belize Conference, May 1987, Society for the Promotion of Education and Research, Belize.
- Brooks, D. M. and S. D. Strahl (compilers). (2000).** Curassows, Guans and Chachalacas. Status Survey and Conservation Action Plan for Cracids 2000–2004. IUCN/SSC Cracid Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK.viii + 182 pp.
- Center for Tropical Forest Science (Download, 2006),** Panama. Trees of the Panama Canal area. www.ctfs.si.edu/webatlas
- Central Statistics Office (2000)** Data for 2000 Census. Government of Belize
- Central Statistics Office (2004).** Mid-term census. Government of Belize
- Cornec, J. (1986).** Notes on the Provisional Geologic Map of Belize, Scale 1:250000. UNDP/BZE/83/001 Petroleum Office, Ministry of Natural Resources, Belize 22 pp. and fig. [Unpublished].

FAO (1978). Proposals for Wildlife Protection and National Parks System Legislation and the Establishment of National Parks and Reserve. Forestry Development Project Working Document BZE/75/008

Figueroa O. A. (2005). Nesting habitat selection and habitat associations of juvenile jabiru storks (*Jabiru mycteria*) in Belize, Central America: Implications for conservation. Masters Thesis. University of Florida.

Florida Department of Environmental Protection (2001). Seagrass and the Economy. <http://www.dep.state.fl.us/coastal/seagrass/facts/economy.htm> Site Visited June 20, 2003.

Ferdie, M. and J. W. Fourqurean (2004). Responses of seagrass communities to fertilization along a gradient of relative availability of nitrogen and phosphorus in a carbonate environment. *Limnology and Oceanography*, 49 (6), 2004, 2082-2094.

Florida Department of Environmental Protection (2001). Seagrass and the Economy.

Gentry, A. H. (1993). A Field Guide to the Families and Genera of Woody Plants of Northwest South America (Columbia, Ecuador, Peru), with supplementary notes on herbaceous taxa. University of Chicago Press. ISBN 0-226-28944-3

Global Amphibian Assessment (2004).

Greenfield D. W. and J. E. Thomerson (1997). Fishes of the Continental Waters of Belize. University Press of Florida. ISBN: 0-8130-1497-2

Greenlee, D. (1994) Mammal Survey Report. 1994 Biodiversity Research Project. Unpublished Report

Guildford S. J. and R. E. Hecky (2000) Total nitrogen, total phosphorus, and nutrient limitation in lakes and oceans: Is there a common relationship?

Henderson, A., G. Galeano, and R. Bernal. (1995). Field Guide to the Palms of the Americas. Princeton University Press. ISBN 0-691-08537-4

Hoare, A. (2002). Past, Present and Future – Gales Point Manatee

Horwich, R. and J. Lyons. (undated). Proposal for Multiple Land Use System for the Community Manatee Reserve. Unpublished.

Iremonger, S. & N. V. L. Brokaw, (1995). Vegetation Classification for Belize. In R. Wilson (ed.). Towards a National Protected Area System Plan for Belize, Synthesis Report. 114 pp. Programme for Belize

IUCN (2006). IUCN Red List of Threatened Species. www.redlist.org.

Jones H. L., A.C. Vallely (2001). Annotated Checklist of the Birds of Belize. Lynx Ediciones. ISBN 84-87334-35-0

Jones H. L. (2003). Birds of Belize. University of Texas Press. ISBN 0-292-70164-0

King R. B., I. C. Baillie, J. R. Dunsmore, R. J. Grimble, M. S. Johnson, J. B. Williams and A. C. S. Wright (1989). Land Resources Assessment of Stann Creek District, Belize. Bulletin No. 19. Overseas Development Natural Resources Institute.

King R. B., I. C. Baillie, T. M. B. Abell, J. R. Dunsmore, D. A. Gray, J. H. Pratt, H. R. Versey, A. C. S. Wright and S. A. Zisman (1989). Land Resource Assessment of Northern Belize. Bulletin 43. Volume I and II. ODA.

Kueny, J. A. and M. J. Day (2002). Designation of Protected Karstlands in Central America: A Regional Assessment. *Journal of Cave and Karst Studies*, 64(3): 165-174.

Belize Lands and Survey (1994). An Account of the Development Plan for the Manatee Special Development Area.

Lee, J. C. (1996). The Amphibians and Reptiles of the Yucatan Peninsula. Comstock Publishing Associates, Cornell University Press. ISBN 0-8014-2450-X

Lee, J. C. (2000). A Field Guide to the Amphibians and Reptiles of the Maya World the Lowlands of Mexico, Northern Guatemala, and Belize. Comstock Publishing Associates, Cornell University Press. ISBN 0-8014-8587-8

Leonard D. (2003). Faunal Taphonomy and Ritual Offerings in Five Caves of the the Sibun River Valley. Xibun Archaeological Research Project. Boston University. Submitted to the Department of Archaeology.

Lyon J. (1994). Gales Point Natural Resources Project: 1994 Summary Report on Vegetation Inventory / Research in the Manatee Special Development Area. Belize Enterprise for Sustainable Development.

McAnany P. A. and B. Thomas (2003). Between the Gorge and the Estuary: Archaeological Investigations of the 2001 Field Season. Xibun Archaeological Research Project. Boston University. Submitted to the Department of Archaeology.

Manatee Advisory Team (1992). Recommendations for the Manatee Special Development Area Submitted to the Lands Utilisation Authority MSDA Sub-committee.

McGill, J. N. 1994. Special Development Areas. Consultant's Report. Forest Planning and Management. Project. Belmopan, **Belize**.

Meerman, J. C. (2005). NPAPSP - Protected Area System Assessment and Analysis: Gap Analysis. Report to the Protected Areas System Plan Office.

Meerman, J. C. (2005). NPAPSP – Protected Areas System Assessment and Analysis: Critical Species. Report to the Protected Areas System Plan Office.

Meerman, J. C. (2004). Central American Ecosystems Map: Belize. (Revised)

Meerman, J. C. and W. Sabido. (2001). Central American Ecosystems Map: Belize. Programme for Belize.

Meerman, J. C. (1996). Environmental Impact Assessment: Gracy Rock Subdivision. Belize Environmental Consultancies Ltd.

Middleton, B. A., E. Sanchez-Rojas, B. Suedmeyer, and A. Michels. (1997). Fire in a tropical dry forest of Central America: a natural part of the disturbance regime? *Biotropica* 29 (4): 515-517.

Miller, B and C. M. Miller. (1995). National Protected Areas System Plan for Belize: Zoological Report. NARMAP

- Miller, T. E. (1996).** Geological and Hydrologic Controls on Karst and Cave Development in Belize. *Journal of Cave and Karst Studies* 58(2): 100 – 120.
- Myers, R. L. (2002).** The ecological role and management of fire in Caribbean and Central American pineland ecosystems. In The Nature Conservancy' Global Fire Initiative – proceedings of the Rio Bravo Conservation & Management Area, Belize workshop 7-9 May 2002.
- New York Botanical Gardens.** Ethnobotany and Floristics of Belize: Family Index. www.nybg.org/bsci/belize/families.html
- National Hurricane Centre. (Downloaded 2006).** Archives. www.nhc.noaa.gov
- National Meteorological Centre (Downloaded 2006).** <http://www.hydromet.gov.bz>
- O'Shea, T. J. and J. S. Salisbury. (1991).** Belize – a last stronghold for the manatees in the Caribbean. *ORYX* 25(3): 156-164.
- Piaskowski V. D. , M.Teul, R. N. Car, K. M. Williams and W. E. Martinez (2003).** The Birds of Central Belize *Caribbean Geography* 2003 13{1}
- Platt, S. G. and J. B. Thorbjarnarson. (1997).** Status and Life History of the American Crocodile in Belize. Final Report to UNDP / GEF, Belize Coastal Zone Management Project BZE/92/G31
- Quintana-Rizzo, E. and Reynolds, J. III. In review.** Regional management plan for the West Indian manatee (*Trichechus manatus*). United Nations Environment Programme, Caribbean Environment Programme.
- Smith G., K. Eckert and J. Gibson. (1992).** WIDECAST Sea Turtle Recovery Action Plan for Belize. CEP Technical Report No. 18. UNEP Caribbean Environmental Programme. Kingston.
- Stafford P. J. and J. R. Meyer. (2000).** A Guide to the Reptiles of Belize. Academic Press. ISBN 0-12-662760-6
- Standley, P. C. and Record, S. J. (1936).** Forest and Flora of British Honduras. Field Museum of Natural History, Botanical Series 12, 432pp.
- Thomas B., K. Marx and T. Bermingham. (2003)** Xibun Archaeological Research Project. Boston University. Submitted to the Department of Archaeology.
- Tripplatt, K. (2003).** The Xibun Contemporary Flora and its Significance. Xibun Archaeological Research Project. Boston University. Submitted to the Department of Archaeology.
- United States Geology and Survey.** Seagrass Habitat in the Gulf of Mexico: Degradation, Conservation and Restoration of a Valuable Resource.
- Walker Z. and P. Walker (2005).** Peccary Hills: Biodiversity Assessment. Wildtracks (Unpublished Report)
- Wilson R. (1995).** Towards a National Protected Areas System Plan for Belize. Report to NARMAP, USAID. Belmopan.
- Wright A.C.S. Romney, D.H., Arbuckle, R.H. & Vial, V.E. (1959).** Land in British Honduras: Report of the British Honduras land use survey team. Colonial Research Publications (24). London: Her Majesty's Stationary Office.

WWF Conservation Science Programme 2001 Terrestrial ecosystems

Young, B. E., S. N. Stuart, J. S. Chanson, N. A. Cox, and T. M. Boucher. (2004).
Disappearing Jewels: The Status of New World Amphibians. NatureServe, Arlington, Virginia.

Zisman, S. (1996). The Directory of Belizean Protected Areas and Sites of Nature Conservation Interest. Second Edition. Report to NARMAP

Annex

Meta Data for BERDS Maps

Meerman, J. C. and J. Clabaugh (ed.) 2005. Biodiversity and Environmental Resource Data System of Belize. Internet address: <http://www.biodiversity.bz>

Spatial Metadata

The metadata information for the various spatial (GIS) data layers (used in the BERDS Map Explorer application)

Spatial Layer: **DISTRICTS**

Source: Land Information Centre Spatial Layer
[Made public through Paseo Pantera Consortium
Univ. of Florida/USAID *Digital Geographic Database: Maya Forest Region:
Mexico, Guatemala, Belize. Version 1, August 19110.*] Note: further modified by Jan Meerman
Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716

Spatial Layer: **ECOSYSTEMS (incl. Agricultural Encroachment, Agricultural Use, Forest Types, Land Use, Mangroves, Marine Habitats and Wetlands Layers)**

Source: Meerman, J. C. and W. Sabido. 2001. Central America Ecosystems Map: Belize. CCAD/World Bank/Programme for Belize. Version 040428. Major Revision by J.Meerman and posted 12 Feb 2005
Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716

Spatial Layer: **ELEVATION**

Source: 1980 DOS 1:50,000 Topographic Maps
Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716

Spatial Layer: **GEOLOGY**

Source: Cornec, J. 1986. Notes on the provisional geologic map of Belize, scale 1:250,000. UNDP/BZE/83/001. Petroleum Office, Ministry of Natural Resources, Belize. 22pp and fig. (unpub).
Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716

Spatial Layer: **PROTECTED AREAS - updated 12 Apr 2005**

Source: GOB Gazettes
Note: Generated by Jan Meerman
Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716

Spatial Layer: RAINFALL

Source: Walker, S. H. 1973. Summary of climatic records for Belize. Land Res. Div. Surbiton, Surrey, England, Suppl. No. 3 Note: further modified by Jan Meerman
Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716

Spatial Layer: RIVERS & STREAMS - Updated 14.10.2005

(including riverine types, water sources, clarity and salinity layers)
Source: Land Information Centre Spatial Layer
[Made public through Paseo Pantera Consortium, Univ. of Florida/USAID *Digital Geographic Database: Maya Forest Region: Mexico, Guatemala, Belize. Version 1, August 19110.*]
Note: further modified by Jan Meerman & Peter Esselman
Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716

Spatial Layer: ROADS & TRACKS - updated 30 Jun 2004

Source: Spatial Presentation of Belizes Road system describing paved, unpaved roads and the most important tracks and trails. Note: Generated by Jan Meerman
Updated 30 Jun 2004
Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716

Spatial Layer: SETTLEMENTS - updated 21 Jun 2004

Source: Int'l Travel Map of Belize (1:350,000), 2000 GOB Census, 2001 CSO Abstract of Statistics
Note: Generated by Jan Meerman and Jerod Clabaugh
Updated: 20 Jun 2004
Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716

Spatial Layer: SOILS

Source: Based on Wright, A. C, et al, 11109. Land in British Honduras. Colonial Res. Publ. No. 24. Note: Generated by PRONATURA for the TNC-led Selva Maya Project (draft form) Further modified to include information from *Baillie, et al. 1993. Revised Classification of the Soils of Belize. NRI Bulletin No. 59.*
Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716

Spatial Layer: WATERSHEDS

Source: based on NARMAP 19110. *Environmental water quality monitoring report. Final Report and Annexes. Department of the Environment, Belize.* Note: further modifications using altitude, stream and ecological data by Jan Meerman and Jerod Clabaugh
Projection: UTM Zone 16
Datum: NAD 27 Central
Spheroid: Clarke 1866
EPSG Code: 26716