Turneffe Atoll

Management Plan

2012 – 2017

Turneffe Atoll Marine Reserve

Management Plan

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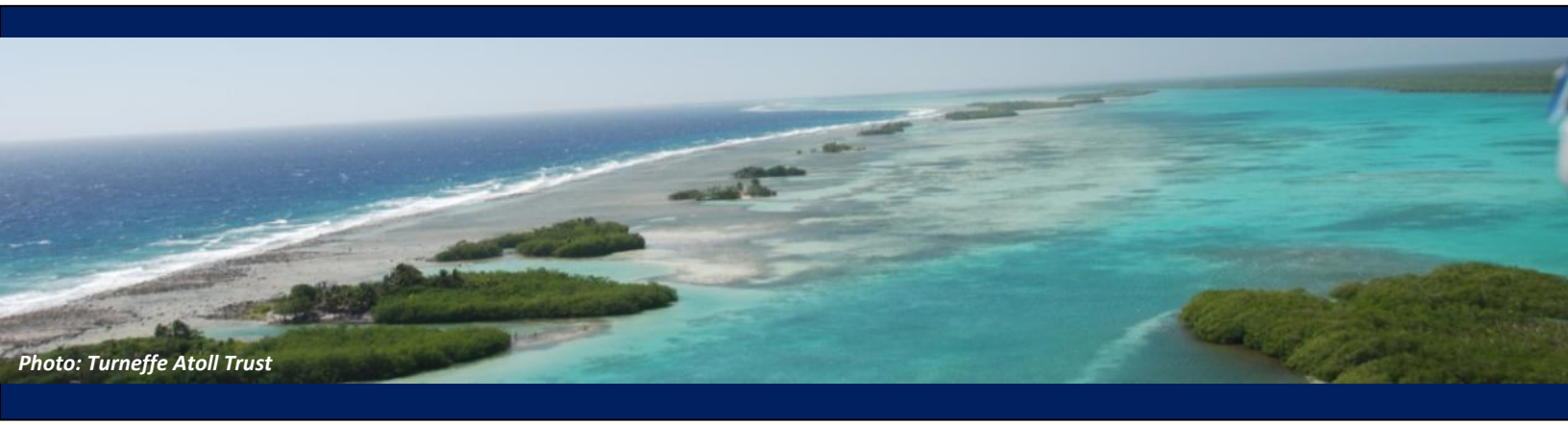

This Management Plan is dedicated to

K. Mustafa Touré

Acknowledgements

We would like to thank the Turneffe Atoll Sustainability Council, and particularly the members of the Core Team, for their input into the management planning process. We would also like to thank those individuals – particularly fishermen, tour guides and researchers - who participated, shared information, proof read sections and provided recommendations. Without this input and support, this Management Plan would not be as strong a foundation for future management as it is.

This Management Plan was significantly strengthened through input from the Fisheries Department, and from a parallel, widely participatory Management Action Planning Process, led by The Nature Conservancy.

Particular recognition also needs to go to Craig Hayes, K. Mustafa Touré, and other members of the Turneffe Atoll Advisory Council, who have spearheaded the Turneffe initiative over many years, and have been instrumental in ensuring that Turneffe is recognized as an important component of Belize's natural heritage.

Financial support towards this management planning process was provided by Turneffe Atoll Trust

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Cover Photo: Turneffe Atoll Trust

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Introduction

Background and Context

Turneffe Atoll, with its high biodiversity, limited anthropogenic threats, has long been identified as a significant gap within Belize's National Protected Areas System (NPAPSP, 2005), with sustained lobbying by a number of stakeholders (both tourism and fishing sectors) towards improved management of the Atoll and its resources.

The need for mechanisms to be put in place for improved management of the Atoll was recognized as early as 1968, and calls for protected area status for Turneffe have been ongoing since the early 1990's. In 1994, this need was recognized by the Ministries of Agriculture & Fisheries, Natural Resources and Tourism. As a first step, the University of Belize and Coral Caye Conservation programme collaborated to establish a Marine Research Centre at Calabash Caye, collecting and analyzing data to support the development of a management plan.

Development guidelines for the Atoll were first drafted in 1996 (McGill et al., 1996), as part of the Coastal Zone Management Programme, and integrated in 1998 into the Coastal Zone Management Authority activities, with the formation of the Turneffe Islands Coastal Advisory Committee (TICAC), composed of Turneffe stakeholders, and updating of the Turneffe Islands Development Guidelines, between 2001 and 2003. Whilst these guidelines were never implemented, they have formed the basis for the new set of

SITE INFORMATION

Size: The Atoll itself is approximately 48.3 km long and 16.1 km wide (30 miles long and 10 miles wide), within a proposed management area encompassing approximately 131,690 ha / 1,317 km^2 (325,412 acres).

Location: Turneffe Atoll is located 32km (20 miles) east of Belize City and is surrounded by deep oceanic waters. Turneffe is considered the largest and most biologically diverse coral atoll in Belize, and in the Mesoamerican Reef ecoregion.

Uses: Extractive and non-extractive – commercial, non industrial fishing (lobster, conch and finfish), tourism (including sport fishing, diving, snorkeling and ecotours), education and research.

Biodiversity information: The land and seascape consists of a network of highly productive flats, creeks, and lagoons dotted by more than 150 mangrove islands and higher cayes with savanna and littoral forest. Large expanses of intact mangrove and seagrass habitat and shallows provide important nursery functionality for a wide array of fish species, crocodiles, lobster, conch and other invertebrates. In addition, at least three known important fish spawning aggregation sites have been identified. The Atoll is surrounded on all sides by open sea

Facilities (2009): The Environmental Research Institute of the University of Belize manages Calabash Caye Field Station. Oceanic Society maintains a facility at Blackbird Caye. Three resorts also operate on the Atoll – Turneffe Flats, Turneffe Island Resort and Blackbird Caye. The Belize Coastguard maintains a manned station on Calabash Caye, and Port Authority has lighthouses on Mauger Caye and Caye Bokel.

guidelines, finalized in 2011 and currently under consideration by Coastal Zone Management Authority and Institute. In June of 2010, Turneffe Atoll Trust, with the support of Coastal Zone, facilitated the establishment of a stakeholder-based organization - the Turneffe Atoll Sustainability Council (TASC) - to represent Turneffe Atoll stakeholders and pursue options for sustainable management of Turneffe Atoll. This effort culminated in a decision to actively seek declaration as a marine managed area, integration into the National Protected Areas System. The Fisheries Department, as the legislated authority for marine resources, led the initiative for improved management of natural resources of Turneffe Atoll, supported by the other members of TASC.

In moving Turneffe Atoll forwards towards an improved management regime, a series of management planning workshops facilitated by The Nature Conservancy brought key stakeholders together in 2011 to discuss and assess the status of biodiversity of the Atoll, and the threats to the continued viability of the area as one of the more pristine, relatively unimpacted, biodiverse sites within the Mesoamerican Reef ecoregion. Priority objectives were identified, and a 'Measures of Success' framework was developed to ensure effective tracking of goal achievement.

The management plan is based on the outputs from the workshops, on stakeholder focal group meeting, interviews, discussions and comments, as well as past and ongoing research data from the Atoll, and seeks to provide structured programmes, strategies and actions that will lead towards fulfilling the stakeholder vision:

> ***Turneffe Atoll is a model of effective planning and management that ensures that the unique ecological values and associated social and economic benefits are used sustainably for future generations through active stakeholder stewardship***

Turneffe Atoll Management Action Plan
Workshop One, July, 2011

Management Objectives for Turneffe Atoll

Objective One:

Maintain and improve healthy, resilient, biodiverse reefs of Turneffe Atoll at or above the 2010 IRHI status of FAIR up to and beyond 2022.

Objective Two:

By 2017, Turneffe Atoll will be a model for ecologically sustainable tourism, with 100% of tourism industry and research stakeholders certified as Best Practices users of the Atoll.

Objective Three:

By the end of 2012, a documented, weekly multi-agency patrol has been established that includes the Belize Fisheries Department, Belize Coast Guard and Stakeholder group (TBD), with effective patrolling covering the entire proposed Turneffe Atoll Marine Management Area.

Objective Four:

By 2016, reverse the decline in commercial production demonstrated at Turneffe Atoll over the last five years by 50%

Objective Five:

By the end of 2013, a Fisheries Management Plan is adopted and implemented for the Turneffe Atoll through active participation of fisheries resource users, which would consider options such as managed access, size limits, gear management, diversification and catch quotas.

Objective Six:

By 2017, the population of invasive lionfish at Turneffe Atoll has been reduced by 50% from the 2012 baseline.

Objective Seven:

By 2013, adopt and implement the TACAC Management guidelines and Best Practices for development at Turneffe Atoll

Objective Eight:

By the end of 2014 establish and implement sustainable financial mechanisms to finance operations and management of Turneffe Atoll Managed Area.

MAP outputs, 2011

Purpose and Scope of Plan

Turneffe Atoll, the largest of three offshore Atolls lying to the east of the coastal shelf of Belize, is considered to be an integral part of Belize's reef system, and one of the best developed Atolls of the Mesoamerican Reef (MAR) region, as well as a global ecological hotspot for marine biodiversity. Until its designation as a Marine Reserve in 2012, Turneffe Atoll lay to a greater extent outside of the National Protected Areas System, with no management structure or presence in place. The Atoll has long been highlighted as a gap in Belize's National Protected Areas System, and there has been recognition from many of the stakeholders that management of the area needed to be established. This has resulted in the declaration of the Atoll and adjacent deep waters as a Marine Reserve. An associated activity is the development of this first management plan, to guide the establishment of management activities within the scope of the area defined by the participatory management process.

Two regionally important spawning aggregation sites are located on the north-east and south walls of the Atoll, and are managed under Fisheries regulations (Statutory Instrument 161 of 2003). A third site, Maugre Caye, has regulated fishing of Nassau Grouper during spawning season, under Statutory Instrument 49 of 2009. A Public Reserve was declared by the Forest Department to protect part of Cockroach Beach and the associated lagoon, in recognition of its importance as the primary American Saltwater Crocodile nesting site in the country (FD, 2005).

The Plan includes general information on the physical and biological attributes of the Marine Reserve, documents the current uses, relevant legislations, identified management challenges, defines the goals and objectives of management, summarizes the outputs of the Management Action Planning process and climate change assessment outputs, outlines specific management programmes, including zoning recommendations, sets in place the means for measuring management effectiveness, and recommends an implementation schedule format.

In line with the National Protected Areas Policy and System Plan, this Management Plan reflects the participatory approach to management being adopted in Belize today, and has been prepared with the input of the key stakeholders of the Atoll, through focal group meetings, a series of Management Action Planning workshops, and interviews with a wide variety of individuals, including fishermen, the tourism sector, Fisheries Department staff and researchers. It seeks to conserve the resources of the management area while promoting economic benefit through sustainable fishing and tourism. The management programmes are based on the best available data and scientific knowledge available, with the integration of management planning strategies.

The management plan seeks to establish an effective management structure, and is designed to guide the management of the Marine Reserve through the next five years, providing a framework for both broad management activities as well as more specific operational, research

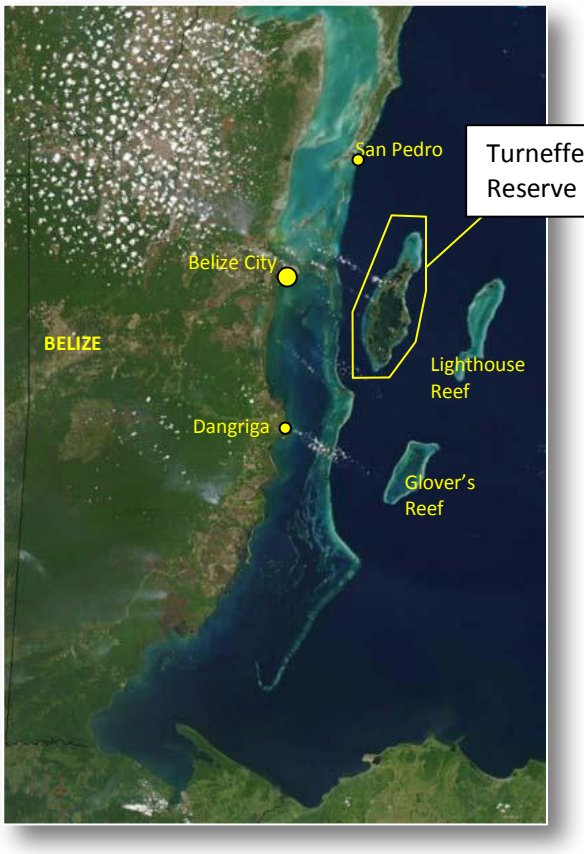
and monitoring, and education and outreach activities. It is recommended that detailed annual operational plans be developed based on the framework provided by this management plan, with an annual review of implementation success, allowing for adaptive management over the five year period.

Photo: Turneffe Atoll Trust

1. Current Status

1.1 Location

Turneffe Atoll Marine Reserve is the largest and best developed of the three atolls within Belize territorial waters that lie beyond the barrier reef. It is situated 50km east of the central Belize coastline and Belize City, and is accessible by boat, plane and helicopter. The marine protected area includes all of the Atoll (1,316.9 sq kms) as well as an area of the surrounding open sea (Maps 1, 2 and 3)

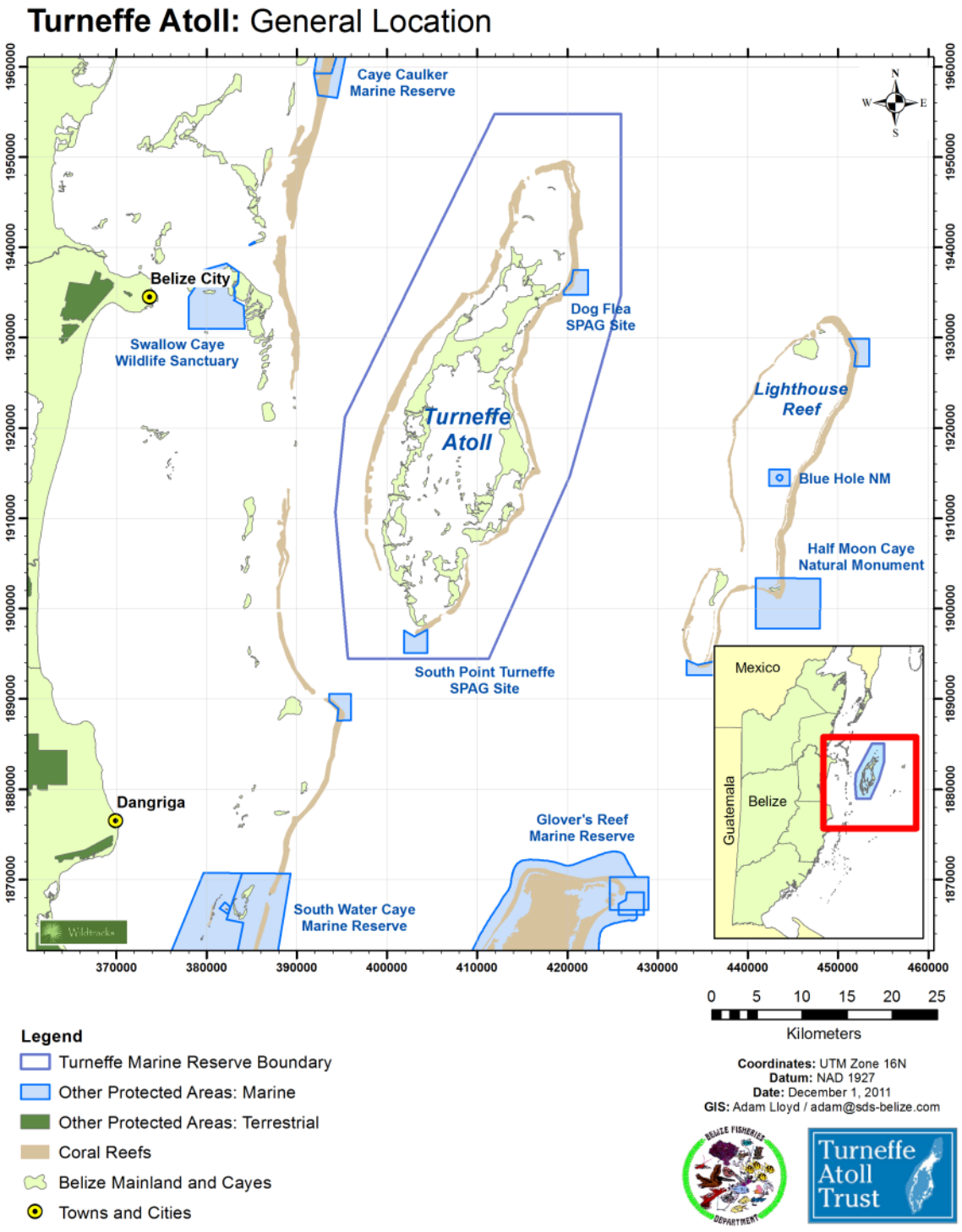


Whilst there are no settlements on the Atoll, there are a number of developments, including three high-end resorts (Turneffe Flats, Turneffe Island Resort, and Blackbird Caye Resort) and two educational / research facilities, focused on the marine environment (Calabash Caye (University of Belize Environmental Research Institute) and Blackbird Caye (Oceanic Society).

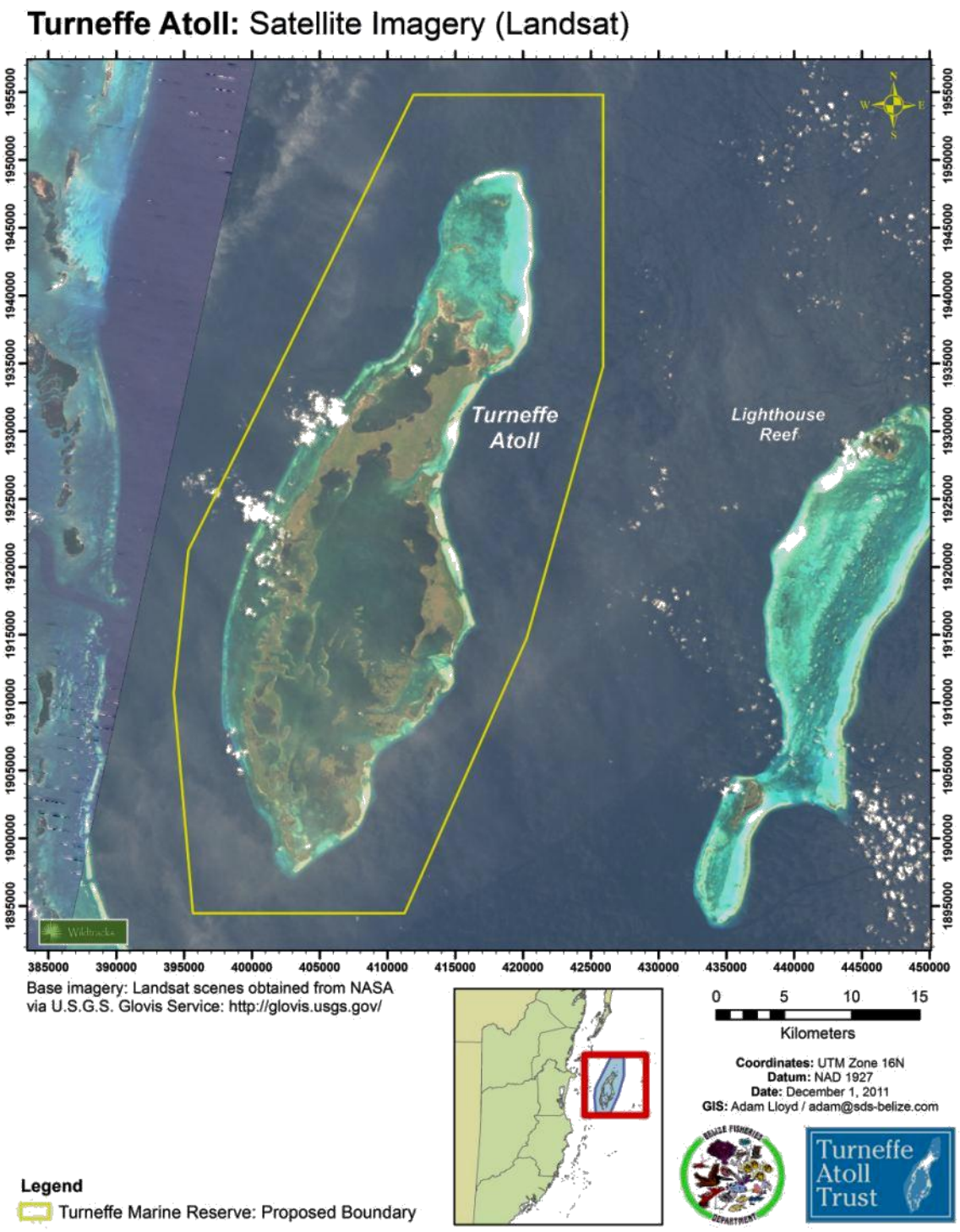
There are also an estimated twenty five semi-permanent fishing camps, scattered across the Atoll (Neal, 2011).

Map 1: Location of Turneffe Atoll

The Marine Reserve encompases three spawning aggregation sites (two protected under SI 162, the third under SI 49 of 2009), and a public reserve protecting the crocodile nesting site at Cockroach Beach into the management responsibilities. Until recently, there has been no on-site surveillance and enforcement.



Map 2: Turneffe Atoll: General Location



Map 3: Turneffe Atoll: General Location - Satellite

1.2 Regional Context

Turneffe Atoll is part of the Mesoamerican Reef (MAR), which stretches for more than 1,000 km along the coast of Belize, Guatemala, Honduras and Mexico. One of the most diverse ecosystems on earth, the MAR is considered outstanding on a global scale, and a priority for conservation action. It stabilizes and protects coastal landscapes, maintains coastal water quality, sustains species of commercial importance, and provides employment in the fishing and tourism industries to more than a million people living in coastal areas (Global Environment Facility, 2001).

Belize has an estimated 1,420 km² of reef within its territorial waters - 5.5% of the reefs of the Wider Caribbean (World Resources Institute, 2004). This reef system is included on a global list of 18 richest centers of endemism and has been highlighted as one of the areas most threatened by human impacts (Roberts et al., 2002). Turneffe Atoll itself is highlighted as an ecoregional priority for conservation planning efforts (World Wildlife Fund, 2002), particularly for the role of the spawning aggregations in the maintenance of regional commercial fish stocks (Heyman et al., 2002), and has been recommended for inclusion in Belize's World Heritage Site based on its unique values (IUCN, 1996). The area includes assemblages of regionally important ecosystems of remarkable biodiversity and beauty, as well as of great scientific value, and importance for many species of global conservation concern, among them the critically endangered hawksbill turtle (*Eretmochelys imbricata*) and goliath grouper (*Epinephelus itajara*), and the endangered green and loggerhead turtles (*Chelonia mydas* and *Caretta caretta*) (IUCN, 2011). The white spotted toadfish (*Sanopus astrifer*), endemic to Belize, has a limited range that includes the Atoll, and it is also provides important habitat for pelagic and migratory species like marlin, sailfish, wahoo (*Acanthocybium solandri*), kingfish, tuna (bonito, yellowfin), mackerel, jack (amber, horse-eye, crevalle), and shark. Some of the highest quality remaining American crocodile habitat in the region is thought to exist at Turneffe (Kramer and Kramer, 2002).

> *The Belize Barrier Reef Reserve System contains an intact ecosystem gradient ranging from the terrestrial to the deep ocean: including, littoral, wetland, and mangrove ecosystems, to seagrass beds interspersed with lagoonal reefs, to the outer barrier reef platform and oceanic atolls. This ecological gradient provides for a full complement of life-cycle needs, supporting critical spawning, nesting, foraging, and nursery ecosystem functions. Maintaining these ecological and biological processes ensures robust and resilient reefs, which are themselves one of the world's most ancient and diverse ecosystems.*
>
> **From: Belize Statement of Outstanding Value, BBRRS World Heritage Site (Draft), 2011**

However, impacts are increasing - recent quantitative data on fish populations comparing 2002 and 2008 observations on the main Belize reef, for example, indicate a staggering decline in populations of larger reef fish such as grouper, snapper, and triggerfish (Mumby, 2009), increasing the importance of the need for areas such Turneffe Atoll to be managed more

effectively. In the Wider Caribbean region, recent studies have shown that nearly two-thirds of coral reefs are threatened by human activities (World Resources Institute, 2004). Belize, with its small population and relatively low coastal development rate, has always been highlighted as having the lowest human impacts in the region, with a relatively high percentage of live coral cover. Recently, however, the average live coral cover has fallen to slightly lower than the average for the Caribbean as a whole (AGGRA /McField et al., 2008 (ed. Wilkinson et al., 2008)).

As a signatory of the Convention on Biological Diversity, Belize has a commitment to ensuring it has measures in place to protect biodiversity, with promotion of sustainable use. In 1983, Belize signed the **Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region** (the 'Cartagena Convention') (Table 1), with the primary objective of protecting the ecosystems of the marine environment, following recognition of the regional importance of the Mesoamerican Reef System, the majority of which lies within Belizean waters.

Increasing management effectiveness of the marine resources of Turneffe Atoll is also a step towards fulfilling Belize's international commitments under the **Convention on Biological Diversity**, signed in 1992, particularly through designation of the deep sea adjacent to the Atoll as a managed area, addressing one of the identified critical gaps within the National Protected Areas System. This would also contribute towards the **International Convention for the Protection and Conservation of Sea Turtles for the Western Hemisphere**, signed in 1997.

In June 1997, with the increasing threats to the overall health of the reef system, the Governments of Mexico, Belize, Guatemala and Honduras (the four countries bordering the MBRS) committed themselves through the Tulum Declaration to the development of a 15-year Action Plan – the **Mesoamerican Barrier Reef System Project** - for the conservation and sustainable use of this ecosystem. This initiative, adopted by the Heads of State in June 1999, is supported by the **Central American Commission on Environment and Development** (CCAD), which works to harmonize environmental policies within the region.

As a signatory of the **Convention for the Regulation of International Trade of Endangered Species** (CITES), Belize is obligated to follow the CITES permitting procedures, with a permit required for every individual export of conch (*Strombus gigas*), validated by Customs Department, in order for Belize to ship this product internationally. The Belize Fisheries Department has developed a sustainable use strategy for this species, in order to maintain its export market. Turneffe Atoll has historically been important for both lobster and conch extraction. However, current reports suggest as much as 50% of the conch harvested from Turneffe is undersized (MAP workshop, 2011) – with a need for strengthening of enforcement and increased management of the area, to ensure that conch delivered for export are within the conch extraction size limits.

Belize is also a signatory to the **Treaty of Chaguaramas**, which establishes the Caribbean Community (CARICOM) and the Caribbean Community Single Market and Economy (CSME). Whilst this treaty seeks to open opportunities to all members of CARICOM, amendments exempt its application to the fisheries regime, preserving the status quo of the Fisheries Act, with the fisheries sector limited to access by Belizean nationals only (Edeson t. al., 2010). Regional fishery initiatives currently seek to standardize the size limits for lobster across countries, though this is still an ongoing process.

Table 1: International and Regional Conventions and Agreements of Relevance to Turneffe Atoll	
Convention on Biological Diversity (Rio de Janeiro, 1992) Ratified in 1993	To conserve biological diversity to promote the sustainable use of its components, and encourage equitable sharing of benefits arising from the utilization of natural resources. ***The spawning aggregation sites of Turneffe Atoll are important and integral parts of the national protected areas system, protecting critical spawning aggregation sites. This Plan seeks to ensure that management is also in place for the Atoll generally, for better protection of threatened biodiversity, and more sustainable use of marine resources, as per Belize's commitment under the CBD. It also seeks better management of the deep sea waters surrounding the Atoll, identified as a critical gap within the current National Protected Areas System.***
Convention on International Trade in Endangered Species (1972)	A global convention that seeks to prevent over-exploitation of animals and plants by regulating or prohibiting their international trade (including of dead specimens, parts and products, and derivatives). ***One of Turneffes focal products, the Queen conch (Strombus gigas) is a CITES listed species, with regulations for exploitation that Belize has to adhere to to be able to continue exporting. A number of other species, particularly sharks may also become listed, with the increasing concerns on population viabilities.***
Caribbean Community (CARICOM) (Revised Treaty of Chaguaramas, 2001)	Promotes economic and social development in the Caribbean through regional cooperation and integration of the economies of state parties as the Caribbean community. Includes provisions for management of natural resources. ***Turneffe has the potential for being a model for sustainable management and conservation of the fisheries resources, and contributing towards the network of aquatic protected areas in the Caribbean.***
Caribbean Regional Fisheries Mechanism (CRFM) Agreement (2002)	Targeted at the efficient management and sustainable development of marine and other aquatic resources, as well as cooperative management of shared / migratory resources. ***The CRFM seeks to achieve its aims through management of fishing capacity and methods, with implications for traditional fishermen of Turneffe.***

Table 1: International Conventions and Agreements of Relevance to Turneffe Atoll	
Alliance for the Sustainable Development of Central America (ALIDES) (1994)	Regional alliance supporting regional sustainable development initiatives. ***Strategies for better management for more sustainable resource extraction have been developed as part of this planning process, with the support of Fisheries Department. Sustainable development guidelines for the Atoll are also being developed under the coastal planning process (CZMAI, 2011)***
Sistema de la Integratción Centramericana (SICA) (Tegucigalpa Protocol 1991)	Regional integration framework for Central America. Includes Central American Commission for Environment and Development (CCAD) and Organización del Sector Pesquero y Acuícola del Istmo Centroamericano (OPESCA)
Central American Commission for Environment and Development (CCAD) (1989)	Regional organization of Heads of State formed under SICA, responsible for the environment of Central America. Initiated Mesoamerican Biological Corridors and Mesoamerican Barrier Reef Systems Programmes. ***Whilst Turneffe Atoll lies outside the Marine Protected Areas System, it is considered a critical component of the MesoAmerican Reef System. The protocols developed and outputs under MBRS provide valuable resources for future monitoring, standardized with the rest of the MAR countries.***
Organización del Sector Pesquero y Acuícola del Istmo Centroamericano (OPESCA)	To promote the coordinated and sustainable development of fisheries and aquaculture as part of the Central American integration process. ***Turneffe Atoll is an important contribution towards its contribution towards the regional goals of coordinated and sustainable development of fisheries***
Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (Cartagena de Indias, Colombia, 1983) **SPAW Protocol** (adopted in 1990)	Regional convention and protocol with the objective of protecting the marine environment of the Wider Caribbean through promoting sustainable development and preventing pollution. ***Whilst Turneffe Atoll lies outside the Marine Protected Areas System, it is considered a critical component of the MesoAmerican Reef System. This Plan recommends mechanisms for greater integration of the Atoll into the National Protected Areas System, increasing Belize's efforts towards biodiversity and threatened species protection, as per Belize's commitment under this Convention.***
Inte-American Convention for the Protection and Conservation of Sea Turtles for the Western Hemisphere (December 21st, 1997)	To protected and conserve sea turtle species of the Western Hemisphere. ***Turneffe Atoll provides an important feeding area for sea turtles, including the Critically Endangered hawksbill, as well as a number of nesting beaches. With improved management of both feeding grounds and nesting beaches, Turneffe will contribute to the increased viability of the three turtle species of Belize.***

1.3 National Context

1.3.1 Legal and Policy Framework

A number of national and regional planning initiatives have identified Turneffe Atoll as an important gap in Belize's and the region's strategies for conservation of the marine environment (Kramer and Kramer, 2002; NPAPSP, 2005, TNC, 2008, TASC, 2011; NPAPSP, 2005; Walker et al., 2011), with identified needs for increased management of commercial fish stocks, and protection of currently under-represented ecosystems - waters over 200m in depth - a national ecosystem gap. The increasing development pressures may lead to conflicts between user rights and the need to balance development with the conservation of the natural resources in this unique and fragile environment. It has been recommended that the Atoll and surrounding deep waters be integrated into the conservation framework of the country as a marine protected area, managed under the Fisheries Department (Fisheries Dept. pers. com.; TASC, 2011).

National Planning Strategies

The national objectives for conservation revolve around the protection, conservation and rational use of Belize's natural resources within the context of sustainable human development. These objectives are supported by the **National Strategy on Biodiversity**, through the National Biodiversity Strategy and Action Plan (Jacobs and Castaneda, 1998) (though this was never ratified at Government level), and more recently, the **National Protected Areas Policy and System Plan (NPAPSP**) (Meerman and Wilson; 2005), adopted by the Government of Belize in 2006. National conservation efforts are theoretically guided by the outputs of the NPAPSP planning, though limited resources currently restrict effective management of natural resources at Government level.

The overall goals of both the National Biodiversity Strategy and the NPAPSP reflect the national objectives - ecological and economic sustainability over the long term, with the development of human and institutional capacity to effectively manage the biodiversity resources within Belize. There are also moves towards decentralisation of the management of these resources, with a strong focus on co-management partnerships, community-based participation and equitable benefit from conservation efforts.

The **National Protected Areas Policy and System Plan** (NPAPSP, 2005) centers around the following policy statement:

> *The Government of Belize shall promote the sustainable use of Belize's protected areas by educating and encouraging resource users and the general public to properly conserve the biological diversity contained in these areas in order to maintain and enhance the quality of life for all. This shall be achieved by facilitating the participation of local communities*

and other stakeholders in decision-making and the equitable distribution of benefits derived from them, through adequate institutional and human capacity building and collaborative research and development.

The **Coastal Zone Management Authority and Institute** was established under the Coastal Zone Management Act for ensuring conservation of the Barrier Reef and other coastal resources, and the planning, management and sustainable development of resources within the coastal zone. The Act does not provide any enforcement capacity (this being through more specific agencies – the Fisheries Dept. (Fisheries Act), the Forest Department (Mangrove Regulations), Department of the Environment (Development regulations) and Geology and Petroleum Department (dredging and oil exploration), but for monitoring, planning and coordination to ensure that activities within the coastal zone are sustainable.

Legal Framework

The **Maritime Act** claims sovereignty over the territorial sea of Belize, including the airspace and the seabed.

Contributing to the conservation framework of Belize are a number of laws designed to protect wildlife and national heritage. The **Fisheries Act** (1948, revised 1983, and currently being overhauled (2011)), administered under the Fisheries Dept, is the principal governing legislation to regulate the fishing industry, and is directly concerned with maintaining sustainable fish stocks and protecting the marine and freshwater environments. It also provides protection for marine turtles and nest sites. The Fisheries Act requires that artisanal fishers and fishing vessels are licensed annually in order to fish for commercial purposes.

Marine turtles themselves have been given some protection since the original Fisheries Ordinance in 1940, and in June 2002, Belize revised its fisheries regulations to prohibit fishing, possession, or trade in products of all 6 species of marine turtles found in the region. A number of statutory instruments also provide more specific protection, both defining boundaries and regulations for marine reserves and spawning aggregation sites, and for some species - Nassau grouper and parrotfish among them.

The **Sport Fishing** regulations (SI 114 and 115 of 2009) were established to better manage the economically important sport fishing species in Belize, and more specifically address the management and conservation of the three major sport fish in Belize - bonefish, tarpon & permit. These three species can only be caught under 'catch and release' practices. Whilst the regulations are legislated under the Fisheries Act, the issuing of Sport Fishing licenses falls under the Coastal Zone Management Authority and Institute. The regulations, however, do not extend to protecting nursery areas or adult habitat – only to the sport fish species themselves.

The **Environmental Protection Act** (1992) was developed under the Department of the Environment (Ministry of Natural Resources) with the aim of ensuring that development initiatives within Belize are planned for minimum environmental impact – important in managing development impacts from cayes in the seascape of the Atoll. Caye development is regulated through the requirement for an Environmental Impact Assessment, (EIA), under the associated **Environmental Impact Assessment Regulations** (SI 105 of 1995), which controls and regulates the EIA process. Under this legislation, an accepted EIA results in the production of an Environmental Compliance Plan (ECP), which is then approved and monitored by the DoE. The Department of the Environment is also responsible for responding to human impacts on the reef, such as pollution, boat groundings and fuel spills, and has a mechanism in place for assessment of damage from boat groundings, based on the area impacted.

Also developed under the Ministry of Natural Resources are the **Forest (Protection of Mangrove) Regulations** (SI 52 of 1989, under revision, 2011), which provide for the protection of mangroves, with restrictions on mangrove alteration and / or clearance. Before granting a permit for mangrove alteration, Belize law requires the Forest Department to consider whether the project will adversely affect the conservation of the area's wildlife, water flow, erosion and values of marine productivity, and to find either 'that the proposed alteration will not significantly lower or change water quality' or that the degradation of water quality is in the "larger and long-term interest of the people of Belize" (Chapter 213, Section 5.5, Belize's Forest Act).

The **Wildlife Protection Act** (SI 12 of 1982, revised 2000) also falls under the Forest Department, and provides protection for West Indian manatee, whales and dolphins, with the prohibition of hunting and commercial extraction.

The **Mines and Minerals Act** (1989) and the **Petroleum Act** (1991), under the Department of Geology and Petroleum, regulate the exploration and extraction of all non-renewable resources, including oil. These Acts also control activities such as dredging, prospecting and drilling which, if conducted in the adjacent seascape, have the potential to impact the Atoll. Under this legislation, Princess Petroleum Ltd. holds a concession area covering most of the northern half of Turneffe Atoll and the seabed to the east.

The Port Authority is mandated to ensure the safety of navigational channels, through the installation of navigational aids (**Belize Port Authority Act,** 1976; revised, 2003) and installation and maintenance of demarcation buoys. Port Authority maintains two lighthouses at Turneffe Atoll (Dog Flea Caye to the north and Caye Bokel to the south). It also has a role in the registration of boats and monitoring of vessels using navigational channels and the removal of boats from the reef, when groundings occur.

Financial sustainability for protected area and natural resource management is partially addressed at Government level through the development of a funding mechanism to assist in

management and development activities within protected areas – the Protected Areas Conservation Trust (**PACT Act**, 1996), through a 'conservation tax' of Bz$7.50 levied on non-residents as they leave the country. This can be accessed once the Atoll has protected area status.

There is currently significant fragmentation in decision making, with these different Acts falling under different Ministries. This is being addressed through the **National Protected Areas Policy and System Plan** (NPAPSP; Figure 1), currently overseen by the National Protected Areas Secretariat, which is guided by the National Protected Areas Technical Committee (NPATC). More recently, the Policy Coordination & Planning Unit of the Ministry of Natural Resources and the Environment has been tasked to strengthen the NPATC and ensure a greater level of inter-departmental communication and coordination than has been the case to date. Under the Strengthening National Protected Area's Capacities Project, a legislative review is currently being completed, tasked with the harmonization of legislation relating to protected areas.

National Protected Area Policy Declaration

Recognizing that:

Protected areas in Belize provide irreplaceable public benefits from ecosystem services such as clean water, clean air, carbon sinks, gene pools, baseline data for research and development, all of which contribute to the local, national and regional economies,

And that:

Protected areas are an important resource base for the development and strengthening of economic activities and contribute to poverty elimination by supporting industries such as agriculture, tourism, fisheries, timber and non-timber products, research, bio-prospecting, mining, water and energy services among others:

The Government of Belize shall promote the sustainable use of Belize's protected areas by educating and encouraging resource users and the general public to properly conserve the biological diversity contained in these areas in order to maintain and enhance the quality of life for all. This shall be achieved by facilitating the participation of local communities and other stakeholders in decision making and the equitable distribution of benefits derived from them, through adequate institutional and human capacity building and collaborative research and development.

General Principles:

The Government of Belize shall:

1. ***Assure, for all Belizeans, safe, healthy, productive, aesthetically and culturally pleasing surroundings by preserving important historic, cultural, aesthetic and natural aspects of Belize's natural heritage;***

2. ***Promote the widest range of beneficial uses of biodiversity without degradation, risk to health or safety, or other undesirable and unintended consequences in order to provide for sustainable economic development;***

3. ***Achieve a balance between population and biodiversity resource use which will permit a higher standard of living and the conservation of natural resources for future generations;***

4. ***Enhance the quality of renewable resources and strive for the optimum use of non-renewable resources.***

NPAPSP, 2005

Figure 1

Site level legislation

Turneffe Atoll was declared as a Marine Reserve in 2012 under the Fisheries Act, and under the mandate of the Fisheries Department of the Ministry of Agriculture and Fisheries (Table 2) with management guided by the Fisheries Act (1948, revised 1983) and Fisheries Department policies, which allow for zoned multiple use, with conservation / no-take areas and areas open for extractive use, regulated under a zoning system embedded within a Statutory Instrument. In addition to Turneffe Atoll, there are currently thirteen marine protected areas within the National Protected Areas System. Eight of these are designated under the Fisheries Department as Marine Reserves, the remaining five being administered under Forest Department.

Table 2: Marine Reserve Legislation

Category	Legal Foundation	Purpose	Activities Permitted
Marine Reserve	Fisheries Act, 1948	To assist in the management, maintenance and sustainable yield of fisheries resources	Sustainable extraction, research, education, tourism

The Fisheries Department is responsible for management associated with the two protected spawning aggregation sites (Caye Bokel and Dog Flea Caye), located on the north east and south walls of the Atoll, are administered under Fisheries regulations), and are two of eleven legislated spawning aggregation sites considered vital for the maintenance of Belize's commercial finfish stocks, protected in Belize under a serial designation (Statutory Instrument 161 of 2003). Whilst these are created as non-extractive, they may be used for limited fishing by traditional users who are designated by Fisheries Department:

> *Area…may be used for limited fishing by traditional users who are designated by, and to the extent recommended by, the co-managers of the respective marine reserve. Fishermen and the type and quantity of fishing so designated shall be approved by the Fisheries Administrator, who shall grant Special Licenses accordingly.*
>
> *Annex 2: Statutory Instrument 161 of 2003*

A third site, Maugre Caye, regulates fishing of the Nassau Grouper spawning site, under Statutory Instrument 49 of 2009 (following repeal of SI 162 of 2003) with allowance for permits to be issued for traditional fishing of Nassau grouper at Maugre Caye. This states that:

- *No person shall take in the waters of Belize, or buy, sell or have in his possession, any Nassau grouper between the 1st December and the 31st March inclusive in any year, except for the Nassau grouper taken from the sites of Maugre Caye at Turneffe Islands and Northern Two Caye at Lighthouse Reef.*
- *No person shall take in the waters of Belize, or buy, sell or have in his possession, any Nassau grouper which is less than 20 inches in total length or greater than 30 inches in total length.*

Annex 3: Statutory Instrument 49 of 2009

A Public Reserve was declared to protect Cockroach Beach (FD, 2005; Annex 4), considered the most important American Saltwater Crocodile nesting site in the country.

Of importance is the need to incorporate the inundated mangrove systems of the lagoons as well as a caye component that provides representation of the terrestrial ecosystems of the Atoll – particularly the highly threatened littoral forest and key turtle and crocodile nesting beaches. This may, however, require private land purchase or protection under the Forest Department legislation.

1.3.2 Land and Sea Tenure

Turneffe Atoll is a matrix of national and private lands, located in Belize's territorial waters (Maritime Areas Act of 1992). The seabed is national land, and thus any construction, such as piers, marinas, and seawalls, needs to be licensed by the Lands Department. Any mining, including beach sand mining or dredging activities, and oil exploration / drilling activities, require a license from the Geology & Petroleum Department.

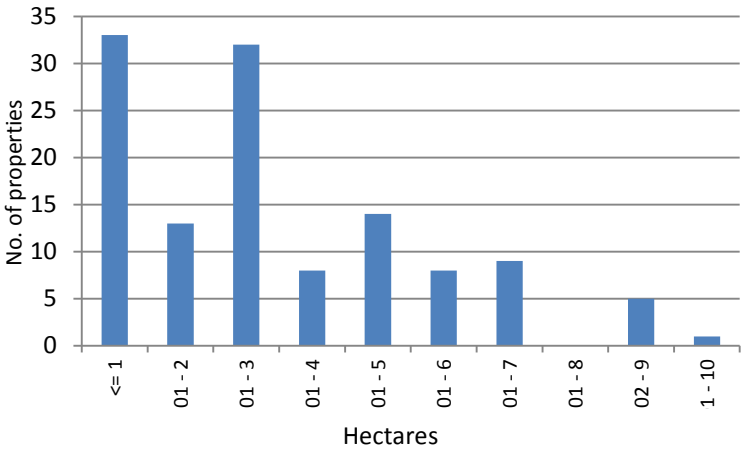


Figure 2: Frequency of leasehold / titled property sizes under 10ha on Turneffe Atoll

Approximately 190 separate parcels on the Turneffe Atoll are privately owned with an additional 19 surveyed but not yet recorded (Hayes, 2011). Many of the cayes are leased or have private ownership, though there is currently little development or on-site residence. Plots range from

0.12 to 285 ha (0.3 to 700 acres), with over 65% under 20ha, and 53% under 5ha (Figure 2; Hayes, pers. com., 2011).

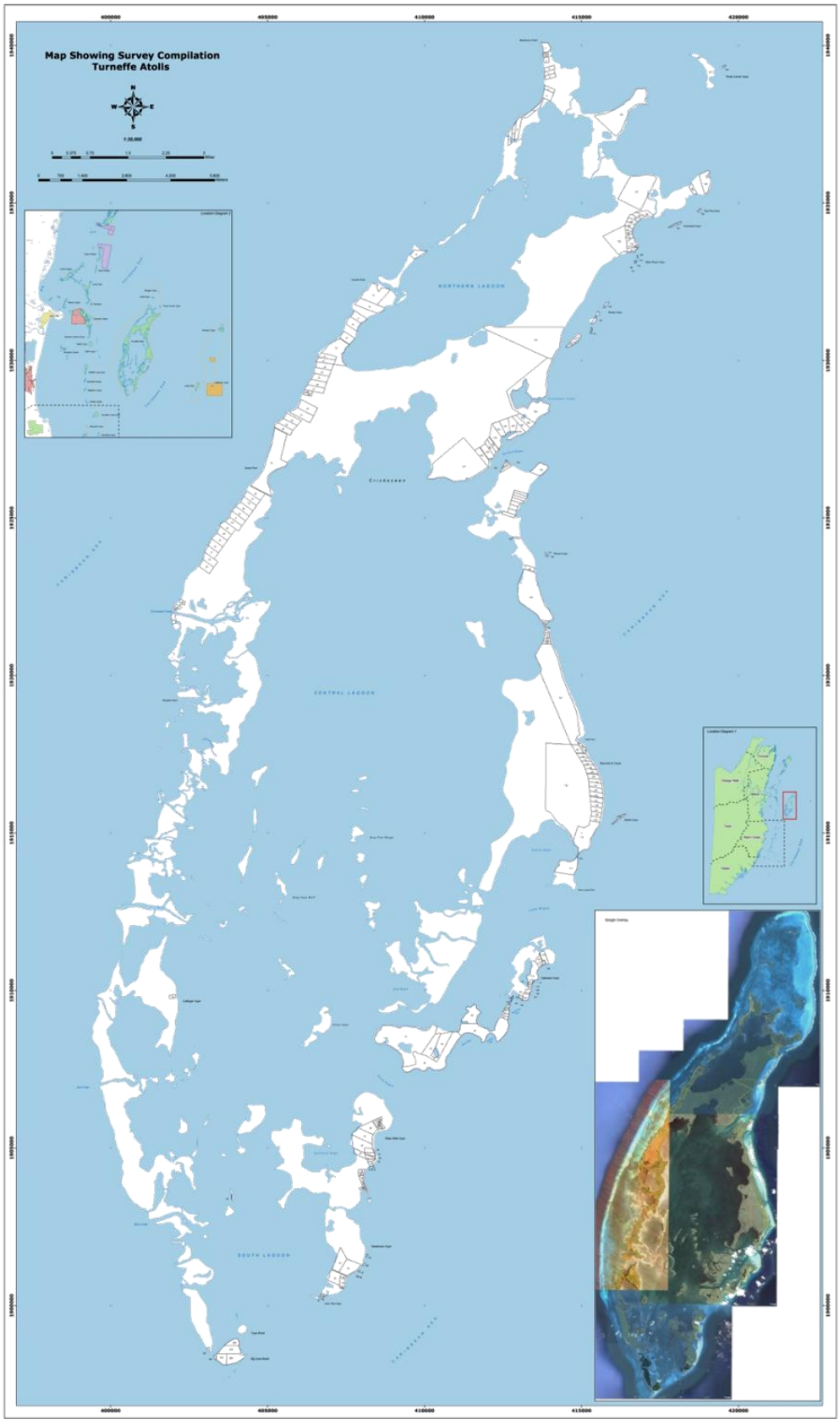
The majority of the properties lie on the eastern sea-ward side of the Atoll, with the Calabash Caye and large portions of Ropewalk Caye and Deadman's Caye now under private ownership, which encompasses the majority of the littoral forest that grows on the higher elevations along the these cayes (Map 4). Few of these are developed yet.

Six locations have been developed for tourism with total acreage of approximately 200 acres. Four to five properties have been partially or fully developed for personal use with an estimated acreage of approximately 25 acres. Several small cayes located on the Turneffe's back reef flats are privately owned, as are several areas denoted by the Turneffe Atoll Coastal Advisory Committee as being "unique and special" areas.

Two manned lighthouses are located on Turneffe Atoll and managed by the Port Authority – one on Maugre Caye to the north (ARLHS BLZ-007), the other on Caye Bokel to the south (ARLHS BLZ 001). The Belize Coastguard has a manned station on Calabash Caye.

Approximately 25 Fisherman's Camps are scattered throughout the atoll, many held as long term leases rather than owned property (Neal, 2011; Cawich, 2011). Belizean fishermen have fished the area for many years, and are considered to have traditional rights to the fishing grounds, though this is regulated to some extent by the Fisheries Act, and will be further regulated by the establishment of the Atoll as a marine protected area, with associated management zones.

Photo: Celso Cawich



Map 4: Leasehold and titled property locations (TAT, 2011)

1.3.3 Evaluation of Turneffe Atoll

Global Importance

Turneffe Atoll is the largest of three offshore Atolls lying to the east of the coastal shelf of Belize and is considered to be an integral part of Belize's reef system, and one of the best developed Atolls of the Mesoamerican Reef (MAR) region, a global ecological hotspot for marine biodiversity.

The Atoll has well-developed reefs along its entire margin, particularly at its southern end, with a complex interior lagoon matrix of numerous interconnected mangroves and seagrass beds, supporting several breeding seabird colonies (including brown booby, Neotropical cormorant, sooty tern, and magnificent frigate bird).

The waters of the Atoll provide nursery and feeding habitats for at least thirty species of international concern, recognized under the IUCN Redlist as Critically Endangered, Endangered or Vulnerable (Table 3; IUCN, 2011), including four species of critically endangered and endangered marine turtles. The wider Turneffe area, with its deep water passages, provides an important habitat for pelagic species such as marlin, sailfish, mackerel, jacks, kingfish and shark. The reefs of the Atoll also provide important habitat for Critically Endangered staghorn and elkhorn corals, the endemic white spotted toadfish (*Sanopus astrifer*), and the sandy beaches and brackish lagoons provide some of the best

Turneffe Atoll Species of International Concern	
Critically Endangered	
Staghorn Coral	*Acropora cervicornis*
Elkhorn Coral	*Acropora palmata*
Goliath Grouper	*Epinephelus itajara*
Hawksbill Turtle	*Eretmochelys imbricata*
Leatherback Turtle	*Dermochelys coriacea*
Endangered	
Lamarck's Sheet Coral	*Agaricia lamarcki*
Loggerhead Turtle	*Caretta caretta*
Green Turtle	*Chelonia mydas*
Pillar Coral	*Dendrogyra cylindrus*
Elliptical Star Coral	*Dichocoenia stokesii*
Nassau Grouper	*Epinephelus striatus*
Fire Coral	*Millepora striata*
Star Coral	*Montastraea annularis*
Star Coral	*Montastraea faveolata*
Montastraea coral	*Montastraea franksi*
Rough Cactus Coral	*Mycetophyllia ferox*
Great Hammerhead	*Sphyrna mokarran*
Scalloped Hammerhead	*Sphyrna lewini*
Vulnerable	
Queen Triggerfish	*Balistes vetula*
West Indian Manatee	*Trichechus manatus*
Marbled Grouper	*Dermatolepis inermis*
White Grouper	*Epinephelus flavolimbatus*
Snowy Grouper	*Epinephelus niveatus*
Hogfish	*Lachnolaimus maximus*
Mutton Snapper	*Lutjanus analis*
Cubera Snapper	*Lutjanus cyanopterus*
Yellowmouth Grouper	*Myctoperca interstitialis*
Whale Shark	*Rhincodon typus*
Whitelined Toadfish	*Sanopus greenfieldorum*
Rainbow Parrotfish	*Scarus guacamaia*

Table 3: Species of International Concern of Turneffe Atoll

remaining nesting and adult habitat for American saltwater crocodiles in the Caribbean (Kramer et al., 2002).

The spawning aggregation sites are important replenishment sources for commercial species throughout the region – particularly for snapper and grouper.

National Importance

The combination of the extensive terrestrial and mangrove vegetation of the offshore Atoll, its close connectivity to the productive coral reefs and seagrass beds of the central lagoon, and limited anthropogenic impacts, makes this area unique within the Belize reef system. The Atoll provides a number of environmental services, supporting livelihoods and protecting lives (Table 4).

The location of the Atoll and the integrity of its reef crest, cayes and mangroves provide protection from storm events along the coast of Belize (including Belize City) (Fedler, 2011). The presence and location of the Atoll also breaks the force of wave action, providing a sheltering buffer to the barrier reef from St. George's Caye down to Emily Caye (Caye Glory), resulting in the relatively intact nature of the reef crest in this stretch of the barrier reef.

Five spawning aggregation sites have been identified on the east facing walls and south point of Turneffe Atoll, essential for the viability of the endangered Nassau grouper and several other species of national, commercial importance - including grouper and snapper - as well as permit, a species that is critical for the success of the Atoll as a sport fishing destination (Fisher consultations, 2011; Heyman et. al., 2003; Graham et al., 2004). The seagrass and mangroves of the Atoll lagoons provide a protected nursery area for many juvenile commercial fish species, as well as habitat for lobster and conch – the backbone of Belize's capture fishery.

The expansive back reef flats, reportedly amongst the best in the world (Pritchett, 2008), provide habitat for species such as permit and bonefish, whilst tarpon are found in the deeper channels, supporting a flourishing, world-renowned and lucrative sport fishing industry that brings US$21.4 million of direct income into Belize each year (Fedler et al., 2008).

The rich variety of coral reef habitats provides both commercial fishing and touristic benefits. A recent evaluation of the reef system demonstrated the economic value of Belize's reef and mangrove to the country (Cooper et. al, 2008). Based on the coastal protection provided by the barrier reef and mangroves, the support of the fisheries industry and the contribution towards providing a tourism resource, the overall value of the reef and mangroves in Belize was estimated at Bz$790 – $1,118 million a year (US$395 - $559 million a year). Reefs and mangroves also protect coastal properties from erosion and wave-induced damage, providing

Table 4: Ecosystem Services of Turneffe Atoll	
Regulation	▪ Protection of the coastline from storm surges and waves through the presence of the Atoll ▪ Protection of the Barrier Reef from oceanic waves, promoting the growth of and maintaining the structural integrity of the Belize Barrier Reef ▪ The reefs of the Atoll provide coral, a major component in the formation of beaches and cayes ▪ The prop roots of red mangroves protect the cayes from erosion ▪ Seagrass plays an important role in stabilizing the substrate and settling turbidity in the water
Recruitment	▪ The coral reefs provide structure to ensure that there are viable populations of commercial species for subsistence and commercial fishing ▪ Mangrove and seagrass provide important nursery areas for both commercial and non-commercial species ▪ Cockroach caye supports nursery and nesting areas for American crocodiles ▪ Sand beaches provide nesting areas for marine turtles ▪ At least five spawning aggregation sites lie on the east-facing Atoll wall, important for recruitment of many commercial species (especially grouper and snapper)
Cultural and Socio-Economic	▪ The Atoll has been an important, traditional commercial fishing ground for the Belize capture fisheries industry ▪ Coral reefs are important resources for tourism and recreation – the reef drop-off supports some of the best dive sites in Belize ▪ The flats support some of the best sport fish species habitat, with an associated sport fishing industry ▪ Aesthetic appreciation of the scenic beauty
Support	▪ Coral reefs, seagrass and mangroves play an important role in the cycling of nutrients ▪ Coral reefs, seagrass beds and mangroves within the Atoll provide ecosystems necessary for different life stages of commercial and non-commercial species ▪ Coral reefs are among the most productive habitats, producing 2,000 decagrams of carbon per square meter per year ▪ Seagrass is effective as a CO_2 sink
	▪ Mangroves provide nesting structure for several bird nesting colonies, as well as the osprey, an important top predator ▪ Littoral forest provides important stop-over habitat for migratory bird species
Adapted from UNEP-WCMC, 2006	

an estimated US$231 to US$347 million in avoided damages per year. The protective annual value of Turneffe has been estimated at US$38.3 million, based on the damages avoided from tropical storms though the presence of coral reef and mangrove (Fedler, 2011), though may well be higher, based on its location directly in front of Belize City.

In total, reef- and mangrove-associated fisheries have an estimated direct economic impact of US$14 to $16 million per year. An estimated 1.2 million pounds of fish were sold to Belize's Fishermen's Co-ops in 2007, of which over 80% was exported, earning US$11.2 million in gross revenue. In addition, Co-ops earned an estimated US$1 million in local sales (Figure 2; Cooper et. al., 2008). Fishermen also sell their catch to local markets and restaurants, and distribute it to family and friends, estimated to contribute an additional US$1.9 to $3.5 million per year to the economy. As one of the largest fishing areas within Belize, Turneffe Atoll has the potential to play an important role in management of fisheries resources.

Also of economic importance is the provision of a tourism resource, contributing directly to Belize's economy - coral reef and mangrove-associated tourism contributed an estimated US$150 million to $196 million to the national economy in 2007 (12 percent to 15 percent of GDP). Tourism in Belize is heavily dependent on the coral reef, with its first class diving sites, bringing an estimated average of US$150 per day per visitor whilst in Belize (Cooper et. al, 2008).

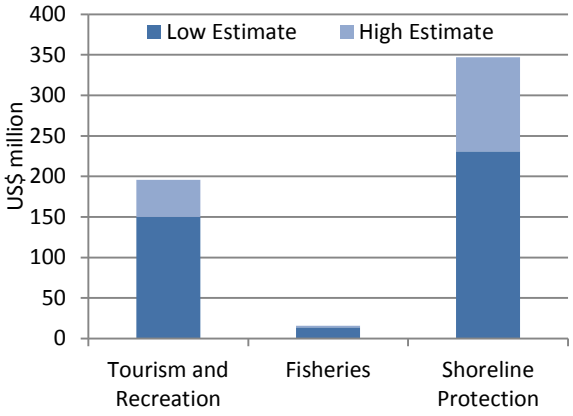


Figure 2: Annual Economic Contribution of Coral Reefs and Mangroves in Belize (From: Cooper, E., L. Burke and N. Bood. 2008)

1.3.4 Socio-Economic Context

Belize has a low population currently estimated at approximately 307,900 (Figure 3; CIA, 2010), of which 51.2% are urban dwellers (UN data, 2007). Population densities are low, with just over 13.1 persons per sq. km., concentrated primarily within the northern plain, southern coastal plain, Belize Valley and Stann Creek Valley, with much of the remaining country being less suited to habitation, with swampy lowlands and steep terrain in the Maya Mountains. It is a country of many ethnic cultures, with Mestizo, Creole, Maya and Garifuna being the major population groups (Figure 4). The Maya occupants of Belize, descendants of the original Central American civilization, at its height approximately 2,000 years ago, form three distinct ethnic groups – the Yucatec Maya of the north, the Mopan Maya of the west and south, and the Ketchi of the southern regions. In general, the northern coastal fishing communities are based on the Mestizo culture, being settled in the 1850s by refugees from the Mexican Caste War. Communities in central Belize, particularly those of the Belize River Valley, are predominantly Creole, founded on the descendents of slaves brought to Belize direct from Africa, or via the West Indies, to work in the logging industry in the late 1700 / early 1800s. The southern coastal communities are more Garifuna based (descendents of Black African / Carib Indian), being settled by refugees who sailed to Belize from St. Vincent in the West Indies.

Belize Demographic Statistics (Average)	
Population (2010 est.)	307,899
Population density (2008 est)	13.1/sq. km.
Annual growth rate (2010)	2.2%
Birth rate (2010 est.)	27.3 per 1000
Mortality rate (2010 est.)	5.8 per 1000
Fertility rate (2010)	3.3 children per woman
Life expectancy (2010)	78 (female); 74 (male)
Below Poverty level	33.5% (2002) 43% (2010)
Literacy rate (2010)	76.9%
Unemployment rate (2008)	8.2%
GDP (2008)	Bz$2.75 billion
GDP (per capita, 2008)	Bz$9,138 per capita
Ref: UN data, 2010 CIA Factbook, 2010 Ministry of Health CSO, Mid-term 2004 CSO, Poverty Assessment Report, 2002	

Figure 3: Belize Demographic Statistics

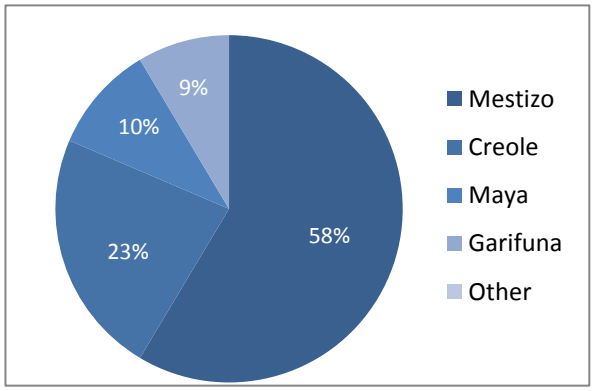


Figure 4: Belize Demographic Statistics

In the last 25 years, there has been a shift in the cultural demographic, with a significant influx of Central American refugees – primarily from Guatemala and Honduras –an estimated 20% of heads of households are born outside of Belize (2010 Poverty Assessment data). There is also an ongoing emigration of Belizeans to the United States – generally those from urban areas who have completed secondary school or have professional training.

The economy of Belize has, in the past, been based largely on agriculture, with fisheries, banana, sugar and citrus forming some of the traditional exports that contribute significantly towards

the GDP. This has recently been exceeded by revenue from oil extraction, and there is an increasing reliance on the established and growing tourism industry, which is rapidly becoming the major foreign exchange earner.

State of the Fisheries Sector in Belize

The fishing sector utilizing Turneffe Atoll is part of a traditional industry that provides employment for over 2,750 fishers (Ministry of Agriculture and Fisheries, 2010). The majority of the Turneffe fishermen originate from Belize City and the northern coastal communities of Sarteneja, Copper Bank and Chunox. Fishing techniques vary, with the Belize City fishermen based from semi-permanent fishing camps on the Atoll, setting traps for lobster and using hand lines for finfish. Those considered traditional fishers of the Maugre spawning aggregation site are also permitted to use handlines at the site during the spawning season. Fishermen from the northern communities focus more on lobster and conch, and fish these more intensively during the open seasons throughout the shallow protected lagoon of the Atoll. Fishermen tend to be between 15 and 35 years of age, often with limited education. Alternative job opportunities in many of these coastal communities, particularly those of the north, are limited, with many fishermen leaving primary school to go directly into fishing (FAO, 2005; SACD, 2009).

State of National Capture Fisheries (2007)

In 2007, overall fisheries production volume decreased by 6.0% from 570.4 tonnes (1,254,861.5 lbs) in 2006 to 534.6 tonnes (1,176,033.7 lbs) in 2007. The overall monetary value of the exports of the capture fishery commodities amounted to Bz$22,700,000. (SIB and Belize Fisheries Department 2008).

Lobster tail production volume increased by 10% from 190 tonnes (419,863 lbs) in 2006 to 210 tonnes (462,152.3lbs) in 2007. The increase in production volume of lobster tails also produced an increase in lobster head meat production volume, from 17.2 tonnes (37,835 pounds) in 2006 to 18.8 tonnes (41,294 lbs) - equivalent to 9.14% in weight - with an export value of $98,480 in 2007.

Conch production volume decreased by almost 17% from 314.7 tonnes (692,302.5 lbs) in 2006 to 261.3 tonnes (574,756.1 lbs) in 2007 with an export value amounting to $5,389,117.

Fish fillet, lobster head meat and whole fish showed an increase in production volume of 37.91 % (from 20 tonnes in 2006 to 27 tonnes in 2007), 9.14% (17 tonnes in 2006 to 19 tonnes in 2007) and 4.64% (4 tonnes in 2006 to 4.3 tonnes in 2007), respectively.

The Fisheries Sector (including aquaculture) ranked 4th in its contribution to the national GDP, in 2008, though the actual percentage contribution had declined from 23% in 2006 to 1.5%, as petroleum exports and tourism sectors continue to grow. Fisheries products are composed of two major components – capture fisheries (predominantly lobster, conch and finfish – representing approximately 45%), and aquaculture (shrimp and tilapia – 55%), primarily for the export market (Ministry of Agriculture and Fisheries, 2010). Capture fisheries export earnings totaled approximately Bz$20.5 million dollars in 2008, primarily from the traditional lobster and conch capture fisheries (Ministry of Agriculture and Fisheries, 2008). The primary exploited

capture fisheries species, lobster and conch, have both declined since the early 1980s, when the industry was at its peak. It is estimated that 80% of the lobster and conch is exported through the four fishing cooperatives, and the remaining 20% is sold for local consumption (Cooper et al., 2008), with the majority of the finfish being marketed locally. Turneffe Atoll is of economic importance as a lobster, conch and finfish resource for traditional fishermen from mainland fishing communities - particularly Belize City, Sarteneja, Chunox and Copper Bank. Based on 2009 data from the fishing cooperatives, Turneffe Atoll contributes 5% of conch and lobster product towards total national cooperative sales, with additional markets outside the cooperatives and an estimated value of US$518,400. It is also estimated that the finfish catch may be in the region of 100,000lbs, with an estimated value of US$200,000, though these figures are not confirmed (Fedler, 2011).

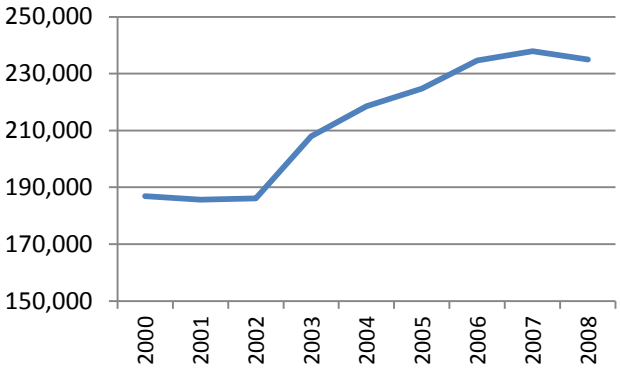


Figure 5: Belize International tourism arrivals (2000 – 2008) (BTB, 2009)

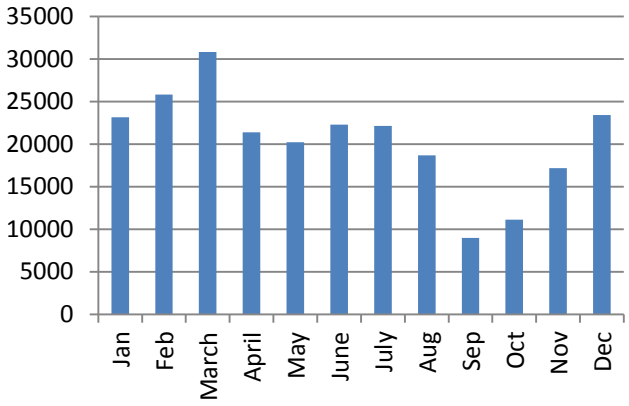


Figure 6: Belize International tourism arrivals per month (BTB, 2009)

State of Tourism in Belize

The growing tourism industry, one of the fastest growing sectors in Belize, is also rapidly becoming one of the major foreign exchange earners. Tourism is the third ranking productive sector in Belize, with 1,035,577 visitors reported for 2010 (Figure 6; BTB, 2011), contributing Bz$952.9mn to GDP. Projections suggest that this will increase to 34.2% in 2021. The tourism sector provided an estimated 39,000 jobs in 2010, 31% of total national employment. This is predicted to increase to 61,000 jobs, 36% of total employment by 2021 (WTTC, 2011).

Overnight tourism in Belize shows a distinct seasonality, with the majority of visitors arriving in the first quarter of the

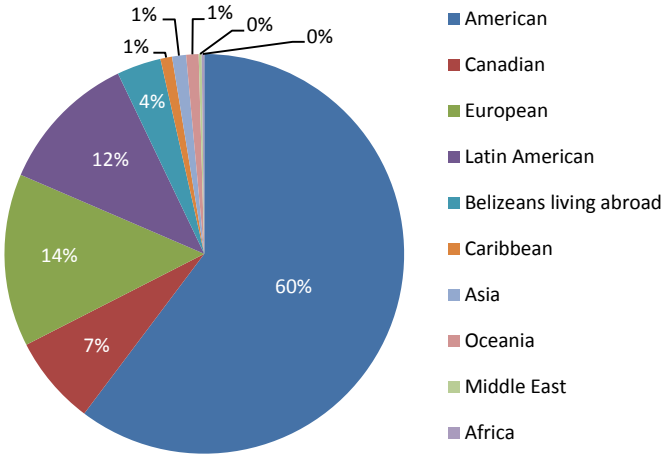


Figure 7: Belize International tourism arrivals by origin (2008) (BTB, 2009)

year (Figure 6), originating from the United States (Figure 7). The lowest months are September and October, the main tropical storm season. 2010 statistics show that the cruise ship visitors far outnumber overnight visitors, with 74% (764,628 visitors) arriving by cruise ship. However this sector provides less income for the country – it is estimated that the average cruise passenger inputs $44 per day into the local economy, while the average overnight visitor spends $96 per day - more than twice as much. Per visit, stay-over visitors spend on average 6.8 days in Belize, translating into an average of $653, or over 14 times more than the average cruise passenger (BTB, 2009).

Despite only a small percentage (just over 4.7%) of annual non-cruise visitors including Turneffe in their itinerary, the Atoll is estimated to have a tourism value of approximately US$23.5 million per year based on direct expenditures through tourism, generating a little over twice the daily income than the national average of $150. An additional US$3.4 million in taxes and service charges to Government are also generated from Turneffe Atoll associated tourism (Fedler, 2011).

Direct Economic Contribution of Turneffe Atoll

A site-specific valuation of Turneffe's socio-economic contribution to Belize was conducted in 2011 (Fedler, 2011), based on a series of previous studies (Fedler et al., 2008; Cooper et al., 2008), and provided information on the economic impact of tourism activities and the commercial fisheries at Turneffe, both in direct income and in terms of supporting livelihoods. It also looked at the shoreline protection values provided by the Atoll.

The results demonstrated that, based on 2007 / 2010 figures (Cooper et al. 2009; Fedler et al., 2008; Fedler, 2011), the annual economic benefit of Turneffe Atoll to Belize is estimated at US$62.4, with the majority of this contributed by the protection afforded to the coastline from tropical storms (US$38.3 million) and direct benefit from tourism expenditures in-country estimated at US$23.5. Fisheries, whilst providing a relatively small contribution (0.8%) to the value of Turneffe Atoll (Figure 8) is perhaps the sector with the largest social dependence, supporting an estimated 180 to 200 fishermen, their families and to some extent, their communities, with few viable alternative options available if the Turneffe fishery continues to decline.

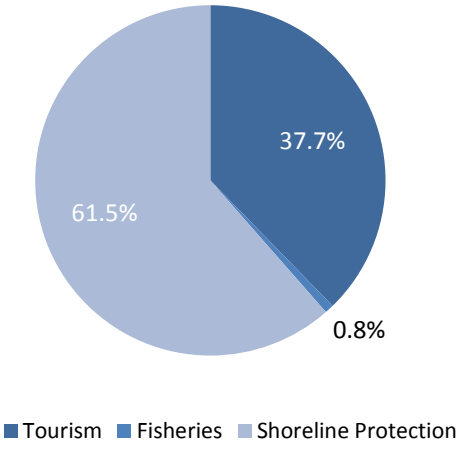


Figure 8: Relative contribution of direct Turneffe benefits to the Belize Economy (Fedler, 2011)

Stakeholder Communities

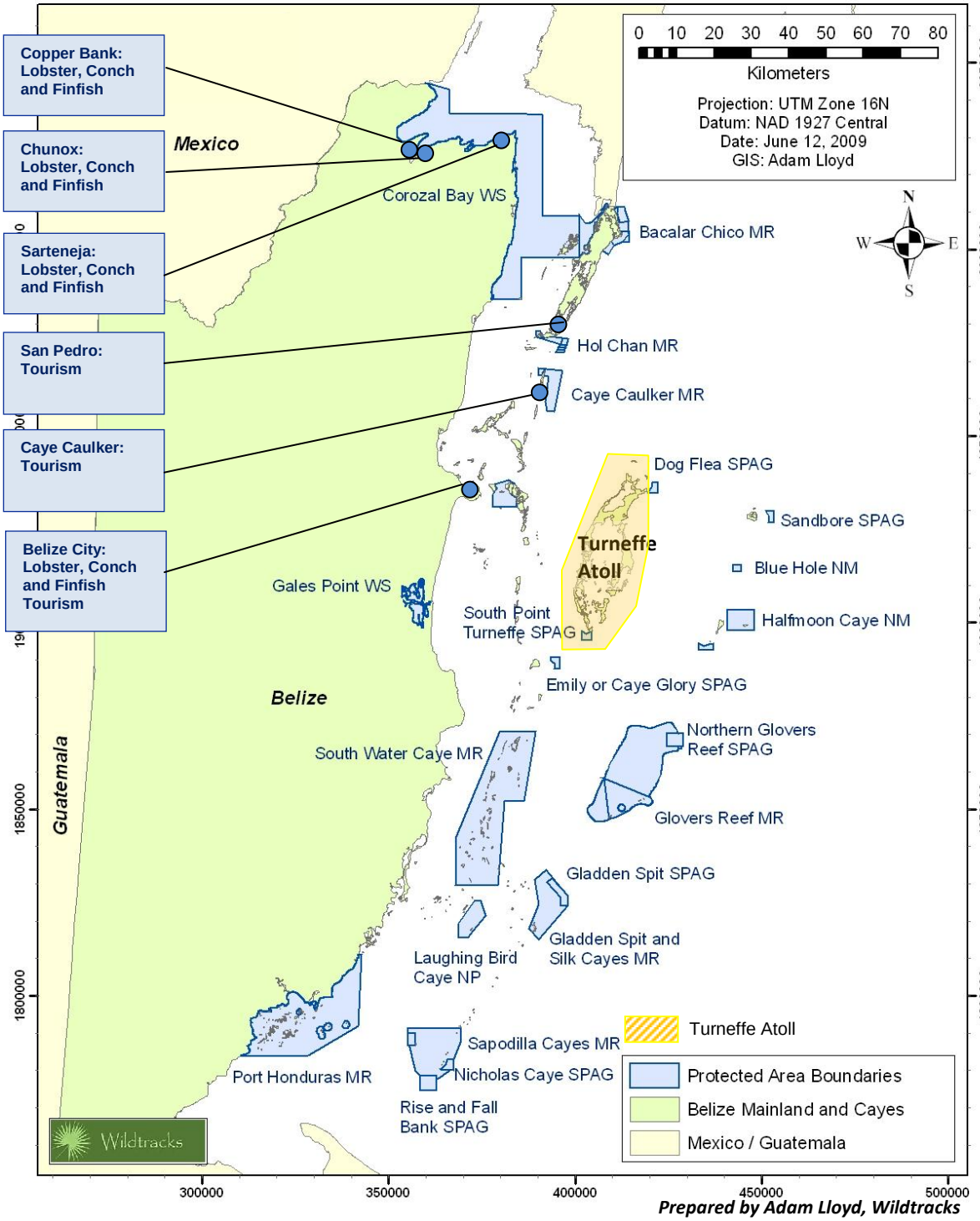
Six communities on the Belize mainland have been identified as key stakeholders in the Atoll area, directly through tourism and/or commercial fishing (Table 5; Map 5). Whilst there is no community established on the Atoll itself, there are three all-inclusive resorts operating either seasonally or throughout the year within Turneffe, with residential staff dependent on the overnight tourism visitation to the Atoll. A basic stakeholder analysis identifies their respective interests and impacts (Tables 6 and 7).

Local staff employment at the tourism resorts is significant (Hayes, pers. com.), employees originating from a wide range of communities across Belize that, whilst not being considered key stakeholder communities, do benefit from the presence of employment opportunities at Turneffe.

Table 5: Stakeholder Communities of Turneffe Atoll

Community	Location (UTM) Distance (km)	Population (approx.)	Population components	Comments
Belize City	E16 372776 N19 34773 (32km)	53,532	Mixed	Fishermen access Turneffe by skiff, some based from fishing camps on the cayes, others crossing for a single day. Predominantly lobster traps and line fishing Tour operators take day visitors to dive, snorkel or fish at the Atoll.
Sarteneja	E16 0378750 N18 20295 (55.8 km)	2,300	Mestizo	Northern fishing community, free dive for lobster and conch throughout Belize waters using traditional sail boats. The majority of boats using Turneffe Atoll do so either exclusively, or as part of the Turneffe /Lighthouse fishing area. Product is taken from Turneffe primarily to Belize City cooperatives. Boats are moored in Belize City between trips in the lobster / conch season.
Copper Bank	E16 0356500 N18 20235 (60 km)	1,400	Mestizo	
Chunox	E16 0356700 N18 20260 (60 km)	525	Mestizo	
San Pedro	E16 396813 N19 80140 (38 km)	11,510	Mestizo	Tourism based economy utilizing the Atoll for its diving, snorkeling, fishing and scenic values, accessing by boat for day visits.
Caye Caulker	E16 391199 N19 61736 (28.5 km)	1,800	Mestizo	

Primary Stakeholder Communities of Turneffe Atoll



Map 5: Principal Stakeholder Communities of Turneffe Atoll

Stakeholder	Role
Fisheries Department	Regulates both fishery and spawning aggregation sites towards maximum sustainable yield. Responsible for enforcement of Fisheries legislation
Forest Department	Responsible for enforcement of mangrove legislation and protection of West Indian manatee / American crocodile
Department of the Environment	Responsible for regulation of development activities on the cayes of the Atoll, and the EIA process
Geology and Petroleum Department	Responsible for regulation of dredging and oil exploration / extraction activities
Belize Tourism Board	Uses protected areas – especially marine – to showcase Belize's natural resources. Encourage visitation
Traditional Fishermen	Have livelihoods based on the marine resources of the area – lobster, conch and finfish.
Fishing Cooperatives	Encourage increased catch
Caye Developers	Clear terrestrial ecosystems to build on Turneffe. Often take short cuts that impact the environment…including dredging, seawalls, over-water constructions
Tourism Lodges	Provide local employment and training in the tourism industry, follow tourism best practices to variable degrees and provide a venue for environmentally sound interpretation activities for visitors. Clearance of / maintenance of cleared terrestrial ecosystems for infrastructure
Tour Guides	Provide interpretation for tourists, and guide visitor behaviour on the reef and for sport fishing activities
Dive operators	Based from Turneffe, Belize City, San Pedro and Caye Caulker. Carry groups to dive, particularly at the Elbow and up the eastern wall. Guide visitor behaviour on the reef
Researchers	University of Belize, Oceanic Society. Provide information on biodiversity and physical parameters for guiding management. Provide long term monitoring data. Clearance of / maintenance of cleared terrestrial ecosystems for infrastructure
Students	Belize and international students learn from field courses based on Turneffe. Participate in field research.
Conservation organizations	Lobby for protection of the Atoll, provide technical input and funding

Table 6: Key Stakeholders of Turneffe Atoll

Table 7: Stakeholder Analysis for Turneffe Atoll				
Stakeholder	**Influence or Impact of Turneffe Atoll on Stakeholder**		**Influence or Impact of Stakeholder on Turneffe Atoll**	
Commercial Fishermen Belize City Sarteneja Chunox Copper Bank	▪ Production of marine products supporting traditional fisheries industry ▪ Presence of reef and spawning aggregation site for support of local fisheries industry ▪ Potential to conserve marine resources in perpetuity for continued use by future generations ▪ Potential of exclusion from some traditional fishing areas	+ + + -	▪ Some support for effective management of proposed protected area ▪ Low level of cooperation or openly antagonistic towards concept of protected areas (Sarteneja) ▪ Unsustainable fishing ▪ Fishing impacts within proposed protected areas (including damage to coral) ▪ Anchor damage to reef ▪ Clearance of littoral forest for fishing camps ▪ Harvesting of forest products for traps and construction ▪ Poor solid waste management	+ - - - - - - -
Tourism Developments on Turneffe Atoll	▪ Presence of reef, largely intact terrestrial ecosystems and high-value sport fishing resources attract tourism ▪ Relatively pristine, wild environment ▪ Limited development provides 'exclusivity' attraction for high end tourism ▪ Unique back reef flats habitats provides world-class sport fishing opportunities ▪ Several World class diving sites ▪ Distance from mainland, deep waters surrounding the Atoll and prevalent currents help maintain high water quality and clarity ▪ Environmental qualities of Turneffe Atoll provide an environment for employment opportunities in tourism	+ + + + + +	▪ Generally support the conservation management goals of Turneffe Atoll ▪ Generally cooperate and collaborate towards effective management of the area ▪ Provide a potential financial sustainability mechanism for future management of the Atoll ▪ Potential for negative impacts on environment - clearance of littoral forest and nesting beaches, dredging for access and landfill ▪ Potential for introduction of invasive species (rats / South East Asian house geckos) in building materials and other transported goods ▪ Potential for contamination of ground water and adjacent sea if sewage is not adequately addressed ▪ Potential for increased solid waste if solid waste management is not adequately addressed ▪ Potential for ground water depletion through un-sustainable extraction ▪ Potential to exceed 'Limits of Acceptable Change' through poorly regulated levels of visitation	+ + + - - - - - -

Table 7: Stakeholder Analysis for Turneffe Atoll				
Stakeholder	**Influence or Impact of Turneffe Atoll on Stakeholder**		**Influence or Impact of Stakeholder on Turneffe Atoll**	
Non-tourism Development on Turneffe Atoll	▪ Relatively pristine, wild environment ▪ High value real-estate investment potential ▪ Limited development provides 'exclusivity' attraction for high end market	+ + +	▪ Generally support the conservation management goals of Turneffe Atoll ▪ Cooperation and collaboration towards effective management of the area ▪ Potential for negative impacts on environment - clearance of littoral forest and nesting beaches, dredging for access and landfill ▪ Potential for introduction of invasive species (rats / South East Asian house geckos) in building materials and other transported goods ▪ Potential for contamination of ground water and adjacent sea if sewage is not adequately addressed ▪ Potential for increased solid waste if solid waste management is not adequately addressed	+ + - - - -
Tourism Stakeholders (Diving / Snorkeling) Belize City San Pedro Turneffe Atoll resorts	▪ Presence of reef, spawning aggregation sites and high-value sport fishing resources for tourism and fisheries industries ▪ Income from using Turneffe Atoll for tourism	+ +	▪ Support the conservation management goals of Turneffe Atoll ▪ Cooperation and collaboration towards effective management of the area ▪ Adoption of reef tourism Best Practices through awareness and alternative livelihood training ▪ Provide a potential financial sustainability mechanism for future management of the Atoll ▪ If well trained, assist with visitor management within the area through in-depth briefings ▪ If poorly trained, can result in poor visitor management and increased impact on corals and associated fauna, anchor damage etc. ▪ Potential to impact behaviour of fish through feeding and other unsustainable tourism practices ▪ Increase the potential for exceeding the carrying capacity ▪ Increased anchor and boat damage to coral and seagrass	+ + + + + - - - -

Table 7: Stakeholder Analysis for Turneffe Atoll				
Stakeholder	**Influence or Impact of Turneffe Atoll on Stakeholder**		**Influence or Impact of Stakeholder on Turneffe Atoll**	
General Belize Public	▪ Production of fish, lobster and conch ▪ Maintenance of spawning aggregation and commercial fish species ▪ Protection of Belize City from storm surges ▪ Cultural and aesthetic appreciation ▪ Increased awareness through education	+ + + + +	▪ Support of the general public will strengthen the position for designation as a marine managed area ▪ Lack of support may decrease chances for designation as a marine managed area ▪ Clearance of riverine vegetation in watershed will increase sediment load reaching the reef ▪ Poor agricultural practices in watershed will increase agrochemical contamination of water and reef fish	+ - - -
Tourists	▪ Enjoy Turneffe Atoll as a tourism destination ▪ Benefit from education and awareness opportunities provided by Turneffe	+ +	▪ Potential for entrance fee to contribute towards financial sustainability ▪ Provide marketing nationally and internationally by word of mouth, if happy with level of tourism product ▪ Presence deters illegal fishing practices within the Atoll ▪ Potential to increase impact on natural values of Turneffe through poor tourism practices ▪ Potential to exceed carrying capacity for tourism sites at Turneffe	+ + + - -
Researchers	▪ Benefit from being based at Turneffe Atoll, at established facilities with access to a virtually pristine reef environment ▪ Benefit from historic baseline information on past research activities within protected areas	+ +	▪ Conservation management benefits from data gathered, greater knowledge of marine and terrestrial environments and species within area ▪ Benefit from increased research activity within area ▪ Potential impact of research activities on marine environments	+ + -
Government of Belize	▪ Provides fisheries source for fishing Industry ▪ Provides environmental services ▪ Potential for Turneffe Atoll to be integrated within the National Protected Areas System – would assist in fulfilling Belize Government's commitment to the conservation of natural resources, CCAD, CBD, MBRS ▪ Income generation of significant foreign revenue ▪ Provides employment opportunities in stakeholder communities	+ + + + +	▪ Political support (currently being strengthened through the NPAPSP) ▪ Lack of political support ▪ Uncertainty of long term future commitment	+ - -

1.4 Physical Environment of Management Area

1.4.1 Climate

Temperature and Rainfall

Climate data is available from Turneffe Flats, providing a baseline for the year 2010 (Hayes, 2011). Previous data (air temperature, minimum and maximum temperatures, and cumulative rainfall) was recorded daily at the Calabash Caye Marine Research Centre Field Station in the 1990's under the Caribbean Coastal Marine Productivity Programme (CARICOMP), but is no longer accessible (Garcia et al.; 1998; Cho-Ricketts, pers. com., 2011).

Turneffe Atoll lies within the lowest rainfall belt, with between 100 and 150cm of rain per year (Figure 9). Rainfall varies throughout the year - there is a pronounced dry season stretching from January through to the end of May, with a total rainfall of 8cm in March, the driest month. This is followed by a wetter season (June to December) with total rainfalls in the region of 200 to 230cm, punctuated by a mini dry season in August / September. The majority of the rain falls within the hurricane season, associated with passing tropical storms, particularly between October and November.

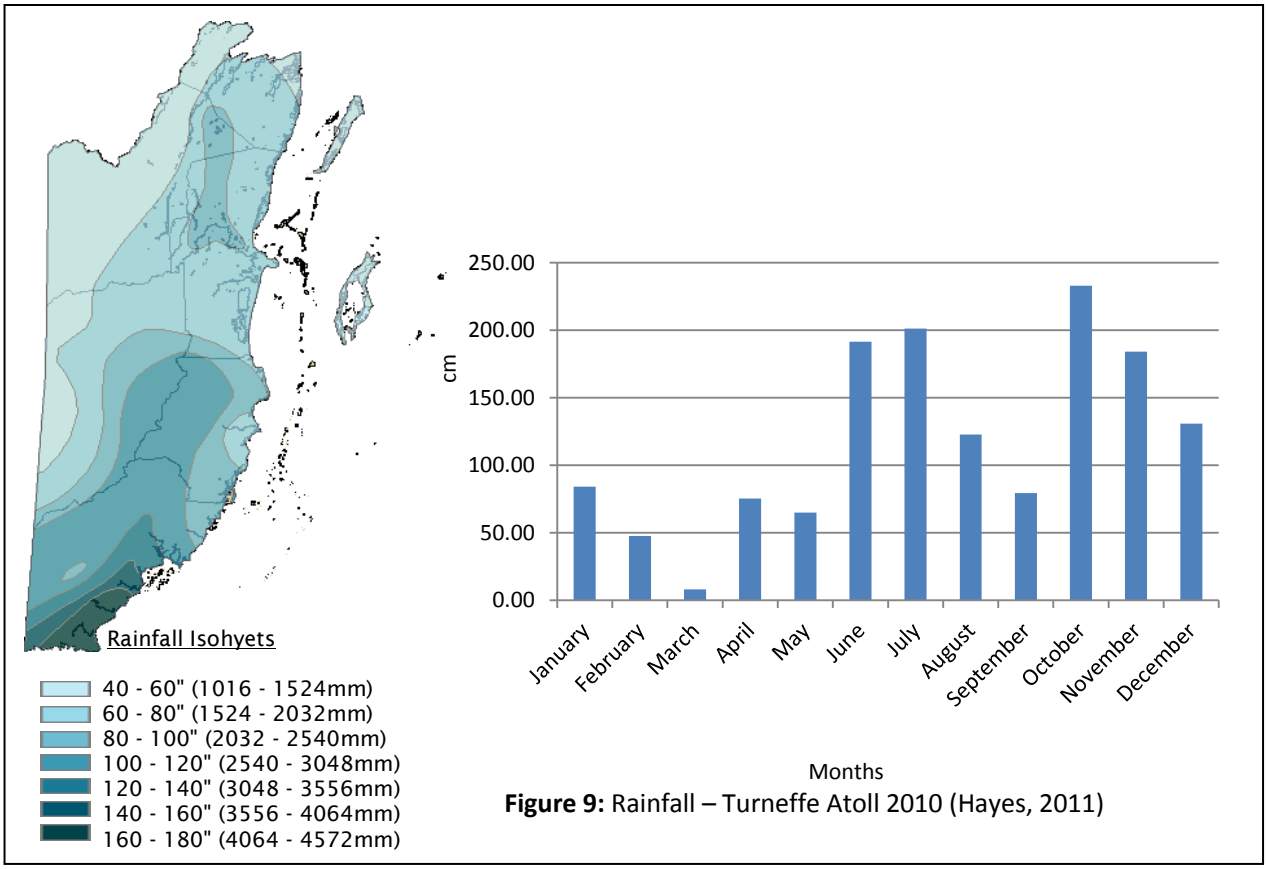


Figure 9: Rainfall – Turneffe Atoll 2010 (Hayes, 2011)

When compared with historical data for Carrie Bow Caye, further south, there has been a shift in seasonality, with the dry season extending into May, and the mini-dry, which was traditionally in August, now extending into September.

The annual mean temperature on Turneffe Atoll for 2010 is 27.2°C, fluctuating throughout the year from a minimum of 24.4°C in December, during the cold fronts, and maximums in June and August of 29.3°C (Table 8; Hayes, 2011).

Month	Mean Temperature 2010	Total Rainfall (mm) 2010
January	25.00	84.1
February	25.33	47.8
March	25.39	8.1
April	27.72	75.4
May	28.56	65.0
June	29.39	191.5
July	28.83	201.2
August	29.39	122.7
September	29.33	79.5
October	27.39	232.9
November	26.39	184.2
December	24.39	130.8

Table 8: Mean Temperature and Total Rainfall per month - Turneffe Atoll 2010 (Hayes, 2011)

Weather Systems: Belize is affected by three very distinct seasonal weather systems: trade winds, northers and tropical storms. All three have an influence on the rainfall and temperature patterns, on the sea level, and on the currents around Turneffe Atoll. The predominant winds are the ***Trade Winds***, blowing from the east and north-east from April to October, interspersed by tropical storms. ***Northers*** - high-pressure fronts moving down from the north - occur between October and April, bringing cooler weather.

Tropical storms affect Belize every year between the beginning of June and end of November, with the effects being felt particularly strongly on the outlying cayes and atolls. Originating in the Atlantic Ocean over warm, tropical waters, these storms are non-frontal, developing highly organized circulations, and ranging in scale from tropical depressions and tropical storms (with sustained wind speed < 74 mph) to hurricanes (with sustained wind speed > 74 mph). These storms move westward towards the Caribbean and Central American coastline, gathering strength until they hit land.

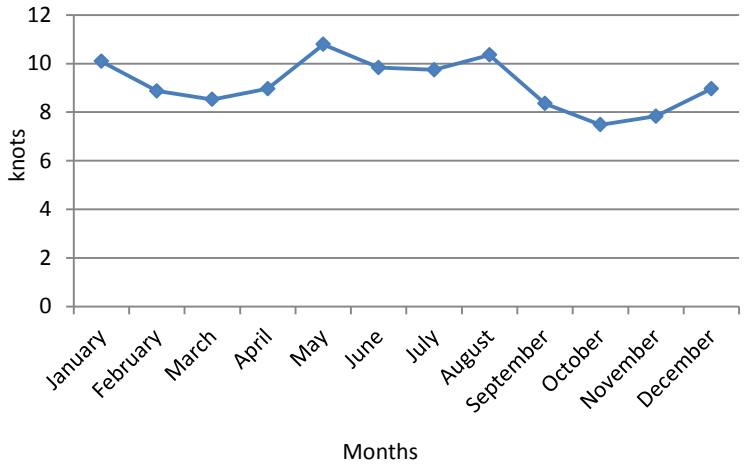


Figure 10: Wind Speed (knots) – Turneffe Atoll 2010 (Hayes, 2011)

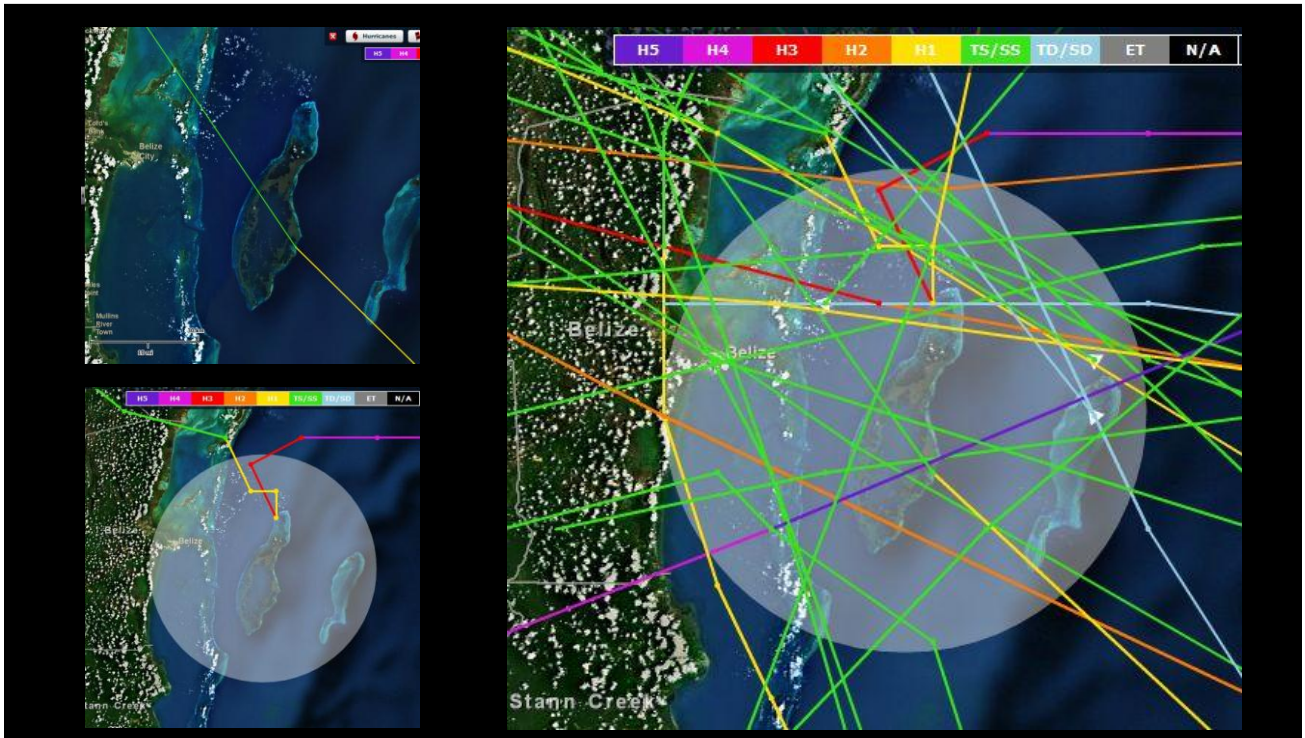


Figure 11: Hurricanes and Tropical Storm paths within 50km of Turneffe Atoll (www.nhc.noaa.gov, 2011)

Historical records identify ten hurricanes and twelve tropical storms that have passed within a 50-km radius of Turneffe Atoll (Table 9; NHC, 2011). Whilst not being within the 50km radius, Hurricane Mitch, in 1998, also had significant impacts on the Atoll. In a number of cases, Turneffe Atoll has impacted the direction of tropical storms and hurricanes, or resulted in a reduction of the wind strength (Figure 11), at times providing protection for mainland Belize to the west.

Whilst many hurricanes have very focused paths of destruction, their effects are wide ranging, particularly at sea. Hurricane Hattie passed over central Turneffe, near Pelican Caye, and completely inundated the Atoll to a depth of 5 to 6 feet (Maugre Caye Stoddart, 1963), estimated to have resulted in the deaths of 27 people Stoddart, 1963):

Caye(s)	No. dead
Berry Caye	3
Soldier Caye	7
Cay Bokel	6
Calabash Caye	10
Bull Bay	1

Hurricane Keith, in 2000, caused widespread defoliation to the northern part of Turneffe Atoll, with uprooting of trees and erosion of coastline along the cayes (Meerman, 2006)

Hurricane Hattie is also thought to have been responsible for removing the introduced white-tailed deer and rat populations. Causing mechanical damage to the coral, hurricanes also stir up the water, reducing water clarity for a significant time after the storm event itself. Water clarity can be further reduced following tropical storms by the associated heavy rainfall, which can exacerbate erosion and increase sediment transport from the mainland via the rivers. The storm will redistribute sand and mud along the reef, filling cavities in the corals, reducing the availability of habitat for reef-living species. Hurricanes can, however, also ameliorate the effects of warming seas, drawing up cooler, deeper water to the surface, and has been shown to reduce water temperatures by as much as 3˚C further north, in Florida (Manzello et al., 2007).

Name	Cat.	Date Passed <50km of TA	Proximity / Area hit
Richard		2011	
Alex	TS	June 26, 2010	Direct (central)
Arthur	TS	May 31, 2008	5km north
Keith	H3 / H1	Oct 2, 2000	Direct (north)
Mitch*	H5	Oct 28, 1998	300km south east
Gert	TS	Sept 18,1993	20km south west
Hermine	TS	Sept 22, 1980	15km north
Edith	H1 / TS	Sept 11, 1971	Direct (central)
Laura	TS	Nov 20, 1971	15km south east
Hattie	H5	Oct 31, 1961	Direct (south)
Not named	TS	Aug 31, 1945	Direct (north)
Not named	TS	Sep 22, 1942	Direct (south)
Not named	H2	Nov 9, 1942	25km north
Not named	TS	Sept 20, 1940	15 km north
Not named	TS	June 12, 1939	20km north west
Not named	TS	Oct 11, 1938	10km south west
Not named	TS / H1	June 8, 1934	Direct (central / west))
Not named	TS	Oct 1, 1932	10km north
Not named	TS	Oct 9, 1932	5km north
Not named	H2/H3	Sept 10, 1931	Direct (north)
Not named	TS	June 17, 1921	Direct (south)
Not named	H1	Oct 14, 1906	50km west
Not named	TS	Sept 16, 1898	5km north
Not named	H1	July 6, 1893	1km north
Not named	H2	Oct 12, 1892	Direct (south)
Not named	H1	Aug 30, 1864	Direct (north)

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

Table 9: Hurricanes Affecting Turneffe Atoll (<50km) (www.nhc.noaa.gov, 2011)

Wind data has been collected for the period January 1994 to early 1997 at about 90% of the Coral Caye Conservation survey sites. Dominant winds were clearly north-easterly or easterly, with northerly winds occurring from September to February. The majority of conditions recorded were 'light' or 'gentle breeze' (2 and 3 on the Beaufort Scale), and calm on 11.7% of surveys (Turnbull et al. 2000). It should be noted, though, that winds were not recorded on a daily basis, and when diving could not be undertaken in winds beyond a rating of 5, strong winds were not recorded, although they certainly occurred, so this data needs to be viewed as incomplete, and an information gap.

Climate Change: Climate change is having a very real impact on the health of the marine environment – with increasing sea temperatures, the coral reef, the ecosystem on which much of Belize's marine

resources is based, has been declining at an alarming rate, and corals are already at the upper limit of their temperature tolerance, with coral bleaching from elevated water temperatures rapidly reducing the resilience of the Belize reef. An assessment of potential climate change impacts is included in Section Two: Conservation Planning.

1.4.2 Geology

The Belize continental shelf underlies the entire coastline of Belize and extends seaward 15-40 km from the coast. It is a complex underwater platform of Pleistocene limestone rock that ends abruptly on top of the first of three northeast-southwest escarpments (and associated fault lines) that lie off the coastline. The first escarpment runs parallel to the coast, dropping off to the east to a depth of about 1km (Figure 12). An extensive reef system has developed upon the rim of this escarpment, forming the Belize Barrier Reef (Rath, 1996), sheltering the lagoon to the west. Cayes dot this platform, some formed on mangrove peat, others from coral outcrops and sand deposition.

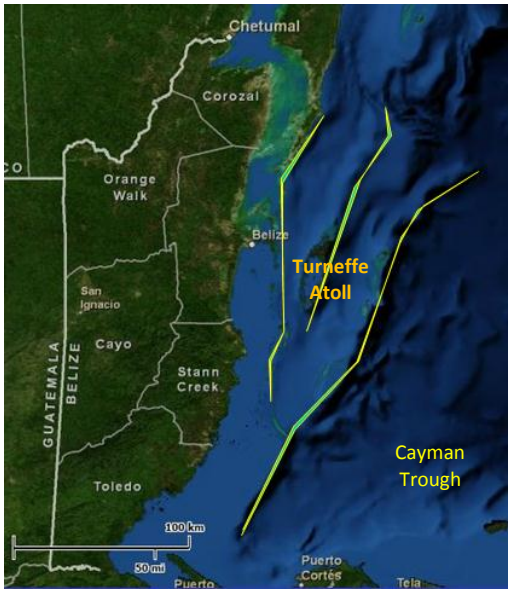


Figure 12: Fault lines / escarpments running parallel to the Belize coastline, forming the base of the barrier reef and atolls (Based on Purdey et al., 2003)

Turneffe Atoll, the largest of the three offshore atolls in Belize, sits on the second of the three tilted submarine escarpments (associated with the Turneffe-Banco Chinchorro Trend (Esker et al. 1998)), and is surrounded by deeper oceanic water on all sides. This ridge joins the main barrier reef escarpment north of South Water Caye Marine Reserve. The third escarpment provides the foundation for Lighthouse Reef and Glover's Reef Atolls, and then extends south to eventually intersect the Barrier Reef at Gladden Spit, before descending into the Cayman Trough, with depths of up to 4,000m.

The cayes of Turneffe have soils falling within the Turneffe and Tintal Suites (King et al., 1992; Murray et al. 1999):

Turneffe Suite: *well- and moderately drained soils formed on Pleistocene to recent coastal deposits, sometimes underlain by shallow coral, and which can be predominantly silicaceous or calcareous.*

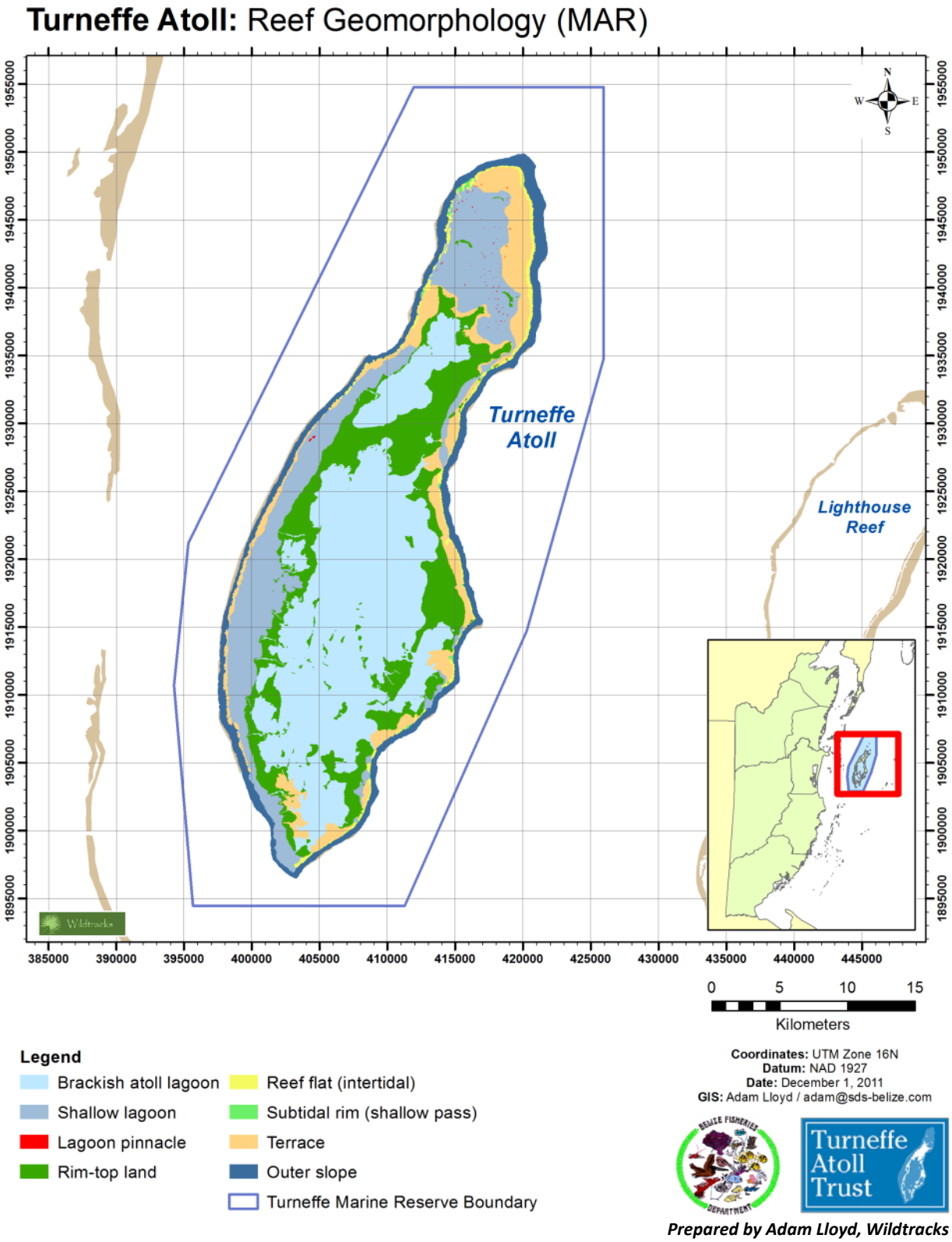
Tintal Suite: *Tintal Suite soils are poorly drained for all or a considerable part of the year. Soil formation is dominated by the gleying processes associated with wet and reducing conditions ....they occur in low-lying positions.*

King et al, 1992

Soil chemistry and plant-soil relationships at Turneffe are broadly similar to those seen on other cays and calcareous-dominated mainland sites in Belize (Murray et al., 1999). All soils are predicted to show limited amounts of available nitrogen and phosphorus, but have different drainage and salinity properties, resulting in the matrix of vegetation types that can be found at Turneffe (Table 10).

	King et al. 1992		Associated Vegetation (Murray et al. 1999)
	Suite	Sub-suite	
Coral Sand	Turneffe Suite	Ambergris	Beach Thicket
Organic Sand	Turneffe Suite	Shipstern	Caye (littoral) forest, beach thicket, broken palmetto thicket
Waterlogged Saline Peat	Tintal Suite	Ycacos	Mangrove
Drained Peat	Tintal Suite	Ycacos?	Broken palmetto thicket, broken palmetto-buttonwood thicket

Table 10: Soil Classifications for terrestrial areas of Turneffe Atoll (After King et al., 1990; Murray et al., 1999)



Map 6: Geomorphology of Turneffe Atoll (MAR data)

These escarpments form part of the western side of the Cayman Trench (or Bartlett Trough), where it abuts the Central American mainland (Stoddart, 1962). The Trench, forming part of the tectonic boundary between the North American Plate and the Caribbean Plate, is the deepest part of the Caribbean Sea, with a maximum recorded depth of 7,686m.

Turneffe Atoll itself is a limestone pillar that rises from the ridge (Map 6), with coral growth thought to have kept pace with sea level rise, leading to the non-volcanic Atoll formation seen today, with coral reef crest fringing the Atoll, encircling the shallow central lagoons, with their raised cayes and extensive seagrass and mangrove ecosystems. Exploration wells on the Turneffe Islands have demonstrated that the recent Atoll sediments lie above 1030 m of largely Tertiary reef and shallow water limestone, underlain by late Cretaceous to early Tertiary clastics and metavolcanics (Gischler, 2003).

1.4.3 Bathymetry

Belize has an extensive maritime area of 10,000km^2 (Hartshorn et al., 1984). Unique to this area is the 250 km long barrier reef that extends from the tip of the Yucatan Peninsula southward into the Gulf of Honduras (Burke, 1982). Seaward of the reef crest are the three coral atolls: Glover's Reef, Lighthouse and Turneffe Islands Atolls. Of these, Turneffe is the largest, most ecologically complex, and closest to the barrier reef.

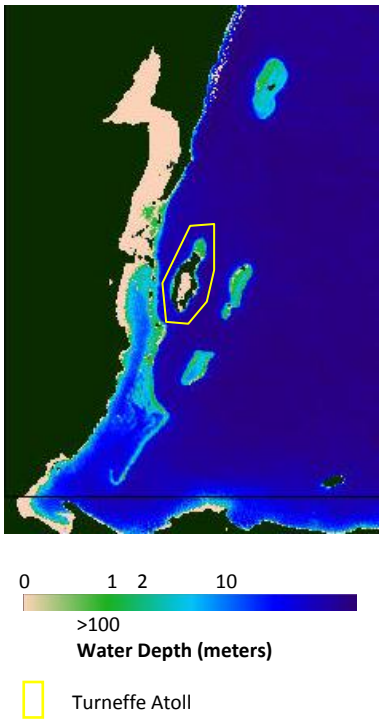


Figure 13: Water Depth (SeaWiFS, 1999)

The Atoll is surrounded by deeper oceanic water on all sides, with depths of up to 300m to the west, between Turneffe and the barrier reef, and 1,100m to the east, between Turneffe and Lighthouse (Figure 13). The Atoll lagoon is an average of between 2 and 4m deep, surrounded by the fringing reef, and punctuated by a series of 23 channels with an average depth of 6m (Stoddart, 1962; Garcia et al. 1998). A number of small sand cayes (including Caye Bokel, Deadman's Cayes, Calabash Caye, Soldier and Blackbird Cayes, Dog-flea Caye and Cockroach Caye) are located on the inner edge of the reef-flat, in water between 0.3 to 0.6m deep. Where the reef flats meet mangrove, a deeper channel often occurs, between 1.2 and 1.8m deep. To the west, there is no sand ridge, and red mangroves fringe the Atoll, encircling two interior lagoons – Southern Lagoon and Central Lagoon (sometimes called Northern or Vincent's Lagoon). Central Lagoon is estimated at an average 2m in depth, whilst the Southern Lagoon is deeper, averaging 4m (Stoddart, 1962; Pritchett, 2008) – neither is thought to exceed 8m in depth (Spalding et al. 2001). Along the majority of the east facing coast of the Atoll, however, a dry sand ridge rises up to 1.5m above sea-level, and stretching back a maximum width of some 180m, decreasing in height

to the interior, mangrove-lined lagoon. The matrix of mangroves and mangrove cayes within the lagoons are linked by channels up to 3m deep, and established on deep mangrove peat deposits. Core analysis has shown that sediments of Turneffe Atoll range from 7000 to 2700 years BP, accumulating at rate ranges from 0.22 to 1.23 m/ky with an average of 0.82 m/ky (Figure 14; Gischler, 2003). Surface sediments are largely peat based, with depths of up to 2m in the lagoons, topped with *Halimeda* wackestone, interpreted to represent a restricted lagoon environment with abundant sea grass beds as seen within the Turneffe Islands platform today (Gischler, 2003).

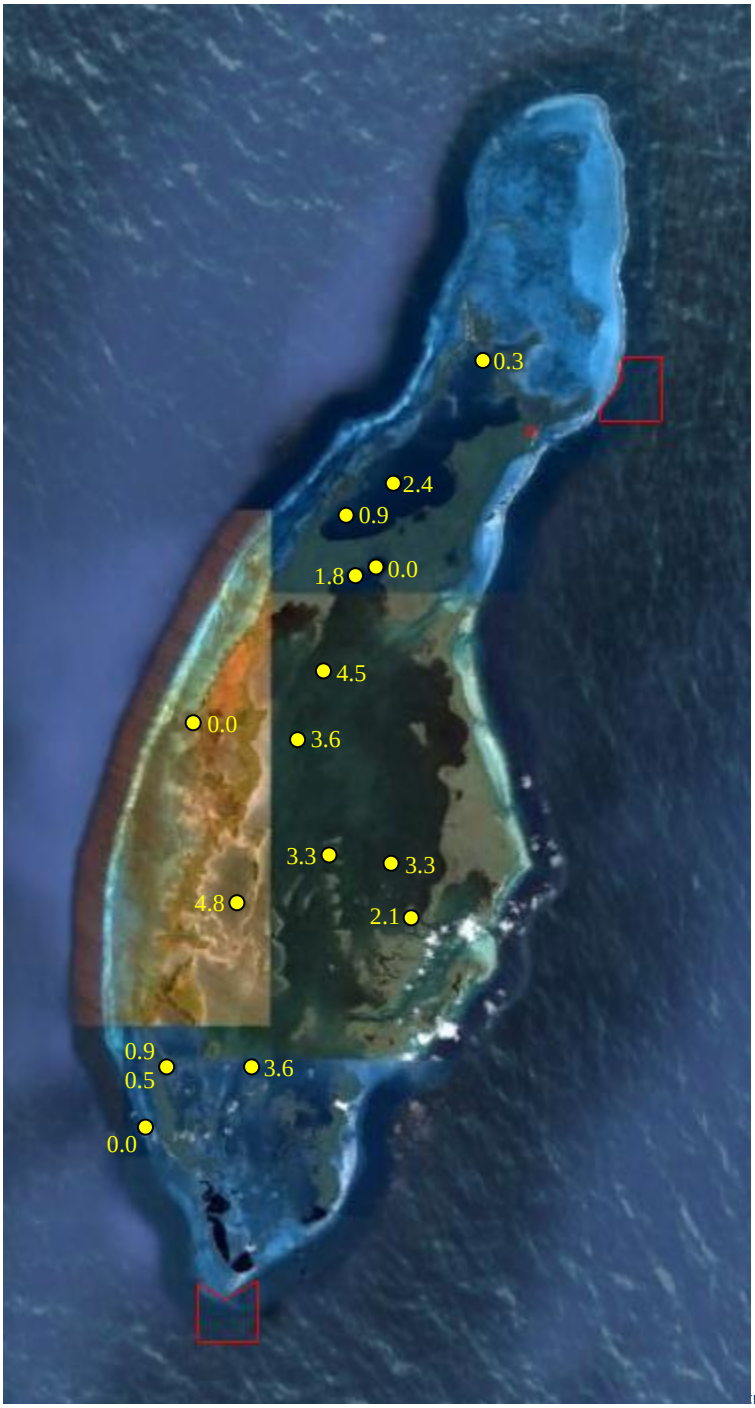


Figure 14: Water depth in Turneffe Atoll lagoons at sample sites (Gischler, 2003)

More detailed 3-D mapping has been conducted for the two legislated Spawning Aggregation sites – Dog Flea Caye and Caye Bokel. Both show the characteristic shelf at 20 – 30m that projects out into the deeper waters, and the steep drop-off. Of the two sites, the Caye Bokel site is the more exposed (Figure 15; Belize Fisheries Department et al., 2008)

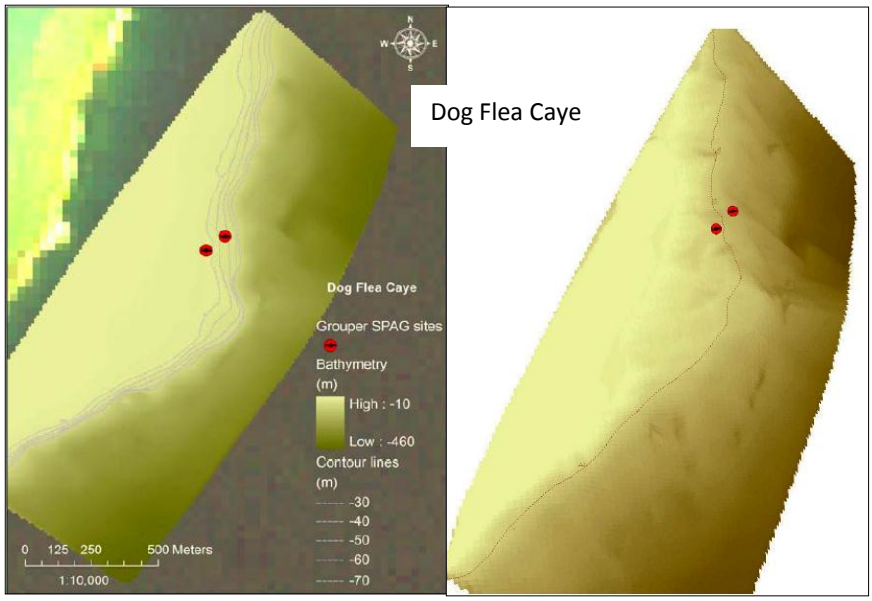
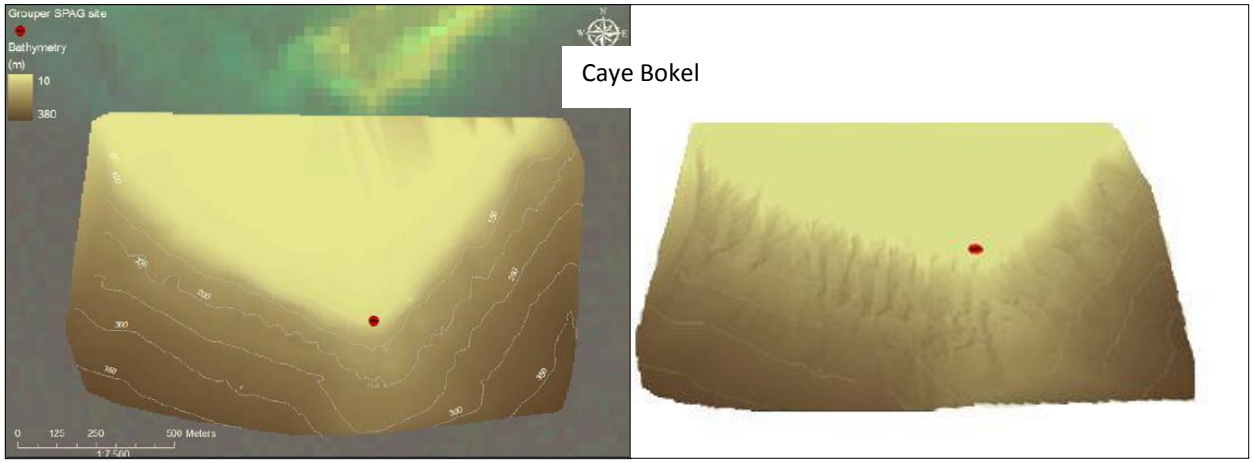


Figure 15: Bathymetry of spawning aggregation sites – Dog Flea Caye (left) and Caye Bokel (below)
(Kobara / Heyman, 2008)



1.4.4 Tides and Water Movement

Knowledge of currents is essential in determining connectivity for larval transport, nutrients and pollutants, as well as for predicting the spread of disease and invasions (demonstrated by the rapid spread of disease in *Diadema antillarum* throughout the Caribbean region in the 1980s). Connectivity through currents has also resulted in the rapid invasion of Belize by the lionfish (*Pterois volitans* and possibly *P. miles*), which has been increasing exponentially at Turneffe Atoll, as part of a larger, regional

invasion. An initial, isolated report of its presence was recorded in 2001, in the Laughing Bird Caye area (B. Sutton / Ecomar), though no more were seen until the first confirmed report, a single specimen taken in December 2008 from Turneffe Atoll (Schofield, 2009). Since then, populations have grown exponentially.

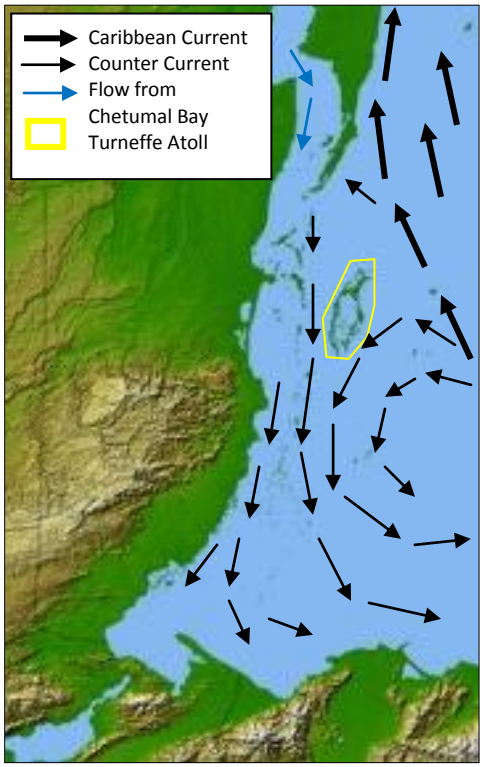


Figure 16: Major Currents of the Belize Reef (after Ezer et al., 2005)

On a regional scale, the main oceanic current, the warm-water Caribbean Current, forms the main surface circulation in the Caribbean Sea, flowing westwards from the Lesser Antilles towards southern Belize, then northwards offshore, beyond the atolls, eventually through the Yucatan Channel, with an average flow rate of between 38 to 43 cm (15 to 17 inches) per second. This creates a counter clockwise gyre in the Gulf of Honduras area, including much of the coastal waters of Belize, which flows south / southwest-wards past the Belize coastline and Barrier Reef (Figure 16; Heyman et al., 2000; Stoddart, 1962), in the shelf lagoon and offshore basins (Purdy et al., 1975), with strong currents up to 5 knots in the reef channels especially during low tides.

On a more local scale, and of particular importance for recruitment modelling for coral and fish larvae, the predominant currents around Turneffe flow from the east, pushing spawn and larvae from the spawning aggregation sites into the Atoll, with studies suggesting a high level of self recruitment. To the west (lee) side, predictive modelling suggests that eddy formation will also assist in self recruitment to the Atoll (Figure 17; Paris et al., 2010; Cetina-Heredia et al., 2011), whilst larvae not caught up in the eddies may get swept to the west, to the barrier reef and coastal shelf.

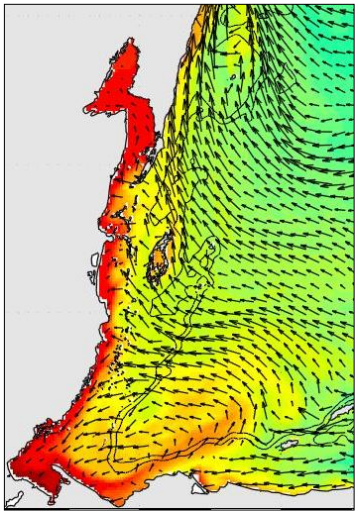


Figure 17: Local Currents of the Belize Reef (Paris et al., 2010)

Tidal exchange in the Turneffe Atoll area is considered to be micro-tidal, and averaging an estimated 30 to 50cm (Stoddart, 1962; Caribbean Coral Ecosystems Program, 2005; Belize Fisheries Department et al., 2008). The currents generated by these tides as they pass through reef cuts are thought to play a significant role in the spatial dispersion of sediment, nutrients, and larvae along the shallow reef flats and back reef, and with the formation of temporary and more permanent sand cayes.

Winds are thought to have a more influential impact on sea level than tides, with strong north winds resulting in lower sea levels - throughout

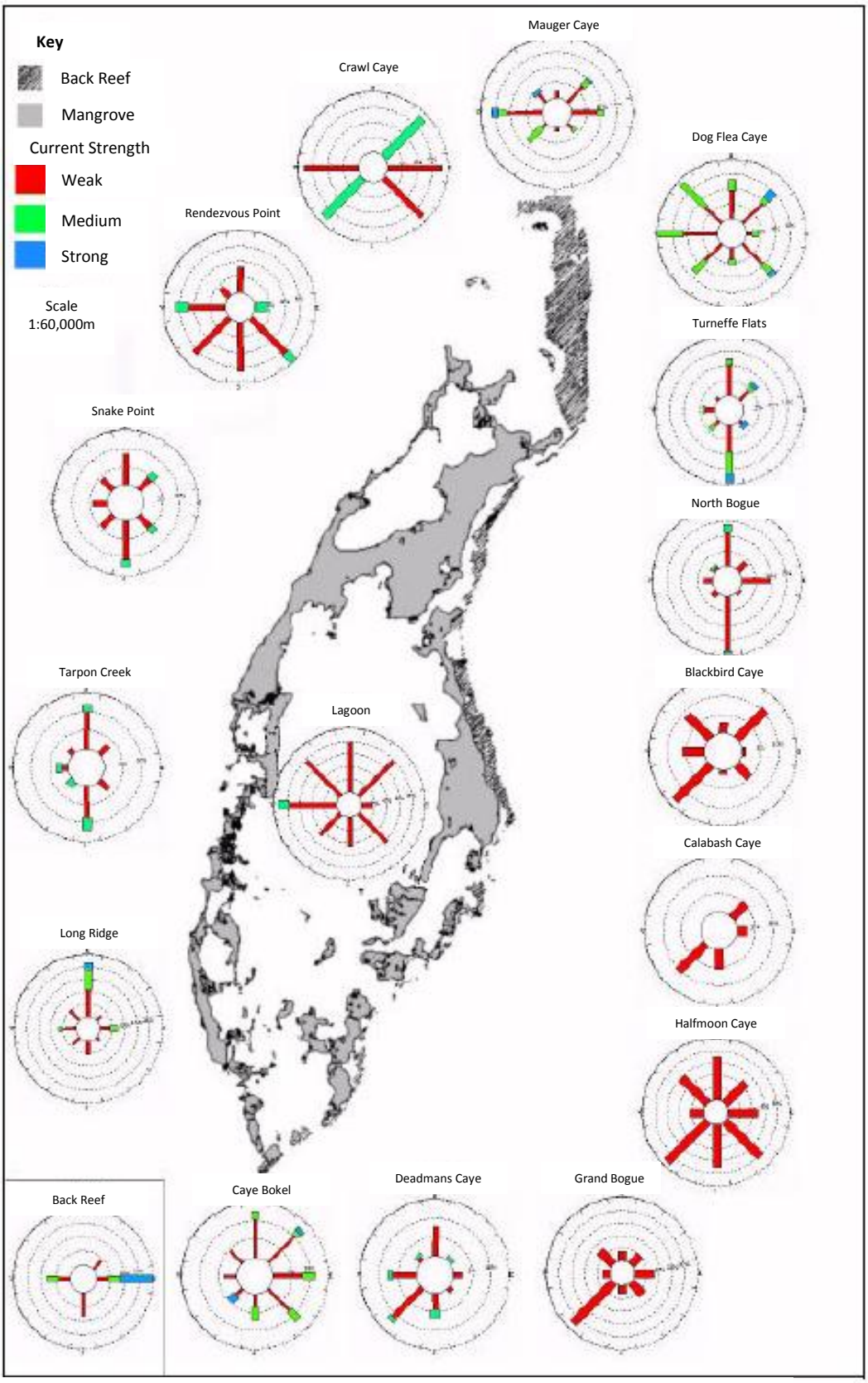


Figure 18: Local surface currents of Turneffe Atoll (Length of bars indicates frequency of occurrence). (Turnbull et. al., 2000)

Belize, the northerly winds are known to depress the water level by as much as a foot for several days at a time between November and February, and probably have a greater influence on shallow water and reef crest biodiversity than the regular tides (Stoddart, 1962; Caribbean Coral Ecosystems Program, 2005).

Localised current data was collected for the period January 1994 to early 1997 at Coral Caye Conservation survey sites[1] (Figure 18). Currents were demonstrated to be generally 'weak', and to flow along the north-south axis on the east and west side, whilst on the east-west axis, they flow around the north and south tips of the atoll. The strongest currents were generally observed in the north-east of the atoll. Strongest currents in the lagoon flowed to the west (Turnball et al. 2000), emptying water from the lagoon that has entered from the east (Stoddart, 1962). Extreme temperature and salinity values were recorded in 1939 within the Turneffe main lagoon, with water temperatures exceeding 31˚C and salinities reaching 70% (Smith, 1941), suggesting that there is a restricted circulation within the Turneffe lagoon. It should, however, be noted, that currents were only measured when dives were conducted at the sites, and that dives were cancelled if winds became too strong, so this data needs to be viewed as incomplete, and an information gap.

1.4.5 Water Parameters

There are few long term, continuous water monitoring data sets available from the coastal shelf of Belize, and only limited data is currently available for Turneffe Atoll. Monitoring was conducted at CCC dive sites between 1994 and 1997, though showed no significant trends over that period, with both horizontal and vertical data estimated at an average of 20m visibility (Turnbull et. al. 2000). As expected, the lagoon had rather lower visibility than the reef itself (19.9m for horizontal and 18.1m for vertical visibility). However, data was not collected concurrently, so accurate comparisons are not possible.

Water Temperature

Water temperatures were monitored for CCC survey sites between 1994 and 1997, and were shown to vary throughout the year. Lowest water temperatures (27˚C) were recorded in March, reaching a peak in June / September of 30˚C. In September, 1995, sea surface temperatures reached a 12-year high of 31°C (Turnbull et al., 2000), resulting in mass coral bleaching. The incidence of periods of high water temperatures has increased over recent years, and has been linked with coral bleaching. More recently, information on maximum monthly mean water temperatures based on an analysis of remote sensing spanning 1991 – 2008 highlights areas most prone to high temperatures (on a spatial resolution of 1km). This mapping has also provided a probability of warm water anomalies around Turneffe Atoll, based on the remote sensing information (Figures 19 and 20).

[1] It should be noted, that currents were only measured when dives were conducted at the sites, and that dives were cancelled if winds became too strong, so this data needs to be viewed as incomplete, and an information gap.

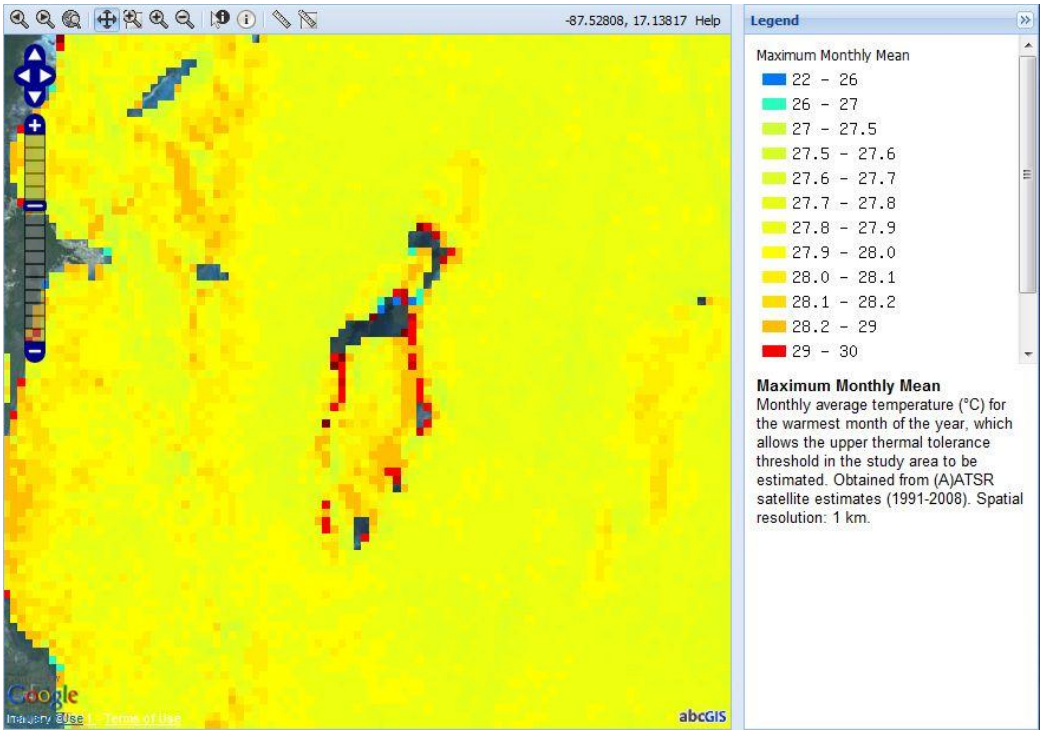


Figure 19: Maximum Mean Monthly Water Temperatures (Marine Spatial Ecology Laboratory, University of Exeter)

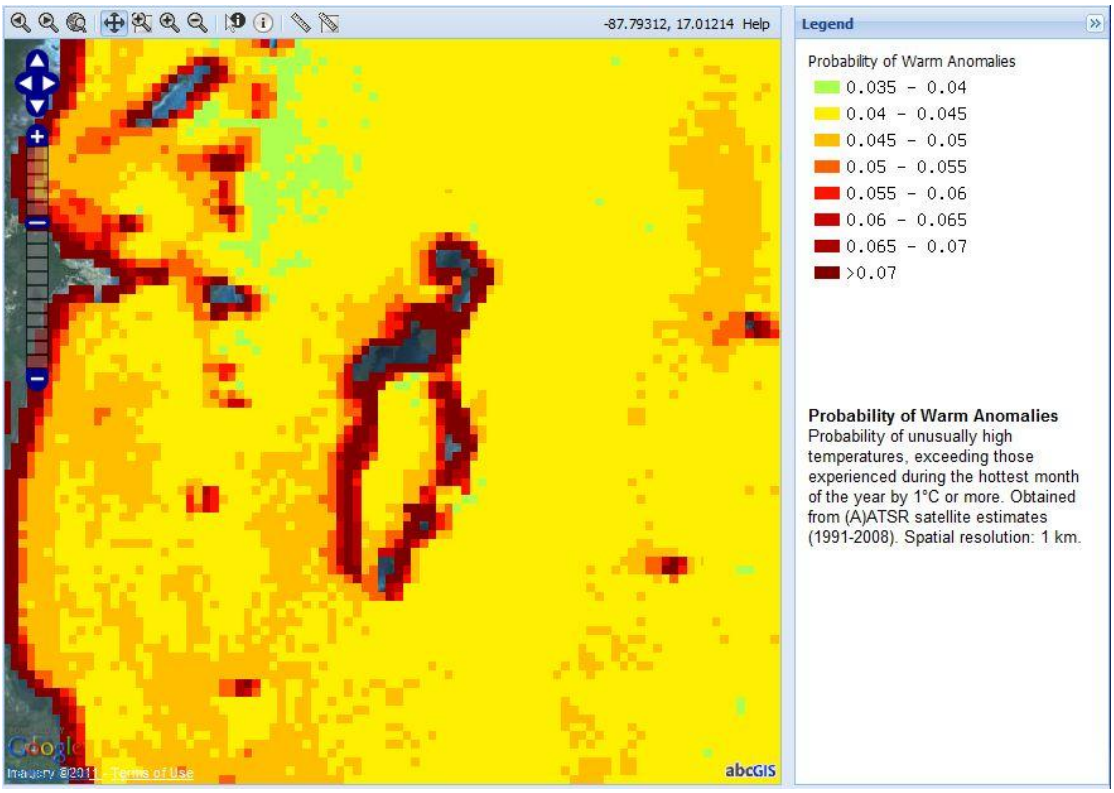


Figure 20: Probability of Warm Water Anomalies (Marine Spatial Ecology Laboratory, University of Exeter)

Sedimentation / Turbidity

Sedimentation and agrochemical contamination from mainland watersheds have been highlighted as perhaps one of the greatest impacts on the Belize reef, after climate change. Turneffe Atoll lies east of three primary watersheds – Northern River, Belize River, Sibun River, and Manatee River (Figure 21; WRI, 2006; Map 7). Following storm events, the increased sediment load of these rivers is also accompanied by an increased pesticide load, as rain washes agrochemicals from the watersheds into the rivers, and from there into the sea. Generally occurring between August and October, these events impact water turbidity and quality throughout the coastal waters of Belize, though less so at Turneffe Atoll, with its distance from the mainland and the containing effect of the barrier reef. However, a significant reduction in water quality on the west facing UB/ERI survey sites was observed in 2011, with visibility reduced to 2m at the surface, down to a maximum depth of approximately 14m (Cawich, pers. com.). Whilst this is not a frequent occurrence, it is reported by fishermen to happen when sediment load of the Belize River is particularly bad (Cawich, pers. com.).

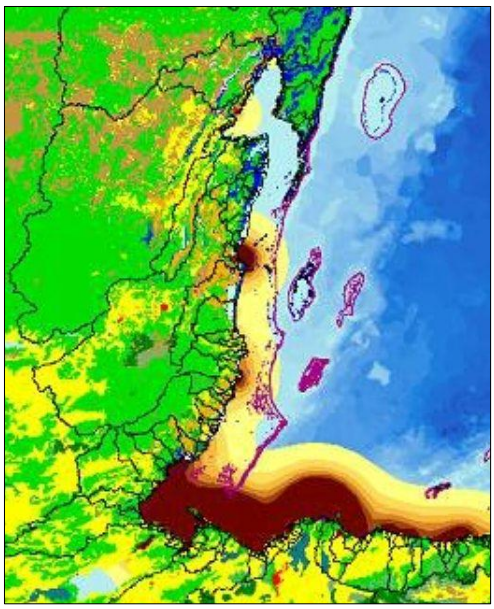


Figure 21: Cherrington, 2011; Based on sediment Delivery by watersheds. (Burks and Sugg / WRI, 2006).

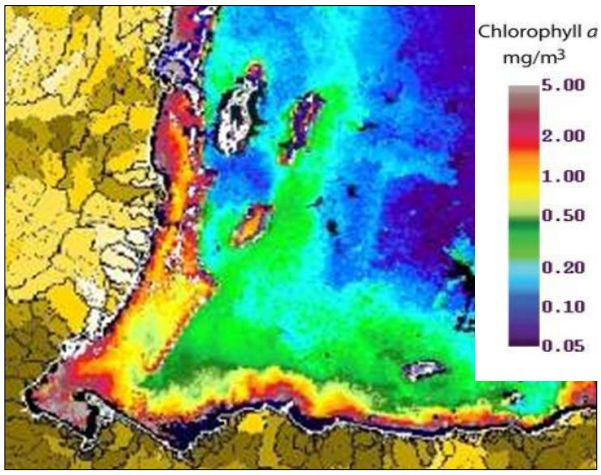
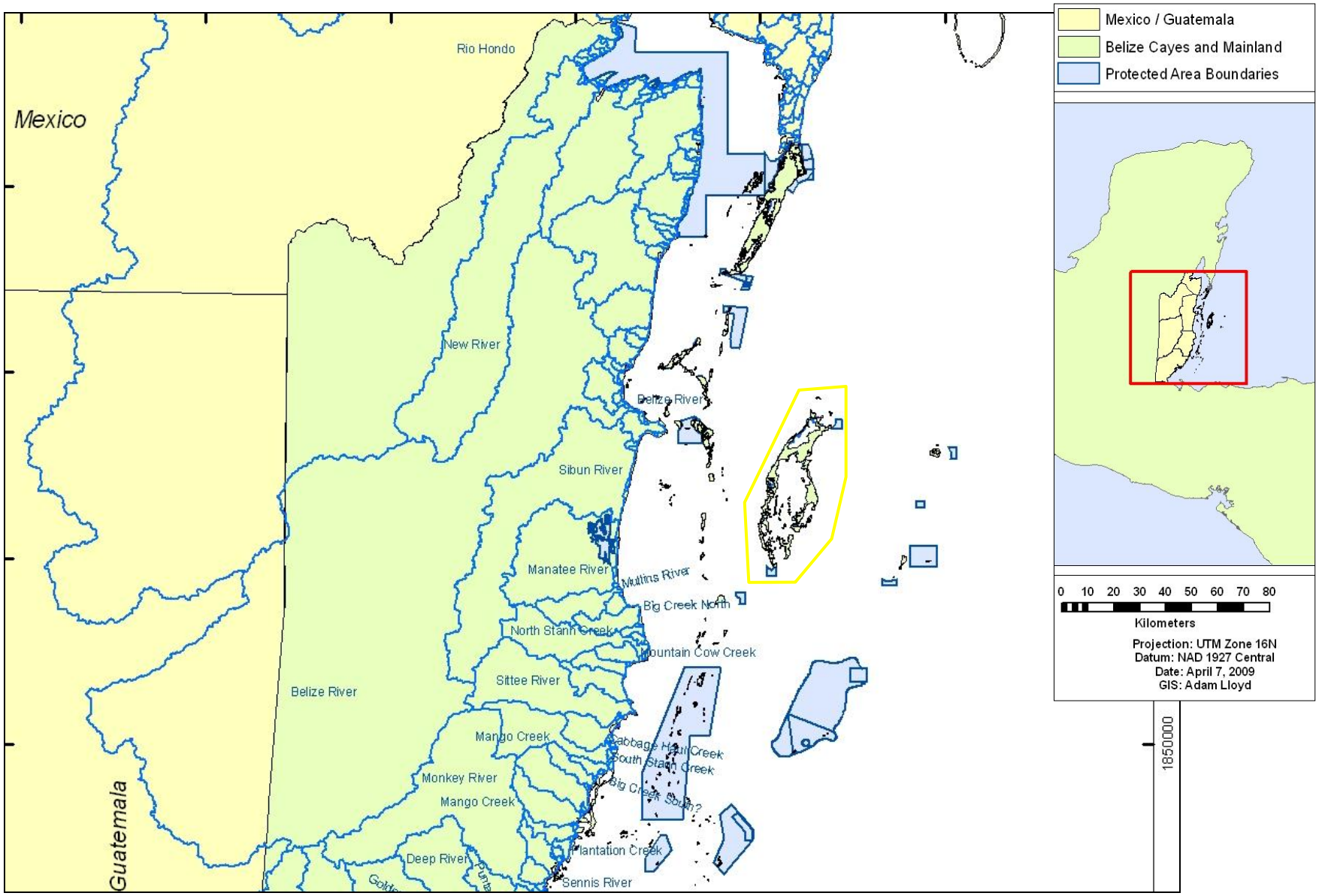


Figure 22: SeaWifs Chlorophyll α. After Shank et al., 2010/ Soto et al., 2009

Sediment core analysis of two sites within the Belize reef system (Turneffe Atoll and Sapodilla Cayes), indicate that sediment and agrochemical runoff onto the reef has increased relatively steadily over time, consistent with historical and current land use trends, though sediment supply to the reef is greater in the south, with its proximity to Honduras. Lower water contamination is thought to link to the ability of reefs to recover from coral bleaching faster, as has been seen at Turneffe (Carilli et al., 2009).

SeaWifs ocean colour images show that a large pulse of river water extends from the Guatemalan and Honduran rivers, stretching to Glover's and Lighthouse Atolls, during these storm events (Figure 22; Soto et al., 2009; WRI/ICRAN, 2006; Andrefouet et al., 2002). More than 80 percent of sediment, and more than half of all nutrients (both nitrogen and phosphorous) entering the Mesoamerican Reef originate in Honduras (WRI, 2006). With the local currents and its location, however, Turneffe Atoll lies outside the



Prepared by Adam Lloyd, Wildtracks

Map 7: Turneffe Atoll: Mainland Watersheds

path of this plume. It is also protected from water-borne pollutants from Belize City by the presence of the barrier reef, and can therefore be considered one of the most pristine reefs in Belize, based on water contamination.

Salinity

Normal seawater salinities of 36‰ have been recorded to the east of the barrier reef, with variation from 33.0‰ to 37.4‰. This range of salinities persists throughout the Belize continental shelf, including the Turneffe Atoll, with slightly lower salinity during the wet season.

It is thought that salinity in the lagoons within the Atoll may vary – readings demonstrate a wide fluctuations of 34.2 – 42.5‰ in the Turneffe Atoll lagoons from 2000 to 2001 (Gischler, 2003), with concentration of salts within the lagoons increasing salinities at certain times of year. One record from 1939 recorded an extreme of 70‰ salinity (Smith, 1941). Tropical storms are also thought to bring sufficient freshwater to significantly reduce the salinity of the lagoons, which was thought to have resulted in the massive mortality of commercial sponges in the early to mid 1900's (Stoddart, 1962). The presence of freshwater and areas of lower salinity is also thought to be why Turneffe Atoll is considered so important in the maintenance of American crocodiles (Meerman, 2006), and why a population of West Indian manatee are resident in the area (Edwards et al., draft). Both of these species may be vulnerable if there is excessive disturbance of the freshwater lenses associated with the cayes.

pH

The general pH of water in reef areas in Belize is 7.2. The alkaline pH is attributed to the high calcium carbonate saturation along the reef. There is a growing global concern about ocean acidification, with the increasing absorption of carbon dioxide from the atmosphere, which is predicted to result in the inhibition of growth of reef builders. Whilst predictions are not yet considered as being precise, the process was identified and flagged as a concern as long as 40 years ago (Kleypas et al., 2006). Studies in Australia have demonstrated that there has been a 13.3 percent drop in calcification over a twenty year period, (1990 – 2009), an unprecedented decline in at least the past 400 years (De'ath et al., 2009), and extrapolations suggests that calcification rates may decrease by up to 60% within the 21st century, with ocean pH levels expected to drop by another 0.3 units by 2100.

1.5. Biodiversity of Turneffe Atoll

Turneffe Atoll is highlighted as one of the most pristine areas within the Mesoamerican Reef, an ecoregion that is recognized for its biodiversity and representational values, considered outstanding on a global scale. This has led to recommendations for the MesoAmerican Reef, and Turneffe, to be recognized as a priority area for conservation (Olson & Dinerstein, 1998; Roberts, 2001; Kramer and Kramer, 2002). Biological information about Turneffe Atoll has been accumulated over the years by a variety of researchers and organizations, with projects focusing on both ecosystems (particularly coral reefs, mangroves, and seagrass) and species / species assemblages (American crocodiles, West Indian manatee, dolphins, spawning aggregations).

1.5.1 Ecosystems

Turneffe Atoll is considered unique - one of the best-developed coral atolls in the Caribbean, with extensive sheltered mangrove and interior lagoonal seagrass systems, in close proximity to the reefs. A chain of islands partially enclose three shallow lagoons: Southern, Central, and Northern or Vincent's Lagoon, and a near continuous beach ridge extends along the eastern shore, with a maximum elevation of about 1.5 m above sea level (Stoddart, 1962). Littoral forests stretch along this ridge, with sandy beaches on the east facing slope, so important for nesting turtles and crocodiles, add to the rich matrix of ecosystems, as do the shallow epipelagic waters of the continental shelf and the bathypelagic zone of the open sea.

Broad Ecosystems (Meerman, 2004)

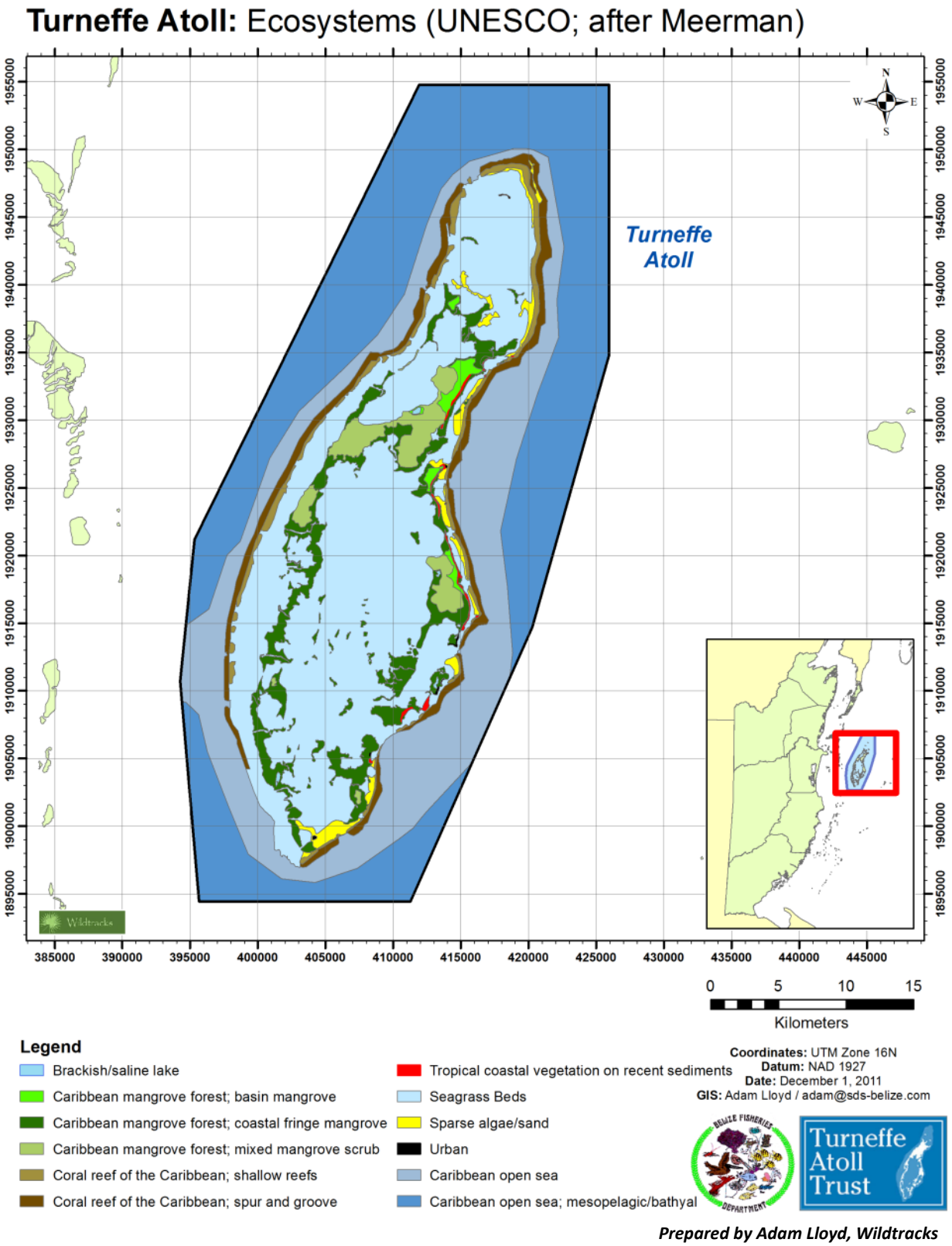
- Tropical Coastal Vegetation
- Caribbean Mangrove
- Seagrass
- Coral reef
- Sparse algae / sand
- Brackish / saline lake
- Open Sea

Seven broad ecosystems / thirteen fine ecosystems have been identified and mapped (Table 11; Map 8; Meerman, 2004).

Ecosystem	General Use Zone		Conservation Zones		Preservation Zone		Special Management Zones		Total protected*	
	hectares	% of total	hectares	% of total	hectares	% of total	hectares	% of total	Hectares protected	% protected
Brackish/saline lake	82.34	100.00								
Basin mangrove	686.74	100.00								
Coastal fringe mangrove	6,234.14	85.32	557.92	7.64	494.21	6.76	20.35	0.28	1052.14	14.40
Mixed mangrove scrub	2,991.83	100.00								
Caribbean open sea	22,974.49	86.88	3,269.26	12.36			200.24	0.76	3269.26	12.36
Caribbean open sea - mesopelagic/ bathyal	36,291.98	81.65	8,155.86	18.35					8155.86	18.35
Coral reef of the Caribbean; Shallow Reefs	1,695.90	75.01	449.14	19.87			115.84	5.12	449.14	19.87
Coral reef of the Caribbean; Spur and groove	3,539.40	76.84	801.07	17.39			265.92	5.77	801.07	17.39
Seagrass Beds	35,685.52	87.08	1,851.91	4.52	695.08	1.70	2,749.81	6.71	2546.99	6.21
Sparse algae/sand	1,115.44	70.26	329.61	20.76			142.63	8.98	329.61	20.76
Tropical coastal vegetation on recent sediments	233.93	97.06	2.50	1.04			4.60	1.91	2.50	1.04
Urban	52.39	100.00								
Totals (ha)	**111,590.27**		**15,417.27**		**1,189.30**		**1134.32**			

* Not including Special Management Zone

Table 11: Ecosystem protection at Turneffe Atoll



Map 8: Turneffe Atoll: Ecosystems (UNESCO /Meerman, 2004)

Marine Ecosystems

Mesopelagic / Bathypelagic Zone (200m and deeper)

The Mesopelagic and Bathypelagic Zones include the deeper waters that surround Turneffe Atoll. The mesopelagic zone extends from a depth of 200m downwards, merging into the bathypelagic zone (which begins at the edge of the continental slope and extends beyond into the deeper water). The deep waters to the east of the Atoll provide the geomorphology and oceanographic current conditions required by many species for the formation of spawning aggregations (Heyman et al., 2008). They also attract other species known to travel up and down in the deep waters parallel to the reef, including whale sharks, pilot and humpbacked whales and orcas.

This ecosystem is considered under-represented within the National Protected Areas System, increasing the importance of inclusion within the proposed management area.

Epipelagic Zone (0m – 200m)

The Epipelagic (sunlit) Zone ranges from 0 to 200 m depth, and includes the shallow waters of the inner lagoon and the deeper waters of the fore reef. Within this zone there is an array of ecosystems that have evolved in response to the degree of exposure and impact of wave action, current direction and intensity, light intensity and light spectra, and are defined by their species composition, formation and substrate characteristics.

Coral Reef

Turneffe Atoll is considered one of the best developed coral atolls in the Caribbean with an extensive fringing reef forming an oval rim around the entire atoll (Kramer et al. 2001). This is particularly so on the northern and eastern sides, where ideal conditions have resulted in the presence of Fore reef, Reef Crest, and Back Reef, with the formation of a distinct reef crest.

On a regional level, more than 75% of Caribbean coral reefs are considered threatened, a figure expected to increase to 90% by 2030, and 100% by 2050 (Burke et al., 2011). The recent decline in the health of the Caribbean reef began in the early 1980's, with the decimation of corals by White Band Disease, which primarily affected reef building corals - the elkhorn and staghorn corals (*Acropora palmata* and *A. cervicornis*) (Aronson et al., 2001). These species are particularly important in the maintenance of the reef as a protective barrier to storms, and as habitat for both the priority commercial species, such as lobster, and the touristic reef fish. Reefs throughout the region have seen a shift in species composition of structural corals, with the loss of *Acropora cervicornis*, and subsequent replacement by *Agaricia tenuifolia* (CCRE, 2002). More recently, increasing water temperatures and coral bleaching have increased coral sensitivity, and declines of up to 70% coral cover have been reported over the last thirty years (Gardner et al., 2003).

Reefs in Belize have historically been perceived to be at slightly lower risk than others in the region, due in part to the small human population and relatively low levels of coastal development. In more recent years, coral health has generally been on a par with, or slightly below, the rest of the Caribbean, with impacts from a combination of coral bleaching, disturbance events (primarily hurricanes) and chronic stressors, leading to declining coral cover and increases in macro-algae (McField, et al., 2008 (ed. Wilkinson et al., 2008)). The extensive loss of key reef-building species (*Acropora cervicornis,. Agaricia tenuifolia, Millepora complanata, Diploria spp.* and *Montastrea spp.*) combined with increasing effects of global warming is of particular concern (Kramer & Kramer 2001), with an ecological shift towards algal dominance at many sites across the Caribbean. Global climate change (with increasing sea temperatures and UV levels) has been identified as the biggest contributing factor in reef health decline (Aronson et al., 2006). This overlies and adds to other stressors, including coral diseases (black, white and yellow band diseases and white plague), overfishing of herbivorous fish, the population crash of the herbivorous long-spined sea urchin *Diadema antillarum* and other environmental stressors such as, sedimentation and pollution (Liddell et al, 1986; Aronson et al, 1998).

Coral Bleaching: Corals are highly sensitive to changes in water temperature, and increases of only 1 to 2°C can have potentially lethal effects. The MAR region has experienced several large-scale bleaching events (e.g., in 1995, 1998 and 2005) that caused significant coral mortality in some areas.

Human-induced global warming is widely believed to be responsible for increases in global sea surface temperature.

Diseases: Coral disease outbreaks are one of the single most devastating disturbances to coral reefs in the Caribbean and Mesoamerican Reef in the recent past.

Disease has always been a natural process in regulating populations, but the recent increased magnitude of disease and resultant mortality may be unique in the last several thousand years. Diseased organisms tend to thrive in higher temperatures, and some may also benefit from increased ultraviolet (UV) radiation. Both stressors (temperature and UV) may render host organisms more vulnerable to disease.

In addition to these effects related to global climate change, diseases have also been linked to elevated nutrients (especially from sewage), sedimentation and runoff.

Similar to humans, corals seem to be more prone to disease when affected by other stressors.

Healthy Reefs for Healthy People Initiative, 2007

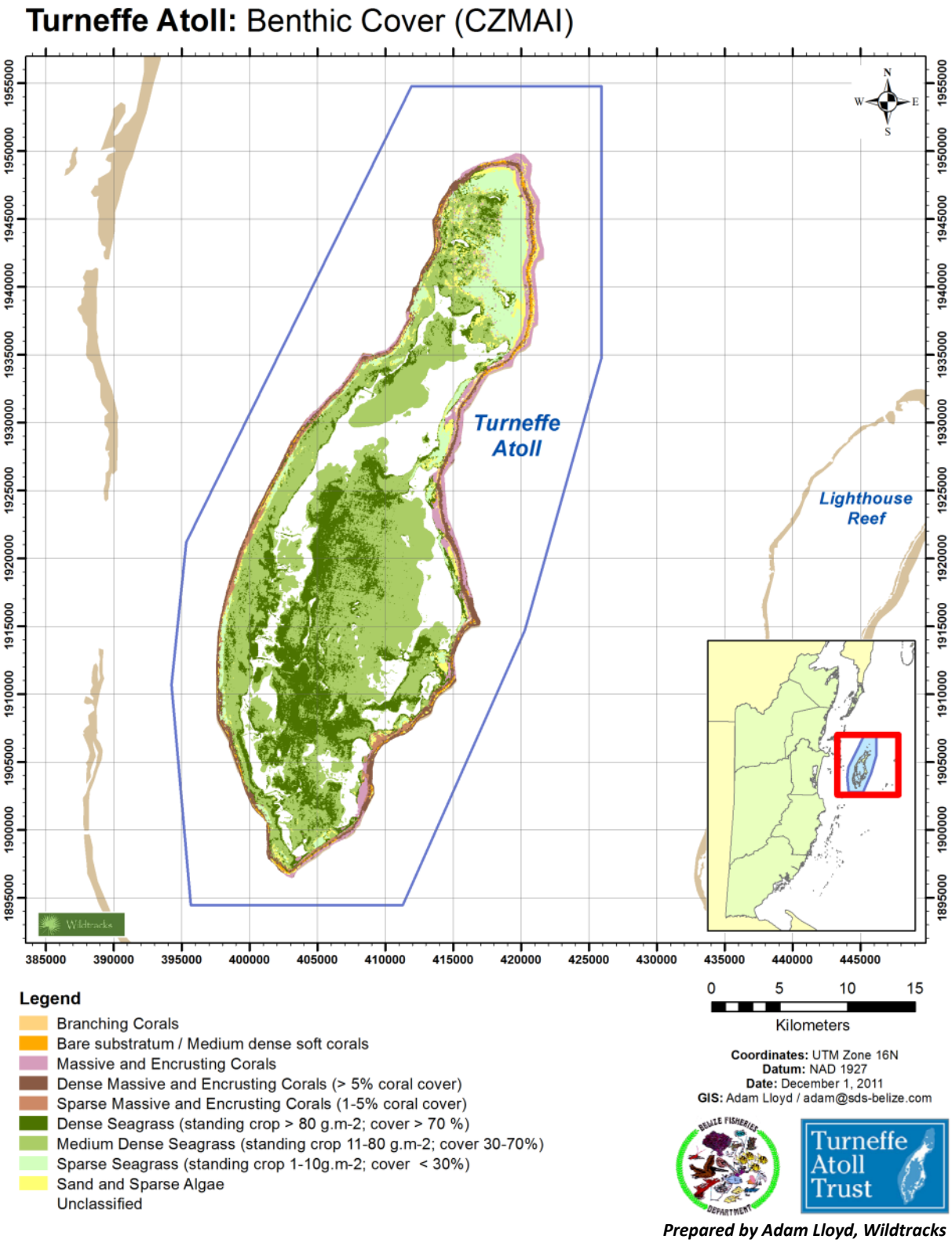
Global bleaching events were first recorded in 1979, and the Belize Barrier Reef experienced mass coral bleaching for first time in 1995 (McField, 1999; McField et al., 2007). This resulted in large-scale bleaching of hard corals throughout Belize (including Turneffe Atoll), particularly impacting *Montastraea annularis.* Bleaching of *Agaricia agaricites, Agaricia tenuifolia, Madracis* spp., and *Porites porites* was also reported in 1995 (McField, 2000). The reef at Turneffe was further stressed by the wave action of Hurricane Mitch, which followed closely on the 1998 bleaching episode. Since then, major bleaching events have been recorded at Turneffe Atoll with increasing frequency, and are thought to be accentuated by increased acidification resulting from higher CO_2 levels (Anthony et al., 2008). 65% of Belize's coral reefs are currently rated as being in Poor or Critical health, and only 1% considered in Very Good health (Healthy Reefs, 2010).

Studies have shown that corals in areas with reduced anthropogenic impacts have recovered faster from past bleaching events (Carilli, 2009). Turneffe Atoll is unique in that anthropogenic impacts are considered to be lower than elsewhere in Belize. It has the advantages of upwellings to the east, bringing cooler waters to the Atoll, and lies outside the currents that regularly draw contaminants and sediments northwards from the Gulf of Honduras. As such, Turneffe Atoll may be one of the most resilient areas Belize has for future maintenance of at least some of its coral reefs. However, despite these resilient features, mean coral cover has dropped by 56% at Calabash Caye, with coral diversity dropping more than 30% from pre-bleaching levels (McField 2001).

Benthic Cover

The Atoll is encircled by a ring of structural corals, a fringing reef, with a typical fore-reef, reef crest, and back reef structure that protect the more sheltered lagoon (Map 9). Sandy and rubble back reef flats on the eastern coastline lie between the reef and the cayes. The inner lagoons, largely separated from the reef crest by a chain of cayes on the east, and mangroves on the west, have a dense to medium dense benthic coverage of seagrass (primarily *Thalassia*) with *Halimeda*, and abundant sponges (*Spheeciospongia* sp.). Coral patch reefs within these lagoons are rare, and branched *Porites* sp. and *Manicina areolata* occur only occasionally.

To the north, the benthic habitats of the northern shelf differ from much of the rest of the Atoll, with mixed sand and seagrass, and numerous patch reefs.



Map 9: Turneffe Atoll: Benthic Classification (CZMAI)

A historical baseline from 1960 provides information on the status of the reef before the recent combined impacts of climate change and coral disease (Figures 24 and 25; Stoddart, 1962). Four initiatives have established more recent baselines, documenting the changes occurring on the Atoll:

- The University of Belize / Coral Caye Conservation have data sets for 1994 to 1997
- Oceanic Society have had ongoing surveys at three fore-reef and four back-reef sites near Blackbird Cay sites on the east facing margin of the Atoll since 2002.
- The University of Belize / Environmental Research institute (UB/ERI) has data on coral bleaching from 2008, and during 2010, established six permanent monitoring sites as part of their Mesoamerican Barrier Reef System (MBRS) monitoring baseline for the wider Turneffe Atoll, and plan on increasing this to ten.
- The World Wildlife Fund assessed the reef health of Caye Bokel and Dog Flea Caye in 2007, as part of the development of management plans for these two protected fish spawning aggregation sites

The World Wildlife Fund assessed coral reef health at the two fish spawning aggregation sites in 2007 (Fisheries Dept. et al., 2008), with the Healthy Reefs initiative establishing monitoring sites on the Atoll in 2009, some of which overlap with those of UB/ERI. Coral reef monitoring data from UB/ERI for 2010 for Turneffe Atoll provides information from six sampling sites scattered across the Atoll, each sub-divided into three sub-sites: shallow fore reef (1-5m depth), deep fore reef (8-15m depth) and back reef (1-5m depth) (Figure 23; UB/ERI, 2010). Four additional monitoring sites have also been established on the east facing side of the Atoll, providing further information on the state of the reef (Oceanic Society, 2010). Mapping outputs (CZMAI, 1997; CCC, 1999; WRI, 2005; Meerman, 2006; Oceanic Society and TAT, 2011) also provide information on ecosystem coverage and benthic communities, as well as species distributions and areas of impact.

Belize is thought to have over sixty species of stony corals, of which forty-eight have been identified at Turneffe Atoll (Fenner, 1999). Ten of these are considered critically endangered, endangered or vulnerable on the global scale (Table 12; IUCN, 2011). Species richness ranges from 5 at the shallow reef sites of WP6, to 14 at the Caye Bokel back reef site (Figure 23), with the most abundant species encountered being *Millepora alcicornis,* followed by *Porites asteroides, Agaricia tenuifolia* and *Montastrea annularis* (UB/ERI, 2010). Some species are widely distributed over the Atoll - two species (*Siderastrea siderea* and *Millepora alcicornis*) are found at over 88% of the ERI survey sites. Four

Turneffe Atoll Coral Species of International Concern	
Critically Endangered	
Staghorn Coral	*Acropora cervicornis*
Elkhorn Coral	*Acropora palmata*
Endangered	
Boulder Star Coral	*Montastraea annularis*
Star Coral	*Montastraea faveolata*
Vulnerable	
Lamarck's Sheet Coral	*Agaricia lamarcki*
Pillar Coral	*Dendrogyra cylindrus*
Elliptical Star Coral	*Dichocoenia stokesii*
Fire Coral	*Millepora striata*
Montastraea coral	*Montastraea franksi*
Rough Cactus Coral	*Mycetophyllia ferox*

Table 12: Coral Species of International Concern of Turneffe Atoll (IUCN, 2011)

species are only represented at single ERI survey sites (*Favia fragum, Acropora cervicornis, Meandrina meandrites* and *Isophyllastrea rigida*). The critically endangered *Acropora cervicornis,* found only at a limited number of sites (including the deep fore-reef of ERI survey site 1206, and at Soldier Caye and Calabash), was once one of Belize's primary reef building corals, forming a major constituent in the reef 1960 assessment (Figures 24 and 25; Stoddart, 1962).

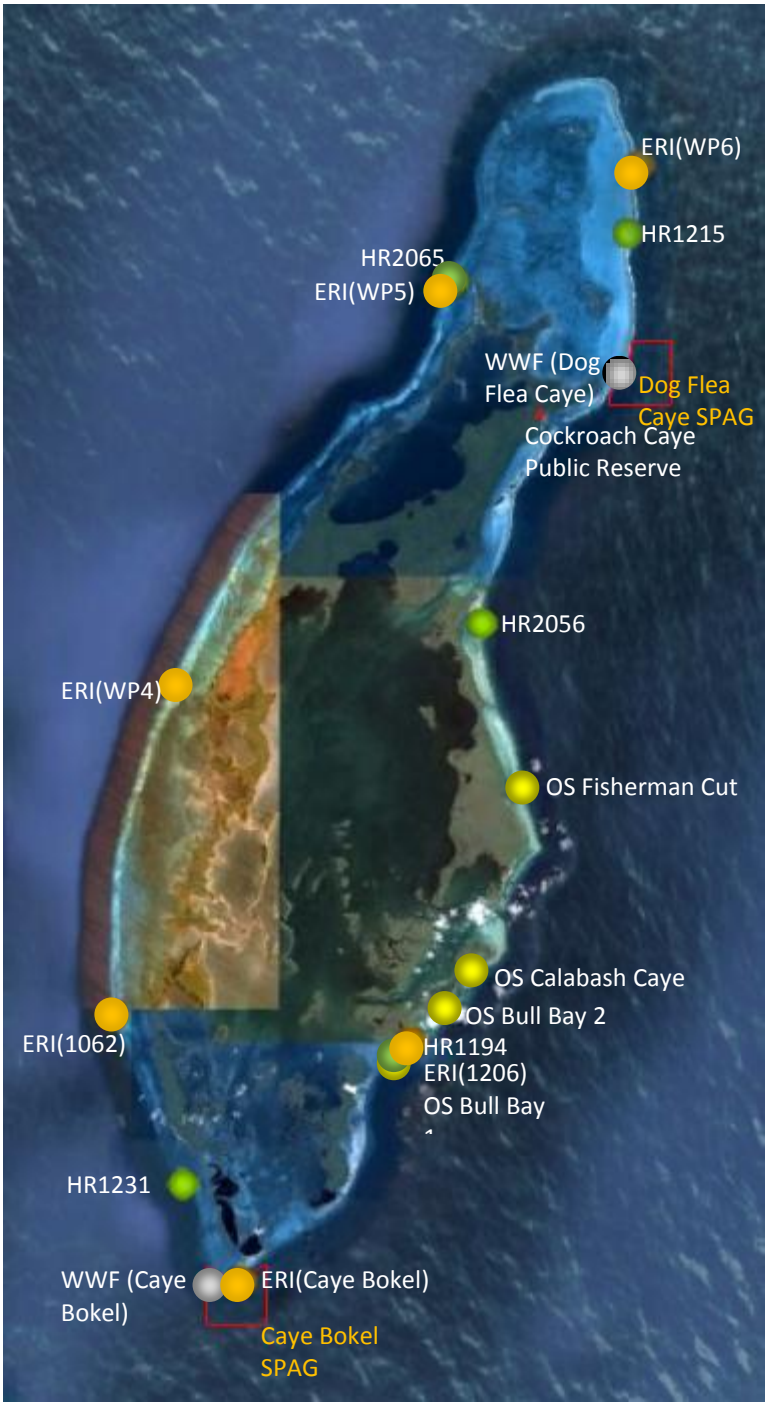
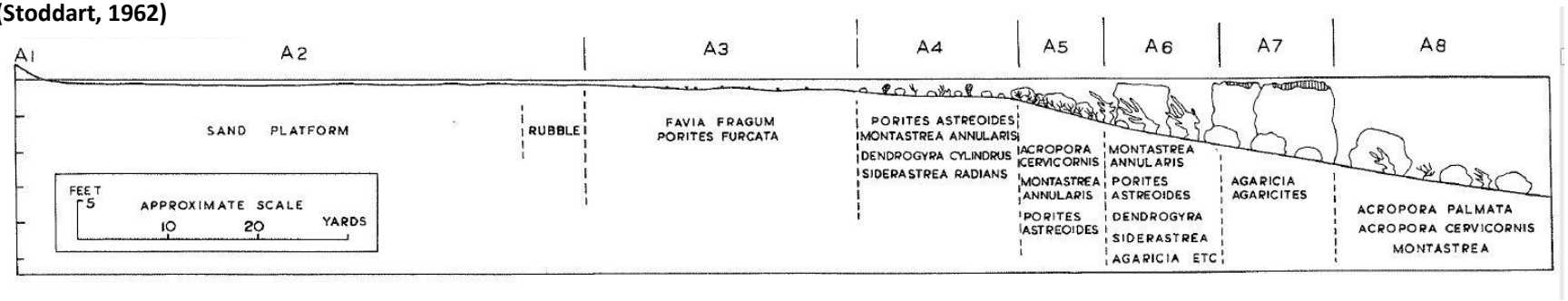


Figure 23: Coral Reef Monitoring sites of Turneffe Atoll

Historical Baseline - Transect on East Facing slope of Turneffe Atoll (Stoddart, 1962)



A 1. Seaward shore of Calabash Caye.

A 2. Sand and rubble platform adjacent to Calabash Caye. Averaging 200 feet wide, covered with 6-12 inches of water. It is carpeted with *Thalassia* and small green algae, including *Halimeda*. The sand content of the flat diminished seaward, and near its outer edge the platform consists of brittle *Porites* rubble.

A 3. Reef flat. A sandy area 20-30 yards wide, sloping gradually seaward, under 12-18 inches of water. Small corals (*Favia fragum*, *Porites divaricata*) and sea-urchins (*Diadema*) are scattered in the turtle grass.

A 4. Inner reef zone. A sandy bottom under two feet of water, with scattered colonies up to a foot in diameter of *Montastrea annularis, Porites astreoides* and *Dendromra cylindrus*, with small colonies of *Siderastrea radians*. Sea fans and sea-whips are also found.

A 5. Cervicornis zone. Same as zone 4, but with a ground cover of *Acropora cervicornis*, much of it dead. The *Montastrea* and *Porites* colonies are larger (up to 2 feet diameter), but sea fans and sea-whips are less abundant.

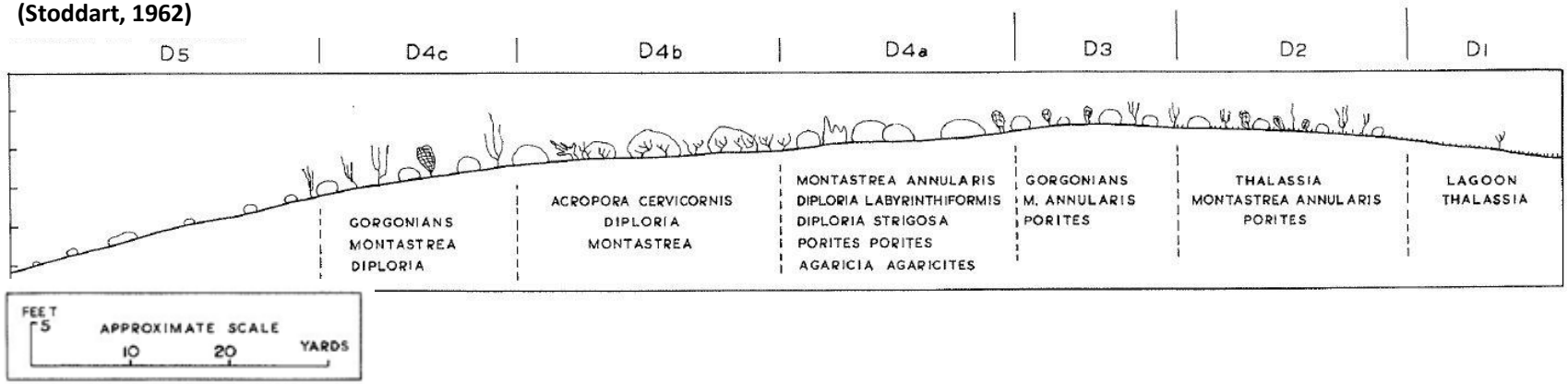
A 6. Annularis zone. This 10-15 yards wide zone is located immediately landward of the breaker zone: the dominant colonies are large blocks of *Montastrea annularis, Porites astreoides, Dendrogyra cylindrus* and *Siderastrea siderea*. Minor constituents include both encrusting and foliaceous *Agaricia*, scattered *Acropora cervicornis*, and massively-built but scattered *Acropora palmata* with branches current-swept lagoonward. The larger colonies are intersected by deep winding channels 6-8 feet deep, fioored with coarse, often rippled sand.

A 7. Reef-crest. This consists of massive blocks of largely dead coral, covered on the upper surface almost exclusively with *Agaricia agaricites*. Channels between the blocks are up to 10 feet deep. The zone has a width of only a few yards.

A 8. Outer slope. A platform 10-15 feet deep, and deepening seaward. Colonies are rather small, perhaps averaging 2 feet in diameter, and very varied (*Montastrea, Porites, Siderastrea*). Between the boulder-like forms are scattered low colonies of *Acropora palmata* and *Acropora cervicornis.*

Figure 24: Results of Calabash Caye transect eastwards (from Stoddart, 1962)

Historical Baseline - Transect on West Facing slope of Turneffe Atoll (Stoddart, 1962)



The transect is taken in the latitude of English Caye, half way along the length of the eastern reef. The west reef of Turneffe does not break surface or rise to a well-marked crest (except in the Rendezvous Caye area (Cho-Ricketts, pers. com., 2011) Reef growth begins a considerable distance from the mangrove fringe, from which it is separated by a lagoon 1.5 - 2 fathoms deep, several hundred yards wide, and floored with *Thalassia*. The bottom of this lagoon slopes gradually from the mangrove fringe to deeper water and coral colonies are distributed on this slope, beginning ¼ to ½ mile from the mangrove, and continuing seaward for 300 - 400 yards and more.

D 1. Lagoon. 9-12 feet deep, with a sandy floor thickly covered with *Thalassia* and gorgonians.
D 2. *Thalassia*-Gorgonian zone, 5-10 feet deep, similar to zone D1 but shallower, with scattered, mainly small colonies of *Montastrea annularis* and *Porites*. The most conspicuous element is the population of large and varied gorgonians. No large algae were seen.
D 3. Gorgonian zone. This is similar to zone D2, except that the *Thalassia* carpet is absent, and the bottom is formed of white sand.
D 4. Main reef zone. This has depths of 10-15 feet and a fairly flat bottom. The dominant corals are *Montastrea annularis*, *Diploria labyrinthiformis* and *Diploria strigosa*, with *Porites porites* and *Agaricia agaricites*, and small colonies of *Dendrogyra cylindrus*, *Montastrea cavernosa*, and occasionally *Mycetophyllia lamarckana* and *Isophyllastrea rigida*. Three subzones, from lagoon to sea, may be recognised:

a) the coral colonies are large and scattered, and interspersed with gorgonians and some sponges from zones D2 and D3.
b) the coral colonies are large and closely spaced, with a continuous undercarpet, not more than 2 feet high, of open-branched *Acropora cervicornis*. Gorgonians and sponges are of small importance.
c) coral colonies are sparser, and the cervicornis carpet gives way to a sandy bottom, populated with very large gorgonians, 4-5 feet high, and sponges.

Subzone (b) is clearly the main reef zone. Only a single small colony of *Acropora palmata* was seen in this transect.
D 5. Here the bottom slopes steeply into the blue, and is covered with much rubble. It is scattered with various small unidentified coral colonies.

Figure 25: Results of English Caye transect leewards (from Stoddart, 1962)

Surveys from 2007 showed live coral cover at Caye Bokel to be 11.9% on shallow reef, and 22.7% on deeper reefs (Belize Fisheries Dept. et al., 2008). 2009 assessments of percentage live coral cover for Turneffe Atoll demonstrated an average of 18.8% across monitoring sites (Healthy Reefs data, 2009), similar to the national average of 18.7% (Healthy Reefs Initiative., 2010). This represents a significant decrease from the 1998 survey, when percent live coral cover averaged aproximately 33% (CCC /Taylor et al., 1999). A more recent survey in 2010 estimates percentage average live coral cover for the Atoll at 9.6%, representing a decline of almost 50% since the previous year, and a trend that is mirrored in two of the three sites monitored during both years (Table 13; UB/ERI). Percentage live coral cover ranges from 2.7% on the east facing back reef at site WP6, to 23.1% on the west-facing back reef at site WP5.

A number of current monitoring sites do still show a healthy % live coral cover : % macroalgal cover ratio. Site WP4 (back reef), WP5 (back reef) and Caye Bokel

Site Code	Sub-site	% Coral Cover	% Macroalgal cover
UB/ERI Monitoring Sites (2010 data)			
WP4	Back reef	7.0	0.2
	Shallow Fore reef	3.2	21.3
	Deep Fore reef	7.7	22.8
WP5	Back reef	23.1	3.0
	Shallow Fore reef	6.5	4.3
	Deep Fore reef	5.8	5.6
WP6	Back reef	2.7	23.2
	Shallow Fore reef	8.2	43.0
	Deep Fore reef	14.5	48.0
Caye Bokel	Back reef	12.8	17.2
	Shallow Fore reef	18.7	3.8
	Deep Fore reef	8.2	9.3
T1062	Back reef	8.2	8.5
	Shallow Fore reef	3.7	8.2
	Deep Fore reef	4.8	4.5
T1206	Back reef	6.5	28.5
	Shallow Fore reef	14.0	29.7
	Deep Fore reef	17.2	17.0
Average (sites on west side of Atoll)		**7.8**	**8.7**
Average (sites on east side of Atoll)		**11.4**	**24.4**
Overall Average		**9.6**	**16.6**

Table 13: % live coral cover and % macroalgal cover, 2010 (UB/ERI, 2011)

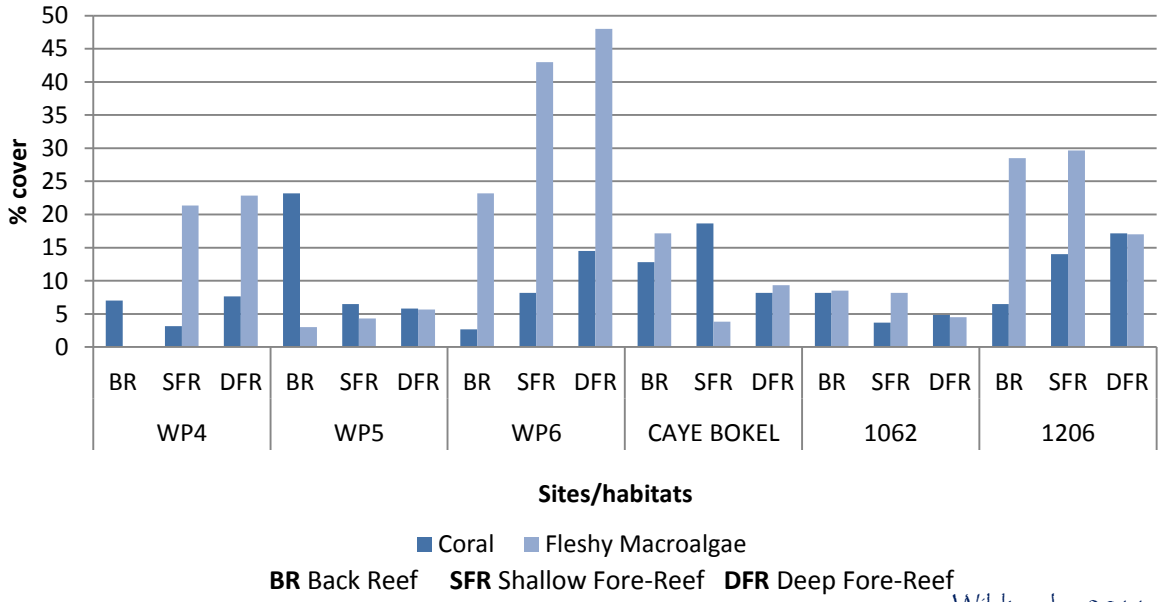


Figure 27: % live coral cover / % macroalgal cover for Turneffe Atoll, 2010 (UB/ERI data, 2010)

(shallow fore reef) all have low % macroalgal cover values, ranging from 0.2% to 3.8%. Site WP5 also has the highest % live coral cover value, at 23.1% (UB/ERI, 2011; Healthy Reefs, 2010; Figure 27).

Whilst it is not possible to compare the results from different survey sites, even within the same general area, it is interesting to note that the 2007 survey showed an increase in live coral cover in the shallow fore reef site at Caye Bokel, with a corrresponding decrease in % macroalgal cover (Table 14; Belize Fisheries Dept. et al., 2008). This survey also included Dog Flea Caye - the second fish spawning aggregation site, considered the furthest from human impacts. The % coral cover : % macroalgal cover results for this site for 2007 show macroalgal figures as double or more those of % live coral cover (Belize Fisheries Dept. et al., 2008). This site was not monitored in 2010.

Site	Sub-Site	2007[1]		2010[2]	
		% Coral Cover	% Macroalgal Cover	% Coral Cover	% Macroalgal Cover
Caye Bokel	Back reef	6.5	11.0	12.8	17.2
	Shallow Fore reef	11.9	10.2	18.7	3.8
	Deep Fore reef	22.7	16.9	8.2	9.3
Dog Flea Caye	Back reef	-	-	-	-
	Shallow Fore reef	8.8	15.4	-	-
	Deep Fore reef	15.6	37.5	-	-

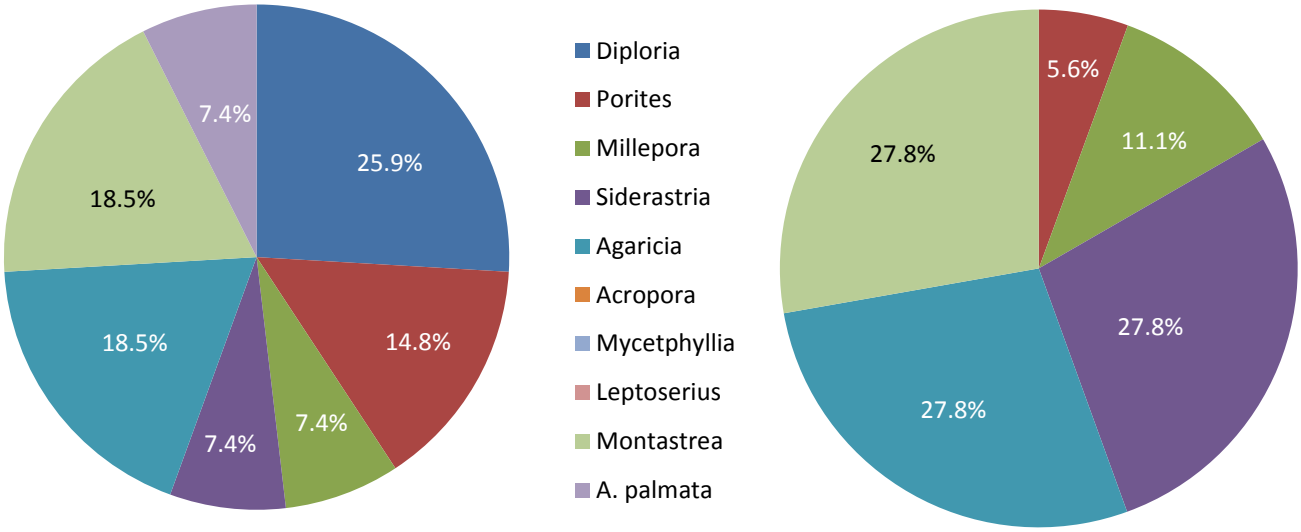
[1] WWF AGGRA results, 2007
[2] UB/ERI results, 2010

Table 14: % coral and macroalgal cover at Caye Bokel and Dog Flea Caye (WWF, 2007; UB/ERI, 2010)

Baseline surveys were conducted in 2007 at both Caye Bokel and Dog Flea Caye, two of Turneffe's spawning aggregation sites, providing information on coral species presence (Figures 39 and 30; Belize Fisheries Dept. et al., 2008). Significant differences were observed in coral species diversity and composition between the north and south of Turneffe Atoll (Figure 31; Belize Fisheries Department et al. 2008). The shallow reef transect at Dog Flea Caye to the north was demonstrated to have a lower coral diversity (n= 28 species), whilst that of Caye Bokel to the south had higher diversity (n=57) for a transect of identical size, a pattern that repeated itself with the deep reef sites of both spawning aggregation sites.

With respect to species composition, at the shallow reef site in the north, the dominant genus is *Diploria* (25.9%), followed by *Agaricia* and *Montastrea*, each representing 18.5% of the total number of corals recorded. The shallow reef of Caye Bokel, in the south, however, is dominated by *Millepora* (42%), followed by *Siderastrea* as the second most abundant (28%) - these two species contribute only 7.4% each to coral composition in the north site at Dog Flea Caye.

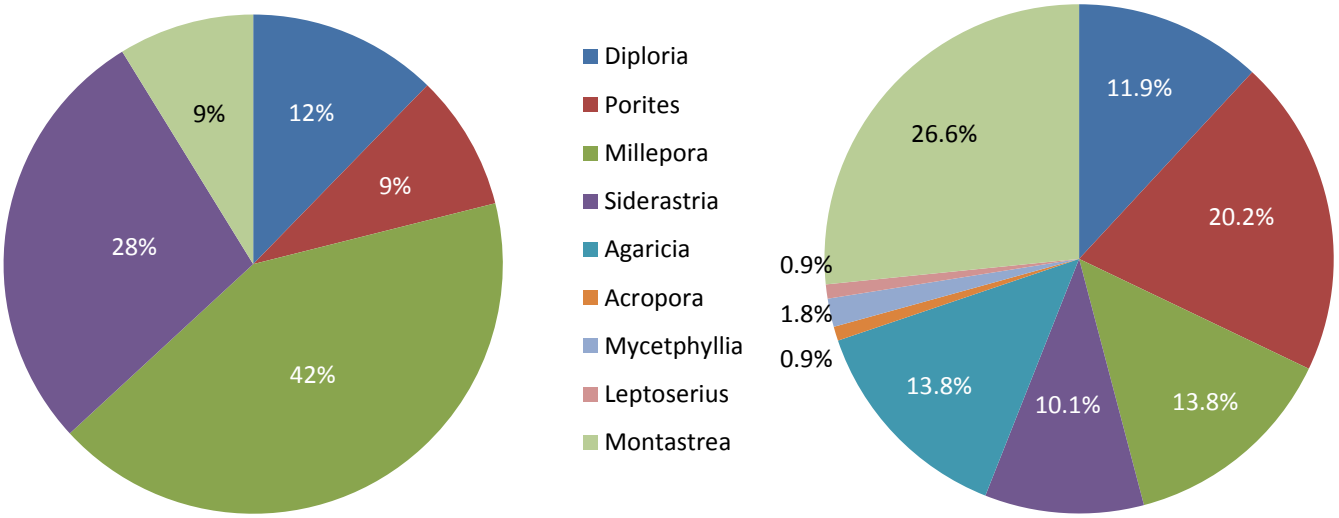
For the deep reef sites, the dominant genera in the north are *Siderastrea, Agaricia* and *Montastrea,* each contributing 27.8% to total composition. In the south, where the total number of corals is three times higher than the north, the dominant genera are *Montastrea* (26.6%), with *Porites* as the second most abundant (20.2%).



Dog Flea Caye (Shallow Reef) N= 28
North Turneffe Atoll

Dog Flea Caye (Deep Reef) N=36
North Turneffe Atoll

Figure 29: Dog Flea Caye Hard Coral Composition (WWF, 2007 in Belize Fisheries Department et al. 2008)



Caye Bokel (Shallow Reef) N= 57
South Turneffe Atoll

Caye Bokel (Deep Reef) N=109
South Turneffe Atoll

Figure 30: Caye Bokel Hard Coral Composition (WWF, 2007 in Belize Fisheries Department et al. 2008)

More recent transects conducted in 2010 also track species composition, with three sub-sites having particularly high species diversities – one to the north (the back reef of WP5 – considered a potentially important resilient site), and two to the south (the shallow fore-reef of Caye Bokel and the deep fore-reef of Site 1206 (Figures 31 and 32; UB/ERI, 2011).

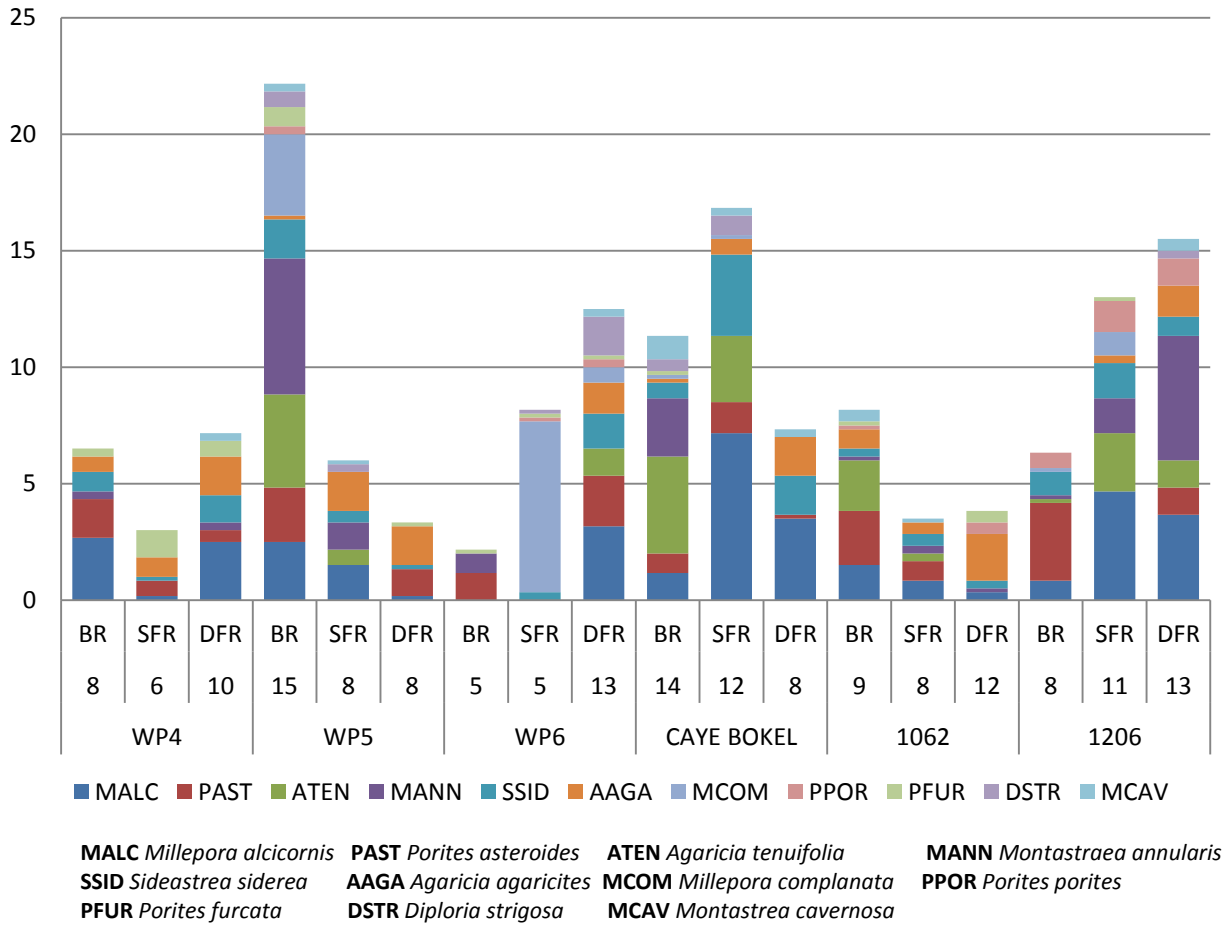


Figure 31: Stony coral species richness and distribution per site at Turneffe Atoll (UB/ERI, 2011)

Overall species presence is also monitored, with *Millepora alcicornis* demonstrating the highest percentage cover, followed by six other species - *Porites asteroides, Agaricia tenuifolia Montastraea annularis, Siderastrea siderea, Agaricia agaricites and Millepora complanata* (Figure 32; UB/ERI, 2011).

MALC *Millepora alcicornis*
PAST *Porites asteroides*
ATEN *Agaricia tenuifolia*
MANN *Montastraea annularis*
SSID *Sideastrea siderea*
AAGA *Agaricia agaricites*
MCOM *Millepora complanata*
PPOR *Porites porites*
PFUR *Porites furcata*
DSTR *Diploria strigosa*
MCAV *Montastrea cavernosa*
PDIV *Porites divaricata*
MFRA *Montastraea franksi*
SINT *Stephanocoenia intersepta*
DSTO*Dichocoenia stokesi*
SRAD *Siderastrea radians*
CNAT *Colophyllia natans*
DLAB *Diploria labyrinthiformis*
SBOU *Solenastrea bournoni*
FFRA *Favia fragum*
ACER *Acropora cervicornis*
MMEA *Meandrina meandrites*
IRIG *Isolphyllastrea rigida*

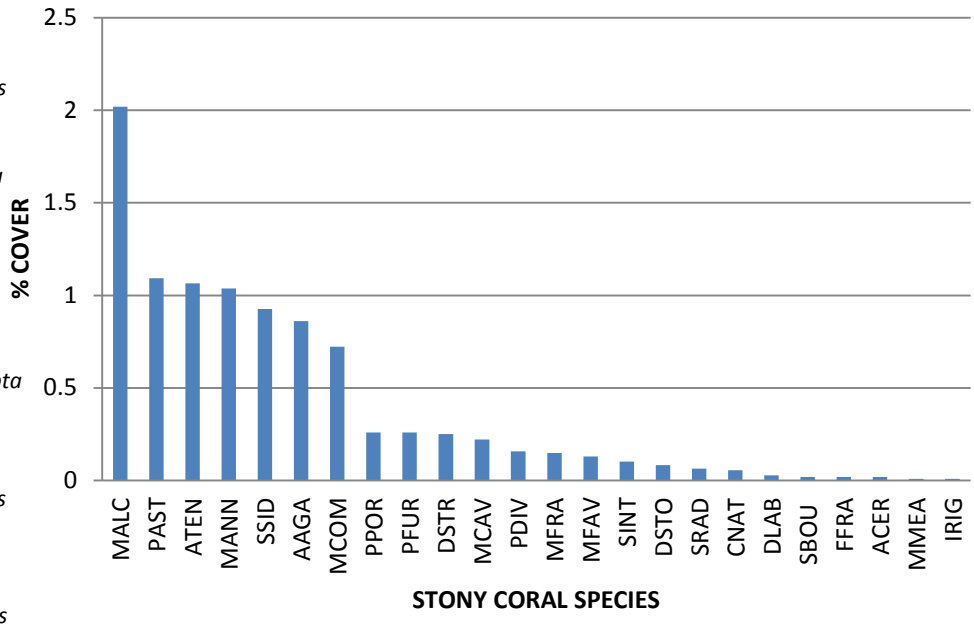


Figure 32: Relative species composition of Stony coral species at Turneffe Atoll (UB/ERI, 2010)

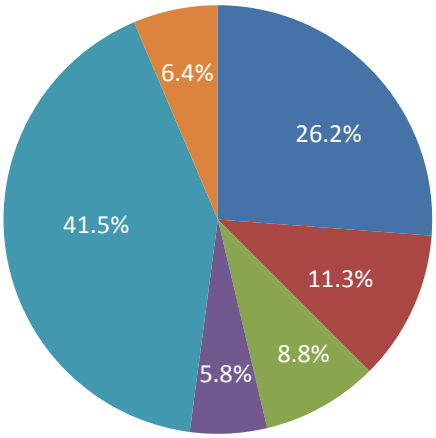
Surveys were also conducted at the four Oceanic Society survey sites, all situated on shallow patch and back reef of the east facing wall, in the southern portion of the Atoll (Table 15; Figure 32; Cure / Oceanic Society, 2009).

Photo: Turneffe Atoll Trust

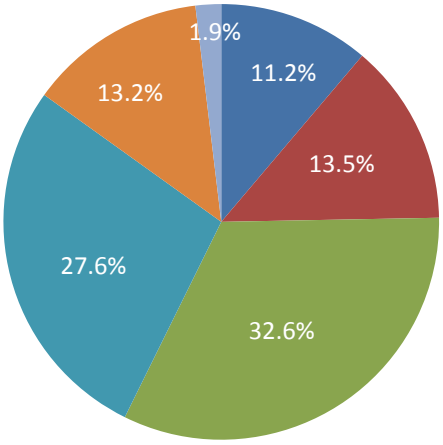
The highest % live coral cover was demonstrated to be at the southern-most site, Bull Bay 1 – also displaying a relatively high species diversity of 13 species. The highest coral species diversity was observed at the Calabash Caye survey site. Only two sites had representative *Acropora* colonies (Bull Bay 1 and Calabash Caye) (Cure / Oceanic Society, 2009).

Site	No. of Species	% live coral cover
Bull Bay 1	13	17.2
Bull Bay 2	11	10.9
Calabash Caye	15	10.1
Fisherman's Cut	6	10.5

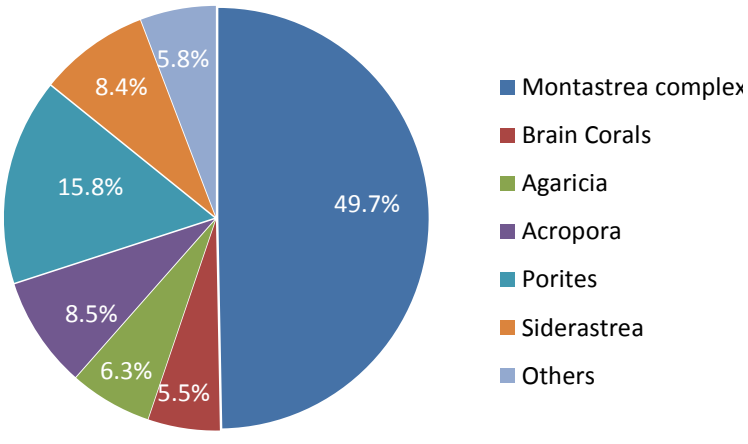
Table 15: Coral diversity and health (Oceanic Society, 2009)



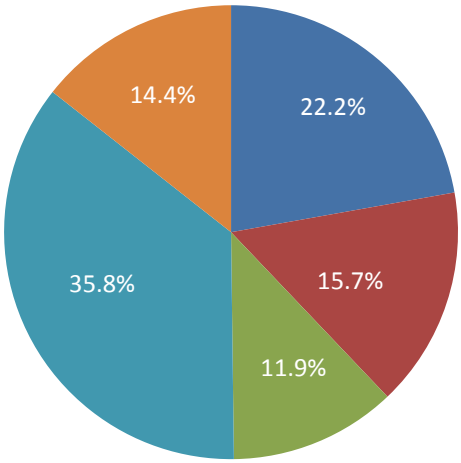
Bull Bay 1



Bull Bay 2



Calabash Caye



Fisherman's Cut

Figure 32: Coral species composition at Oceanic Society survey sites during 2009 monitoring event; data shown corresponds to percentage of total coral composition (Cure / Oceanic Society, 2009)

Coral Bleaching

Coral bleaching has become an emerging issue for coral reef conservation and management over the last fifteen years, since the first mass bleaching of 1997/98. Bleaching reduces the health of corals, as the symbiotic partnership between corals and zooxanthellae algae breaks down with higher sea temperatures, leaving corals more vulnerable to disease and infection until sea temperatures fall, and the symbiotic relationship can be re-established (Marshall et al., 2006). Bleaching events are predicted to rise significantly with increasing sea temperature (Westmacott et al., 2000), with an associated increase in coral mortality, loss of coral cover and losses in biological diversity. This will have economic implications for the fisheries and tourism sectors.

In Belize, increased water temperatures generally occur during August – October, coral recovering as cooler weather reduces sea temperatures in December. Tropical storms may help to prevent bleaching, reducing sea temperatures, with cooler, deeper water being drawn to the surface, and oceanic waters being pushed onto the Atolls and coastal shelf.

Incidence of coral bleaching in 2011 for Belize follows this pattern (291 surveys) (Figure 33: NCRMN, 2011). September was the month with the highest bleaching incidence (24.62%), and records indicate that 49 out of 57 species monitored showed signs of bleaching (NCRMN, 2011).

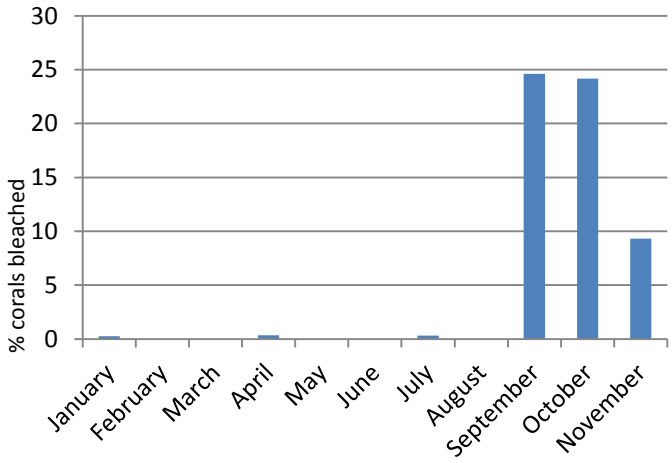


Figure 33: Incidence of coral bleaching, Belize 2011 (NRCMN, 2011)

Coral bleaching has been monitored at Turneffe Atoll by UB/ERI and Oceanic Society since 2008, based on three consistent monitoring sites – Site 1062 (ERI), Calabash Caye and Happy Hour (Oceanic Society). Using September, 2011 as a snapshot of coral bleaching and disease on the Atoll, 54% of the corals sampled (n=577) showed no sign of bleaching whilst 22.4% showed coloration indicative of stress, and 6% were completely bleached

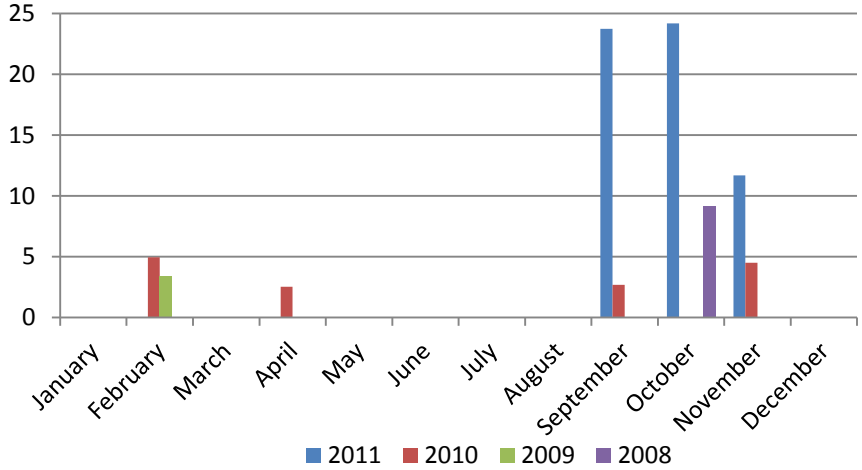


Figure 34: Incidence of coral bleaching at Turneffe, 2008 - 2011 (ERI/Oceanic Society data, NRCMN, 2011)

(Figure 35; ERI/Oceanic Society data, NCRMN, 2011).

Ten of the coral species were affected by total bleaching ('wholly bleached'), with levels ranging from 0.5% of the colonies recorded (*Dichocoenia stokesi, Porites furcata*) to 9.8% (*Siderastrea siderea*) (Table 16; ERI/Oceanic Society data, NCRMN, 2011).

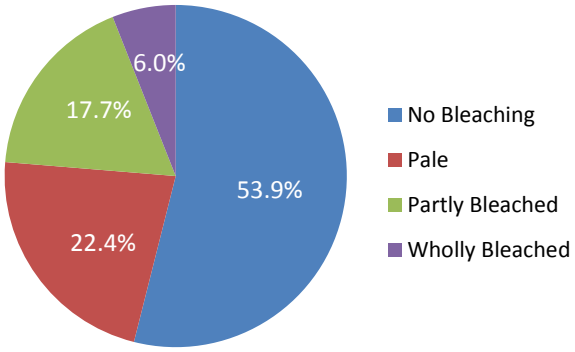


Figure 35: Incidence of bleaching at Turneffe, September, 2011 (ERI/Oceanic Society data, NRCMN, 2011)

Species			% wholly bleached
Siderastrea siderea	SSID	Massive starlet coral	9.13
Millepora alcicornis	MALC	Branching fire coral	1.50
Porites astreoides	PAST	Mustard hill coral	1.50
Porites porites	PPOR	Club-tip finger coral	1.50
Porites divaricata	PDIV	Thin finger coral	1.00
Agaricia tenuifolia	ATEN	Thin leaf lettuce coral	0.75
Meandrina meandrites	MMEA	Maze coral	0.56
Agaricia agaricites	AAGA	Lettuce coral	0.53
Dichocoenia stokesi	DSTO	Elliptical star coral	0.50
Porites furcata	PFUR	Branched finger coral	0.50

Table 16: % of coral species reported as 'wholly bleached', Turneffe Atoll monitoring sites, September, 2011

With respect to coral disease, incidence at the same sites in September 2011 was relatively low - the highest incidence being White Plague 3% of corals surveyed (Figure 36; UB/ERI data, NCRMN, 2011)). Other diseases present at low levels were White Spot, Dark Spot, Red Band, and White Band.

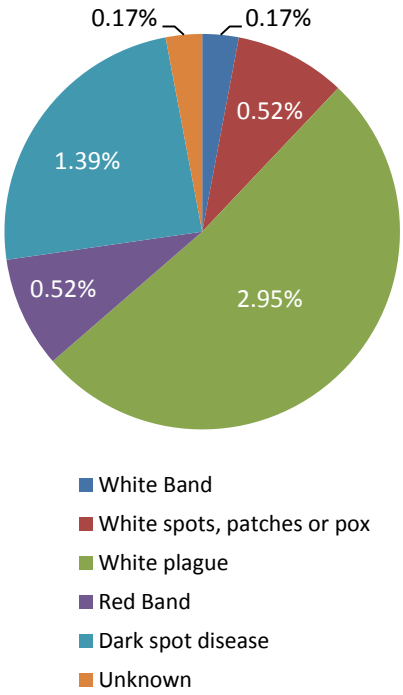


Figure 36: Incidence of coral disease at Turneffe, September, 2011 (ERI/Oceanic Society data, NRCMN, 2011)

Integrated Healthy Reef Index

The coral reef of Turneffe Atoll is considered to be declining in health, with an overall Integrated Healthy Reef Index (IHRI) score of 2.6 out of a possible 5.0 – **POOR** (Table 17; UB/ERI, 2011), similar to the IRHI score of 2.3 for the Atoll in 2009 (Healthy Reefs, 2010). No sites rated as **VERY GOOD** under the Integrated Reef Health Index, and only one sub-site rated as **GOOD** (the deep fore reef of Site 1206). The majority of sites (10 out of 18 (55.6%)) rated as **POOR** (Figure 37; UB/ERI, 2010).

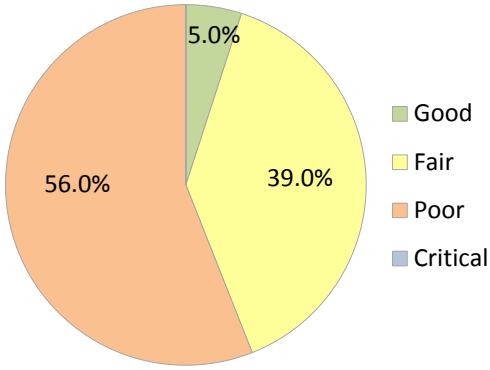


Figure 37: State of coral reef sites at Turneffe, 2010 (n = 18). (UB/ERI, 2011)

The back reef sites rated as **FAIR,** with an IRHI score of 2.75, whilst both shallow fore-reefs and deep fore-reefs rated as **POOR** (2.55 and 2.36 respectively) (Figure 38; UB/ERI, 2010). Generally, the reefs at the southern end of the Atoll tend to be in better health than those at the northern end (UB / ERI, 2010; WWF, 2007 in Belize Fisheries Department et al. 2008).

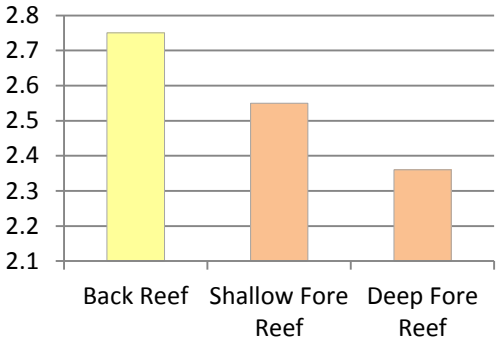


Figure 38: State of coral reef sites by habitat at Turneffe, 2010. (UB/ERI, 2011)

Integrated Reef Health Index	Very good (5)	Good (4)	Fair (3)	Poor (2)	Critical (1)	Average for Turneffe Sites
Coral cover	≥ 40	20-39.9	10-19.9	5.0-9.9	<5	**Poor**
Coral disease prevalence	>1	1.1-1.9	2.0-3.9	4.0-6.0	>6	**Good**
Fleshy macroalgae % cover	0-0.9	1.0-5.0	5.5-12.0	12.1-25	>25.0	**Good**
Commercial fish abundance	≥2800	2100-2799	1400-2099	700-1399	<700	**Poor**
Herbivorous fish abundance	≥4800	3600-4799	2400-3599	1200-2399	<1200	**Critical**
***Diadema* abundance**	>2.5 (and	1.1-2.5	0.5-1.0	0.25-0.49	<0.25	**Critical**
Overall IRHI for Turneffe Atoll, 2010						**POOR**

Table 17: 2010 Mean IRHI Core Values for Turneffe Atoll (UB/ERI, 2011)

Seagrass

Seagrass is the most extensive ecosystem of the Turneffe Atoll, with approximately 67% of the shallow Atoll platform supporting extensive meadows (UB/ERI, 2011; Meerman, 2004), dominated by *Thalassia testudinum.* These seagrass meadows stretch from the reef crest across the back reef, particularly on the west side of the Atoll, and through the southern and central lagoons, providing stabilization to the sediments of the sea bed and helping to maintain some of the most productive lobster grounds in Belize (Mcfield). Three species of seagrass have been identified to date within Turneffe Atoll - turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*), and *Halodule wrightii* (Cawich, pers. com.), along with algae such as *Halimeda* spp., which also considered important components of this ecosystem, and distributed throughout the seagrass beds.

Seagrass meadows create high diversity habitats in shallow marine ecosystems, with important roles in nutrient cycling, filtration and sediment stabilization (Bos et al., 2007). Seagrass also provides a critical habitat for many fish and invertebrate species - an acre of seagrass has been shown to support up to 40,000 fish and 50 million small invertebrates (Seagrass Ecosystems Research Laboratory, 2005). This ecosystem fills a critical role as a nursery area for the commercially important conch, many reef fish (including commercial species such as tarpon, hogfish, yellowtail snapper and great barracuda), and for the key herbivore guild species assemblages - the parrotfish. The seagrass also provide corridors for juvenile lobsters between habitats and important settlement areas for post-larval stages of commercial species (Acosta, 2001).

Seagrass areas of Turneffe Atoll are considered to be in very good condition, with minimal human impacts, restricted to scarring of the seagrass beds in shallow areas of high boat activity, and limited dredging impacts in isolated development areas (MAP, 2011).

Photo: Turneffe Atoll Trust

Monitoring of two seagrass sites has just started under the UB/ERI monitoring programme – one at Calabash, on the east facing side of the Atoll, and one on Western Turneffe. The results suggest that the seagrass at Turneffe Atoll falls within the average range of seagrass biomass across the Mesoamerican Reef, based on MBRS 2006 data (UB/ERI, 2010).

Terrestrial Ecosystems

Turneffe Atoll has an area of 525 km^2 of which 110.1 km^2 is considered terrestrial, consisting of approximately 450 cayes, ranging from large land masses almost 4,500 ha (45km^2) in size, to rubble cayes smaller than 0.02 ha (Murray et al., 1999).

Under the UNESCO system of vegetation classification, four natural ecosystems have been identified and mapped on Turneffe Atoll (Meerman, 2004):

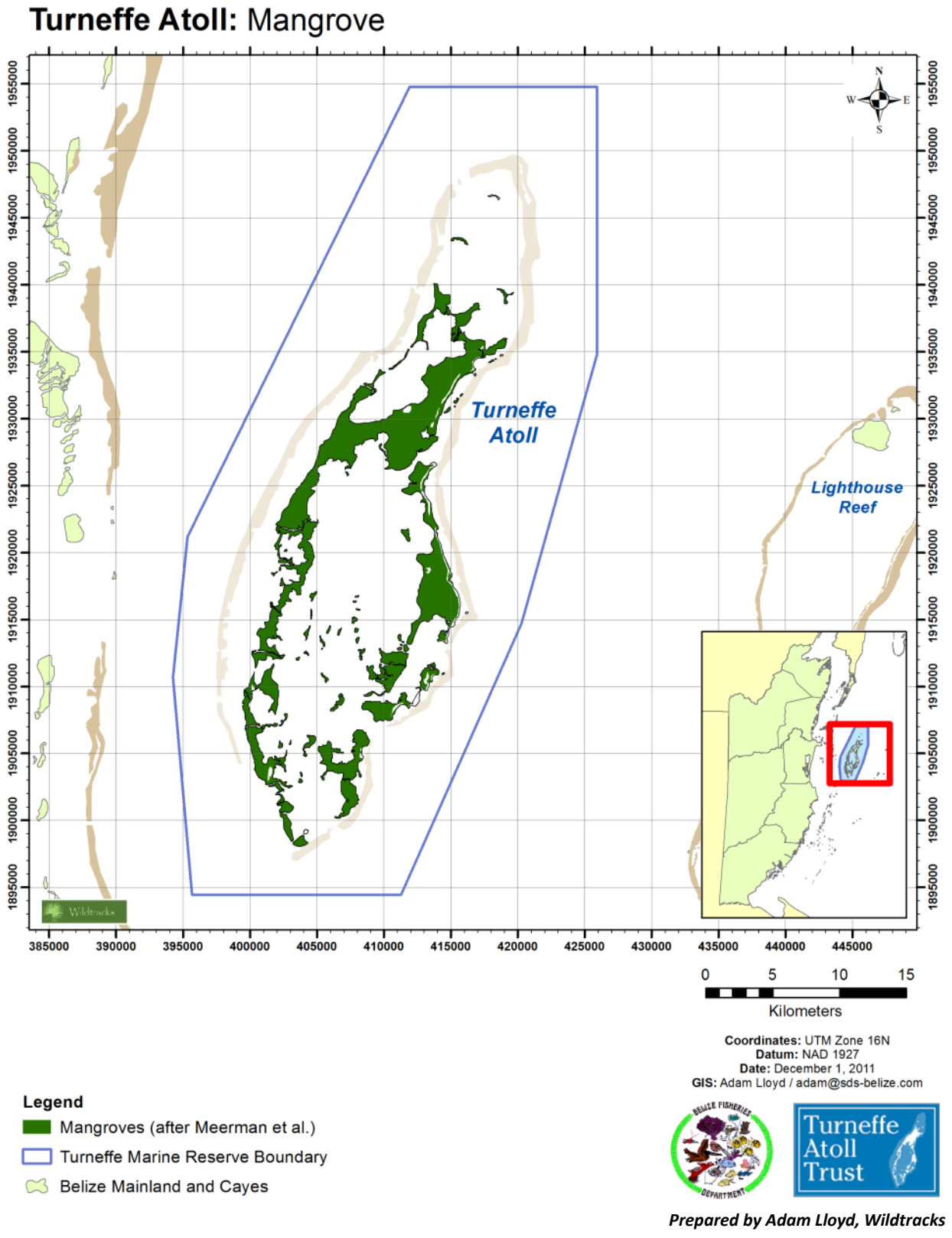
- Caribbean mangrove forest: basin mangrove
- Caribbean mangrove forest: coastal fringe mangrove
- Caribbean mangrove forest: mixed mangrove scrub
- Tropical coastal vegetation on recent sediments: littoral forest and herbaceous beach vegetation

Of these, the most extensive system is the Caribbean mangrove Forest, covering an estimated 11,000 hectares (Map 10), whilst littoral forest (as Belize's most threatened ecosystem) is now reduced to 240 hectares on the Atoll, primarily as the result of anthropogenic impacts. Natural impacts are also important - as elsewhere in the Caribbean, the terrestrial vegetation of the Turneffe cayes is constantly changing over time, as past and current storm events change the shape, height and substrate of the caye (Stoddart, 1963). Changes in elevation above sea level of just a few centimeters can have profound impacts on plant succession, species composition and vegetation structure, and will affect response to increased sea levels.

Tropical storms and hurricanes not only impact standing vegetation, but often redefine island shapes, size and elevation – resulting in accelerated or even diverted successional paths and thereby having a profound impact on the landscape. In mapping and describing the ecosystems and vegetation of Turneffe, as on all other low-lying islands that typify Belize's cayes, it is therefore important to bear in mind that this is a current snapshot of a dynamic system that is driven by natural processes and which is becoming increasingly impacted by human activities.

Caribbean mangrove forest: basin mangrove

Occurring on water-logged and generally peaty soils at sea-level, basin mangrove has been mapped as having a coverage of approximately 686 hectares, or 6.8% of the land of Turneffe Atoll (Meerman, 2004). Normally occurring in patches on sheltered coastal lagoons, basin mangrove on Turneffe mostly occurs on the easternmost areas of the Atoll, in far larger stands than is typical for this ecosystem in Belize. This reflects both the degree of shelter from tropical storm events provided by the reef itself, and the almost unique topography of the Atoll that has enabled the deep peaty soils to develop in shallow basins between the sea and the mixed mangrove scrub on its leeward side.



Map 10: Turneffe Atoll: Extent of Mangrove (Data: Meerman, 2004)

Caribbean mangrove forest: coastal fringe mangrove

Dominated by red mangrove (*Rhizophora mangle)*, this ecosystem generally occupies a narrow fringe between land and water. Mapped as being the most extensive terrestrial ecosystem on Turneffe, with approximately 6,250 hectares or 62% of the overall land area, the coverage of this ecosystem reflects the fact that much of Turneffe lies more-or-less at sea level, with a multitude of islets that cannot be considered as being 'dry land'. These fringing mangroves, with often dense forests of stilt roots standing in the water, are one of the most important fish and invertebrate nursery grounds of the Turneffe system, as well as affording significant storm surge protection.

Caribbean mangrove forest: mixed mangrove scrub

Mixed mangrove scrub (as defined under Meerman, 2004), occurs on soils that are not permanently inundated. Characteristic species within this ecosystem include all three mangrove species – black (*Avicennia germinans),* white *(Laguncularia racemosa)* and red mangrove (*Rhizophora mangle)* – with associates such as palmetto (*Acoelorraphe wrightii),* mangrove fern *(Acrostichum aurem),* buttonwood *(Conocarpus erectus),* teabox (*Myrica cerifera)* and mangrove vine (*Rhabdadenia biflora)*.
Mixed mangrove scrub is the second most extensive terrestrial ecosystem on Turneffe – covering approximately 2,955 hectares – 29% of the land area.

Tropical coastal vegetation on recent sediments: littoral forest and herbaceous beach vegetation

This ecosystem dominates the higher ridges, and typically includes both 'caye forest' and 'beach thicket' - with herbaceous ground-cover plants and vines on the upper beach, grading into woody shrubs with a relatively open canopy of salt-tolerant trees. Tropical Littoral Forest and Beach Vegetation is Belize's most threatened ecosystem, and highlighted under Belize's National Protected Areas System Plan as being significantly under-represented within the current protected area system, with only 8.6% of the national coverage being under protection, as compared with the national target of 60% for this ecosystem.

In 2004, this ecosystem was mapped as having a coverage of approximately 230 hectares on Turneffe Atoll (Meerman, 2004), with much of this being herbaceous beach communities and shrubs, rather than the taller littoral forest. Much of the littoral forest was historically cleared for coconut plantations, and has more recently been superceeded by tourism developments. The higher sandy ridges that support littoral forest have some of the most valuable pieces of real estate in Belize. Indeed, most areas identified as being littoral forest in 1990 (Murray et al., 1990) can now be identified primarily by the presence of cleared lands for tourism development projects or existing tourism developments - Cockroach Bay, Blackbird Caye, Calabash Caye, Ropewalk, and Turneffe Flats.

As vegetation classification systems have changed in recent years, it is difficult to accurately calculate the area of littoral forest on Turneffe that has been lost to development, but it can be presumed that the majority of the current 52 hectares of "urban" category of vegetation was once littoral forest. Currently just 2.3% of Turneffe's lands support this ecosystem.

Changes in nomenclature and classification systems cause confusion in the study and mapping of ecosystems, with Turneffe being no exception. The UNESCO classification has now become the standard for the region, as used by Meerman (2004) – and replaces earlier approaches that often considered specific species assemblages to be ecosystems in their own right, rather than being sub-suites of a wider ecosystem. To help clarify the reclassification implemented for the National Ecosystem Map (Meerman 2004), current ecosystem names and categorizations have been aligned with those used in earlier works (e.g. Murray, et al., 1990), whilst retaining some of the more specific characterization of these earlier works (Tables 18 and 19).

Meerman (2004)	Murray et al. (1999)
Natural Ecosystems	
Tropical Coastal Vegetation on Recent Sediments	Caye Forest
	Beach Thicket
Mixed Mangrove Scrub	Broken Palmetto Thicket
	Broken Palmetto-Buttonwood Thicket
	Palmetto Buttonwood Scrub
Mangrove	Mangrove
Anthropogenically Altered Ecosystems	
Urban	Coconut Plantation
	Other Modified Land Cover
	Degraded and Cleared Vegetation

Table 18: Terrestrial Ecosystems of Turneffe Atoll

Many of the cayes retain the characteristic plants of the natural herbaceous beach community, providing critical nesting habitat for endangered marine turtles and vulnerable American crocodiles, as well as important re-fuelling stations for migratory birds. The above and below ground structure of littoral forest /herbaceous beach vegetation is important in providing protection against potentially massive beach erosion by tropical storm events, which can rearrange or even remove entire cayes. Where anthropogenic clearance has taken place in some areas, and the beaches maintained as stretches of sand with coconut trees, the cayes are significantly destabilized and exposed to greatly increased risk of erosion or complete loss, as is being seen at Ropewalk.

Meerman (2004)	Murray et al. (1999)	Description (Murray et al., 1999)
Tropical Coastal Vegetation on Recent Sediments	Caye Forest	**Height:** 7-15m **Canopy:** *Bursera simaruba, Metopium brownei, Cordia sebestena, Thrinax radiate Pouteria campechiana, Bumelia retusa,* occasional *Coccoloba uvifera* **Understory:** *Ficus* spp. and young of above **Shrub layer:** *Pithecellobium keyense* **Ground Cover:** Leaf litter **Soil Association:** Organic Sand
	Beach Thicket	**Height:** 2 - 7m, dependent on degree of exposure and stunting **Canopy:** *Coccoloba uvifera, Cordia sebestena, Bursera simaruba, Cocos nucifera, Conocarpus erectus, Surianan maritime, Thrinax radiate* and occasional mangroves **Understory and shrub layer:** *Erithalis fruticosa, Pithecellobium keyense, Chrysobalanous icaco, Tournefortia gnaphalodes* **Herb layer:** *Hymneocallis littoralis, Sesuvium portulacastrum, Wedelia, Stachytapheta, Andropogon, Cyperus* and *Eragrostris* **Ground cover:** Leaf litter or base sand / rubble **NB.** This grades down into strand vegetation identified by Stoddart (1962), including *Sesuvium portalacastrum Ipomea per-caprae, Sporobolus virginicus, Euphorobia spp. Canavalia rosea* **Soil Association:** Organic sand, coral sand
Mixed Mangrove Scrub	Broken Palmetto Thicket	**Height:** 3 - 8m **Canopy:** *Acoelorrhaphe wrightii*, *Metopium brownei*, *Conocarpus erectus* **Understory:** *Myrica cerfera* **Shrub layer:** *Scleria bracteata* **Ground cover:** Leaf litter **Soil Association:** Drained peat
	Broken Palmetto-Buttonwood Thicket	**Height:** 3 - 7m **Canopy:** *Acoelorrhaphe wrightii*, *Conocarpus erectus, with occasional Metopium brownei* **Understory:** *Myrica cerfera* **Shrub layer:** *Scleria bracteata* **Ground cover:** Bare ground, algal mats or leaf litter **Soil Association:** Drained peat
	Palmetto Buttonwood Scrub	**Height:** 0.3 – 2mm **Canopy:** *Acoelorrhaphe wrightii*, *Conocarpus erectus* **Understory:** *Myrica cerfera* **Shrub layer:** *Scleria bracteata* **Ground cover:** Leaf litter **Soil Association:** Drained peat

Table 19: Terrestrial Ecosystems of Turneffe – Merrman, 2004) and Murray et al., 1999

Two mangrove survey sites have been established by UB/ERI on the Atoll - Calabash, on the east of the Atoll (N 17^0 17.060' W 087^0 48.778'), and the West Turneffe site (N 17^0 13.302' W 087^0 56.195'). All three mangrove species (red (*Rhizophora mangle*), black (*Avicennia germinans*) and white mangrove (*Laguncularia racemosa*) are present at both sites. Community composition was similar at both sites, with red mangrove as the dominant species (contributing 75% of mangroves at the Calabash Caye site, and 78% at West Turneffe) (Figure 39; UB/ERI, 2011). Black mangroves were more abundant in the Calabash Caye site, forming 14% of the species composition. At the West Turneffe site, this species was uncommon, forming only 3% of mangroves present. White mangroves were present at both sites (11% of mangroves at Calabash Caye and 19% at West Turneffe).

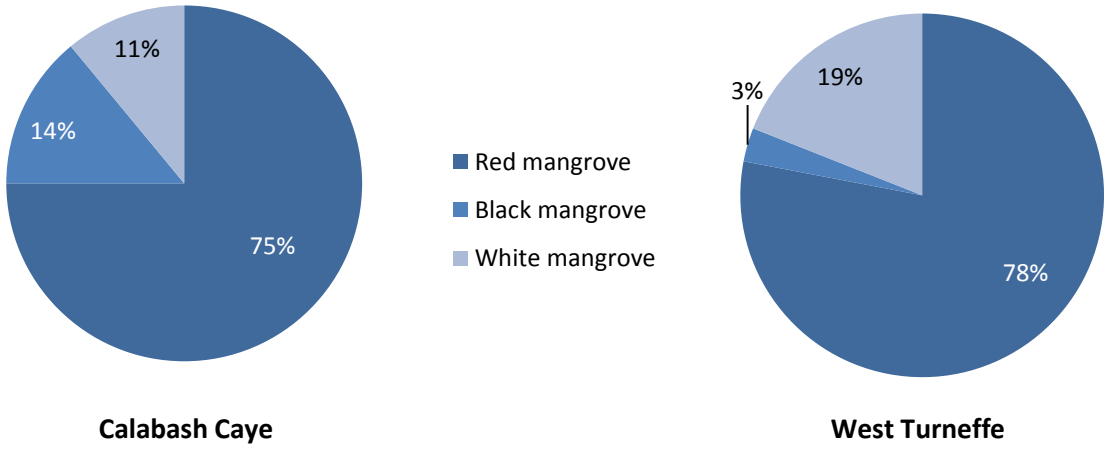


Figure 39: Species composition of mangrove survey sites

Results from the 2010 assessment indicate that the Calabash site has the highest regional density of mangroves of the MBRS monitoring sites, with a density of 9,736 /ha. The West Turneffe site ranked fourth in the region, with a mean density of 2,142.5 per hectare.

The Calabash Caye site had a lower mean canopy height, averaging 3m, and ranging from 1.2m to 6m, increasing with increased distance from shoreline. Mangroves of the West Turneffe site were generally taller, ranging from 1.7m to 12m in height, with an average of 8m, decreasing in height with distance from the shoreline.

1.5.2 Fauna

Turneffe Atoll has long been recognized for its regionally important spawning aggregation sites, as well as for its rich and diverse reef fauna. Conch, lobster and commercial finfish species are covered under Commercial Species

Fish

Of the 550 or so species of fish found in Belize waters (Fishbase, 2011), over 260 are included on the species list for Turneffe Atoll (Harborne, 2000; Cawich pers. com.; Cure pers. com.). Four are considered to be Critically Endangered or Endangered at global scale, including the critically endangered goliath grouper (*Epinephelus itajara*) and endangered Nassau grouper (*Epinephelus striatus*), great and scalloped hammerheads (*Sphyrna mokarran* and *S. lewini*) (IUCN, 2011; Table 20), all of which have been targeted commercially in the past. A further 14 are considered Vulnerable (IUCN, 2011). The rich mosaic of reef, seagrass and mangroves, all in close proximity, has been demonstrated to increase fish biomass within an area - several reef fish species have been shown to reach much greater biomass in Turneffe, where mangroves are abundant, than on other atolls where mangrove habitat is less abundant (Mumby et al., 2004). Observed higher abundances include fish of commercial value such as the blue striped grunt (*Haemulon sciurus*; 25 times higher biomass at Turneffe) and the yellowtail snapper (*Ocyurus chrysurus*; twice higher biomass at Turneffe (Mumby et al., 2004).

Fish Species of International Concern	
Critically Endangered	
Goliath Grouper	*Epinephelus itajara*
Endangered	
Nassau Grouper	*Epinephelus striatus*
Great Hammerhead	*Sphyrna mokarran*
Scalloped Hammerhead	*Sphyrna lewini*
Vulnerable	
Queen Triggerfish	*Balistes vetula*
Marbled Grouper	*Dermatolepis inermis*
White Grouper	*Epinephelus flavolimbatus*
Snowy Grouper	*Epinephelus niveatus*
Northern Seahorse	*Hippocampus erectus*
Hogfish	*Lachnolaimus maximus*
Mutton Snapper	*Lutjanus analis*
Cubera Snapper	*Lutjanus cyanopterus*
Yellowmouth Grouper	*Myctoperca interstitialis*
Whale Shark	*Rhincodon typus*
Whitespotted Toadfish	*Sanopus astrifer*
Whitelined Toadfish	*Sanopus greenfieldorum*
Splendid Toadfish	*Sanopus splendidus*
Rainbow Parrotfish	*Scarus guacamaia*

Table 20: Fish Species of International Concern (IUCN, 2011)

Herbivorous fish populations, such as some species of parrotfish (Scaridae) and surgeonfish (Acanthuridae) are the dominant grazers of the reef ecosystem, and considered important for the maintenance of the health of the reef. These species keep algal growth under control and effectively reduce algal cover, increasing substrate availability for coral recruitment (Mumby et al., 2006). At Turneffe in 2010, herbivore fish species biomass ranged between 129.8g per $100m^2$ and 1955.8g per $100m^2$ per site, with a mean of 781.0g per $100m^2$ (Figure 40; UB/ERI 2011). The highest herbivore

biomass (1956g per 100m^2) was observed on the deep fore-reef at site 1206 (UB/ERI, 2011). These values are considered a sign of a healthy reef.

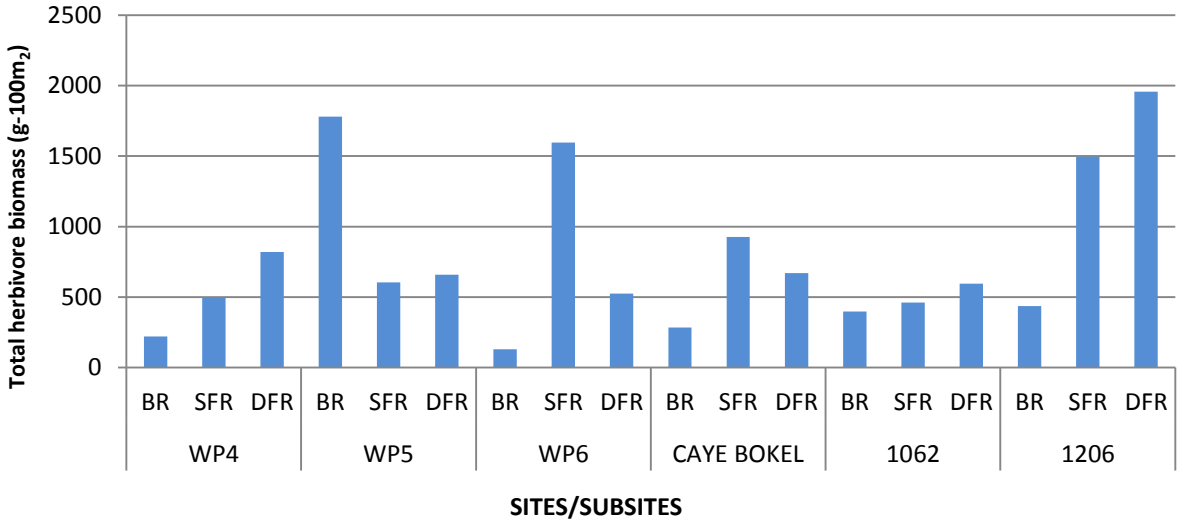


Figure 40: Herbivorous fish species biomass per subsite at Turneffe Atoll (UB/ERI data, 2010)

Comparison of the AGGRA biomass from 2006 and the more recent 2010 UB/ERI figures, shows a significant drop in average parrotfish biomass over the four years, from 1,912g per 100m^2 to 781.0g per 100m^2 (though it should also be noted that the survey sites were not identical). Results from Oceanic Society surveys also show the same pattern, with both scarids and acanthurids decreasing in abundance since 2004, and possibly before (Cure / Oceanic Society, pers. com.). Whilst Turneffe Atoll still retains a population of rainbow parrotfish (*Scarus guacamaia* (Vulnerable – IUCN, 2011), large parrotfish species such as this and the midnight parrotfish (*Scarus coelestinus*), have gone from being abundant to scarce (Cure / Oceanic Society, pers. com.). This is thought to be directly related to speargun fishing on the Atoll (Hayes, pers. com., 2011). The Turneffe average biomass is only 68% of the national Healthy Reefs average for Belize for 2009 (UB/ERI, 2011), possibly a result of limited management presence, and of limited enforcement of SI 49 of 2009, banning fishing of herbivorous fish species.

Surveys of elasmobranchs in the Turneffe Atoll area have identified 16 species, dominated by nurse and Caribbean reef sharks (*Ginglymostoma cirratum* and *Carcharhinus perezi*) (Chapman et al., 2011), representing an estimated third of the elasmobranch species recorded in Belize (Graham, 2007). Aggregations of up to 16 large scalloped hammerheads have been recorded off of Caye Bokel on the southern end of Turneffe, primarily during the cooler months of January-March (Graham pers. comm.), whilst those caught in nets are small, suggesting that the Atoll is both an aggregation area for adults and a nursery area for juveniles (Chapman et al., 2011). The sheltered lagoons and extensive seagrass and mangroves also provide ideal nursery functionality for several other shark species, including great hammerheads (*Sphyrna mokarran*), lemon (*Negaprion brevirostris*) and blacktip sharks (*Carcharhinus limbatus*) (Chapman et al., 2011). A rapid shark and ray survey conducted with the University of Belize in

June 2011 revealed areas of concentration of southern stingrays on the central eastern flank of the atoll in the sandy fore-reef flats. The ray transects further revealed the presence of the little know Caribbean whiptail stingray (*Himantura schmardae* – Data Deficient IUCN 2011) in shallower mixed sandy and seagrass sites (Graham 2011). The capture of a young of the year tiger shark (*Galeocerdo cuvier*) during the same assessment suggests that Turneffe may also be utilised as a nursery areas for this species (Graham 2011).

Studies at the two adjacent atolls of Glover's Reef and Lighthouse Reef have also demonstrated the presence of several deep water species - smooth dogfish (*Mustelus canis insularis*) (Chapman, 2011) and through capture, fisher and jaw identification, a smoothhound species (*Mustelus canis ssp*), the bigeye sixgill (*Hexanchus nakamurai*) and the extremely rare goblin shark (*Mitsukurina owstoni*) (Graham, 2007). Presence of the silky shark (*Carcharhinus falciformis*), the Galapagos shark (*Carcharhinus galapagensis*) and night shark (*Carcharhinus signatus*) at Glover's suggests that these species may also pass within the proposed marine protected area boundaries of Turneffe Atoll. The latter two are not considered common inhabitants of the waters of Central America (Chapman et al., 2011). Southern stingrays (*Dasyatis americana*), spotted eagle rays (*Aetobatus narinari*) and Caribbean whiprays (*Himantura schmardae*) are also present at Turneffe and the other two atolls (Graham et al., 2010; Chapman, 2011).

Connectivity between Turneffe Atoll and the two other atolls or other sites along the Belize Barrier Reef has been documented for at least two species. Satellite and acoustic tracking coupled with diver and fisher observations confirmed that Turneffe is visited by whale sharks (*Rhincodon typus*, Vulnerable - IUCN, 2011) that were originally tagged at the snapper spawning aggregation in Gladden Spit. However, there is no indication that whale sharks feed on spawn on the seasonal snapper spawning aggregations at Caye Bokel, (Graham, 2003). Satellite tracking of Caribbean reef sharks (*C. perezi*) revealed return movements between Lighthouse Reef and Turneffe's Central eastern side (Graham, unpublished data). As all large species of sharks recorded at Turneffe are known to be highly mobile, it is therefore likely that they move broadly around the deep waters surrounding the Atoll.

Currently both the whale shark and the nurse shark are protected under Belize legislation (2003 and 2011 respectively) and the ban on the use of seine / gill nets and longlines within MPA boundaries has provided a degree of protection for sharks through increased abundance of sharks recorded inside versus outside of the MPAs in Southern Belize (Graham unpublished data). There is increasing realization of the touristic value provided by the presence of other shark species, which may lead to a move towards greater protection.

Despite their globally Endangered status (IUCN 2011) both great and scalloped hammerheads are still fished within Belize, increasingly as targets of the Asian fin trade (Graham, 2007). However, Belize is no longer permitted to export hammerhead products as a contracting party with the International Commission for the Conservation of Atlantic Tunas (ICCAT) which may provide additional management measures, if enforced, for hammerheads (Graham, pers. com.).

Two species of lionfish are thought to be present in Belize - the more common red lionfish (*Pterois volitans* - with 11 dorsal and 7 anal fin rays), and the less abundant devil firefish, (*P. miles* - with 10 dorsal and 6 anal-fin rays) (Schofield, 2009). Both species are invasive - the first non-native species to become established in the Western North Atlantic. The first individual documented in Belize was reported from the east side of Turneffe by a dive master from the Belize Aggressor live-aboard dive boat in December, 2008 (Belize Fisheries Dept. et al., draft)[2]. Since then they have increased exponentially, becoming common in Belize by 2010. This trend of increasing lionfish density is expected to continue, with possible implications on the viability of local marine species, including predation upon juvenile native fish in important nursery habitats such as mangroves and seagrass beds (Morris and Akins 2009), reduction of recruitment of commercial species, species of touristic value and herbivorous species important for maintenance of the reef (Albins and Hixon 2008), and competition with other native predatory coral reef fish for the same food resource (Albins, in press). With their venomous spines, they also pose a risk to divers – particularly fishermen.

Lionfish are found throughout Turneffe Atoll, from the reef to the seagrass beds and mangroves (Anderson, 2010; Cawich, pers. com., 2011), and have been caught up to depths of 150m (Westby (Anecdotal information in: Belize Fisheries Dept et al., draft). Surveys around the Atoll have demonstrated that lionfish were present at all sites, with densities ranging from no individuals reported from the shallow fore-reef survey sites to 2.6 per 100m^2 at back reef sites. The deep fore-reef and mangrove sites had intermediate densities of 0.7 per 100m^2 and 1.1 per 100m^2 respectively (Figure 41; Anderson, 2010).

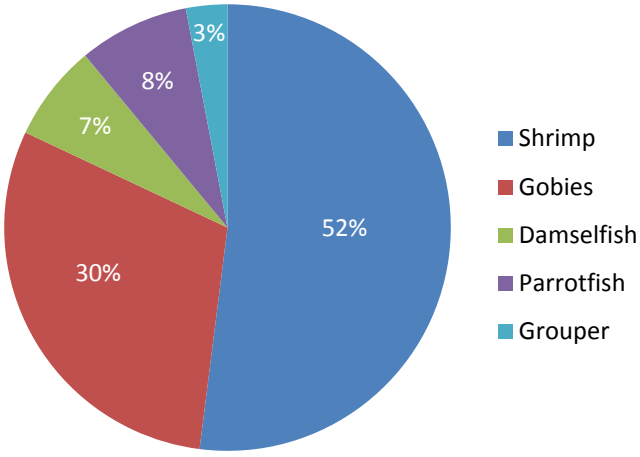


Figure 41: Analysis of lionfish gut content - prey frequency (Anderson data, 2010)

Lionfish are known to be voracious predators, able to expand their stomach volumes over thirty times to accommodate large prey (Fishelson, 1997), and have a broad diet that includes a large range of juvenile fish, shrimps and crabs (Morris and Akins 2009). Limited surveys of lionfish gut content from Turneffe Atoll suggest that just over half the prey (52%) are shrimp, the remainder are juvenile fish species – juvenile damselfish, gobies, parrotfish and grouper (red hind) (Anderson, 2010).

[2] There has also been an unconfirmed report of a lionfish sighting in Belize from September 2001.

Mammals

Turneffe Atoll is home to a number of terrestrial and marine mammals. Dolphins and manatees form the marine component. Whilst the cayes of the Atoll lack the diversity of terrestrial mammals associated with the Belize mainland, a number of smaller mammals have been recorded, with a total of 10 native species thought to be currently present – either resident or transient, and a further 6 recorded in adjacent seas, or in pre-1960 literature (Table 21).

Mammal Species of Turneffe Atoll	
Confirmed	
Atlantic bottlenose dolphin	*Tursiops truncatus*
Atlantic spotted dolphin	*Stenella frontalis*
Rough-toothed dolphin	*Steno bredanensis*
Clymene's dolphin	*Stenella clymene*
Orca	*Orcinus orca*
Humpback whale	*Megaptera novaeangliae*
Short-finned Pilot whale	*Globicephala macrorhynchus*
Antillean manatee	*Trichechus manatus*
Northern racoon	*Procyon lotor*
Nine-banded armadillos	*Dasypus novemcinctus*
To be confirmed	
Fraser's dolphin	*Lagenodelphis hosei*
Pygmy sperm whales	*Kogia breviceps*
Sperm Whale	*Physeter macrocephalus*
Coue's rice rat	*Oryzomys couesi*
Mouse opossum	*Marmosa sp.*
Little yellow bat	*Rhogeessa parvula*

Table 21: Mammal Species of Turneffe Atoll

Two species of dolphin (Atlantic bottlenose dolphin (*Tursiops truncatus*) and the Atlantic spotted dolphin (*Stenella frontalis*) are commonly seen inside the Belize Barrier Reef, and have been reported from Turneffe Atoll (CCC, 1993; Oceanic Society). Clymene's dolphin (*Stenella clymene*) has also been recorded (Grigg et al. 1997), though less frequently, as has the deeper-water rough-toothed (*Steno bredanensis*), spinner dolphins (*Stenella longirostris*) and orcas (*Orcinus orca*) (Robinson, pers. com.; Oceanic Society).

Fraser's dolphin (*Lagenodelphis hosei*) has been reported from Glover's Reef and the Southern Belize Reef Complex, and would therefore be expected to occur in the waters around Turneffe, even if only as a transient species in the deeper waters.

Photo: Turneffe Atoll Trust

The Atoll lagoon is known to provide habitat for both permanent and seasonal resident Atlantic bottlenose dolphin as part of a much larger home range (Dick et al., 2011). There is a relatively large seasonal population of mothers and neonatal / nursing calves, suggesting that the protected waters of the Atoll lagoon may be

an important calving area for this species (Dick et al., 2011). Population estimates range from 125 recorded in 2002 (Hancock, 2007) to 216 dolphins (Dick et al., 2011). Current studies (2011) have identified over 160 individuals (Ramos, pers. com.), higher than previous estimates, which suggested that 90 individuals used the area in the early 1990's, whilst approximately 85 were thought to be in the area in 2002 (Campbell *et al*. 2002). The majority of sightings (84.5%) were of clusters of 3 or fewer dolphins (Dick et al., 2011), generally sighted in or near mangrove creeks (leeward side) and bogues (windward side) (Grigg and Markowitz, 1997; Grigg, 1998; Dick et al., 2011) possibly due to higher prey abundance and better foraging opportunities (Dick et al., 2011). In the fall, group size increases, with groups of up to 26, with an increased percentage of calves (Campbell, 2002).

Whales occasionally pass in the deeper waters to the west and east of the Atoll – humpback (*Megaptera novaeangliae*) and pilot whales (*Globicephala macrorhynchus*) have both been recorded adjacent to the Atoll though are not considered resident - a recent pod of pilot whales estimated at 50 individuals was observed in December, 2011, to the south of Caye Bokel (Pott, pers. com.). Sperm whale (*Physeter macrocephalus*) and pygmy sperm whale (*Kogia breviceps*) are known to be in Belize's waters, and pass through the area, with a stranding of a dead pygmy sperm whale at Blackbird Caye in 2008.

The Belize coast is home to the largest population of West Indian manatee (*Trichechus manatus*) in the Caribbean (Morales-Vela *et al*, 2000; O'Shea and Salisbury, 1991; Auil, 1998), with a national population estimated at between 800 and 1,000 individuals (Auil, pers. com.). Historically the manatee has been hunted for meat, with bone middens discovered on archaeological sites, and in the 17th century, was hunted to provide food for privateers and explorers (Self-Sullivan et al., 2004). Today, the West Indian manatee is considered threatened throughout its range, and is listed as 'Vulnerable' (IUCN, 2011), with the Antillean sub-species (*Trichechus manatus manatus*) considered Endangered (IUCN, 2012). In Belize, it is afforded full legal protection protected under the Wildlife Protection Act (Forest Department, 1981 (revised 2000)).

The shallow protected waters of the Turneffe lagoons, with their abundant seagrass beds and areas of reduced water salinity, provide habitat for the Antillean manatees, particularly in the creeks and shoreline areas in Central Lagoon and Long Bogue. First population estimates were conducted using aerial surveys in January and May of 1994, and January of 1995, producing a population estimate of 11 individuals (Morales-Vela *et al*., 2000). More recent monitoring of manatees was started in 2002 by the Oceanic Society by both boat and aircraft, with 38 manatees recorded, including cow/calf pairs (Figure 42).

There is exchange with the coastal population, using the channels along the western side, particularly near Douglas Lagoon, to access the atoll - a radio-tracked manatee has been recorded crossing the barrier reef from the mainland and travelling to Turneffe in 2004 (Edwards et al., 2011).

Figure 42: Manatee Sightings for Turneffe Atoll

- Meerman, 2006;
- Edwards et al., 2011; Oceanic Society data; 2002 - 2010

There has been no recent, comprehensive survey of native terrestrial mammals, but a number of species records exist for the area, including the northern raccoon (*Procyon lotor*), reported from Calabash, Blackbird, Deadman's, and Northern Cayes, and thought to occur throughout the Atoll (Platt et al. 2000; Meerman, 2006). Specimens of Coue's rice rat (*Oryzomys couesi*) and the little yellow bat (*Rhogeessa parvula*) were collected from Calabash Caye in 1956 (Platt et al., 2000), though neither species has been reported more recently. A mouse opossum (*Marmosa sp.*) and fruit bats have been reported (Platt et al. 2000; Meerman, 2006; Cawich, pers. com.; Cure/Oceanic Society, pers. com.), but identification to species level has not been confirmed.

Records show that a number of species have been introduced to the Atoll in the past, either accidently or on purpose - white tailed deer (*Odocoileus virginianus*) were introduced by resident fishermen hoping to establish a herd to exploit for fresh meat, though more recent studies suggest that these are no longer present (Platt et al., 2000). There are also reports of a population of nine-banded armadillos *(Dasypus novemcinctus*) that may have been introduced to Blackbird Caye in the same way, with a carcass providing evidence of its continued existence on the caye in 1997 (Platt et al., 2000). Semi-feral pigs were noted near settlements, particularly on Calabash, in the early 1960's (Stoddart, 1962), and anecdotal reports suggest feral pigs are still present in some areas (Cawich, pers. com.), though it is thought that the deer may well have been removed during Hurricane Hattie (along with native mammal species), following the storm surge that swept across the Atoll. Many of the fishing camps and resorts have dogs – both historically and currently, which have the potential to impact nesting turtles and crocodiles.

Rats were also considered a major pest in the coconut plantations from Ropewalk to Northern Bogue in the 1960's (Stoddart, 1960's), and unverified rodent species are reported from Calabash (Cho-Ricketts, pers. com., 2011).

The limited information available suggests that a more in-depth survey of the area should be conducted if effective conservation management of terrestrial mammalian species, in particular, is to be implemented.

Birds

No long term monitoring of bird species has been conducted for Turneffe Atoll, with only grey literature reports from two rapid surveys of Northern Turneffe (Cottle et. al., 2006; Schreiber, 2007). It is thought that more than sixty species of birds have been identified from Turneffe, including coastal/sea species such as the osprey (*Pandion haliaetus*), brown pelican (*Pelecanus occidentalis*), brown booby (*Sula leaucogaster*), magnificent frigatebird (*Fregata magnificens*), mangrove warbler (*Dendroica petechia*), and herons and egrets - snowy egret (*Egretta thula*), little blue heron (*Egretta caerulea*), great blue heron (*Ardea herodias*), tricolored heron (*Egretta tricolor*), and yellow-crowned night heron (*Nyctanassa violacea*).

The matrix of terrestrial ecosystems – littoral forest, mangroves and palmetto savannas, also provide habitat for species such as clapper rail (*Rallus longirostris*), mangrove warbler (*Dendroica petechia*), golden-fronted woodpecker (*Melanerpes aurifrons*), cinnamon hummingbird (*Amazilia rutila*), green breasted mango (*Anthracothorax prevostii*), and hooded oriole (*Icterus cucullatus*). The white crowned pigeon (*Patagioenas leucocephala*), a globally Near Threatened species (IUCN, 2011), has a limited distribution in Central America, ranging from Yucatan Mexico to Honduras. In Belize, it is restricted primarily to the cayes of Belize, and has been recorded nesting at Turneffe, on Calabash Caye (Cottle et al. 2006). Rapid development of cayes along the entire the Belize reef and Atolls is threatening the habitats required by this species for nesting and foraging. The great tailed grackle (*Quiscalus mexicanus*), a human commensal, is found in areas of the Atoll associated with human activity and developments, including tourism developments and fishing camps.

A number of terns have been reported as nesting on exposed reef both historically (Stoddart, 1962) and more recently (Cottle et al., 2006). In 2006, the main identified tern nesting site was (and possibly still is) located on the barrier reef south of the last seaward caye of the Grassy Cayes range, and hosted an estimated 40 individual roseate terns (*Sterna dougallii*) and 5 to 6 least terns (*Sterna antillarum*) (Cottle et al. 2006). Least terns also nest on Soldier's Caye and chicks have been photographed and recorded on a seasonal basis. Wilson's plover (*Charadrius wilsonia*) were also once recorded from this area (Stoddart, 1962). Records suggest that Maugre Caye may support nesting brown boobies (Table 22; Stoddart, 1962; Jones et al, 2011).

Species		Nesting Location
White Crowned Pigeon	*Columba leucocephala*	Pelican Caye
Great-Tailed Grackle	*Quiscalus mexicanus*	Pelican Caye
Golden Fronted Woodpecker	*Melanerpes pucherani*	Pelican Caye
Least Terns	*Sterna antillarum*	Grassy Caye Range
Roseate Terns	*Sterna dougallii*	Grassy Caye Range
Wilson's Plover	*Charadrius wilsonia*	Grassy Caye Range

Table 22: Bird species recorded nesting at Turneffe Atoll

The cayes and mangroves of Turneffe Atoll are an important stepping stone for migratory species during southbound and northbound migrations. Many thousands of migrants follow the mainland coast southwards and meander off course each year, ending up on the cayes every spring and fall after being blown offshore by shifting winds. Others may use the cayes and ranges of Belize as part of a straight line migration path down the Yucatan Peninsula coastline, through Ambergris Caye and southwards, and from there to Guatemala and Honduras, where they again hook up with the mainland and its food resources. These include the Yucatan vireo (*Vireo magister*) (a Yucatan endemic, the white-eyed vireo (*Vireo griseus*), red-eyed vireo (*Vireo olivaceus*), northern waterthrush (*Parkesia noveboracensis),* barn swallow (*Hirunda rustica*), common yellowthroat (*Geothlypis trichas*), bay breasted warbler (*Dendroica castanea*), palm warbler (*Dendroica palmarum*), Cape May warbler (*Dendroica tigrina*), eastern wood pewee (*Contopus virens*), summer tanager (*Piranga ruber*), and American redstart (*Setophaga ruticilla*).

Two migratory raptors – the peregrine falcon (*Falco peregrines*) and merlin (*Falco columbarius*), have also been recorded at Turneffe, feeding on the smaller warblers and vireos flying along the same routes.

Amphibians and Reptiles

As Belize's largest Atoll and second largest island land area, Turneffe boasts a relatively diverse herpetofauna by island standards, with a total species inventory of 16, with a current species tally of 1 amphibian, 1 crocodile, 4 sea turtles, 1 terrestrial turtle, 6 lizards and 3 snakes (Platt et al., 1999, Platt et al., 2002; Walker pers. obs., 2011). Five of these spescies (the four marine turtles and the American crocodiles) are considered globally threatened (Vulnerable, Endangered or Critically Endangered – IUCN, 2011; Table 23). An unvalidated record of an invasive blind snake is not included here on the list of herptiles confirmed as occurring on Turneffe.

Turneffe Atoll Reptiles of International Concern	
Critically Endangered	
Hawksbill Turtle	*Eretmochelys imbricata*
Leatherback Turtle	*Dermochelys coriacea*
Endangered	
Loggerhead Turtle	*Caretta caretta*
Green Turtle	*Chelonia mydas*
Vulnerable	
American Crocodile	*Crocodylus acutus*

Table 23: Reptile species of International Concern (IUCN, 2011)

Amphibians

The generally saline conditions found on most cayes, couple with the general lack of surface freshwater creates an environment that is generally unsuitable for most amphibians. One species known to have some degree of tolerance for such conditions is the marine toad (*Chaunus marinus*), which has been recorded as being present in low numbers on Turneffe (Platt et al., 1999). Its presence here is attributed to the relatively large land mass and its rainwater catchment capacity, the likely presence of some near-freshwater pools in wet season on peaty soils, and the larger brackish pools known to be important nursery pools for American crocodiles.

Reptiles

Sea Turtles: All four species of sea turtle listed for Turneffe Atoll are of conservation interest (critically endangered or endangered, IUCN, 2011) – the critically endangered hawksbill (*Eretmochelys imbricata*) and the endangered green and loggerhead turtles (*Chelonia mydas* and *Caretta caretta*) are reported to nest on the beaches of Turneffe, and a single observation exists of a critically endangered leatherback (*Dermochelys coriacea*) nesting by Blackbird Caye Resort in the early 1990's (L. Searle, pers. com.), representing the only record of this species nesting in Belize. Isolated sightings of this species are occasionally reported in the deeper waters along the barrier reef (Bacalar Chico / Chapman pers. com., 2011; Pelican Cayes / Coral Caye Conservation Expedition Report, 1993). The Belize's Sea Turtle

Recovery Action Plan lists a number of sites in Turneffe Atoll where evidence of sea turtle nesting was noted, including Three Corner, Grassy and Cockroach Cayes, and beaches around Cockroach Bogue, but the species could not be determined, (Smith et al., 1992). Later surveys recorded only hawksbill turtles nesting at Turneffe (Platt et. al., 1999), on Calabash Caye, Northern Caye and Blackbird Caye, whilst loggerheads have been recorded nesting on Blackbird Caye in recent years (Oceanic Society, pers. comm.), and green turtles just north of Crooked Creek (A. Cherrington, pers. comm.) in the proposed Preservation Zone.

The Atoll has vast sea grass meadows dominated by *Thalassia* and *Syringodium* that provide food for the green turtles, whilst the coral reefs, sponge beds and abundant crustaceans are ideal food sources for hawksbills and loggerheads respectively (Mota, 2007). The leatherback, with a single nesting record on Turneffe, feeds on seaweeds and marine invertebrates, and often in deeper offshore waters on jelly fish, tunicates, fish and crustaceans.

The optimal sea turtle nesting habitats occur on high sandy beaches that are naturally covered by littoral forest and beach community vegetation. Throughout their range, hawksbill turtles typically nest higher on the beaches than either greens or loggerheads, often digging nest chambers amongst the dense tangles of herbaceous beach community vines and woody shrubs at the edge of littoral forest. Suitable beaches are more common in northern Turneffe than in the southern portion of the Atoll, so it is no surprise that hawksbill nesting is more prevalent in northern Turneffe than in the south. Historically these beach strands were extensively cleared for coconut plantations (Stoddart, 1962), and more recently have been heavily impacted by coastal development. Reports state that 'an extensive nesting beach once occurred on Blackbird Caye (near the present site of Blackbird Resort), but has since been destroyed by development' (Perkins, 1983; Platt, et al., 1999). Some of these cleared beaches have started being used again by smaller numbers of turtles, as developers have apparently gained a greater awareness of turtle-friendly operations, or areas start to regenerate.

In the absence of historical data, and with only limited information on current and recent nesting, it is difficult to assess the national contribution of turtle nesting on Turneffe. Whilst the single record of a leatherback nesting there is important – it might simply represent a single occurrence of a passing turtle depositing a 'leftover' clutch (Mota, pers. comm.) rather than necessarily signifying a historical use of that site. It is thought that the national importance of Turneffe for hawksbill and green turtles is in the provision of developmental habitat for hatchlings and juveniles (Mota, pers. com.).

As relatively recently as 1925, sea turtle numbers were considered inexhaustible in Belize (Smith, et al., 1992) but numbers have plummeted in recent decades, these species having been exposed to enormous exploitation for over 250 years in Belize and adjacent countries. In the early 1900s, the demand for turtle shell supported an active export industry with a massive impact on the turtle populations of the entire Belize shelf. Whilst now afforded full legal protection from harvesting in Belize, turtle populations remain highly threatened by loss or degradation of nesting habitat - the same high, sandy beaches used for millennia by turtles are now being converted into beach properties, with all the impacts associated with human habitation on mainland beaches and inhabited cayes, increasing the critical importance of

maintaining those of the cayes of Turneffe Atoll, and balancing their conservation with tourism activities and development in the area.

The hawksbill turtle has a protracted nesting season of 6 months or more – peaking in June and July, with the period between nesting seasons generally being 2-4 years, sometimes longer. With a regional average of 4.5 nests per female in the years they breed, 1 to 3 nests in all probability represent only 1 or 2 females coming ashore to breed. Nesting occurs at night, generally at high tide, with a clutch size of 50-200 eggs. Nests tend to be concealed in beach vegetation quite high on the beach and except for a faint asymmetrical crawl leading to and from the sea, there is seldom any obvious evidence of the visiting female. Whilst the green turtle is primarily herbivorous, feeding mostly upon sea grasses and seaweeds, the loggerhead is more omnivorous, feeding on a wide range of marine invertebrates, seaweeds and turtle grass.

Crocodiles: Nationally, the population of American crocodile (*Crocodylus acutus*, Vulnerable - IUCN, 2011) is thought to include fewer than 1,000 non-hatchling animals, with the largest population and highest concentration of nesting activity occurring on Turneffe (Rainwater et. al., 2011). Turneffe is considered a critical area for this crocodile in the Belize, with an estimated 200-300 non-hatchlings (juveniles/sub-adults) and 15-25 breeding females inhabiting the Atoll (Platt, et al., 2004). Additionally, Turneffe Atoll is thought to serve as a source population for the American crocodile in Belize, with dispersal along the coastal zone of Belize – and with Turneffe therefore playing a critical role in regional metapopulation dynamics (Platt et. al., 2000a; Platt et al., 2004).

The existence of a large, low-salinity nursery lagoon, elevated beach ridges needed for nesting, extensive cover protecting hatchlings and adults alike provides near optimal conditions for this increasingly uncommon species. In recognition of the national importance of some of the nesting beaches and nursery areas at Turneffe Atoll, and the developmental pressures threatening their existence, the Forest Department declared a portion of Cockroach Bay on Northern Caye a Crocodile Reserve in 2005 (Figure 43; Belize Gazette, 2005).

Recent and ongoing research has shown that crocodile encounter rates, accepted as being a measure of actual numbers, have decreased significantly at Turneffe since the 1990's, but appear to have stabilized with increased nesting activity in recent years (Rainwater et. al., 2011). This stability is, however, considered highly threatened by the potential development of nesting habitat on the Atoll, with the prediction of a spiralling decline in the population with the loss of even one nesting beach - the protection of nesting and nursery habitat is identified as critical for long-term population viability for both the population at Turneffe, and the national population (Rainwater et. al., 2011).

Accidental drowning in monofilament fishing nets has been identified the greatest source of mortality of American crocodiles in Belize, with a ban on the use of monofilament fishing nets recommended for Conservation Zones of the Atoll.

Photo: Turneffe Atoll Trust

Figure 43: Location of Cockroach Bay Crocodile Reserve (Belize Gazette, 2005).

In the interests of establishing consensus amongst all stakeholders, and the limits of Marine Reserve coverage to only the 66' or high water mark of beach areas, the recommended zonation for the proposed Turneffe Atoll Marine Reserve falls short of protecting all known American crocodile nesting sites on Turneffe. In this direction, existing data has been collated and analysed to make recommendations for areas that should be zoned for "no development" (Jenson, C., 2011), to enable the Turneffe Management Committee, Lands Department, and Department of the Environment to make informed decisions on land use in the Atoll, for the continued survival of this species on the Atoll. Additional protected area designation may be required under the National Protected Areas Act for protection of terrestrial areas.

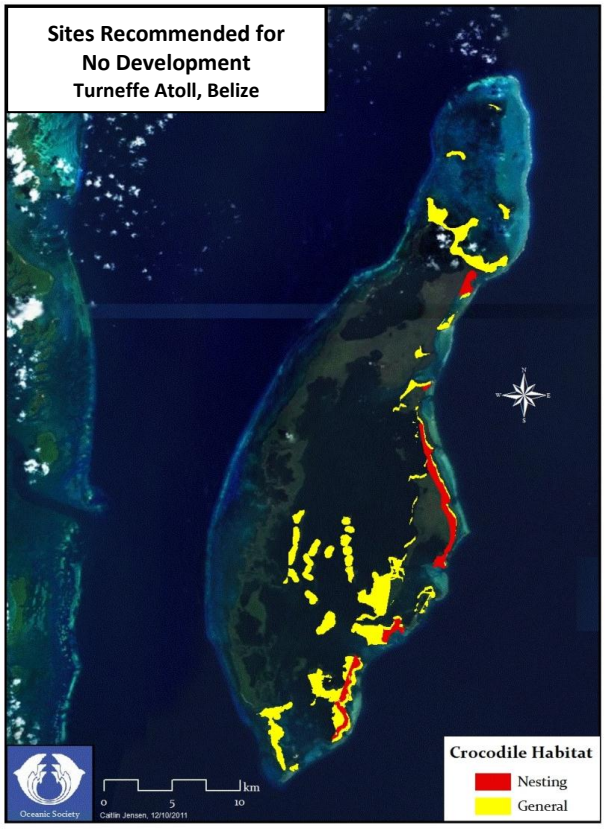


Figure 44: Recommended Development Guidelines (Jenson, 2011 / Oceanic Society)

Observed and potential crocodile habitats,

Nesting habitat - created by including only the coastal areas of the observed habitat.

Snakes and Lizards: Also of conservation importance is the subspecies of parrot snake (*Leptophis mexicanus hoeversi*), endemic to Turneffe Atoll. Occurring in two colour morphs – blue and green – this subspecies has a broad range across several islands on Turneffe. The fact that these morphs, and indeed the subspecies itself, are confined to Turneffe indicates that the species has been present and genetically isolated on the Atoll for a long time, having almost certainly arrived there on driftwood centuries ago. It was noted that all juvenile and sub-adult specimens of black iguana (*Ctenosaura similis*) on Calabash Caye differed markedly in their colouration from any populations seen on the Belizean mainland – with a more vibrant shade of green banding occurring dorsally, and persisting in older animals in an ocellated pattern, longer than in animals seen elsewhere (Walker, pers. obs, 2011). It is suspected that, like the Turneffe parrot snake, the population of the black iguana on Turneffe is genetically isolated from that on the mainland, and may represent a new subspecies.

Photo: Turneffe Atoll Trust

A noteworthy new species record is Maslin's whiptail lizard (*Cnemidophorus maslini*), which is extremely common in the littoral forest and mixed mangrove scrub habitats of Calabash Caye (Walker, pers. obs., 2011). This species is apparently a recent colonizer in Turneffe, not being reported in the extensive surveys conducted between 1994 and 1997 (Platt, et. al., 1999), and has colonized Calabash Caye in the space of no more than 14 years, now possibly being the most abundant reptile species there. The actual colonization may well have occurred with the transportation of eggs in construction sand carried to the caye – possibly for the construction of the Coast Guard Station. The rapid population growth may perhaps be attributed in part to the species being parthenogenetic, with all specimens being female (Lee, 2000). Given the relatively low lizard species diversity on most cayes (because of their geographic isolation being a largely effective barrier to colonization), it is likely that *Cnemidophorus maslini* is now occupying a niche that was left largely vacant by the lizards already there.

Photo: Wildtracks

A blind snake was reported on Calabash Caye, based on a photograph from 1994 (Platt et. al., 1999) and provisionally identified by a third party as *Ramphotyphlops braminus,* a non-native invasive species. Given the nature of the provisional identification, the lack of any other record of this species in Belize, nor within the Yucatan peninsula (Lee, 1996), this species would require verification before being included on the species list.

1.5.3 Economically Important Species

Turneffe Atoll has historically been known as one of the primary production areas for the Caribbean spiny lobster (*Panulirus argus*) and, to a lesser extent, the Queen conch (*Strombus gigas*) fishery in Belize. The lobster and conch fisheries form the two most important components of the capture fisheries in Belize, with national production representing over 90% of total capture fisheries production in 2008, with an export value of Bz$20.3 million (Ministry of Agriculture and Fisheries, 2009).

It is significant to note that the general trend of total national lobster production over the period from 1981 to 2008 is a decline of almost 77%. National lobster landings peaked in 1981 at 2,204,622 lbs, but fell to 457,680 lbs in 2006, with 511,389 lbs harvested in 2009 (tails and head meat combined - with a market value of Bz$13.8 million (Ministry of Agriculture and Fisheries, 2009)). Whilst in the past there has been continued optimism that lobster is being harvested at a sustainable level (Gillet, 2003), there have been some concerns for the continued long term ecological sustainability of the lobster fishing industry, with average size per lobster declining, and the value of the catch per fisherman, in some cases, no longer sufficient to support a fisherman and his family (anecdotal reports, fishermen, Sarteneja, 2009, 2010, 2011).

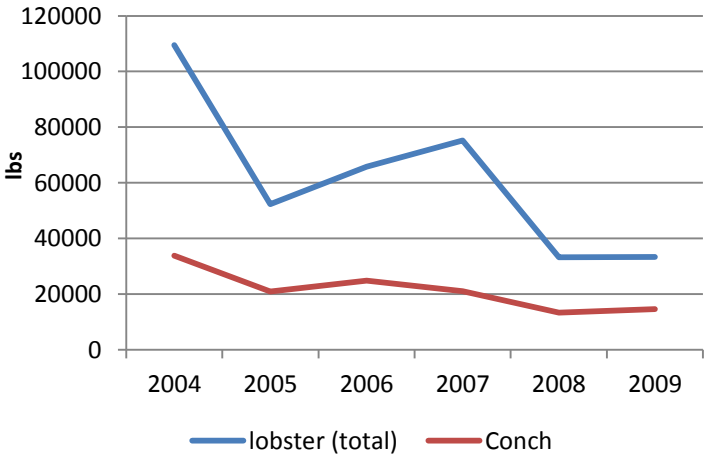


Figure 45: lbs of Lobster and Conch from Turneffe Atoll delivered to the Cooperatives (Fisheries data 2004 – 2009; Fedler, 2011)

Fishermen using Turneffe Atoll sell virtually all their lobster and conch product to the fishing cooperatives (Turneffe Fishermen workshop, 2011). There has been a 70% decline in Turneffe lobster sales[3] to cooperatives between 2004 and 2009 - from 109,533 lbs to 33,381 lbs (Figure 45; Fisheries Dept. data 2004 – 2009; Fedler, 2011)[4]. Turneffe lobster sales, as a percentage of national sales, decreased from 20.4% to 6.2% over this period implying that the Turneffe fishery may be declining faster than others in Belize.

[3] Head and tails combined

[4] There are some issues with this figure, as several fishermen note that the cooperatives are not very accurate as to the origin of product when filling in forms. It is agreed, however, that these figures do provide indications of the trends being seen in the Turneffe fishery (Turneffe Fishermen workshop, 2011).

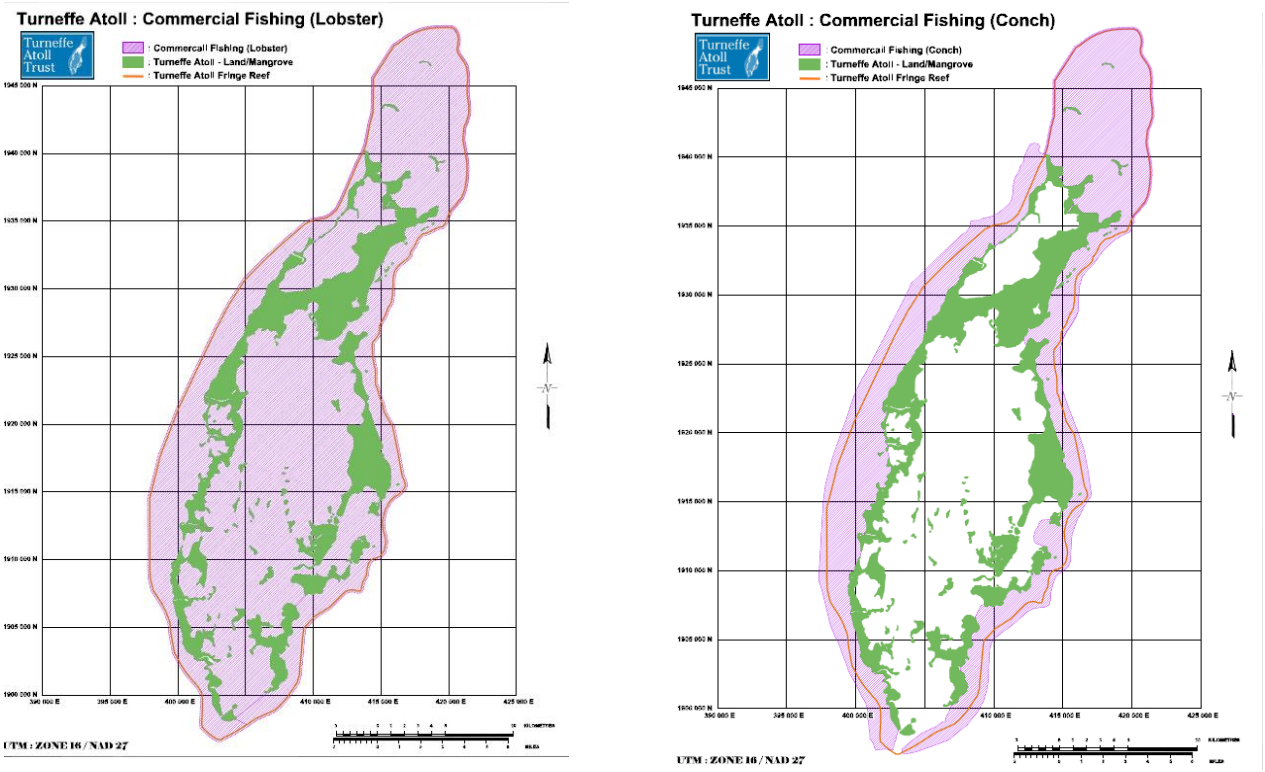


Figure 46: Commercial fishing areas of Turneffe Atoll – lobster (left) and conch (right) (TAT, 2011)

As with lobster, national conch landings have declined significantly, peaking at 1,239,000 lbs in 1972, and subsequently declining by 54% to 574,756 lbs in 2008 (Ministry of Agriculture and Fisheries, 2008). As far back as 1996, there was evidence that fishing pressure was too high, with the national population consisting primarily of juveniles, resulting in recommendations for capping of the number of fishermen. It has been suggested that the maximum sustainable yield for this species was reached in 2006, with the steep decline of 17% observed in 2007 serving as an indication of the "maturity" of the fishing industry, and the possible overfishing of this fishery resource (Ministry of Agriculture and Fisheries, 2007). Strict regulations and quotas are now being implemented towards more sustainable use of this resource, and an increase in production was noted in 2008 (Ministry of Agriculture and Fisheries, 2009), though the number of fishermen has still not been capped. During 2004 to 2009, the relative contribution of conch sales originating from Turneffe to the cooperatives declined by 57%, from 33,813 lbs to 14,639 lbs, the percentage of national conch product contributed from Turneffe decreasing from 6.2% to 2.0% over the same period (Figure 45; Fisheries data 2004 – 2009; Fedler, 2011).

For conch population viability, it is thought that populations need to be above 50/ha (Stoner and Ray-Culp, 2000). The Healthy Reef target is 300 – 400 adults per hectare. Turneffe Atoll currently supports a population abundance considered to be 'Fair' – between 51 and 300 per hectare (MAP, 2011).

The Atoll has five known spawning aggregation sites – locations on the reef drop-off with conditions ideally suited for the aggregation of spawning groupers (Family Serranidae), snappers (Lutjanidae) and other reef fish important to the commercial fishery that gather in large numbers at specific locations, seasons, and moon phases in order to spawn (Table 24).

Dog Flea Caye to the north east of the Atoll and Caye Bokel to the south are both protected under Belize legislation (SI 161 of 2003). Both are considered to be significant aggregations, with thousands of individuals and a high species diversity (15 species spawning at Dog Flea Caye and 18 at Caye Bokel) (Belize Fisheries Department et al., 2008). Maugre Caye, to the north, whilst not fully protected under SI 161, has restricted fishing under SI 49 of 2009, though enforcement is currently limited.

Photo: Turneffe Atoll Trust

Dog Flea Caye
Spawning Aggregation Species

Epinephelus striatus	Nassau grouper
Mycteroperca tigris	Tiger grouper
Mycertoperca venenosa	Yellowfin grouper
Mycteroperca bonaci	Black grouper
Melichthys niger	Black durgon
Anisotremus surinamensis	Black margate
Lutjanus cyanopterus	Cubera snapper
Caranx latus	Horse-eye jack
Clepticus parrae	Creole Wrasse
Scomberomorous maculatus	Spanish mackerel
Canthidermis sufflamen	Ocean triggerfish
Elagatis bipinnulata	Rainbow Runner
Caranx rube	Bar jack
Ocyurus chrysurus	Yellowtail snapper
Kyphosus sectatrix	Bermuda chub

Caye Bokel
Spawning Aggregation Species

Trachionatus fulcatus	Permit
Epinephelus striatus	Nassau grouper
Mycteroperca bonaci	Black grouper
Mycteroperca tigris	Tiger grouper
Caranx rube	Bar jack
Caranx latus	Horse-eye jack
Scomberomorous maculatus	Spanish mackerel
Acanthostracion quadricornis	Scrawled Cowfish
Kyphosus sectatrix	Bermuda chub
Anisotremus surinamensis	Black margate
Lutjanus griseus	Black snapper
Lutjanus jocu	Dog snapper
Ocyurus chrysurus	Yellowtail snapper
Lutjanus cyanopterus	Cubera snapper
Lutjanus analis	Mutton snapper
Clepticus parrae	Creole Wrasse
Canthidermis sufflamen	Ocean triggerfish
Lactophrys triqueter	Smooth trunkfish

Spawning Aggregation Site	Species[1] (2002, 2003, 2008)
High importance[2]. High Vulnerability[3]	
Maugre Caye *Turneffe Atoll* **SI 49 of 2009** **(prev SI 162 of 2003)**	Nassau Grouper; no other data
Medium Importance, High Vulnerability	
Caye Bokel *Turneffe Atoll* **SI 161 of 2003**	Permit, Nassau grouper, black grouper, tiger grouper, bar jack, horse-eye jack, spanish mackerel, scrawled cowfish. bermuda chub, black margate, black snapper, dog snapper, yellowtail snapper, cubera snapper, mutton snapper, creole wrasse, ocean triggerfish, smooth trunkfish
Low Importance, High Vulnerability	
Dog Flea Caye *Turneffe Atoll* 3 species **SI 161 of 2003**	Nassau grouper, tiger grouper, yellowfin grouper, black grouper black durgon, black margate, cubera snapper, horse-eye jack, creole wrasse, spanish mackerel, ocean triggerfish, rainbow runner, bar jack, yellowtail snapper, bermuda chub
Unknown	
Soldier Caye *Turneffe Atoll* 6 species	Nassau grouper, black grouper, tiger grouper, bar jack, horse-eye jack, smooth trunkfish
Calabash Caye *Turneffe Atoll* 7 species	Yellowtail snapper, Nassau grouper, black grouper, permit, bar jack, horse-eye jack, permit

[1] Heyman et. al., 2002, Heyman et. al., 2003; Belize Fisheries Dept. et al., 2008
[2] Heyman et. al. 2003, based on number of species and individuals
[3] Heyman et. al. 2003, based on existing and predicted fishing pressure

Table 24: Species per Spawning Aggregation for Turneffe Atoll (Heyman et al., 2002; Heyman et al., 2003)

Nassau grouper, once the second most commonly caught fish in Belize, and of major commercial importance to the fishermen, showed a decline in the national population of more than 80% by 2001, and was predicted to disappear from Belize waters by the year 2013 under current management conditions (Paz and Grimshaw, 2001). This species is indicative of the declines that can be predicted in other aggregating sites, primarily due to fishing pressure at spawning aggregation sites, where these species are most vulnerable. Before 1990, over nine Nassau grouper aggregation sites (including Dog Flea Caye and Maugre Caye) were known in Belize, with at least 30,000 fish each. During the national monitoring survey of January 2003, no significant numbers of Nassau grouper were observed at any of these banks except for Dog Flea Caye, with an aggregation estimated at 5,000 - still the highest count at any reef site in Belize (Belize Fisheries Dept. et al., 2008).

Studies of Nassau grouper catch continued in 2004 at both the Dog Flea Caye and Maugre Caye sites (Belize Fisheries Dept. et al., 2010). Groupers generally reach sexual maturity at between 30 and 80cm (Belize Spawning Aggregation Working Group newsletter, 2005). Landings data for Dog Flea Caye

showed a very distinct shift to smaller fish, with more than 95% of Nassau grouper potentially non-reproductive with body lengths of less than 40 cm. At Maugre Caye, however, 88% of caught fish were within the mid-range of reproductive size, with lengths between 50 and 70 cm. Two years later, in 2006, only one individual was counted at Dog Flea Caye, raising concerns that the site may have collapsed in the intervening three years with the pressures of unregulated fishing (Belize Fisheries Dept. et al., 2010). A subsequent survey of the site in the 2011 spawning season found no evidence of Nassau grouper (Belize Spawning Aggregation Working Group newsletter, 2011).

In light of these concerns amendments made in 2009 to the regulations impose size and time limits limiting Nassau catch, and make it illegal to fish

(not less than 50.8cm, or greater than 76.2cm) as well as making it illegal to take Nassau grouper during the peak spawning months of 1st December to 31st March (Government of Belize, SI 49 of 2009) However, it can still be fished outside of this time, and special permits may be given to traditional fishermen to continue fishing at Maugre Caye, with limited capacity at Turneffe for effective enforcement. The Belize Spawning Aggregation Group hopes to address this through further amendments to the regulations.

The regional outlook is similarly bleak - it is thought that one third of all known Nassau grouper spawning aggregation sites in the Caribbean region have been disappeared following overfishing. There are concerns that the Turneffe Atoll sites, lacking in effective protection, may also have declined to the point of extinction. This once abundant top predator species, a keystone species in many reef communities, would have played a major role in maintaining ecological balances. Its loss has the potential to have caused many shifts and changes in local food webs.

Nassau Grouper become sexually mature at 4 years, with a life span of up to 29 years, and strong site fidelity, adults returning to the same spawning sites year after year (Starr et al., 2007). More and more studies suggest that localized currents around Atolls lead to greater self-recruitment (Paris et al. 2010, Cetina-Heredia et al., 2011). Most spawning aggregation sites are thought to self-recruit, with 70% of larvae settling within 100 km of the spawning site (Cowen et al., 2006). The prevailing winds and currents are predicted to assist dispersion of the pelagic larvae produced at the aggregation sites into Turneffe's central lagoon, with its massive seagrass beds lined by mangroves (Belize Fisheries Department et al., 2008). This is an optimal nursery site for juvenile settlement and growth. Those larvae produced on the leeward side of the Atoll are thought to be caught in eddies and slower moving waters to the west of the Atoll, that allow them to swim towards the shelter of Turneffe's lagoons. The population of Nassau grouper of the adjacent Glovers Reef Atoll is considered relatively closed - growing at Glovers, spawning there and generally not leaving the Atoll (Starr et al., 2007). The limited knowledge of connectivity between reef fish spawning aggregations and nursery areas is, however, perhaps one of the most important scientific gaps in being able to manage areas for effective conservation at both site and system level (Cowen et al., 2006).

Small juvenile Nassau grouper are common in shallow seagrass beds, macro-algae, and around stands of *Porites spp*., appearing to preferentially settle into macroalgal clumps. Once they are safely hidden in

the macroalgae or seagrass, the larvae develop into tiny fish, shifting to patch reefs the root systems of mangroves within about three months when total length reached 12-15cm. Juvenile grouper and snapper vary in their nursery habitat preference - Nassau grouper prefer to grow out around coral heads of small fringing reefs, living in crevices, whereas gray snapper move back into sea grass from the mangroves and grow out there, demonstrating the importance of connectivity between seagrass and mangrove habitat, preferably within 50 km of the spawning site (NOAA, 2001).

Caye Bokel is not a major spawning site for grouper, but is considered important for snapper, which spawn in large groups. More than 10,000 dog snappers and 5,000 cubera snappers are frequently seen, and generate enough spawn to attract occasional whale sharks. Some spawning species have limited migration and are considered as resident, inhabiting the nearby reef. Other species, like Nassau grouper and mutton snapper, may travel hundreds of kilometers to reach the site – one Nassau grouper tagged in Belize was demonstrated to move over 250km along the Mesoamerican Reef. Other studies, however, suggest that the majority of species using Atoll aggregation sites may remain close to the Atoll.

Nationally, finfish delivery to the cooperatives has dropped significantly over the last 25 years, from a peak in 1983 of 1,003,785 lbs to current levels (2009) of less than 10,000 lbs (Figure 47; Fisheries Dept. data, Fedler, 2011) – representing a 90% decline in deliveries. This reflects both the declining catch, and the declining export market.

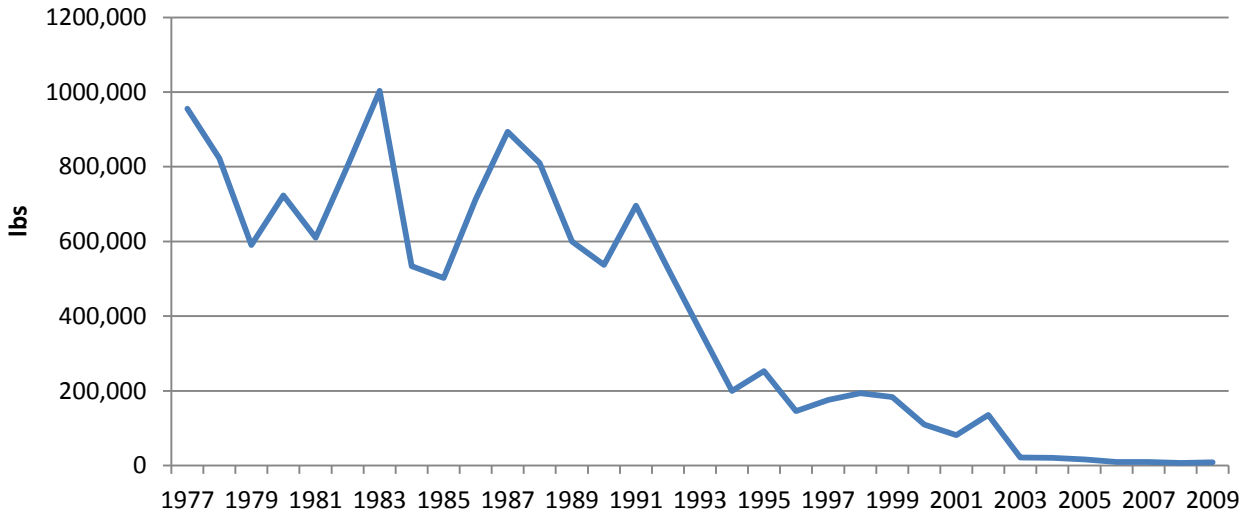


Figure 47: National delivery of finfish to the Cooperatives (Fedler, 2011)

An estimated 100,000 lbs of deep-water snapper are harvested from pinnacles near Turneffe annually (Fedler, 2011), though exact figures are not available. Much of this catch, and that of spear and hand-line fishing on the Atoll drop off, is sold in local markets (primarily Vernon Street) and directly to hotels rather than through the co-operatives (Fishermen workshop, 2011), with targeted species including groupers (*Epinephelus* spp. and *Mycteroperca* spp.), snappers (*Lutjanus* spp. and *Ocyurus* spp.), the

hogfish (*Lachnolaimus maximus*), king mackerel (*Scomberomorus cavalla*), great barracuda (*Syhyraena barracuda*), and jacks (*Alectis* spp., *Caranx* spp. and *Trachinotus* spp.) (FAO).

Whilst finfish do form an important extraction target for fishermen at Turneffe Atoll (Neal, 2011; Cawich, 2011), and the traditional shallow water finfish catch from the Turneffe's creeks, channels and reef is thought to be in severe decline (Hayes, 2011), 2010 surveys suggest that populations are still significantly higher than the Belize average reported by Healthy Reefs (UB/ERI, 2011), which reports the mean commercial fish biomass for Belize in 2009 as 609 g per 100m^2 (Healthy Reefs, 2010). Data for Turneffe for 2010 demonstrated a mean of almost double this, of 1143.4 g per 100m^2 (UB/ERI, 2011), significantly higher than the AGGRA results from four years previously, averaged over three sites, at 701 g per 100m^2 (AGGRA, 2006). In the 2010 survey, there was significant variation between sites and sub-sites (Figure 48). The highest biomass (4,964 g per 100m^2) occurs on the fore reef of site 1062, on the south west rim of the Atoll (interestingly, though, the deep fore reef at the same site had no commercial species reported at all) (Figure 48; UB/ERI, 2011).

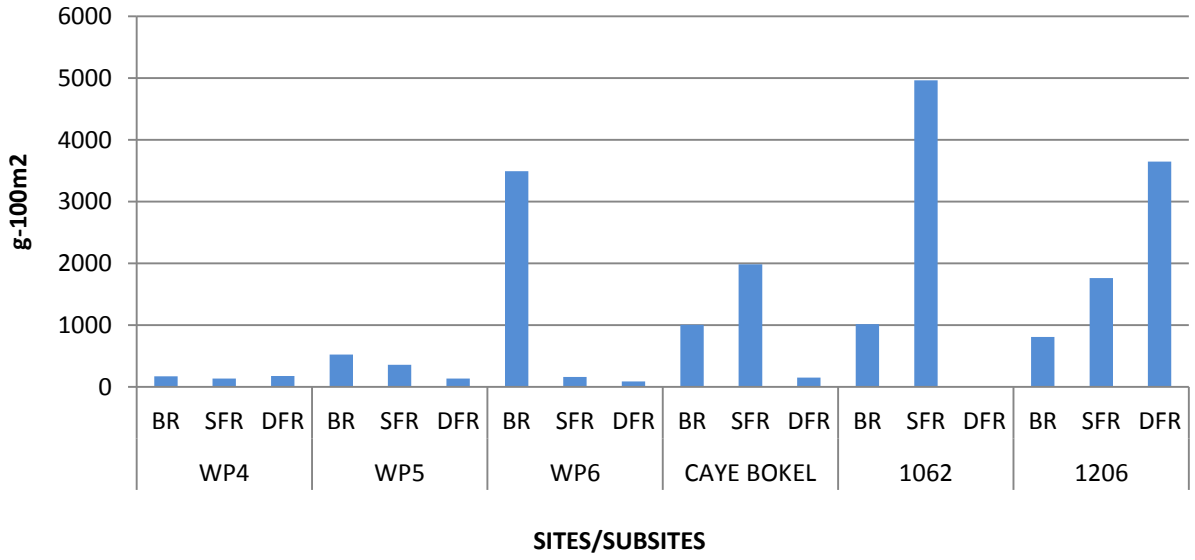


Figure 48: Commercial fish species biomass per subsite at Turneffe Atoll (UB/ERI, 2010)

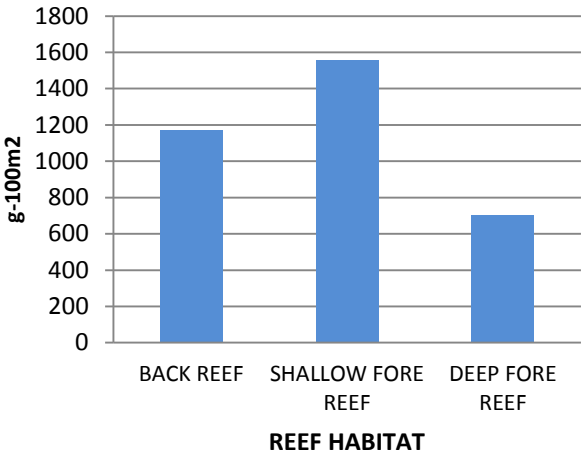


Figure 49: Commercial fish biomass per habitat (UB/ERI, 2010)

When data is averaged over all sites, the biomass of commercial fish species at Turneffe is generally higher in the shallow fore reef (Figure 49; UB/ERI, 2010).

Except for the whale shark (for which there is a complete ban on fishing under the Fisheries Act), there is the recognition in Belize that sharks, in general, are under pressure from over-fishing, having a close stock-recruitment relationship, long recovery times in response to over-fishing, with few offspring and late sexual maturity, resulting in low biological productivity. This, in combination with complicated patterns of size/sex segregation and seasonal migration, raise concerns at the national levels about the sustainability of the shark fishery, particularly under the current unregulated fishing levels. The Belize Fisheries Department is developing a National Plan of Action for the shark fishery following the guidelines of the International Plan of Action for the Conservation and Management of Sharks (IPOA – Sharks), which is designed to achieve the conservation and sustainable use of shark species through the protection of the marine environment (ecosystems and biodiversity), with the minimization of by-catch, waste and discard, and through the adoption of selective and environmentally safe fishing practices.

Exploitation of shark species throughout Belize has been rapidly increasing, particularly with the demand for shark fins (Graham, per com.). Surveys of gill net catches at Turneffe from 2008 to 2011 suggest that there is continuing commercial extraction of elasmobranchs – primarily Caribbean sharpnose (*Rhizoprionodon porosus*) and Caribbean reef sharks (*Carcharhinus perezi*), but also including species such as blacktip, lemon (*Negaprion brevirostris*) and great hammerhead sharks. Scalloped hammerhead (*Sphyrna lewini*) and bull sharks (*Carcharhinus leucas*) were also identified in the net catches, though less frequently (Chapman et al., 2011). Studies have shown that significantly fewer Caribbean reef sharks are seen on the fished reefs of Turneffe (Chapman et al., 2011), suggesting that fishing pressure is having a detrimental effect on the shark populations of the Atoll, with implications on the health of the reef with the alteration of the trophic structure.

Shark fishing in Belize was assessed in 2005 during the initial drafting of the National Plan of Action – Sharks (Fisheries Department, 2005), when an estimated twenty-five fishermen were identified as being involved nationally, originating from various communities along the coastline, with the greatest activity concentrated between December and March. The largest market is the illegal trade with Guatemala and Honduras (R. Graham, pers. com., 2010).

The species of greatest economic value are those targeted by the catch and release sport fishing industry – particularly bonefish (*Albula vulpes*), tarpon (*Megalops atlanticus*) and permit (*Trachinotus*

falcatus) (Fedler, 2011). Common snook (*Centropomus undecimalis*) and great barracuda (*Sphyraena barracuda*) are also considered important to the sport fishing industry of Turneffe, but not to the same degree. Sport fishing, particularly fly fishing, is the primary tourism / recreational market Turneffe attracts, and is a multimillion-dollar global industry, generating an estimated US$60,420 million in annual contribution to the US economy alone (Outdoor Industry Foundation, 2006), with an estimated 45.4 million US participants (Belize's primary tourism market) - 16% of the US population (Outdoor Foundation, 2011). In 2007, Turneffe was recognized as one of the top ten permit fishing destinations in the World (Flyfishing in Saltwater, 2007), and one of the best for bonefish (Brown, 2008), highlighting the importance of these species in attracting sport fishermen from the US and elsewhere in the World, for the economy of both Turneffe and Belize.

With its long stretch of east facing sandy shoreline, Turneffe is thought to support the greatest abundance of bonefishing sites in Belize (Grimshaw et al., 2010). Bonefish are considered resident and abundant at Turneffe Atoll, travelling in loose schools in the shallow back-reef flats, particularly along the east facing coastline of Turneffe. In Belize, this species spawns between November and May (Bonefish and Tarpon Trust, 2011), though the spawning site is unknown, and recruitment sites have yet to be identified for Turneffe Atoll.

Turneffe is considered as one of the primary tarpon fishing areas in Belize, this species being found in the mangrove-lined creeks and lagoons of the Atoll. Both resident and migratory individuals are known to use the Atoll. When sexually mature, the migratory, or mega-tarpon, migrate to form spawning aggregations offshore, near the new and full moons during late spring and summer. The exact location is unknown, though it is suspected that it may be to the closest known site lies to the north of Belize in the southern Yucatan. With a long lasting larval stage in the open sea for several months before reaching the brackish mangroves of Turneffe and the Belize mainland, this species has the potential for wide recruitment throughout the region, with a need for management at the regional level (Grimshaw et al., 2010). The mangrove-lined brackish lagoons and river mouths of the Belize mainland and Ambergris Caye are considered important as juvenile nursery habitat, where this species can survive in near stagnant waters. As the fish mature, they move further offshore, some forming a resident population at Turneffe, where they are joined by migratory tarpon between April and October.

A resident population of permit primarily occupies the inshore region, in water depths of less than 0.6 meters - the flats and sandy beaches of Turneffe, as well as deeper cuts, channels, and adjacent holes. This species is known to form spawning aggregations at the Turneffe Elbow between February and October, with groups of 300 or more reproductive adults gathering at sunset during the full moon spawning period, exhibiting group spawning behaviour (Graham et al., 2005). Whilst recruitment is potentially from the Turneffe Atoll spawning sites, as hypothesized for other spawning aggregation species (Paris et al. 2010, Cetina-Heredia et al., 2011), the planktonic larval stage also allows for connectivity with other spawning populations in the Mesoamerican region and Wider Caribbean. The juveniles actively settle along sandy beaches on the east-facing shoreline of the Atoll in areas of sand bottom 6 to 9m wide, between the high tide line and seagrass beds and exposed to moderate wave energy (Adams et al. 2006).

1.5.4 Past and Present Research

The earliest research focused on the problems with the sponge industry, established at Turneffe in the late 1800's, particularly following the decimation of the sponges by disease (Stoddart, 1962; Stevely et al., 1994).

In 1999, a comprehensive study of reptiles and amphibians of the cayes collated past reports and added new species records from site observations (Platt et al., 1999).

Extensive studies of modern sediments of Turneffe Atoll have been made by Gischler (1994), Gischler and Hudson (1998), and Gischler and Lomando (1999).

As would be expected, there has been a focus on coral reef ecosystems and coral health. A series of transects were conducted in the early 1960's, providing a historical baseline of benthic and coral composition (Stoddart, 1962), and in 1992, Planetary Coral Reef Foundation in 1992, using a chain transect and video. The study site was on Calabash Reef 2 km south of the channel separating Calabash Caye from Blackbird Caye, an area representative of the most well-developed region on the windward reef. Their 900 m transects extended from behind the reef crest seaward to a depth of 45 m.

In 1993, the University College of Belize entered into a working agreement with Coral Caye Conservation to collaborate towards the establishment of a permanent, self-financing Marine Research Centre at Calabash Cay on Turneffe Atoll (UNEP/IUCN, 1988). The principle objectives of collaboration were identified as protection of the terrestrial and marine resources of Turneffe Atoll, strengthening the capacity of the University College of Belize to undertake coastal marine research and training and providing technical assistance to the Fisheries Department. A core component of the MOU guiding the collaboration, signed in August 1994, was the establishment of a management plan for Turneffe Atoll, and monitoring of the biodiversity resources. Between January 1994 and early 1998, Coral Caye Conservation volunteers carried out surveys around the whole atoll, resulting in extensive baseline information complemented by on-going surveys to quantitatively document the abundance of commercially important fish species, the initiation of basic assessments of reef health close to Calabash Cay via Reef Check and Atlantic and Gulf Rapid Reef Assessment surveys, and the development of a Turneffe Atoll Habitat Map (Taylor et al., 1999; Turnbull et al., 2000; Gardiner et al., 2000; Harborne, 2000).

This has been updated through ongoing work conducted by the University of Belize (and the recently established Environmental Research Institute) and Oceanic Society. Dr. Peter Sale of the University of Windsor in Canada has studied connectivity at Turneffe Atoll since 2001 through the ECONAR program which focused on genetic and microchemistry to tease out patterns of larval dispersion. Dr. Sale is

continuing his work at Turneffe with a new project called, "Coral Reef Targeted Research and Capacity Building for Management."

A 2003 study by Walsh compared back reef and fore reef sites in the two Spawning Aggregation sites. Many of the reef-builders showed signs of damage from bleaching. At Caye Bokel, fore reef sites showed 24% bleaching and the back reef showed 50% mortality. At Dog Flea Caye, 52% of the fore reef and 81% of the back reef, and McField and Walsh began to study the coral-zooxanthellae symbiosis at Turneffe, as part of a Mesoamerican Reef-wide study.

Mumby et al. (2004) compared fish biomass on several atolls in the Caribbean, including Turneffe. They showed that several reef fish species reach much greater biomass when mangroves are present - *Haemulon sciurus* had 25 times the biomass on Turneffe than other atolls, and the biomass of *O. chrysurus* doubled when its preferred *Montastraea* habitat was adjacent to rich mangroves.

In 2006, a study was completed on the taxonomy of bonefish, comparing spatial and temporal habitat use, species composition of mature *Albula* spp. and a comparison of age and growth estimates (Adams et al., 2006).

Turneffe Atoll currently has four Healthy Reef monitoring sites (Table 25; Healthy Reefs, 2010), developed to provide an indication of the status of coral reefs throughout the region. The first Healthy Reef report was based on data from 2006, the second from 2009.

Site Code	Location	Latitude	Longitude
1215	North east	17.56666	-87.748930
2056	Central East	17.414280	-87.809360
1194	South east	17.250970	-87.838600
1231	South west	17.195580	-87.93183
2065	North west	17.548190	-87.821040

Table 25.: Healthy Reef 2009 Monitoring Sites for Turneffe Atoll (Healthy Reefs data, 2010)

Turneffe Atoll has also been used as the site for pilot studies by Fisheries Department into the feasibility of using Fish Aggregating Devices (FADs), with the deployment of two to the south-east of Turneffe, at a depth of approximately 480m, and five miles apart. These were installed to test the feasibility of use for the exploitation of commercially important pelagic species in the deeper waters, considered an under-exploited resource, and providing diversification from current traditional dependence on lobster and conch. Preliminary results indicate the species attracted to the FADs included snapper (*Lutjanus spp),* jack (*Carangidae spp)*, dolphin fish (Coryphaenidae *spp*), wahoo (*Scombribae spp*) triple tail (*Lobotidae spp*)*,* among others (CZMAI, 2003). Trials for deep sea fishing as a means of diversification of effort have not been overly successful, however, with at least three survey vessels (a UN survey vessel in 1970, Red Lobster in 1990, and most recently two Spanish vessels (2011) (Cruz, pers. com., 2011))

1.6 Cultural and Stakeholder Use of Turneffe Atoll

Turneffe Atoll has had a long history of use, starting with Maya traders travelling the coastal waters of the Mesoamerican reef. Maya shell-middens are reported from the Calabash Caye area and Northern Bogue on Turneffe, and pottery shards dating from the late Classic to early Post-Classic are particularly evident at Grand Bogue Point (Stoddart, 1962), suggesting that the area was once used as a stopping point for the sea trade between Yucatan and the Bay Islands, though there is no evidence of permanent settlement. In more recent history, the Atoll was first mapped by Vooght in 1690, labeled as 'Terre Neuf', and again by Speer in 1766 (revised in 1776), in the West India Pilot. Jefferys included Turneffe and Caye Bokel in mapping of the area in 1775, with Maugre Caye being added in 1792 (Stoddart, 1962).

In the 18th century, anecdotal reports are of pirates and trading sloops used the Atoll for replenishing with fresh water, and as a base of operations, its creeks and mangroves providing effective protection from authority as they harried the shipping routes established in the area. Historical records show that Blackbeard spent a short time based from here with his ship, the Queen Anne's Revenge, in 1716, capturing an eighty-ton logwood cutting sloop from Jamaica, (the Adventure), which inadvertently ended up in Turneffe Lagoon at the same time, in search of water (Marley, 2010).

In the late 1800's, the lagoons of Turneffe supported a thriving sponge industry, based on "Velvet," wool sponge (*Hippospongia lachne*), and "glove" sponges, which once grew in profusion on scattered rocky areas, until a disease came through the area in 1919, decimating the sponges (Stoddart, 1962; Stevely et al., 1994). In the mid-1920's, in an attempt to revive the industry, the Colonial Research Committee facilitated efforts towards re-establishment of the sponges. The central lagoon of Turneffe Island was divided into 1,000 acre concessions and leased to individuals who were instructed in special techniques of sponge cultivation, and efforts were made to increase the amount of hard substrate available within the lagoon through use of cement discs. With ideal conditions, the growth rate of sponges at Turneffe was thirty-three per cent greater than that observed in the Bahamas. This came to an abrupt halt, however, when the devastating hurricane of 1931, passed over the Atoll, damaging the Turneffe sponge concessions. Regeneration was rapid, and by 1935, another crop of adult sponges was ready for market and the export of sponges again became a thriving business. The beds continued to fluctuate in health, and were thought to be badly damaged in 1936 by high rainfall, which lowered salinity in the lagoon (Stoddart, 1962; Stevely et al., 1994).

The Death of the Sponge Industry of Turneffe

The disease "..appearing in Soldier Bight (Calabash Entrance), Turneffe, in June 1939, killing *H. lachne*. Within seven weeks it had spread to the whole Southern Lagoon, and at the end of July, *H. lachne* was everywhere dead and *H. gossypina* dying. In August came a second attack, in the southern part of Southern Lagoon, killing only *H. gossypina*, and in September a third outbreak, killing all the sponges at Long Ridge (between Joe's Hole and Grand Bogue Creek). Noncommercial sponges were not affected, but 95% of the commercial ones were killed"

(Stoddart, 1962).

By 1939, under concession holders Foote and Grant, an estimated 700,000 cuttings were being cultivated in Turneffe lagoon, "…including 225,000 sheepwool sponges (*Hippospongia lachne*), 475,000 velvet sponges (*Hippospongia gossypina*), and smaller quantities of other commercial sponges, such as *Spongia barbara*, *S. dura and S. graminea"* - these were decimated in 1939 by disease, thought to be related to a series of red tides, with a reported mortality of 95%. The industry never recovered from this disaster, partly because of the war, partly because of competition from the synthetic sponge industry. In 1960, one resident was still cultivating a few sponges, and piles of the small concrete plates used to plant out the sponges were still to be found at Calabash Caye.

Prior to 1961, the cayes on the east-facing side of Turneffe Atoll supported a number of coconut plantations, with an industry large enough to have a warehouse and collection centre on Calabash Cay. At its peak in 1914, national production for Belize averaged 6 millions nuts a year, exported to the United States from coastal and caye plantations such as those at Turneffe. By 1920, Turneffe was considered as one of the main coconut producing areas (Murray et al., 1999), and in the early 1950's, Turneffe was still estimated to have 405ha farmed as coconut plantations. Most of this infrastructure was destroyed by Hurricane Hattie in October 1961 (Stoddart, 2963). Lethal yellow (a phytoplasma disease spread by the American palm cixiid (*Myndus crudus*)) swept through Belize in the mid to late '90's, resulted in high mortality of remaining coconut stands at Turneffe.

A survey of the Turneffe area in the 1990s sought to establish whether there was anything left of the sponges established by the sponge industry, and in a number of other locations (Soldier Bight and Grand Bogue Creek). Velvet sponges were found to be abundant in waters 1 to 2m deep in the area of the Crooked Creek entrance into the Turneffe lagoon. *Iricinia* sp. and *Spheciospongia vesparium* were also observed in the area.

Whilst sponge farming is perhaps the most lucrative of the historical industries of Turneffe Atoll, turtle fishing, lobster and conch have also been ongoing since the 1940's (Neal, 2011) - though turtle fishing ceased once these species were protected by law.

Whilst seasonal fish camps were formed on Turneffe for lobster fishing in the 1930's (Murray et al. 1999), fishing as an industry, didn't become fully established until the 1960's and 70's, when outboard engines facilitated access both to the area as a fishing ground, and for taking marine products to market on the mainland. These fishing camps, which still remain in the area, have also led to the harvesting of palmetto (*Acoelorraphe* wrightii) for lobster traps, and mangroves (*Rhizophora mangle* and *Lagunularia racemosa*) for construction around the fishing camps, and for marking the location of lobster pots. Buttonwood and other dead woods (including red mangrove) were also harvested for firewood (Murray et al., 1999).

1.6.1 Current Community and Stakeholder Use

Turneffe Atoll is an important component of the traditional fishing waters of Belize, known for its significance as a lobster production area. In the early 1990's, Turneffe supplied more than 40% of the National Cooperatives total production. It is also one of Belize's foremost sport fishing destinations, supporting a multi-million dollar industry based on the extensive flats that lie within the Atoll. The impressive reef drop offs attract snorkelers and divers from around the world, and the scenic beauty of the mangroves, lagoons, sandy beaches and clear waters places this firmly as one of Belize's jewels, and an important tourism destination. During peak times, as many as 400 to 500 people – tourists / tourism industry, sport fishermen and commercial fishermen can be on the Atoll at any one time (Hayes, pers. com., 2011).

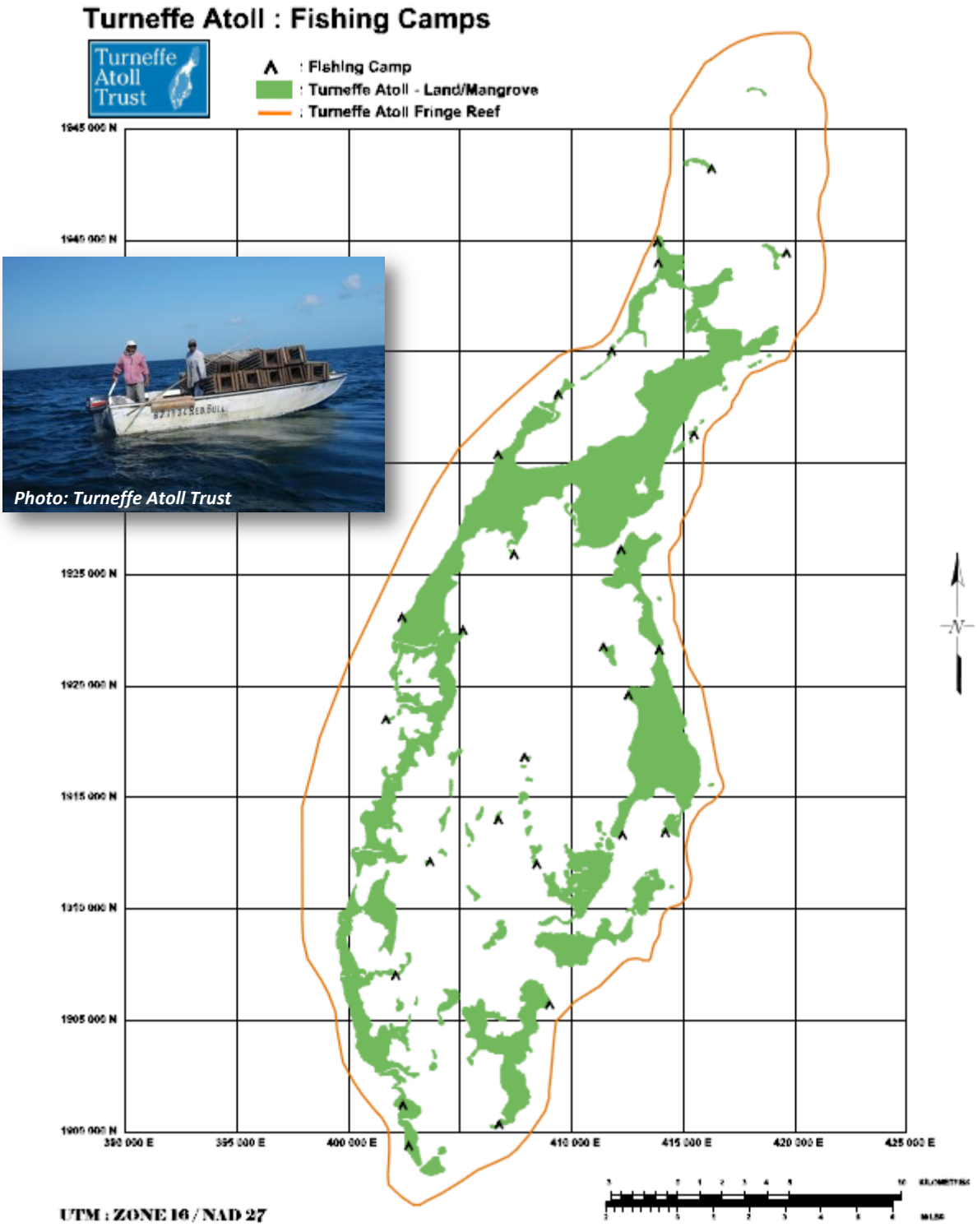
Traditional Fishing

Commercial fishing at Turneffe began in earnest in the 1960's and'70s, following the crash of the Caye Glory spawning aggregation site, and with the introduction of the outboard engine. With easier access to the grouper banks, and with the establishment of fishing camps by fishermen of Belize City and Sarteneja, Turneffe produced more than 40% of the National Cooperative's total annual production in the early 1990's (Belize Fisheries Department, 2008). Lobster, conch and finfish have traditionally been the major fisheries target at Turneffe Atoll, and up to 1990, thirty or more northern sailboats would move to Turneffe at the start of each lobster season, waiting with the fish camp fishermen for the lobster to start moving, and then profiting from the bumper harvests.

This continued until lobster numbers declined to a level too low to support the number of fishermen. Trap use increased, and the massive annual lobster migration ceased, resulting in the development of today's commercial fishing profile. Two hundred or more fishers work in Turneffe on a regular basis, based from 25 active fishing camps that focus entirely on the Atoll, and approximately 20 sailboats that regularly fish the Atoll and are considered economically dependent on its resources (Neal, pers. com.). A small number of skiffs also visit the Atoll on short trips (Cawich, 2011)

Three very different fishing styles were identified at the Atoll:

> **Fish Camp Fishermen**: An estimated 25 fishing camps are scattered across the Atoll (Map 10; TAT, 2011; Neal, 2011), generally located on the sheltered western side of the Atoll, or within one of the three lagoons (Cawich, 2011). They provide a base from which fishermen work, using lines for finfish for sale principally in Belize City (Vernon Street, and complementing this with lobster fishing using lobster traps and shades (Cawich, 2011). Each camp supports an average of 3 to 4 fishermen, with fishing trips normally lasting between 4 to 12 days - an average of 9 days per trip (Cawich, 2011). A total of 2,100 shades, 2,160 lobster traps and 200 drums were in use by 11 of the 25 fishing camps surveyed (TAT, 2011).



Map 10: Fishing camps, Turneffe Atoll (TAT, 2011)

55% of these fishermen were squatting on the land where their camps are located, whilst 27% held titles and 18% had leases (TAT, 2011). Only two fishermen consider themselves residents of Turneffe - the majority (over 73%) of the camp fishermen are resident in Belize City (Figure 50; Cawich, 2011). The remainder originate from communities as diverse as San Ignacio and Gales Point (Cawich, 2011).

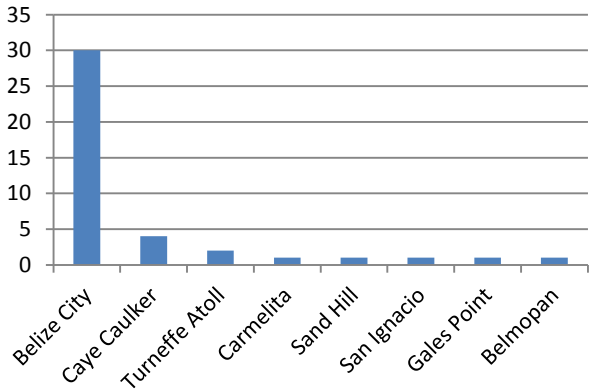


Figure 50: Origin of camp fishermen (sample size = 41). (Cawich, 2011)

Fishermen have been based at Turneffe for up to a maximum of 40 years, though the mean is closer to 29 years (TAT, 2011).

Sail boats fishers: 20 commercial fishing boats were reported as using Turneffe Atoll regularly in 2011, originating primarily from the northern communities – Copper Bank, Chunox and Sarteneja (Figure 51; TAT, 2011; Cawich, 2011). The northern fishermen use larger traditional sailboats to reach the Atoll, and dug-out canoes, or dories for daily fishing (one per fisherman). Each sailboat carries between 7 and 10 fishermen (TAT, 2011) who free dive for lobster and conch on the outer reef around the Atoll, whilst catching fin fish opportunistically using hand lines and spear guns to supplement their catch and for consumption on the trip. Fishing trips normally last between 6 to 10 days, with an average of 7.6 days per trip (Cawich, 2011).

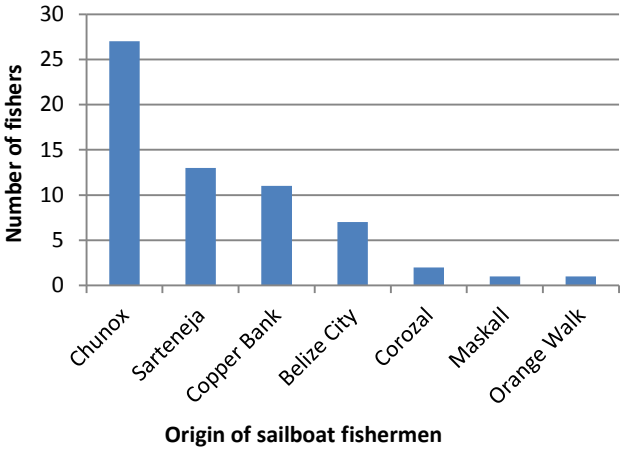


Figure 51: Origin of sailboat fishermen (sample size = 62). (Cawich, 2011)

Lobster hook sticks are the primary gear used by these fishers, followed by spear guns (Neal, 2011), Turneffe being one of the remaining places where spear guns are still allowed. Hand lines are also used, more as a way to pass the time either at night or when travelling between fishing locations than for serious commercial fishing (TAT, 2011).

Although some sailboat fishermen currently active on the Atoll have been using the area for over 25 years (and in fact established fish camps in the area in the early 1960's, before they were removed during tropical storms), the mean time of use for the fishermen interviewed is 15.3 years (TAT, 2011). The majority of fishermen are reported to spend nearly all (an average of 96%) of their fishing time at Turneffe, though some sailboats also utilise Lighthouse Reef Atoll,

particularly at the start of the conch season if the area becomes too congested or there is difficulty finding product, returning to Turneffe when the weather and rough seas prevents boats from making the crossing from Turneffe to Lightouse Atoll (Neal, pers. com.).

One-Two Night Skiffs: These vessels (small 15-25 ft skiffs) normally depart from Belize City on one to two day trips to Turneffe Atoll to fish for lobster and conch, particularly during the opening of the season. However several camp and sailboat fishermen consider that these fishermen are opportunistic, with reports of robbing of lobster traps, illegal fishing, and theft of fishing equipment and boats (Turneffe Fishermen Consultation Workshop, 2011).

1.6.2 Recreation and Tourism Use

Belize is a well known tourism destination for those seeking the reef, coral sand beaches and laid-back Caribbean culture. Turneffe Atoll provides an excellent resource for marine based activities - the proximity of colorful reefs in clear water, dive sites, and world class sport fishing draws many visitors to the area. Snorkeling, diving eco-tours and sport fishing trips are either from residential packages supplied by resorts located on the Atoll, or from day tour packages originating from Belize City, San Pedro and Caye Caulker, and even as far away as Hopkins and Placencia (Table 26).

Visitor Activity	Number of Visitors
Diving	
All Inclusive Resorts	1,387
Daily Diving Trips	6,894
Sport Fishing	
All Inclusive Resorts	1,250
Daily Sport Fishing Trips	267
Ecotours	
All Inclusive Resorts	1,221
Daily Ecotour Trips	512

Table 26: Number of tourists estimated as using Turneffe Atoll in 2010 (Fedler, 2011)

Three high end resorts are based on cayes within Turneffe itself, all of which have excellent fishing and dive operations and offer fishing, dive, and general vacation packages. Considered Belize's premier saltwater fly fishing destination, Turneffe Atoll offers the opportunity for fishermen to strive for a "Grand Slam" – catching bonefish, permit and tarpon in a single day.

Turneffe Flats is located on the Northeastern side of Turneffe Atoll, on the north end of Blackbird Caye, and has been established since 1981 Whilst primarily focused on fly fishing, Turneffe Flats is also equipped and staffed to offer diving, snorkeling, marine mammal / crocodile watching, kayaking and educational activities. The resort employs 35 local staff on average (dependent on time of year and number of guests), and has eight cabanas and two villas, with a total possible occupancy of 28.

Turneffe Flats – 1% for the Planet

"Through 1% For the Planet, Turneffe Flats has donated 1% of all income to conservation since 2002. Our efforts have primarily been related to promoting the sustainable use of Turneffe Atoll and other sensitive marine habitats."

Turneffe Island Resort, established in 1962, is located on Caye Bokel, at the southern tip of the Atoll. The resort has a total possible occupancy of 48, with eight cabanas, and twelve guest rooms, and a staff estimated at 40 or more. Activities are focused primarily on diving, snorkeling and sport fishing – particularly targeting bonefish, permit and tarpon

Blackbird Caye Resort is located on Blackbird Caye. With its own private airstrip, Blackbird Caye Resort is the most accessible of the three resorts, and provides diving, snorkelling and kayak opportunities for its guests. This resort has the most rooms, with 18 individual beachfront, air conditioned cabanas.

Blackbird Caye Resort - Best Practices Operation

- Minimize cutting of mangrove (including alternative mangrove pruning practices to maintain storm buffers, view and ventilation corridors
- Systematic program to minimize demand for electricity through use of (CFL and LED) lighting
- Partial renewable energy for buildings and desalination via solar and wind farm
- Four-stroke engines
- Solar hot water
- Rainwater water capture and water savings
- Solid waste management and recycling
- Implement environmentally friendly diving and snorkeling practices

Diving and Snorkelling

All in all, it is estimated that approximately 4,000 divers visit Turneffe annually – In season, the three lodges located on the Atoll provide access for approximately 1,000 divers annually (Fedler, 2011). Two live-aboard dive boats visit the Elbow weekly (the *Belize Aggressor* and the *Sun Dancer*), each carrying about 20 divers – an addition of approximately 2,000 divers and snorkelers over the year (Fedler, 2011). In addition, several dive shops from San Pedro, Caye Caulker, Placencia, Hopkins and Belize City offer trips to Turneffe (Fedler, 2011).

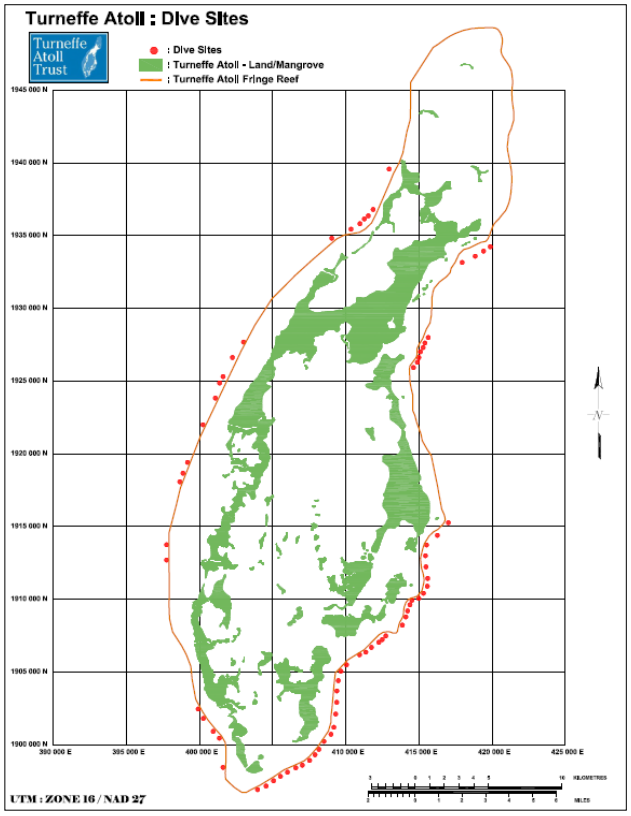


Figure 52: Recognised dive sites of Turneffe Atoll (TAT, 2011)

The shallow, clear waters of the Atoll provide sheltered snorkeling opportunities, whilst the deeper walls of the Atoll attract divers from around the world (Figure 52). With the potential to see turtle, sharks, rays and a multitude of colorful corals and fish in a pristine setting, Turneffe is considered one of Belize's primary marine attractions. The decreasing health of the reef, and continuing pressure for development of the cayes however, is of increasing concern, with the potential to negatively impact the ability of Turneffe to continue to attract visitors.

One of the main draws for dive tours is drift diving at The Elbow (Caye Bokel) - one of the most popular adventurous dive sites in the region. The spawning aggregation site itself, located on the eastern wall, is seldom used as a dive site, reducing human impact on the spawning species (Belize Fisheries Department, 2008).

Sport Fishing

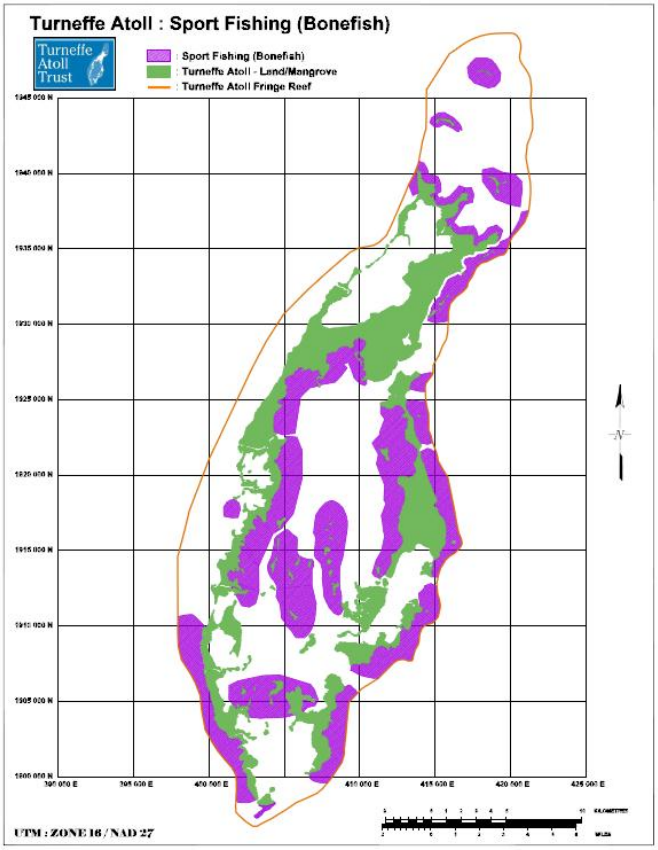
Bonefish, permit, and tarpon, if caught in the same day, qualify as a 'Grand Slam', the ultimate achievement for sport fishermen, and one that can only be fulfilled in a limited number of places around the world - Turneffe Atoll is one of those places. The Atoll has built a solid reputation for hosting Grand Slam opportunities. Early recreational fishermen employed local guides and camped at the Atoll, and several live-aboard operations started provided fishermen with the opportunity to stay in greater comfort at the Atoll. With increasing demand, three high-end resorts are now established on the Atoll promote all inclusive sport fishing packages. The majority of anglers are 'catch and release' fly fishermen, utilizing the eastern flats between the cayes and reef (Figure 53).

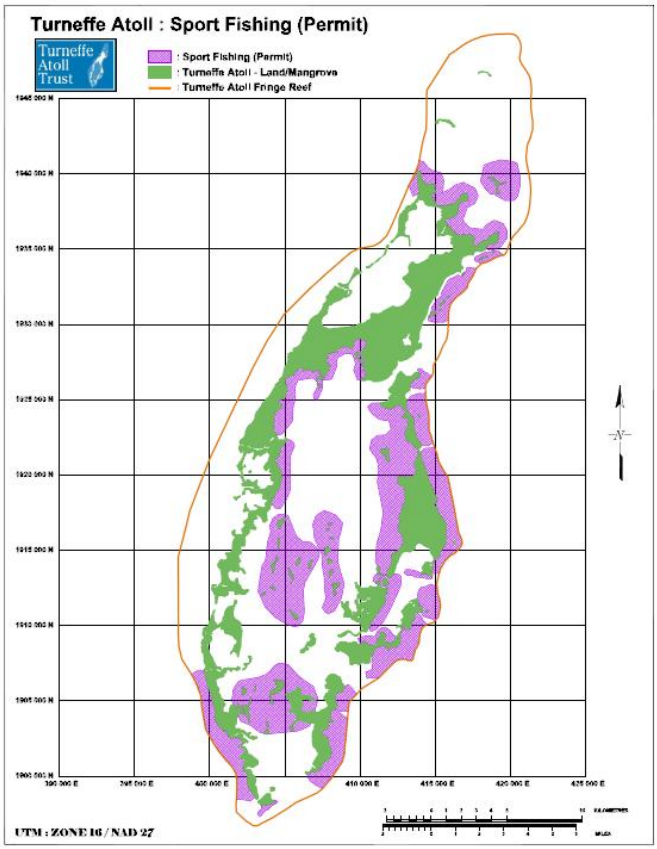
Sport fishing for bonefish, permit and tarpon has become of increasing importance over the years in its contribution towards the tourism sector GDP. In 2007, it accounted for more than $25 million in direct expenditures within the Belizean economy - approximately 6.3% of the national expenditure (Fedler and Hayes, 2008). It also provides a wide range of direct and supporting employment opportunities, valuable in particular for traditional fishermen wishing to shift away from the declining commercial fishery into an alternative income base.

Economic valuation outputs of catch-and-release sport fishing in Belize – bonefish, permit, and tarpon

- Tourists contribute nearly $400 million (BZ) annually to the Belizean economy and support more than 13,000 jobs which accounts for nearly 17% of the Belize GDP.
- Sport fishing for bonefish, permit and tarpon creates an annual economic impact of over $25 million (BZ) in direct expenditures in the Belizean economy plus an additional $31 million in Value Added expenditures for a total yearly economic impact of roughly $56 million. This amounts to approximately 6% of the Belize's tourist economy.
- Sport fishing for these three species results in approximately $2.7 million in Hotel Tax, Property Tax, Business Tax, GST, Employee (income and social security) Taxes, and Airport Exit Taxes generated for the Belizean treasury.
- Nearly $30 million in annual wages and salaries as well as 1,800 full-time jobs are supported by these three species.
- In 2007, more than 100 independent fishing guides provide services to approximately 4,800 international fishing guests at hotels and resorts throughout Belize, and at least 13 fishing lodges hosted nearly 1,000 international anglers from Europe, Canada, the United States and elsewhere.
- Virtually all bonefish, permit and tarpon caught by sport fishermen in Belize are released back to the water alive making this annual economic contribution fully sustainable. Therefore, with adequate management, it is quite realistic to suggest that sport fishing for bonefish, permit and tarpon will generate an economic impact of roughly $600 million for Belize over the upcoming decade

Fedler et al., 2008





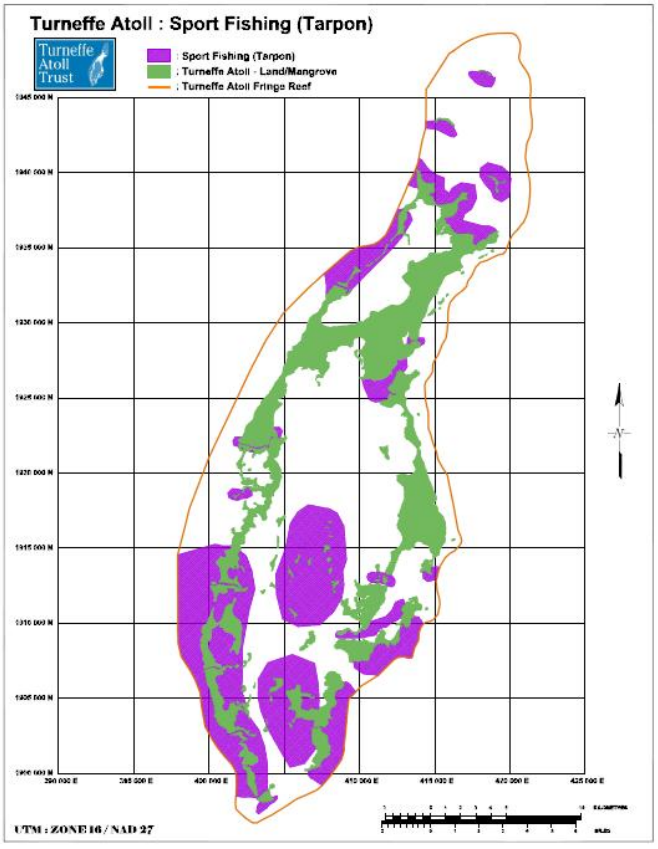


Photo: Turneffe Atoll Trust

Figure 53: Sport fishing locations per species for Turneffe Atoll (TAT, 2011)

1.6.3 Educational Use

Two educational facilities operate out of Turneffe Atoll, offering structured courses and activities for national and international students and researchers.

- University of Belize / Environmental Research Institute
- Oceanic Society

The University of Belize Environmental Research Institute

The Environmental Research Institute (ERI) has recently taken on management of the Calabash Caye Field Station - Belize's first nationally owned and managed marine research facility, officially opening on September 27th 1995. The field station sits on a 5 acre plot on Calabash Caye in the south-eastern portion of Turneffe. Current focus is on upgrading the facilities and services and establishing research and study abroad programs.

MISSION

The Environmental Research Institute continuously builds national scientific capacity for the effective management, sustainable use and conservation of Belize's natural resources.

VISION

As the premiere environmental research institute in Belize and highly respected in the region, ERI provides sound science and creates a culture of evidence-based decision-making in the public and private sector in areas relevant to Belize's sustainable development.

ERI has established ten permanent monitoring sites, with an ongoing monitoring program designed to address the data needs for management of Turneffe Atoll. Monitoring focuses on coral reef, mangrove, and seagrass, following MBRS protocols. Coral bleaching monitoring is also ongoing, coordinated through the National Coral Reef Monitoring Network, with the identification of eleven sites with more than 10% of corals affected during the February 2010 surveys.

ERI has also been involved in marine research efforts during the academic year, with studies on parrot fish populations and cross shelf connectivity.

Photo: Wildtracks

Oceanic Society

Oceanic Society, a nonprofit conservation organization established in 1969 is headquartered in California with field projects in the Caribbean and Micronesia. In Belize, research and education programs operate from the Blackbird Oceanic Field Station, located on Blackbird Caye, the largest of the cayes of Turneffe Atoll. The organization runs a number of different expeditions and projects at Turneffe, much of the research supported both financially and physically by volunteers

MISSION

To protect endangered wildlife and preserve threatened marine habitats worldwide. The Society works to establish protected natural areas, supported and sustained through scientific research, in cooperation with local communities.

Many of the studies are long term and on-going. These include investigation of the abundance distribution, and behavioral ecology of bottlenose dolphins (*Tursiops truncatus*), started in 1992, and providing significant information on the Atoll's dolphin population. Additional long term monitoring projects include the habitat use and distribution of manatees at Turneffe Atoll, and monitoring of American crocodiles and their nesting success, providing information on population trends, and recommendations for effective conservation management strategies.

Oceanic Society has also established a number of permanent shallow water coral reef monitoring sites, and have been monitoring reef health for several years, contributing to information on coral bleaching, and commercial and herbivorous fish biomass at Turneffe.

The Field Station hosts approximately 200 researchers and volunteers annually, with between 6 and 9 local staff employed at any one time, dependent on the ongoing projects.

Oceanic Society has also worked to improve sustainable operational practices at resorts on the Atoll through partnering with Blackbird Caye Resort and promoting best practices.

2. Conservation Planning

2.1 Identification of Conservation Targets

Conservation planning is a structured process that identifies and assesses the species and ecosystems of concern, the threats that impact them, and the strategies that can be used within the management of the area to mitigate these threats.

2.1 Conservation Targets

Conservation targets are species, species assemblages or ecosystems that are selected as representing the biodiversity of a protected area – such that strategic actions, taken to ensure their continued viability and reduce the pressures impacting them, will adequately address the conservation needs of the system as a whole.

2.1.1 Identification of Conservation Targets

Nine **Conservation Targets,** or elements, were chosen to represent and encompass the biodiversity values of the Turneffe Atoll, and to provide a basis for setting goals, developing strategies and actions, and monitoring success.

Focal Conservation Targets for Turneffe Atoll

- Coral Reefs
- Lagoon System
- Seagrass
- Back Reef Flats
- Terrestrial Ecosystems
- Spawning Aggregations
- Commercial Species
- Sport Fishing Species
- Open Sea Ecosystems

For the purposes of the Management Action Planning Process, the selected targets were required to meet the following criteria, where possible (adapted from TNC, 2007):

- **Targets should represent the biodiversity of the site.** The focal targets should represent or capture the array of ecological systems, communities, and species of importance at the project area and the multiple spatial scales at which they occur.

- **Targets reflect ecoregion or other existing conservation goals**. Focal targets should reflect efforts at the regional and national level where they exist, such as TNC and CI Ecoregional Assessments, the National Protected Areas System Plan, and the National Biodiversity Action Plan. Focal targets that are grounded in the focus for the project area's protection, and the identification of the Turneffe Atoll as one of the regions key

marine areas of ecological, biological and social importance (Kramer and Kramer, 2002).

- **Targets are viable or at least feasibly restorable**. Viability (or integrity) indicates the ability of a conservation target to persist for many generations. If a target is on the threshold of collapse, or conserving a proposed target requires extraordinary human intervention, it may not represent the best use of limited conservation resources.

- **Targets are highly threatened**. All else being equal, focusing on highly threatened targets will help ensure that critical threats are identified and addressed through conservation actions.

Ecosystem and species assemblage targets were selected to represent the Turneffe Atoll:

Ecosystem Level Targets: Assemblages of ecological communities that occur together, share common ecological processes, and have similar characteristics. Two coastal and three marine ecosystems have been selected

- ***Coral Reef Ecosystem***
- ***Lagoon System***
- ***Seagrass***
- ***Back reef Flats***
- ***Terrestrial Ecosystems***
- ***Open Sea Ecosystems***

Species Assemblages: Groups of species that share common natural process or have similar conservation requirements:

- ***Spawning Aggregations***
- ***Commercial Species***
- ***Sport Fishing Species***

Each of these targets has a series of associated **nested targets –** species or species assemblages considered of particular conservation importance that are represented by the target (Table 27).

Table 27: Conservation Targets and Nested Targets		
Conservation Target	**Nested Target**	
Coral Reef Ecosystem	Coral species Reef fish species Parrotfish Diadema Marine endemic species	Ecotourism Diving Snorkelling
Lagoon System	Creeks Inundated mangroves Lagoonal flats Patch reefs	Manatees Dolphins American saltwater crocodiles Juvenile fish
Seagrass	Marine turtles Herbivores	Manatees
Back reef flats	Flying gurnard Sport fishing industry	Rainbow parrotfish
Terrestrial Ecosystems	Littoral forest Sandy beaches Savannah Mangrove Marine turtles (nesting)	American saltwater crocodile (nesting) Terrestrial endemic species Migratory bird species White-crowned pigeon Osprey
Commercial species	Lobster Conch Finfish Sharks	Non-traditional species (eg. sea cucumber, sponge, seaweed, urchins)
Spawning Aggregations	Nassau grouper	Reef fish species (spawning)
Sport Fishing Species	Permit Tarpon Bonefish Snook	Submerged sandy beach (juvenile habitat) Foraging habitats Sport fishing industry
Open Sea Ecosystems	Deep sea banks Commercial species Pelagic sport fish sp (blue Sharks	Traditional handline fishermen Ocean jack, red, yellow eye and silk snapper, deep water black fin snapper Marlin, white marlin, sailfish billfish, dolphin fish, wahoo and king mackerel

2.2 Assessing Biodiversity Viability

The Viability Assessment, as conducted under the Conservation Planning process, provides:

- A means for determining changes in the status of each focal target over time, to measure success of conservation strategies, compare the status of a specific conservation target with future conditions, and with other projects in Belize / Central America that focus on that target

- A basis for the identification of current and potential threats to a target and identification of past impacts that require mitigation actions

- A basis for strategy design and the foundation for monitoring

Each Conservation Target was assessed using the following viability ratings:

- **Very Good** – The Indicator is considered to have an ecologically desirable status, requiring little or no intervention for maintenance.

- **Good** – The indicator lies within the acceptable range of variation, though some intervention is required for maintenance.

- **Fair** – The indicator lies outside the acceptable range of variation, and human intervention is required if the viability of the target is to be maintained

- **Poor** – Restoration of the conservation target is increasingly difficult, and impacts may result in extirpation from the conservation area

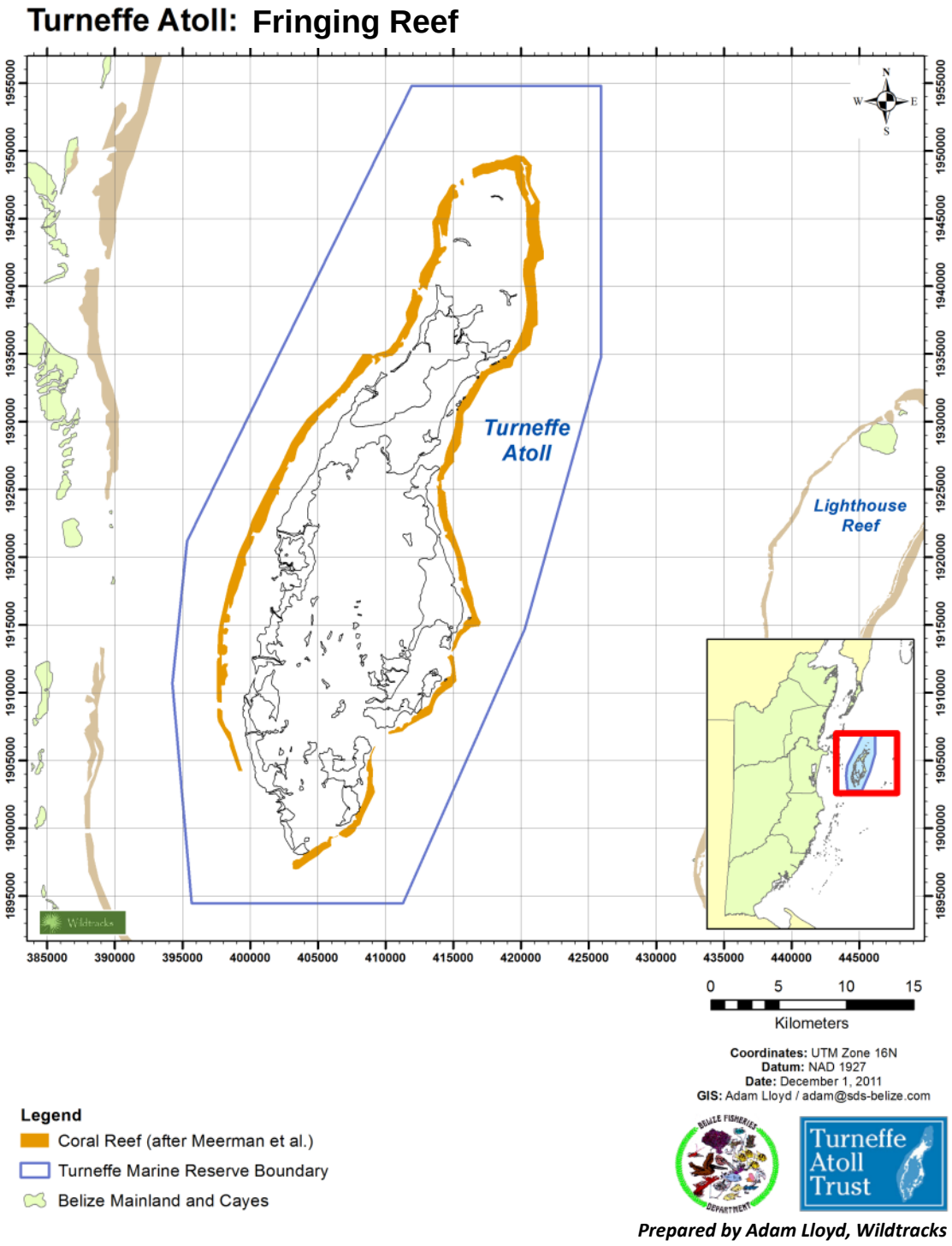
The overall viability rating for Turneffe Atoll is **GOOD**, with two targets rating as **FAIR** – **Coral Reef** and **Commercial Species** (Table 28)**.** Only one target, seagrass rates as **VERY GOOD.** The relatively good biodiversity health of Turneffe Atoll is one of the reasons for its high conservation importance.

Conservation Targets Current Rating	Landscape Context	Condition	Size	Viability Rank
Coral Reefs	Very Good	Poor	Good	**Fair**
Lagoon System	Very Good	Fair	Very Good	**Good**
Terrestrial Ecosystems	-	Fair	Good	**Good**
Seagrass	Very Good	Very Good	Very Good	**Very Good**
Spawning Aggregations	Very Good	Fair	-	**Good**
Commercial Species	Good	Fair	Fair	**Fair**
Back Reef Flats	Very Good	Fair	Good	**Good**
Sport Fishing Species	-	Good	Good	**Good**
Project Biodiversity Health Rank				**Good**

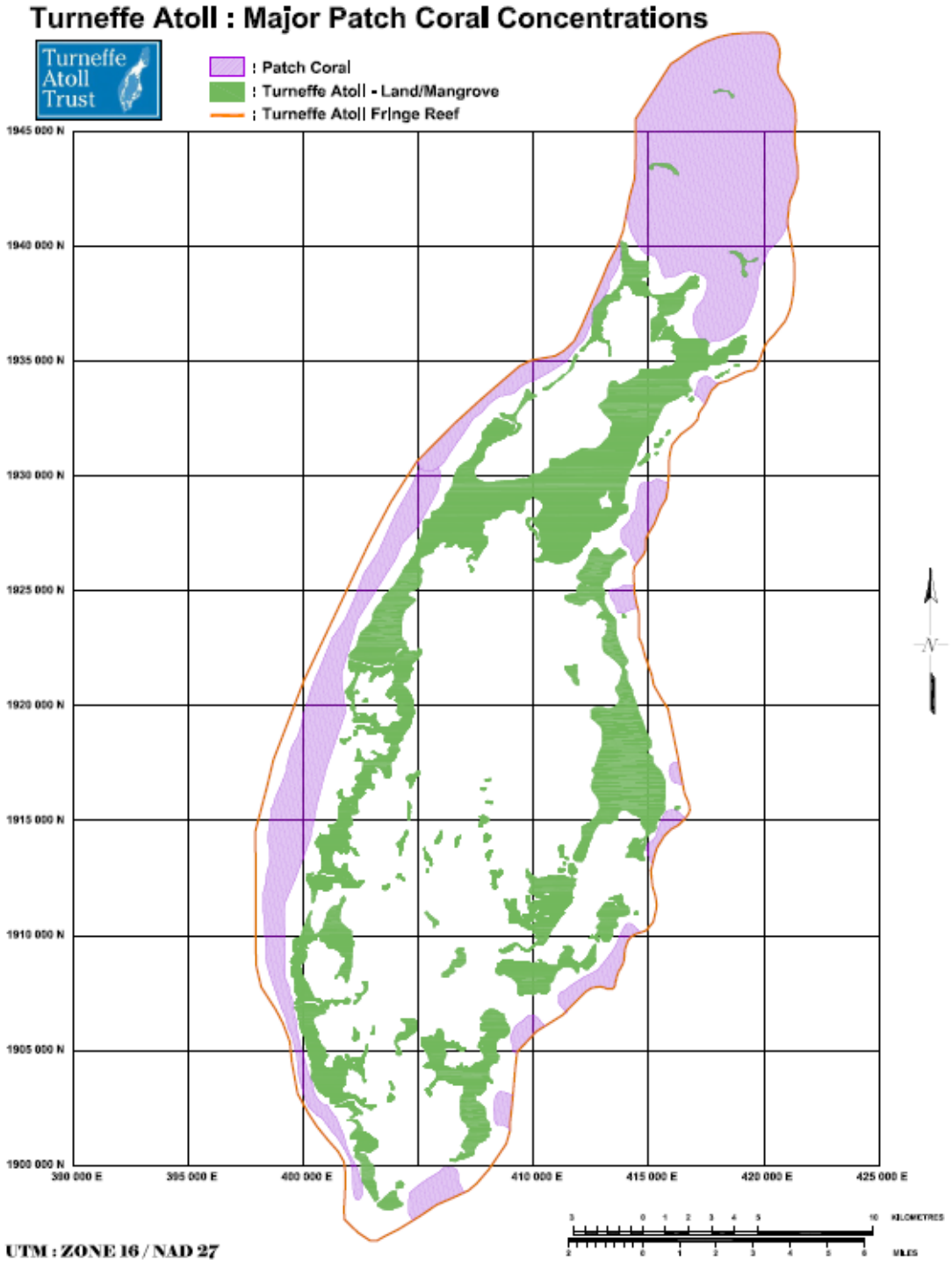
Table 28: Biodiversity Viability Summary for Turneffe Atoll

Turneffe Atoll Conservation Target: Coral Reef		
Conservation Target	**Justification**	**Species / ecosystems nested in this target**
Coral Reef	The reef building corals of Turneffe Atoll are critical to the maintenance of local biodiversity and the artisanal fishing industry, (particularly for spiny lobster populations), on which an estimated 180 fishermen and their families are reliant. It also provides the focus for tourism-related activities – diving and snorkeling - supporting employment in the Turneffe-based resorts and the dive operations providing day trips to the Atoll. Herbivores such as *Diadema* and the large parrotfish (Scaridae – *Scarus guacamaia, coelestinus, Sparisoma chrysopterum* and *S. virida)*, are critical in maintaining a healthy reef by reducing macroalgal cover, ensuring coral recruitment sites are available for continued coral health, particularly in recovery following bleaching episodes. A healthy reef can be characterized by relatively high live coral cover, moderate cover of crustose coralline calcareous and short turf algae, and low covering of fleshy macroalgae. The regional live coral cover average is 14% (15% on fore reefs and 11% on the reef crest) (Healthy Reef Initiative, 2010). ▪ Average live coral cover: 9.6% (POOR) ▪ Coral disease prevalence: GOOD ▪ Fleshy macroalgal cover: 16.6% (GOOD) ▪ Commercial fish biomass: 1143.4g per 100m^2 (POOR) ▪ Herbivorous fish biomass: 781.0g per 100m^2 (CRITICAL)	The reef ecosystems of the Turneffe Atoll include fore reef, back-reef, reef slope, and patch reef. These reef types are composed of many scleractinian coral species, including eleven highly threatened species (IUCN, 2011): **Staghorn Coral** *Acropora cervicornis* **CR** **Elkhorn Coral** *Acropora palmata* **CR** **Lamarck's Sheet Coral** *Agarica lamarcki* **EN** **Fire Coral** *Millepora striata* **EN** **Pillar Coral** *Dendrogyra cylindrus* **EN** **Elliptical Star Coral** *Dichocoenia stokesii* **EN** **Fire Coral** *Millepora striata* **EN** **Star Coral** *Montastraea annularis* **EN** **Star Coral** *Montastraea faveolata* **EN** **Montastraea Coral** *Montastraea franksi* **EN** **Rough Cactus Coral** *Mycetophyllia ferox* **EN** This provides a diverse range of habitats for a multitude of fish species and invertebrates, including commercially important species, the endemic whitespotted toadfish (*Sanopus astrifer)* and at least eleven IUCN redlist species: **Goliath Grouper** *Epinephelus itajara* **CR** **Nassau Grouper** *Epinephelus striatus* **EN** **Great Hammerhead** *Sphyrna mokarran* **EN** **Scalloped Hammerhead** *Sphyrna lewini* **EN**

Coral Reef - Target Viability								
Category	**Key Attribute / Characteristic**	**Indicator**	**Poor**	**Fair**	**Good**	**Very Good**	**Current Status**	**Desired Status**
Landscape Context	Water quality	Turbidity	>100mg/l	10 - 100mg/l	<10mg/l	**0mg/l**	**Very Good**	**Very Good**
		Water temperature	<24 or >30˚C	24-25 or 29-30˚C	**25-26 or 28-29˚C**	26-28˚C	**Good**	**Good**
	Connectivity	# man-made structures / impacts that block natural water flow				**0**	**Very Good**	**Very Good**
Condition	Coral health	% live coral cover	**Current status - 9.59 (ERI)**		>14% (HRI)		**Poor**	**Fair**
	Recruitment	# coral recruits / m^2	**0.00 to 10.0 recruits/m^2**	10.0 to 15 recruits/m^2	15 to 20 recruits/m^2	> 20 recruits/m^2	**Poor**	**Fair**
	Trophic Structure	# species of sharks		**Current Status**			**Fair**	**Good**
Size	Abundance of reef fish species	Biomass of reef fish (g/100m^2) north		**Current status**			**Fair**	**Good**
		Biomass of reef fish (g/100m^2) south			**Current Status**		**Good**	**Very Good**



Map 11: Fringing Reef of Turneffe Atoll (Data: Meerman 2004)



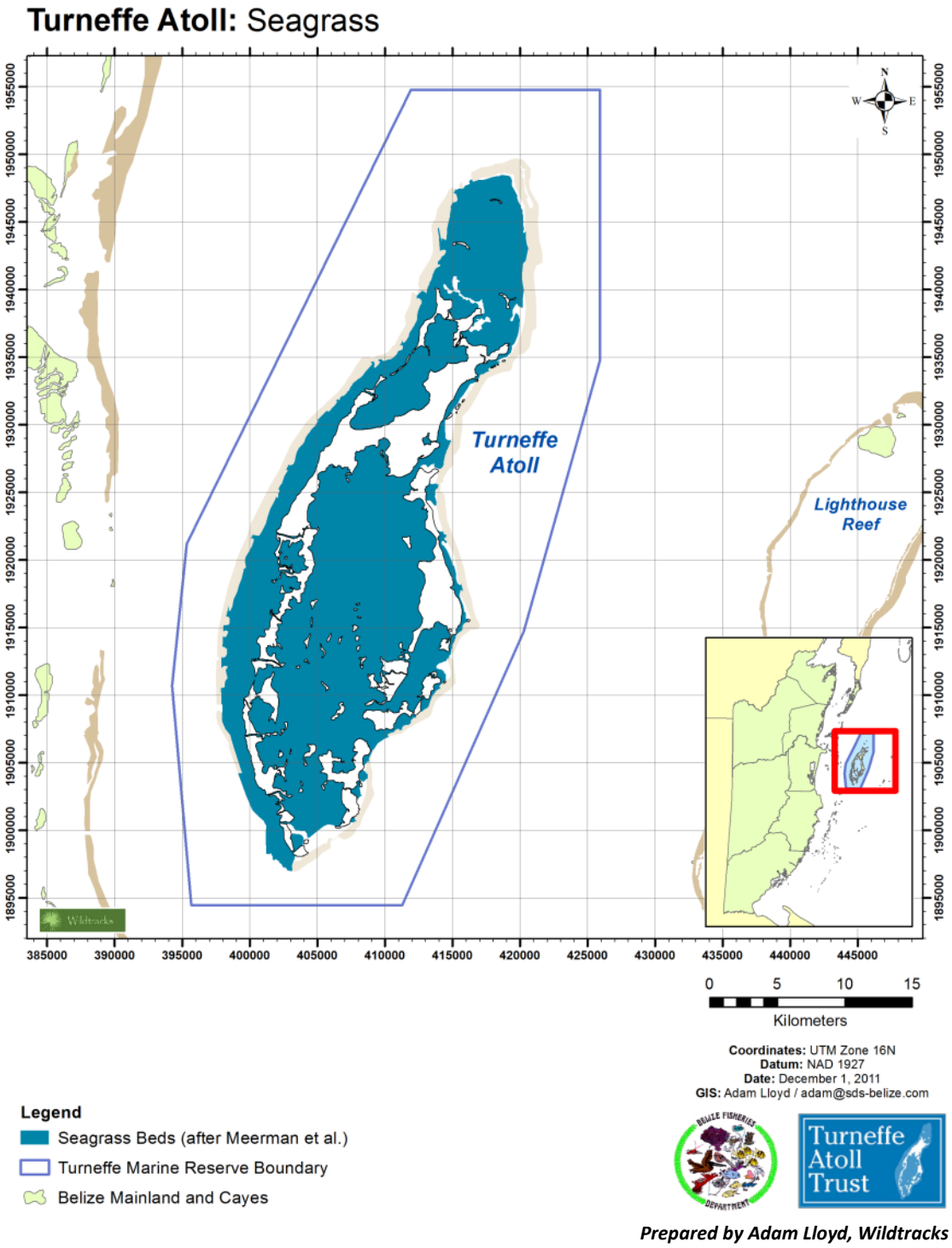
Map 12: Patch Reef Concentrations (TAT, 2011)

Turneffe Atoll Conservation Target: Lagoon Ecosystem		
Conservation Target	**Justification**	**Species / ecosystems nested in this target**
Lagoon Ecosystem	The lagoons of Turneffe Atoll (Central Lagoon and Northern (Vincente's) Lagoon are sheltered, being protected by a line of cayes to the east and mangroves to the west. They are characterized by the presence of open lagoons, mangrove-lined creeks and inundated mangroves, with scattered patch reefs. The benthic composition of the lagoons and creeks is generally dominated by a thick seagrass meadow. The mangrove is dominated by a single species – red mangrove. Turneffe Atoll lagoons provide one of the best examples of connectivity between seagrass and mangroves, with close proximity to the reef - critical for the viability of marine species that utilize the shelter of the seagrass and mangrove roots of the lagoons for the juvenile and growing-out phases of their lives. The Central Lagoon supports lobster fishing, with both sailboat divers and lobster trap fishermen, though catches have decreased since fishing started on the Atoll. The red mangroves provide important support structure for roosting and nesting birds – herons, egrets and osprey among them. NB: This target doesn't include the more exposed area of northern Atoll lagoon, which is included under coral reef	The seagrass beds are dominated by dense **turtle grass** (*Thalassia testudinum*), with some **shoal grass** (*Syringodium filiforme*). **Red mangrove** (*Rhizophora mangle*) is the dominant mangrove species, with prop roots extending into the water, supporting the trees. Areas of the lagoon are covered by inundated red mangrove, providing important nursery habitats for juvenile fish. **Caribbean lobster, Queen conch** and several species of **grouper** and **snapper**, all important commercial species, are dependent on the connectivity between the spawning aggregation sites, coral reef, seagrass and mangrove. A number of shark species are also thought to use the lagoons as nursery areas. Two mammals are considered resident or seasonally resident within the lagoons: **Atlantic bottlenose dolphin** *Tursiops truncatus* and the **West Indian (Antillean) manatee** *Trichechus manatus* (**VU –** IUCN, 2011). The **American crocodile** (*Crocodylus acutus*) (**VU –** IUCN, 2011) is found in the lagoon system, Turneffe being important for supporting the largest breeding population of this species in Belize. Several bird species rely on the lagoons and red mangroves, including **brown pelican** (*Pelecanus occidentalis*), **brown booby** (*Sula leucogastor*), **magnificent frigatebird** (*Fregata magnificens*), **great blue heron** (*Ardea herodias*), **snowy egret** (*Egretta thula*), **little blue heron** (*E. caerulea*) and **tricolored heron** (*E. tricolor*). Osprey (*Pandion haliaetus*), important top predators, have several nests on the Atoll.

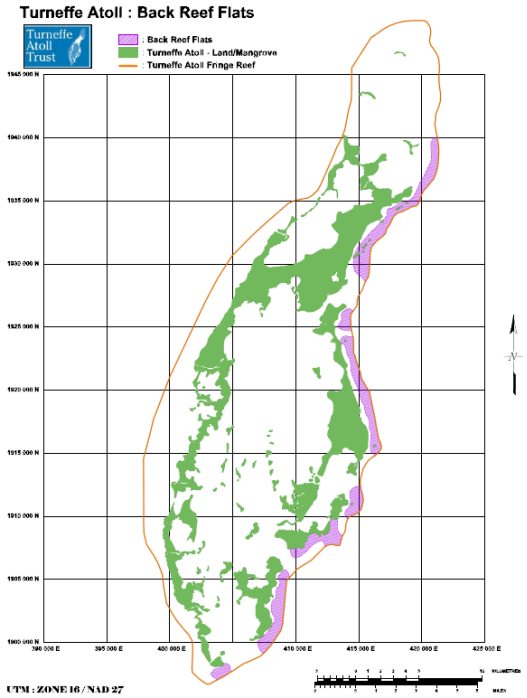
Lagoon Ecosystem - Target Viability								
Category	**Key Attribute / Characteristic**	**Indicator**	**Poor**	**Fair**	**Good**	**Very Good**	**Current Status**	**Desired Status**
Landscape Context	Connectivity among communities & ecosystems	# manmade structures / impacts that block natural water flow				**No interruption to natural water flow**	**Very Good**	**Very Good**
Condition	Nursery functionality	Biomass of juvenile fish in inundated mangrove areas			**Current status**		**Good**	**Very Good**
	Population structure & recruitment	Density of reproducing red mangroves				**Current status**	**Very Good**	**Very Good**
	Presence of invasive species	Density of lionfish on patch reef		**Highest density 30 per 50 ft2**	Highest density 5 per 50ft2		**Fair**	**Good**
Size	Extent of key habitats	% unimpacted innundated red mangroves				**99.9%**	**Very Good**	**Very Good**

Turneffe Atoll Conservation Targets: Seagrass		
Conservation Target	**Justification**	**Species / ecosystems nested in this target**
Seagrass	This target focuses on the extensive seagrass beds of Turneffe lagoon, representing 67% of the benthic cover of the Atoll. 90 – 100% of the sea grass beds are considered to be intact, with only marginal impacts from tourism and boats in the shallow waters around the cayes themselves, and in the anchoring point for boats waiting to access the spawning aggregation area. Seagrass meadows are essential for maintaining the ecological health of the shallow marine ecosystems, with an important role in nutrient cycling and sediment stabilization. They are also a critical ecosystem for many fish and invertebrate species, with an acre of sea grass being shown to support up to 40,000 fish and 50 million small invertebrates (Seagrass Ecosystems Research Laboratory, 2005).	Three species of seagrass are present at Turneffe – **turtle grass** (*Thalassia testudinum*), **shoal grass** (*Syringodium filiforme*) and **manatee grass** (*Halodule wrightii*). Seagrass beds are essential for the **Queen Conch** *(Strombus gigas)*, one of the two most important commercial species extracted from the sea, and for the juveniles of **lobster** and many commercial fish species. **Parrotfish**, herbivores that play a critical role in maintaining the reef, also rely on the seagrass beds as juveniles. Nested targets also include the **West Indian Manatee** (*Trichechus manatus)*, the largest of Belize's herbivorous marine mammals, as well as marine turtles. These species play a role in the maintenance of the seagrass and increase the productivity of this ecosystem through grazing.

Target Viability - Seagrass								
Category	**Key Attribute / Characteristic**	**Indicator**	**Poor**	**Fair**	**Good**	**Very Good**	**Current Status**	**Desired Status**
Landscape Context	Water quality	Turbidity				**Current Status**	**Very Good**	**Very Good**
Condition	Density of Seagrass	% cover of seagrass				**Current Status**	**Very Good**	**Very Good**
Size	Size / extent of ecosystem	Extent of seagrass cover				**Current Status**	**Very Good**	**Very Good**



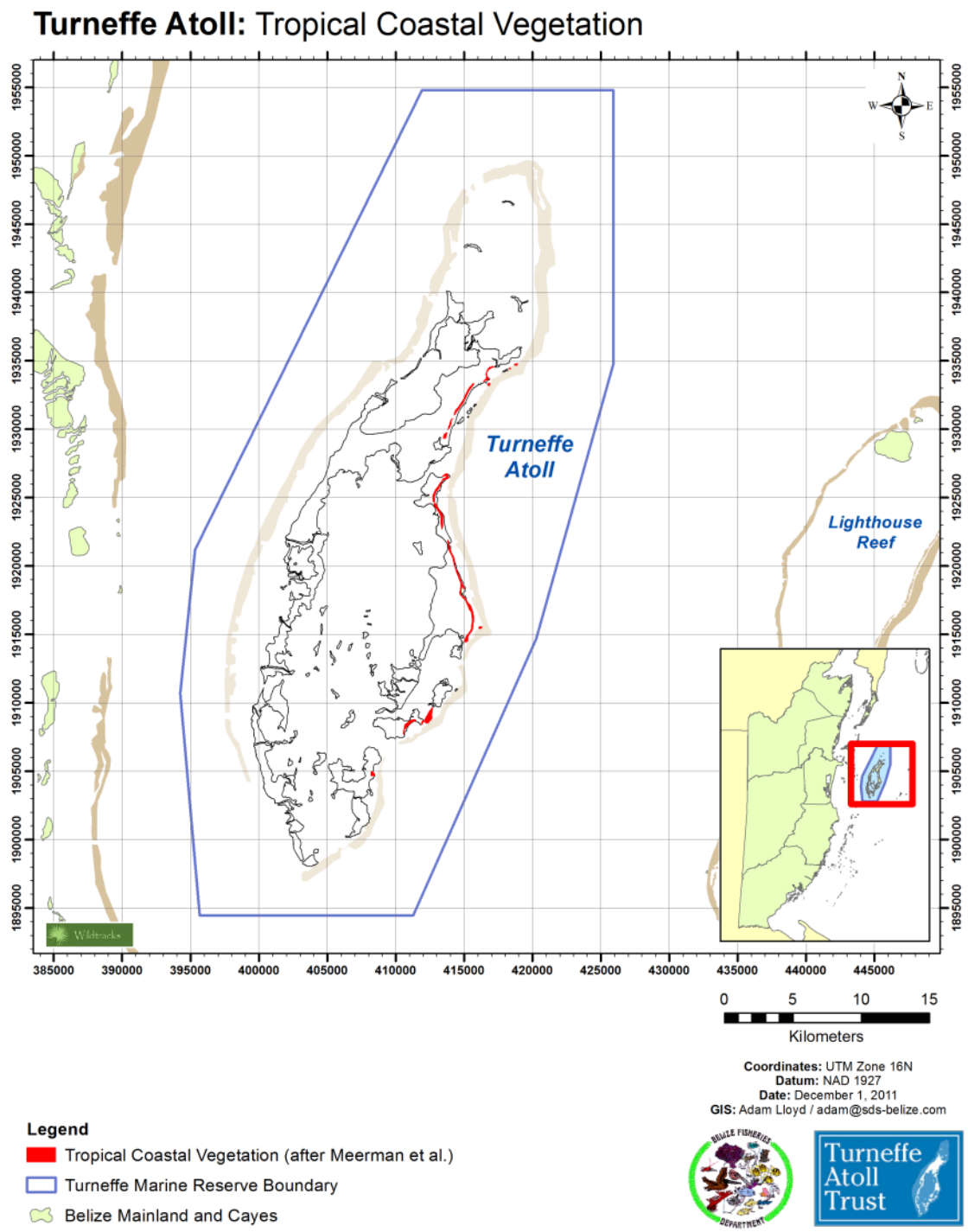
Map 13: Seagrass distribution, Turneffe Atoll (Data: Meerman, 2004)

Turneffe Atoll Conservation Targets: Back reef flats		
Conservation Target	**Justification**	**Species / ecosystems nested in this target**
Back reef flats	The back reef flats are characterized by use, rather than ecosystem type, and include shallow waters that may range from sandy hard bottom to seagrass, located between the reef crest and the cayes on the east facing side of the Atoll. These areas are the primary bonefish and permit flats that attract sport fishermen to Turneffe.  	The shallow waters of the back reef flats are particularly important for recreational fish - large schools of **bonefish** (*Albula vulpes*), a major saltwater fly fishing species that contributes to the support of Belize's sport fishing industry. An estimated 500 sport fishermen a year visit Turneffe Atoll, providing employment for significant local staff - **local guides, boat captains, resort staff** on the cayes, and **tour operations** based on both the Atoll and the mainland. Providing an essential habitat for both adult and juvenile fish, the flats are also important for juvenile **Queen conch** (*Strombus gigas*)

Target Viability – Back reef flats								
Category	**Key Attribute / Characteristic**	**Indicator**	**Poor**	**Fair**	**Good**	**Very Good**	**Current Status**	**Desired Status**
Landscape Context	Water quality	Nutrient levels				**Current status**	**Very Good**	**Very Good**
	Water quality	Turbidity				**Current status**	**Very Good**	**Very Good**
Condition	Fish species diversity	HRI diversity index for fish species		**Current status**			**Fair**	**Good**
Size	Abundance of fish (back reef flats)	HRI abundance index for fish species			**Current status**		**Good**	**Very Good**
	Extent of key habitats	Extent of back reef flats				**>95% remain intact**	**Very Good**	**Very Good**

Turneffe Atoll Conservation Target: Terrestrial Ecosystems		
Conservation Target	**Conservation Target**	**Nested Targets**
Terrestrial Ecosystems	***Tropical Coastal Vegetation on recent sediments*** (Meerman and Sabido, 2001) is probably Belize's most threatened ecosystem - tropical littoral forest is highlighted under Belize's National Protected Areas System Plan as being significantly under-represented within the current protected area system, with only 8.6% of the national coverage being under protection, as compared with the national target of 60% for this ecosystem. Natural vegetation has been modified and/or cleared extensively on all cayes of the Turneffe range to make way for coconut plantations, with significant regeneration following Hurricane Hattie, in 1961. More recently, the highest areas of littoral forest have been targeted for tourism and residential development. The littoral forest is an important component of the Neotropical migratory bird route, with species moving down the Atolls of Turneffe, Lighthouse Reef and Glover's Reef, on to the Sapodilla Cayes, and from there to Guatemala and Honduras, where they again hook up with the mainland and its plentiful food resources. The lower herbaceous beach vegetation grows along the coastal strand – a combination of low growing shrubs and vines that provide structure that binds the sand and prevents erosion, as well as providing optimal nesting conditions for American crocodiles and marine turtles	Nested within the Terrestrial Ecosystem target are both **tropical littoral forests** and **herbaceous beach vegetation,** with a series of associated plant species (**Annex …:** Plant Species list for Turneffe Atoll). A number of bird species rely on the littoral forest and mangroves, either as residents such as the **white crowned pigeon** (*Patagioenas leucocephala*) and **cinnamon hummingbird** (*Amazilia rutila*), or as migrants - species such as the **bay breasted warbler** (*Dendroica castanea*) and **northern waterthrush** (*Seiurus noveboracensis*). Terrestrial reptiles and amphibians include the blue and green colour morph subspecies of the **parrot snake** (*Leptophis mexicanus hoeversi*), and the recently established **Maslin's whiptail lizard** (*Cnemidophorus maslini*), as well as the more ubiquitous **black iguana** (*Ctenosaura similis*) The herbaceous beach vegetation and sandy beaches provide optimal nesting habitat for the **American crocodile** (*Crocodylus acutus*) and four species of marine turtle – **hawksbill** (*Eretmochelys imbricata*), **green** (*Chelonia mydas*), **loggerhead** (*Caretta caretta*) and **leatherback** (*Dermochelys coriacea*) turtles.

Target Viability – Terrestrial Ecosystems								
Category	**Key Attribute / Characteristic**	**Indicator**	**Poor**	**Fair**	**Good**	**Very Good**	**Current Status**	**Desired Status**
Condition	Nursery functionality	# successful American Crocodile nests		**Current status**			**Fair**	**Good**
	Nursery functionality	# successful marine turtle nests		**Default**			**Fair**	**Good**
Size	Extent of key habitats	% of littoral forest unimpacted			**Current status?**		**Good**	**Very Good**



Map 14: Tropical Coastal Vegetation, Turneffe Atoll (Data: Meerman, 2004)

Turneffe Atoll Conservation Target: Spawning Aggregations

Conservation Target	Conservation Target	Nested Targets
Spawning Aggregation	Many of the groupers and snappers form large spawning aggregations at predictable times and places, making them very vulnerable to fishing pressure. In 1998, Nassau grouper spawning in Belize was estimated to have declined by 81% over a 10 year period. These aggregation sites are critical to the maintenance of these fish species and, in Belize, are seasonally protected under SI 161 of 2003, including two sites within Turneffe Dog Flea Caye and the Elbow at Caye Bokel. A third site, Maugre Caye allows for traditional fishing under species permit, and two more have no legal protection. Protected spawning aggregation sites (both through SI and through surveillance and enforcement presence) increase viability of commercially important fin-fish species such as grouper, snapper and jack, during the reproductive stage of their life cycle, providing important benefits to the fishing sector.	**Spawning Aggregation Species**

SPAG Site	Vulnerability	Ecological Importance
Dog Flea Caye	3	1
Caye Bokel	3	2
Maugre Caye	3	3
Soldier Caye	Not assessed	Not assessed
Calabash	Not assessed	Not assessed

(1) Vulnerability: (Existing and future fishing pressure)
1. Low vulnerability
2. Medium vulnerability
3. High vulnerability

(2) Ecological Importance: (Based on the number of species and individuals spawning at the site)
1. Low importance
2. Medium importance
3. High importance

MBRS SPAG Monitoring Recommendations, Heyman et al., 2003

Epinephelus striatus	Nassau grouper	M,CB, DF, SC
Mycteroperca tigris	Tiger grouper	CB, DF, SC
Mycteroperca venenosa	Yellowfin grouper	DF
Mycteroperca bonsai	Black grouper	CB, DF, SC, C
Melichthys niger	Black durgon	DF
Anisotremus surinamensis	Black margate	CB, DF
Lutjanus cyanopterus	Cubera snapper	CB, DF
Lutjanus griseus	Black snapper	CB
Lutjanus jocu	Dog snapper	CB
Ocyurus chrysurus	Yellowtail snapper	CB, DF, C
Lutjanus analis	Mutton snapper	CB
Caranx latus	Horse-eye jack	CB, DF, SC, C
Caranx rube	Bar jack	CB, DF, SC, C
Scomberomorous maculatus	Spanish mackerel	CB, DF
Canthidermis sufflamen	Ocean triggerfish	CB, DF,
Elagatis bipinnulata	Rainbow runner	DF
Kyphosus sectatrix	Bermuda chub	CB, DF
Trachionatus fulcatus	Permit	CB, C
Clepticus parrae	Creole wrasse	CB, DF
Acanthostracion quadricornis	Scrawled cowfish	CB
Lactophrys triqueter	Smooth trunkfish	CB, SC

M: Maugre Caye	SI 49 of 2009
CB: Caye Bokel	SI 161 of 2003
DF: Dog Flea Caye	SI 161 of 2003
SC: Soldier Caye	No protection
C: Calabash Caye	No protection

Target Viability – Spawning Aggregations								
Category	**Key Attribute / Characteristic**	**Indicator**	**Poor**	**Fair**	**Good**	**Very Good**	**Current Status**	**Desired Status**
Landscape Context	Sedimentation	Turbidity	<30cm			**>60'**	**Very Good**	**Very Good**
	Water quality	Salinity	<30ppt			**36ppt**	**Very Good**	**Very Good**
	Water quality	Water temperature	High > 30 deg C / 86 deg F. Low < 24 deg C / 75 deg F			**High 28 deg C. Low 25 deg C**	**Very Good**	**Very Good**
Condition	Population structure & recruitment	# of large adults at SPAG site	<25% of spawning population are large adults	**25 - 35% of spawning population are large adults**	36-50% of spawning population are large adults	> 50% and <75% of spawning population are large adults	**Fair**	**Good**
	Population structure & recruitment	% size class composition of SPAG fish	<50% above size of 1st yr maturity	**50 - 74% above size of 1st yr maturity**	75-99% above size of 1st yr maturity	100% above size of 1st yr maturity	**Fair**	**Good**

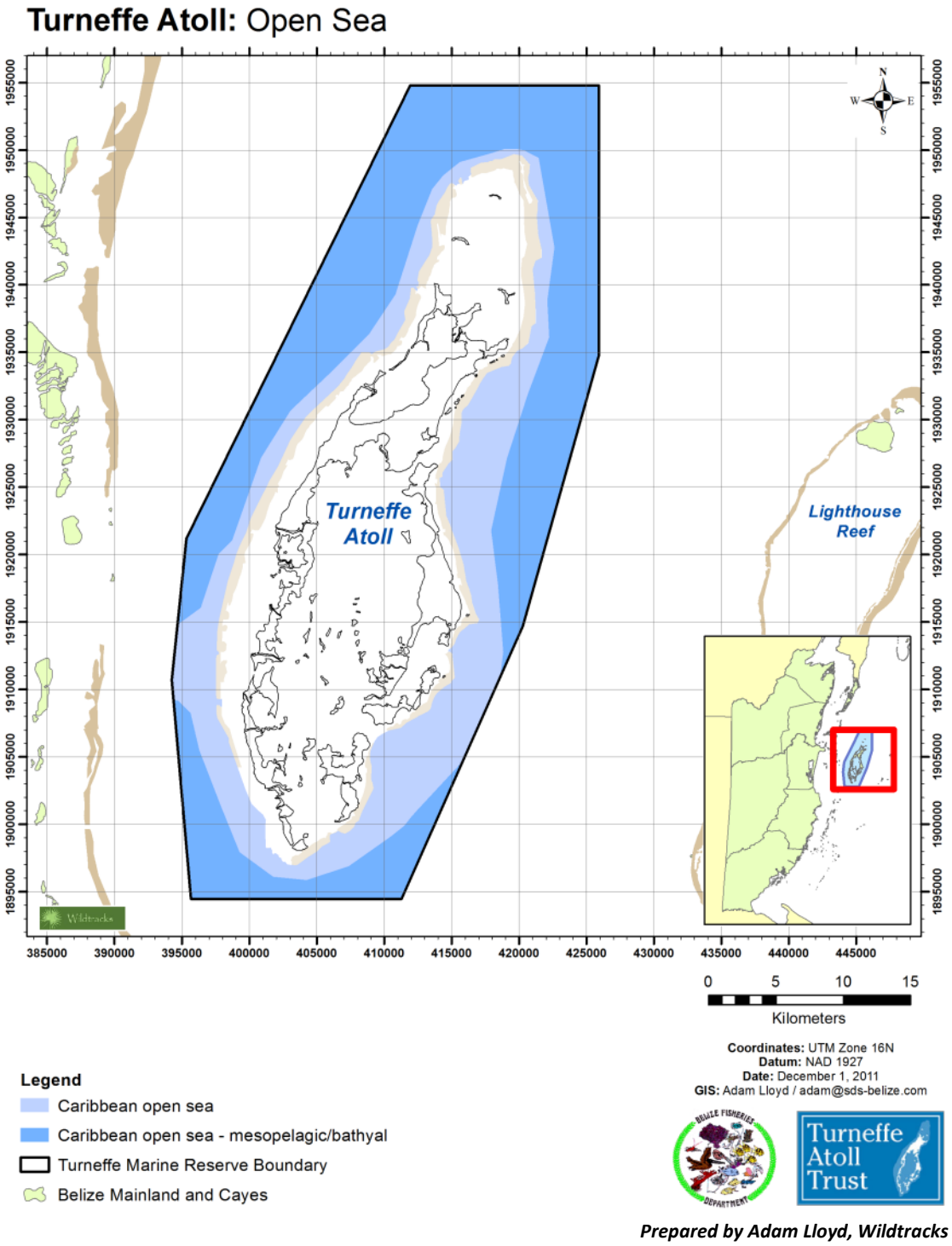
Turneffe Atoll Conservation Target: Commercial Species		
Conservation Target	**Conservation Target**	**Nested Targets**
Commercial Species	Commercial species provide the basis for a fishing industry on which many people depend. The role of many of the target fin-fish species as top predators is also essential in reef community structure. Most commercially important marine species have complicated life cycles that rely on the health and connectivity of the entire marine ecosystem – utilizing not just the reef, but also the seagrass beds and the mangroves at some point during their life cycles, and reflect the state of the reef. The two invertebrate species of highest commercial importance extracted from Turneffe Atoll are the **Caribbean Spiny Lobster** (*Panulirus argus*) and **Queen conch** (*Strombus gigas*), both of which are fished extensively throughout the General Use Zone. Commercial finfish species are fished both on the Atoll (in the creeks and on the reef) and at the drop off. There is also traditional fishing of the spawning aggregation sites – particularly Caye Bokel (despite its closure under the Fisheries legislation).	This target covers primarily **Caribbean spiny lobster, Queen conch** and fin fish, – fished by two sectors – fishermen based from fish camps (predominantly from Belize City), and sailboat fishermen of the northern fishing communities (predominantly Chunox, Copper Bank and Sarteneja). Ensuring continued sustainable extraction for these fishermen is as much a target as conservation of the species targeted. A number of other commercial crustaceans are also included, such as the **spotted lobster** (*Panulirus guttatus*), **stone crab** (*Menippe* sp.) and blue crab (*Callinectes sapidus*) though these make up only a small portion of the total catch Snappers and groupers - both shallow and deep water species - are the predominant commercial species harvested from the Atoll. **Nassau grouper** (*Epinephelus striatus*) has been one of the most targeted species, though the near population collapse has led to fishermen concentrating on other species – for example: **black grouper** (*Myctoperca bonaci*), **cubera snapper** (*Lutjanus cyanopterus*), **black snapper** (*Lutjanus griseus*), **dog snapper** (*Lutjanus jocu*), and **mutton snapper** (*Lutjanus analis*). **Hogfish** (*Lachnolaimus maximus*), too, is considered an important commercial species, as are **grunts,** and **barracuda.** There is a small-scale shark fishery primarily targeting **Caribbean sharpnose** (*Rhizoprionodon porosus*) and **Caribbean reef sharks** (*Carcharhinus perezi*).

Target Viability – Commercial Species								
Category	**Key Attribute / Characteristic**	**Indicator**	**Poor**	**Fair**	**Good**	**Very Good**	**Current Status**	**Desired Status**
Landscape Context	Connectivity among communities & ecosystems	% of waterways and coastline that have been artificially altered				**< 5%**	**Very Good**	**Very Good**
Condition	Population structure & recruitment	% size class composition (lobster)	35% <4oz	**50% 5 - 7oz**	50%> 6oz	35% > 8oz	**Fair**	**Good**
	Population structure & recruitment	% size class composition of catch (lobster)	80% of catch is 4 - 6oz tails	**80% of catch is 5 - 7oz tails**	80% of catch is 6 - 8oz tails	50% of catch is >8oz tails	**Fair**	**Good**
Size	Population size & dynamics	Biomass of commercial finfish	420-839 g/100m2	840 - 1259 g/100m2	**1260 - 1679 g/100m2**	>1680 g/100m2	**Good**	**Good**
	Population size & dynamics	Density of conch	< 50 / ha	**51 - 300/ ha**	300 - 800 / ha	>800 / ha	**Fair**	**Good**

Turneffe Atoll Conservation Target: Sport Fishing Species		
Conservation Target	**Conservation Target**	**Nested Targets**
Sport Fishing	The back reef flats, mangrove-lined creeks and lagoons provide optimal habitat for recreational fishing species. The presence of permit, tarpon and bonefish in close proximity provide 'Grand Slam' opportunities – catch and release of all three in one day. Caye Bokel provides ideal conditions for spawning permit, which aggregate in groups of reproductive adults, and the seagrass, mangroves and shallow waters of the Atoll provide sheltered juvenile and growing out habitat.	The three primary sport fishing species of Turneffe Atoll are **permit** (*Trachinotus falcatus*), **tarpon** (*Megalops atlanticus*) and **bonefish** (*Albula vulpes*), providing the foundation for the successful sport fishing industry. Also sought by sport fishermen are a number of other species from the shallower waters of the Atoll (**great barracuda** (*Sphyraena barracuda*), **snapper and grouper**) and from the deeper waters beyond the drop-off (**blue marlin** (*Makaira nigricans*), **white marlin** (*Tetrapterus albidus*)**, sailfish** (*Istiophorus albicans)*, **wahoo** (*Acanthocybium solandri*), **dorado** (*Coryphaena hippurus*) and **king mackerel** (*Scomberomorus cavalla*). The sport fishing industry based on the resources of Turneffe Atoll provides significant employment to **local guides, boat captains, resort staff** on the cayes, and **tour operations** based on both the Atoll and the mainland.

Target Viability – Sport Fishing Species								
Category	**Key Attribute / Characteristic**	**Indicator**	**Poor**	**Fair**	**Good**	**Very Good**	**Current Status**	**Desired Status**
Condition	Habitat health (sport fishing species)	% of sport fishing species habitat unimpacted by anthropogenic causes			**Current status**		**Good**	**Very Good**
	Trophic structure	Abundance of food species (sport fishing species)				**Current status**	**Very Good**	**Very Good**
Size	Extent of key habitats	Extent of sport fish key habitats			**Current status**		**Good**	**Very Good**
	Population size & dynamics	Density of key sport fishing species			**Current status**		**Good**	**Very Good**

Turneffe Atoll Conservation Target: Open Sea Ecosystems		
Conservation Target	**Conservation Target**	**Nested Targets**
Open Sea Ecosystems	The Open Sea Ecosystems, with depths starting at 70m (200ft), are considered to be under-represented within the national protected areas system, and an important addition under the proposed marine managed area. A number of deep sea banks are thought to project from the sea floor to the west of the Atoll, used as fishing grounds by traditional fishermen. Surveys have been conducted to assess the feasibility of a commercial deep sea fishery in Belize, though it is thought that, with its limited continental shelf, the conditions may not be optimal, with returns too low to be economically viable.	This target includes deep sea banks, commercial species (ocean jack, red, yellow eye and silk snapper, deep water black fin snapper), sharks and pelagic sport fish species (**blue marlin** (*Makaira nigricans*), **white marlin** (*Tetrapterus albidus*), **sailfish** (*Istiophorus albicans*), **wahoo** (*Acanthocybium solandri*), **dorado** (*Coryphaena hippurus*), billfish, dolphin fish, and **king mackerel** (*Scomberomorus cavalla*). These deeper waters provide habitat for a number of resident and transient species. This includes the **rough-toothed** (*Steno bredanensis*) and **spinner dolphins** (*Stenella longirostris*), **Fraser's dolphin** (*Lagenodelphis hosei*), **Clymene's dolphin** (*Stenella clymene*), **orcas** (*Orcinus orca*), **humpback whales** (*Megaptera novaeangliae*) and **pilot whales** (*Globicephala macrorhynchus*), **sperm whales** (*Physeter macrocephalus*) and potentially **pygmy sperm whales** (*Kogia breviceps*), thought to pass through the area. Deep sea shark species - **silky sharks** (*Carcharhinus falciformis*), **smooth dogfish** (*Mustelus canis insularis*), the **Galapagos shark** (*Carcharhinus galapagensis*) and **night shark** (*Carcharhinus signatus*), as well as those species that patrol the Atoll wall - including **great hammerheads** (*Sphyrna mokarran*), **blacktip sharks** (*Carcharhinus limbatus*) and **tiger sharks** (*Galeocerdo cuvier*). **Whale sharks** (*Rhincodon typus*), too, are considered transient within the Open Sea ecosystem.



Map 15: Open Sea, Turneffe Atoll (Data: Meerman, 2004)

2.3 Assessment of Critical Threats

Threats were assessed using the TNC Conservation Action Planning methodology at the Turneffe Atoll Management Action Planning workshop, with representation from the fishing and tourism sectors, property owners, researchers, Fisheries and Forest Departments, Department of Geology and Petroleum and a range of other stakeholders.

The stresses and sources of stress were identified and assessed, allowing prioritization of management actions and resources towards the most critical threats. This was achieved through analyzing the stresses in terms of scope and severity, and the sources of stress through assessment of contribution and irreversibility. The summary results from the planning process provide each focal target with a threat status rating (Table 29).

The overall threat rating for Turneffe Atoll is assessed as **Very High**, with the highest threats identified as:

- **Fishing Pressure / Unsustainable Fishing Practices,**
- **Unsustainable Development**
- **Dredging / Removal of Habitats**

Three focal targets have threat ratings of **Very High**, reflecting the particularly heavy pressure on the natural resources from unsustainable development and fishing**:**

- **Coral Reefs**
- **Commercial Species**
- **Sport Fishing Species**

Two focal targets are rated as **High**:

- **Terrestrial Ecosystems**
- **Back Reef Flats**

One focal target has a threat rating of **Medium**: **Spawning Aggregation Sites**

Two focal targets are both rated as having a threat status of **Low**.

- **Lagoon System**
- **Seagrass**

Management Action Planning Assessment of Critical Threats for Turneffe Atoll (MAP2)

Threat Status:

Very High

- Fishing Pressure / Unsustainable Fishing Practices
- Unsustainable Development
- Dredging / removal of habitats

High

- Illegal Fishing

Medium

- Invasive Species - Lionfish

Low

- Extraction of Non-Timber Forest Products
- Anthropogenic Fires
- Boat Impacts
- Improper Sport Fishing Practices
- Tourism / Recreation Impacts

Rating Critical Threats – definitions (TNC, 2007)

Stress: The impaired aspects of conservation targets that result directly or indirectly from human activities (e.g., low population size, reduced extent of littoral forest; increased sedimentation; lowered groundwater table level). Generally equivalent to degraded key attributes / characteristics (e.g., habitat loss).

Stress		(TNC, 2007)
Criteria	**Score**	
Severity: The level of damage to the conservation target that can reasonably be expected within 10 years under current circumstances (i.e., given the continuation of the existing situation).	**Very High**	The threat is likely to destroy or eliminate the conservation target over some portion of the target's occurrence at the site
	High	The threat is likely to seriously degrade the conservation target over some portion of the target's occurrence at the site
	Medium	Medium: The threat is likely to moderately degrade the conservation target over some portion of the target's occurrence at the site.
	Low	The threat is likely to only slightly impair the conservation target over some portion of the target's occurrence at the site.
Criteria	**Score**	
Scope: The geographic scope of impact on the conservation target at the site that can reasonably be expected within 10 years under current circumstances (i.e., given the continuation of the existing situation).	**Very High**	The threat is likely to be widespread or pervasive in its scope and affect the conservation target throughout the target's occurrences at the site.
	High	The threat is likely to be widespread in its scope and affect the conservation target at many of its locations at the site.
	Medium	The threat is likely to be localized in its scope and affect the conservation target at some of the target's locations at the site.
	Low	The threat is likely to be very localized in its scope and affect the conservation target at a limited portion of the target's location at the site

Source of Stress (Direct Threat) – The proximate activities or processes that directly have caused, are causing or may cause stresses and thus the destruction, degradation and/or impairment of focal conservation targets (e.g., Unsustainable caye development).

Source of Stress		(TNC, 2007)
Criteria	**Score**	
Contribution: The expected contribution of the source, acting alone, to the full expression of a stress (as determined in the stress assessment) under current circumstances (i.e., given the continuation of the existing management/ conservation situation).	**Very High**	The source is a very large contributor of the particular stress.
	High	The source is a large contributor of the particular stress.
	Medium	The source is a moderate contributor of the particular stress.
	Low	The source is a low contributor of the particular stress.
Criteria	**Score**	
Irreversibility: The degree to which the effects of a source of stress can be restored	**Very High**	The source produces a stress that is not reversible (e.g., wetlands converted to a shopping center).
	High	The source produces a stress that is reversible, but not practically affordable (e.g., wetland converted to agriculture).
	Medium	The source produces a stress that is reversible with a reasonable commitment of resources (e.g., ditching and draining of wetland).
	Low	The source produces a stress that is easily reversible at relatively low cost (e.g., off-road vehicles trespassing in wetland).

A general assessment was completed (Table 29), and for those threats rating as **Very High** (Fishing Pressure, Unsustainable Development and Dredging)**,** threat assessment tables have been developed and strategies identified for addressing the issues (Tables 30, 31 and 32). The final threat assessment output from the MAP process

Table 29 Identified Local Anthropogenic Threats in the Turneffe Atoll area	
Fishing Pressure / Unsustainable Fishing Practices	Unsustainable extraction – too many fishermen, too limited a resource
	Exponential growth of lobster traps
	Fishing of reproductive adults at spawning aggregation sites
	Illegal use of seine / gill nets on reef and in channels
Unsustainable Development:	
Clearance of Mangrove	Removal of important marine nursery areas
	Removal of important habitat for nesting and migrating birds
	Erosion of caye soils
	Removal of important habitat for lizards
	Removal of important nutrient source within the marine system
Anthropogenic Impacts on Sandy Beaches	Removal of herbaceous beach vegetation – an ecosystem that is under-represented within the national protected areas system, and which is essential for good turtle nesting success
	Removal of critical turtle and crocodiles nesting habitats
	Light pollution, impacting turtle nesting and hatching success
	Presence of introduced predators – particularly dogs - reducing hatching success
	Introduction of exotics – *Casuarina,* coconut palms
Pollution	Contamination of waters near developed cayes and from boats throughout Turneffe Atoll, due to inappropriate sewage and grey water treatment, leading to eutrophication, with associated accelerated algal growth and coral loss
	Inappropriate solid waste disposal from boats and cayes
	Contamination of waters by runoff containing herbicides, insecticides/detergents from cayes
	Reduction and pollution of freshwater lenses beneath cayes
Dredging and Associated Sedimentation	Destruction of seagrass habitat, supporting many vertebrate and invertebrate species
	Sedimentation of coral, reducing coral viability
	Sedimentation of seagrass, reducing seagrass viability
	Re-suspension of pollutants
Invasive Species: Lionfish	Reduction of native marine species – voracious predator of juvenile fish and crustaceans
Extraction of Non-timber Forest Products	Extraction of palmetto for fish trap construction
	Extraction of mangrove and timber trees for construction of fish camps and for marking position of lobster traps
Anthropogenic Fires	Impacts to mixed mangrove scrub, palmetto and littoral forest through escaped fires (land clearance)
Boat Impacts	Mechanical damage to coral reef communities and nursery sites (seagrass beds) from anchor damage, sedimentation and propeller damage from shallow water boat traffic, ship and boat groundings
	Erosion from boat wash in creeks
	Pollution from poor fuel management and poorly maintained outboards

Table 29: Identified Local Anthropogenic Threats in the Turneffe Atoll area / 2	
Poor Sport Fishing Practices	Non-catch and release
	Impacts on conch nursery area and seagrass
Tourism/ Recreation Impacts	No enforcement of tourism regulations
	Pollution from sun blocks and insecticides
	No carrying capacity guidelines in place
Threats from Adjacent Shipping Lane	Blackwater: Sewage, waste water from toilets and medical facilities. Release of untreated or inadequately treated sewage
	Ballast Water: With potential to introduce invasive species
	Greywater: Wastewater containing a variety of contaminants such as detergents, oil, grease, metals, petroleum hydrocarbons
	Bilge Water: Oil-contaminated water from engine oil leaks, which is flushed out at intervals

Table 30: Threats to biodiversity of Turneffe Atoll

Climate Change	***Status:***	***Historical***	***Active***	***Potential***
	Conservation Target(s): All			
	Stresses (*Direct*)*:* ▪ Reduced live coral cover ▪ Reduced coral growth rates ▪ Reduced biodiversity ▪ Erosion of beach ▪ Reduction in extent of herbaceous beach vegetation forest ▪ Ecological shifts in benthic communities			
	Sources of Stress (Indirect)***:*** ▪ Increased water temperatures ▪ Increased strength of storm events / hurricanes ▪ Sea level rise ▪ Changes in currents ▪ Ocean acidification ▪ Removal of herbivorous species through illegal fishing practices ▪ Other local anthropogenic threats			
Severity	***Very High***	Climate change is a global phenomenon, and is considered a significant risk to a wide range of species and ecosystems throughout Turneffe Atoll – particularly the terrestrial ecosystems		
Scope	***Very High***	The impacts of climate change are currently being felt at Turneffe Atoll through increased bleaching and storm events, and it is expected that the severity and frequency of these events will increase over the coming years		
Contribution	***Very High***	Climate change is the single largest contributing factor to the decline in biodiversity viability of the marine ecosystems		
Irreversibility	***Very High***	Climate change impacts may not be reversible within our life time – strategies are geared towards mitigation		
	Management Strategies: **Strategy 1:** Identify resilient areas within Turneffe Atoll in the context of site level management and the national marine protected areas system **Strategy 2:** Identify and increase protection of resilient reefs, source populations and key larval dispersal routes **Strategy 3:** Establish monitoring protocols that inform management for building reef resilience **Strategy 4:** Engage caye landowners in climate change adaptation strategies – including shoreline protection through conservation / re-planting of mangroves **Strategy 5:** Investigate mechanisms for direct interventions – eg. coral nurseries, shading of key sites, promoting higher herbivore densities **Strategy 6:** Strengthen protection of marine trophic structure - maintenance of top predators and herbivores			

Table 31: Threats to biodiversity of Turneffe Atoll

Fishing Pressure / Unsustainable Fishing Practices	***Status:***	***Historical***	***Active***	***Potential***
	Conservation Target(s): Commercial Species, Coral Reefs			
	Stresses (*Direct*)*:* ▪ Reduced commercial species populations ▪ Trophic shifts in marine ecological communities			
	Sources of Stress (Indirect)***:*** ▪ Lack of management presence ▪ Limited enforcement of fishing regulations ▪ Low income in fishing communities ▪ Traditional occupation ▪ Market demand from fishing coops ▪ Increased local and tourist demand for local fresh fish			
Severity	***Very High***	Lobster, conch and finfish populations are considered to be significantly lower than ten years ago		
Scope	***Very High***	Fishing occurs throughout the Atoll platform. The open sea is considered a separate target		
Contribution	***Very High***	Fishing pressure and unsustainable fishing practices are considered to be the primary cause of stock decline, with increasing numbers of fish traps, and increasing numbers of fishermen		
Irreversibility	***High***	It would be feasible to reduce the fishing pressure with adequate patrols and the strengthening of the prosecution system		
	Management Strategies: **Strategy 1:** Establish an effective surveillance and enforcement presence in the Turneffe Atoll, with effective enforcement of Fisheries regulations and zones **Strategy 2:** Engage fishermen in surveillance and enforcement activities **Strategy 3:** Establish zones for fisheries management based on informed decisions and strong scientific data **Strategy 4:** Develop and implement an effective sustainable fisheries management plan for Turneffe Atoll and in adjacent open sea, integrating mechanisms including: ▪ Education of fishers on policies and regulations and long term benefits ▪ Catch monitoring, ▪ Strategy evaluation and adaptation Catch shares, quotas and permits **Strategy 5:** Investigate feasibility for active rehabilitation and restoration of traditional and non-traditional commercial species **Strategy 6:** Investigate potential for diversification into other marine resource use /extraction activities **Strategy 7:** Develop and implement a supplemental / alternative livelihood programme targeting traditional users of Turneffe Atoll, focused both at Turneffe and in stakeholder communities, to reduce reliance on natural resource extraction at Turneffe			

Table 32: Threats to biodiversity of Turneffe Atoll

Unsustainable Development	***Status:***	***Historical***	***Active***	***Potential***
	Conservation Target(s): Terrestrial Ecosystems, Sport Fishing Species			
	Stresses (*Direct*)*:* ▪ Reduced extent of littoral forest, mangroves and herbaceous beach vegetation ▪ Reduced viability of terrestrial species ▪ Reduced viability of nesting turtle and crocodile populations ▪ Reduced viability of nesting bird populations ▪ Reduced viability of coral reef ▪ Removal of important marine nursery habitat ▪ Reduction / pollution of freshwater lens			
	Sources of Stress (Indirect)***:*** ▪ Infrastructure development (tourism, research, enforcement, etc.) with removal of natural vegetation and disturbance of nesting beaches ▪ Increased demand for land / tourism at Turneffe Atoll ▪ Increased erosion of caye soils / sandy beaches ▪ Inadequate, unplanned water and fuel management practices, with increased nutrients, sediment and pollutants in marine environment and freshwater lens ▪ Lack of management presence in area and lack of direct management control over cayes			
Severity	***Very High***	Where development occurs, there is generally complete removal of terrestrial vegetation, with associated impacts on biodiversity (dredging is being addressed as a separate issue)		
Scope	***Low***	There is currently only localised development activity, though this is predicted to increase in the future		
Contribution	***Very High***	Where development impacts occur, they are the primary contribution to habitat loss and associated impacts		
Irreversibility	***High***	It would be feasible to reverse the threat, but there would be very high economic and political barriers.		
	Management Strategies: **Strategy 1:** Develop, adopt and promote Turneffe Atoll development guidelines, with input from TACAC / CZMAI guidelines **Strategy 2:** Ensure effective surveillance and enforcement against illegal development activities at Turneffe Atoll – eg. non-permitted clearance of mangroves, overwater / seawall construction, dredging **Strategy 3:** Ensure effective surveillance and enforcement against illegal development activities at Turneffe Atoll – eg. non-permitted clearance of mangroves, overwater / seawall construction, dredging **Strategy 4:** Identify and map sensitive areas that would be severely damaged by vegetation clearance and inform Geology and Petroleum Department, Belize Fisheries Department, Forest Department, Department of the Environment			

Table 32: Threats to biodiversity of Turneffe Atoll	
Unsustainable Development	**Strategy 5:** Strengthen and implement guidelines for sustainable development for any new developments, and ensure that new development activity is accomplished in a low-impact, eco-friendly manner (to be defined – DOE/IUCN/certification etc.) and minimizes impacts to the natural environment **Strategy 6:** Ensure development guidelines are followed in the construction and operation of the Headquarters and rangers stations **Strategy 7:** Encourage caye-based residents / education / tourism developments to adopt and follow Turneffe Atoll development guidelines **Strategy 8:** Ensure all EIAs for Turneffe Atoll developments are fully vetted and approved, and take into account zoning recommendations and regulations, Turneffe Atoll and TACAC / CZMAI guidelines

Table 33: Threats to biodiversity of Turneffe Atoll

Dredging / Removal of Habitats	***Status:***	***Historical***	***Active***	***Potential***
	Conservation Target(s): Coral Reefs, Sport Fishing Species			
	Stresses (*Direct*)*:* ▪ Reduced extent of seagrass and viability of associated biodiversity ▪ Reduced viability of seagrass in adjacent areas ▪ Reduced viability of coral reef ▪ Removal of important marine nursery habitat			
	Sources of Stress (Indirect)***:*** ▪ Sedimentation impacts on seagrass and coral from dredging ▪ Demand for landfill for caye developments ▪ Demand for deep water access			
Severity	***Very High***	Where dredging occurs, there is complete removal of the benthic flora and fauna (predominantly seagrass)		
Scope	***Low***	There is currently only localised dredging activity, though this is predicted to increase in the future		
Contribution	***Very High***	Where development impacts occur, they are the primary contribution to habitat loss and associated impacts		
Irreversibility	***Medium***	It would be feasible to reverse the threat with some effort		
	Management Strategies: **Strategy 1:** Develop, adopt and promote Turneffe Atoll development guidelines, with input from TACAC / CZMAI guidelines **Strategy 2:** Ensure effective surveillance and enforcement against illegal dredging activities at Turneffe Atoll **Strategy 3:** Identify and map sensitive areas that would be severely damaged by dredging and inform Geology and Petroleum Department **Strategy 4:** Limit dredging on Turneffe Atoll to small scale non-mechanical operations (artisanal permits only) and for access purposes only, with a more robust assessment process to include strengthened environmental clearance process for dredging applications **Strategy 5:** Ensure all EIAs for Turneffe Atoll developments are fully vetted and approved, and take into account zoning recommendations and regulations, Turneffe Atoll and TACAC / CZMAI guidelines			

Turneffe Atoll – Threat Summary Table									
Threats Across Targets **Project-specific threats**	Coral Reefs	Commercial Species	Sport Fishing Species	Terrestrial Ecosystems	Back Reef Flats	Spawning Aggregations	Lagoon System	Seagrass	**Overall Threat Rank**
Fishing Pressure / Unsustainable Fishing Practices	**Very High**	**Very High**	**High**		**High**	**High**	**Low**		**Very High**
Unsustainable Development	**Medium**	**Medium**	**Very High**	**Very High**	**Medium**	**Medium**	**Low**		**Very High**
Dredging / removing of habitats	**Very High**		**Very High**		**High**		**Low**	**Low**	**Very High**
Illegal Fishing		**Very high**				**Medium**			**High**
Invasive species - Lionfish	**High**						**Low**		**Medium**
Extraction of NTFP				**Medium**					**Low**
Anthropogenic fires				**Medium**					**Low**
Boat impacts (wash / fuel / anchors / groundings)			**Low**		**Low**				**Low**
Improper Sport Fishing Practices			**Low**		**Low**				**Low**
Tourism / recreation impacts	**Low**							**Low**	**Low**
Threat Status for Targets and Project	**Very High**	**Very High**	**Very High**	**High**	**High**	**Medium**	**Low**	**Low**	**Very High**

Table 34: Summary of Threat Assessment Outputs, MAP, 2011

2.4 Monitoring of Success of Conservation Strategies

The series of indicators allocated to each conservation target provides a framework for site level monitoring, which have been incorporated into the Science Programme. A Measures of Success programme has been developed to monitor the success of conservation strategies, as an integrated component of the Management Action Planning process (Table 35).

Table 35: Measuring Success – Turneffe Atoll Monitoring Framework							
Category	**Indicator**	**Methods**	**Frequency**	**Location**	**Who**	**Cost**	**Funding Source**
Coral Reefs							
Status	IRHI	MBRS protocols, 2010 baseline	Annually	ERI monitoring sites, Oceanic monitoring sites	ERI Oceanic Society	Moderate	
Stress	Turbidity	Secchi disc at ERI monitoring sites,	Annually	ERI monitoring sites, Oceanic Monitoring site	ERI Oceanic Society	Low	
Source of Stress	No. incidence of significant increased turbidity from development impacts / year	Patrol reports	Annually	Fisheries Department	Fisheries Compliance Officer	Low	
Source of Stress	No. of incidents of poor development practices reported and confirmed / year	Patrol reports	Annually	Fisheries Department Department of the Environment	Fisheries Compliance Officer	Low	
Strategy	No. of fishing infractions as a % of total number fishing boats / year	Patrol Reports	Annually	Fisheries Department	Fisheries Compliance Officer	Low	

Measuring Success – Turneffe Atoll Monitoring Framework / 2							
Category	**Indicator**	**Methods**	**Frequency**	**Location**	**Who**	**Cost**	**Funding Source**
Coral Reefs							
Strategy	% of illegal fishing cases presented that are successfully prosecuted / year	Fisheries Compliance Unit reports	Annually	Fisheries Department	Fisheries Compliance Officer	Low	
Terrestrial Indicators							
Status	Extent of littoral forest	Satellite imagery, aerial flyover	Annual	Turneffe, ERI office	ERI	Low	CATHALAC, Lighthawk
Status	Extent of Mangrove	Satellite imagery, over flight; separation of inundated mangrove	Annual	Turneffe, ERI office	ERI	Low	CATHALAC, Lighthawk
Source of Stress	% of developments following TACAC /ECP guidelines	Overflight; site survey	Annual	Turneffe, DoE office	ERI DoE	Low	Lighthawk
Source of Stress	No. of incidents of poor development practices reported and confirmed /year	Patrol reports	Annually	Fisheries Compliance Unit DoE office	DoE	Low	

Measuring Success – Turneffe Atoll Monitoring Framework / 3							
Category	**Indicator**	**Methods**	**Frequency**	**Location**	**Who**	**Cost**	**Funding Source**
Lagoon Ecosystem							
Status	Abundance of juvenile fish in inundated mangroves	Light traps – catch per unit effort	Quarterly	Turneffe mangroves	ERI	Moderate	
Source of stress	Abundance of lionfish in inundated mangroves	Visual survey	Quarterly	Turneffe mangroves	ERI	Low	
Strategy	Total no. lionfish caught in tournaments per year	Tournament statistics	Annually	Turneffe	?	?	
Strategy	% of Turneffe fishermen engaged in lionfish removal per year	Patrol reports, collection points	Annually	Fisheries Compliance Unit, Turneffe			
Commercial Species							
Status	Conch density	LAMP surveys (ERI) Conch surveys (Fisheries)	2 x / year (pre and post season), BFD assessment (every 2 yrs)	TBD (ERI), Fisheries (set locations – get from Mauro)	ERI & Fisheries	Medium	

Measuring Success – Turneffe Atoll Monitoring Framework / 4							
Category	**Indicator**	**Methods**	**Frequency**	**Location**	**Who**	**Cost**	**Funding Source**
Commercial Species							
Stress	Average catch per boat (conch & lobster, finfish?)	Fisheries CpUE, determine method possibly through Coops or landing stations (3 across Turneffe)	Conch season (October 1st – June 30th) / Lobster Season (July 15th - Feb 15th)	Weighting stations (Calabash, 1 north/south – have fishers Id locations)	Fisheries, Reserve Rangers, Coops, ERI	High	
Source of Stress	Weight of illegal product	Weigh confiscated product	All year	Everywhere	Fisheries & Coast Guard	Low	
Strategy	# of day/ routine patrols	Patrol reports/annual reports	All year	Everywhere	Fisheries & Coast Guard	Low	
Stress	Average lobster catch by trap fishers	Fisheries CpUE - determine method.. possibly through Coops or at stations	lobster season	Coops and stations	Fisheries, Reserve Rangers, Coops, ERI	High	
Status	Lobster density & reproductive population density	LAMP surveys (ERI)	Twice per year (before & after season)	TBD (ERI),	ERI	Medium	

Measuring Success – Turneffe Atoll Monitoring Framework / 5							
Category	**Indicator**	**Methods**	**Frequency**	**Location**	**Who**	**Cost**	**Funding Source**
Spawning Aggregations							
Status	Grouper spawning population abundance	SPAG Protocol	Once per year during peak	Caye Bokel, Dog Flea, Mauger Caye and Soldier Caye	ERI, Fisheries	High	
Status	Population abundance of spawning snapper (cubera & dog)	SPAG Protocol	twice per year during peak	Caye Bokel	ERI, Fisheries	High	
Strategy	# of night and daytime patrols monitoring sites during spawning peak	Patrol reports/annual reports	Spawning season (3-4 times per year)	Caye Bokel and Dog Flea	Fisheries & Coast Guard	High	
Stress	# of fishers caught fishing illegally at SPAGs	Patrol reports/annual reports	Spawning season	Caye Bokel and Dog Flea	Fisheries & Coast Guard	Low	
Seagrass							
Status	Seagrass biomass	SeagrassNet	4 times/yr	Calabash and Blackbird	ERI	$8,000/yr	SeagrassNet

Measuring Success – Turneffe Atoll Monitoring Framework / 6							
Category	**Indicator**	**Methods**	**Frequency**	**Location**	**Who**	**Cost**	**Funding Source**
Seagrass							
Status/stress	Seagrass % cover	SeagrassNet	4 times/yr	Calabash & Blackbird	ERI & Oceanic	$8,000/yr	SeagrassNet
Status	Seagrass height	SeagrassNet	4 times/yr	Calabash & Blackbird	ERI & Oceanic	$8,000/yr	SeagrassNet
Status	Seagrass production	SeagrassNet	4 times/yr	Calabash & Blackbird	ERI & Oceanic	$8,000/yr	SeagrassNet
Status/stress	Light intensity	SeagrassNet	4 times/yr	Calabash & Blackbird	ERI & Oceanic		SeagrassNet
Status/stress	Water temperature	SeagrassNet	all year	Calabash & Blackbird	ERI & Oceanic		SeagrassNet
Back Reef Flats							
Source of stress	No. of dredging permits issued / year	GPD records	Quarterly	GPD Office	MR Mangt.	Low	
Stress	Area of BRF removed by dredging	Site visits / assessments / patrols GDP permit details Aerial surveys "Neighbourhood watch"	As needed (if dredging occurring) Bi-annually	On site On site	Rangers Coast Guard MR Mangt, GPD	Low (incremental increase in fuel costs) Low (if Lighthawk)	Lighthawk

Measuring Success – Turneffe Atoll Monitoring Framework / 7							
Category	**Indicator**	**Methods**	**Frequency**	**Location**	**Who**	**Cost**	**Funding Source**
Back Reef Flats							
Stress	Area of BRF impacted by increased turbidity	Site visits / assessments / patrols	As needed (if dredging occurring)	On site	ERI, Rangers & biologist	Low	
		Measure turbidity (Roberto to determine) Aerial surveys	TBD				
Status	Density of key sport fishing species	CPUE + gathered data	Baseline in 1st yr, then annually	On site	ERI, Biologist Rangers Fisheries Guides	Baseline – moderate Annual - low	
		Underwater visual surveys					
Strategy	No. patrols	Patrol logs & reports	Weekly	Office	Rangers .	Low	Strategy
	No. nets	Patrol & Guide logs & reports					
	No. arrests	Management records					

2.5 Planning for Climate Change

2.5.1 Site Resilience Assessment

Managing for Climate Change is a fundamental necessity of marine conservation in the current environment of predicted increasing sea surface temperatures, ocean acidification and tropical storm strength with a need to determine resilience to climate change, and adaptive strategies that can assist in maintaining the viability of the Atoll and its terrestrial and marine life. The following attributes were highlighted for Turneffe Atoll:

The Fisheries Sector consists primarily of a traditional capture fisheries focused on lobster, conch and finfish. Turneffe is one of the traditional fishing grounds, particularly for lobster fishermen, and used to be a major contributor to the marine export products of Belize, with 40% of product delivered to the cooperatives once originating from the Atoll.

▪ Conch, Lobster	Turneffe Atoll is considered a significant lobster extraction area on the national level, and also contributes to conch production, providing an important income for traditional fishermen
▪ Snapper / Grouper	The spawning aggregation sites of Turneffe Atoll are important for the maintenance of snapper and grouper populations, maintaining populations of important commercial species, including the Nassau Grouper

The Tourism Sector ranks 3rd in its contribution to the national GDP, and is one of the fastest growing industries, rapidly becoming the major foreign exchange earner, with over 840,000 tourists arriving in Belize in 2008 (BTB, 2009). Turneffe Atoll is considered an important tourism resource for the upper end tourism resorts based on the Atoll itself, and for San Pedro and Belize City.

▪ Healthy reef	A large number of popular dive sites are found along the walls of the Atoll. There are reef sites at Turneffe rated as FAIR and GOOD. The reef also attracts research /volunteer organizations such as Oceanic Society
▪ Sandy beaches	The east facing cayes of Turneffe Atoll are known for their sandy beaches, leading to the focused development of tourism in this area, as well as providing nesting sites for the touristic turtle species and the American Crocodile
▪ Fly-fishing / sport fishing (tarpon, bonefish, permit)	Turneffe Atoll is considered one of the foremost fly-fishing destinations in the world, contributing significantly to tourism income, with fly-fishing resorts providing employment and training for local staff

Ecosystem Service: The health of the marine environment is critical to the social and economic health of Belize. The ecosystem services provided by the coral reefs and mangroves, in particular, cannot be over-estimated. The protection Turneffe provides for coastal communities of central Belize, including Belize City, from tropical storms, and the support of the traditional artisanal fishing industries have been important in the development of Belize. Scenic values and coral reefs also provide the foundation for an active tourism industry.

▪ Mangroves	Turneffe Atoll has some of the most extensive stands of mangroves, with high connectivity to reef and seagrass, providing ideal nursery habitat for juvenile commercial species. Mangrove is also recognized for its CO_2 absorbing qualities, leading to the establishment of a wet carbon market.
▪ Seagrass	The central and southern lagoons of Turneffe Atoll harbour extensive seagrass beds, with high connectivity to reef and mangrove, providing ideal nursery habitat for juvenile commercial species, as well as threatened species such as marine turtles and manatees. Seagrass is also recognized for its CO_2 absorbing qualities.
▪ Corals	Turneffe Atoll has diverse reef types, ranging from reef wall to reef crest, back reef and patch reefs, with a high diversity of reef species.
▪ Littoral forest	The cayes of Turneffe Atoll support some of the last, and most important, remnants of extensive littoral forest, considered one of the most threatened ecosystems in Belize.

2.5.2 Climate Change Impacts

Climate Change Impacts	Current Status	25 - 50 yrs	100 yrs
Sea level rise	▪ Increased global average sea level rise rate of 1.8mm per year from 1961 – 2003 (IPCC, 2007). Current average increase in sea level rise in the Mesoamerican region is estimated at 3.1mm per year (IPCC, 2007).		▪ Predicted increase of between 0.6m and 1.0m over next 100 years, though could be higher (up to 3.3m), dependent on the rate of melt of ice sheets (Simpson et al., 2009)
Sea surface temperature rise	▪ Water temperature has increased by 0.74˚C between 1906 and 2005 ▪ Current levels of increase are estimated at 0.4˚C per decade (Simpson et al., 2009)		▪ Predicted regional increase of temperature by up to 5˚C by 2080, with the greatest warming being experienced in the north-west Caribbean (including Belize) (WWF, 2009).
Increased frequency of storms	▪ Increased storms from 1999 onwards, with annual fluctuations. More storms during La Nina, fewer El Nino. Stronger storms >Cat 4 / 5		
Ocean acidification (corals, lobster / conch)	▪ Atmospheric CO_2 concentration has increased from 280 parts per million (ppm) in 1880 to 385 ppm in 2008 - 35% increase in hydrogen (Simpson et al., 2009). ▪ 48% of all atmospheric CO_2 resulting from burning of fossil fuels has been taken up by the ocean (Hartley et. al, 2010).	▪ Predicted atmospheric CO_2 levels of 450 by 2040 (Simpson et al., 2009) ▪ Predicted 30% decrease in pH ▪ Predicted decrease in calcification rate by 20 - 50% by 2050	▪ Decrease of between 0.3 and 0.5 units by 2100 (Hartley et. al. 2010). ▪ Some experts predict a 35% reduction in coral growth by 2100 (Simpson et al., 2009)
Decreased Precipitation	▪ Mean annual rainfall over Belize has decreased at an average rate of 3.1mm per month per decade since 1960 (NCSP/UNDP)	▪ Predicted ecological shifts up the altitudinal gradient of the Maya Mountains Massif may remove the cloud forest, and the catchment functionality important for maintaining rivers in dry season in the south of Belize, and providing nutrients to the reef environment. ▪ Increased concentration and seasonality of agrochemical delivery	▪ Predicted decrease in precipitation of 9% by 2099 (IPCC, 2007), with significant fluctuations, attributed to El Niño ▪ Some models predict a decrease of as much as 22% (IPCC 2007)

Climate Change Impacts	Current Status	25 - 50 yrs	100 yrs
Air Temperature	▪ Mean annual temperature has increased in Belize by 0.45°C since 1960, an average rate of 0.10°C per decade. ▪ Average number of 'hot' days per year in Belize (days exceeding 10% of current average temperature) has increased by 18.3% between 1960 and 2003 (NCSP/UNDP).		▪ Predicted mean annual temperature increase is 3.5° by 2099 (UNDP, 2009).

	Ecosystem		
	Coral Reef	**Seagrass**	**Mangrove**
Sea level rise	Coral reefs may be able to keep up with sea level rise, barring other impacts (anthropogenic impacts, bleaching, acidification, disease and erosion). Also dependent on rate of sea level rise. Change in dispersal / recruitment routes / sources. There may be a loss of deeper corals, shift in distribution, as light availability decreases. Increased sedimentation and reduced light availability due to shore erosion. Possible reduction in water temperature with increased water exchange between deep water and coastal lagoon.	Increases in water depths above present meadows will reduce light availability and changes in currents may cause erosion and increased turbidity of water column. Shifts in distribution of seagrass beds. Over the medium term, seagrass should be able to survive in increased water depth	Greatest climate change challenges that mangrove ecosystems face are inundation, habitat loss, distribution shift. Greater inundation of fringing mangroves lenticels in aerial roots can cause the oxygen concentrations in the mangrove to decrease, resulting in death Damage to coral reefs may adversely impact mangrove systems depending on the reefs to provide shelter from wave action. If inland migration cannot occur, then mangroves may disappear. Increase in salinity – more saltwater intrusion may also affect distribution. Changes in dispersal patterns for mangrove propagules
Sea surface temperature rise	▪ Increased coral bleaching, potential mortality and erosion, and eventual loss of ecosystem functionality. ▪ Increased prevalence of coral disease. ▪ Possible impacts from new invasive species and algal blooms. ▪ A shift towards more tolerant species and symbiont types, and more opportunistic species, with reduced diversity. ▪ May alter localized current patterns and therefore larval dispersion. ▪ Less tolerant species will disappear – though increased sea level rise may assist against increased water temperature	▪ Temperature stress on seagrasses will result in distribution shifts, changes in patterns of sexual reproduction, altered seagrass growth rates, metabolism, and changes in their carbon balance. ▪ When temperatures reach the upper thermal limit for individual species, the reduced productivity will cause plants to die (above 35˚C for *T. testudinum*). ▪ Higher temperatures may increase epiphytic algal growth, increasing shading and reducing available sunlight.	▪ Loss of reef may reduce protection from erosion and storm events, increasing risk to mangroves.

Climate Change Impacts	Ecosystem		
	Coral Reef	Seagrass	Coral Reef
Increased frequency and intensity of storms	▪ Increased mechanical damage of corals, increased sedimentation. Reduced ability of colonies to re-establish after storm events. ▪ Removal of macro algae, resulting in more available substrate for recruitment. ▪ Fragmentation – dispersal and colonization	▪ Massive sediment movements that can uproot or bury seagrass. It may also become harder for seagrasses to become re-established. ▪ Would be exacerbated by anthropogenic impacts – primarily dredging and landfill	▪ Destruction, inundation, changes in sediment dynamics. ▪ Possible increase in nutrients / growth. ▪ Large storm impacts result in mass mortality. ▪ Projected increases in the frequency of high water events could affect mangrove health and composition due to changes in salinity, and inundation. ▪ More frequent Inundation is also projected to decrease the ability of mangroves to photosynthesize.
Ocean acidification (corals, lobster / conch)	▪ Decreases in coral calcification rates, growth rates and structural strength. Also other invertebrates. ▪ Weakening of reef matrix. ▪ If there are areas of localised calcification, acidification will have a drastic impact on the localized environment. ▪ Change in ratio of accretion / dissolution	▪ Possible direct positive effect on photosynthesis and growth, as in some situations, seagrass is carbon limited. ▪ Higher CO2 levels may also increase the production and biomass of epiphytic algae on seagrass leaves, which may adversely impact seagrasses by causing shading. ▪The acidification of seawater could counter the high pH formed by photosynthesis in dense seagrass stands, thus increasing seagrass photosynthesis and productivity.	▪ Positive increase in growth. ▪ However, damage to coral reefs may adversely impact mangrove systems that depend on the reefs to provide shelter from wave action. ▪ May affect mangrove root communities – especially invertebrates
Decreased Precipitation	▪ There is a hypothesis that the increased algal bloom may be attributed to reduced precipitation...decreased visibility – might be positive, may shade the corals		▪ Reduction of freshwater lens, affect on carbon uptake, photosynthesis. ▪ Decreased precipitation results in a decrease in mangrove productivity, growth, and seedling survival, and may change species composition favouring more salt tolerant species. ▪ Projected loss of the inner cayes to unvegetated hypersaline flats

Climate Change Impacts	Ecosystem		
	Coral Reef	Seagrass	Mangrove
Air Temperature			▪ May alter phenological patterns - timing of flowering and fruiting. ▪ At temperatures above 25°C, some species show a declining leaf formation rate. ▪ Above 35°C have led to thermal stress affecting mangrove root structures and establishment of mangrove seedlings. ▪ At leaf temperatures of 38-40°C, almost no photosynthesis occurs (IUCN, 2006). ▪ Possible localized changes in distribution.

Climate Change Impacts	Ecosystem
	Coral Reef
Sea-level rise	▪ The ranges may become inundated ▪ Salt incursion of water table may alter terrestrial vegetation cover, with changes in species presence / diversity. ▪ Potential loss of low-lying crocodile and turtle nesting beaches
Increased Storm Frequency	▪ Removal of some or all natural vegetation with less time for regeneration between storms, lower scrubbier vegetation, change in forest structure / reduced species diversity. ▪ Increased erosion, loss of part or entire cayes, changes in beaches. ▪ Arrival of opportunistic species. ▪ Impacts on bird colonies (nesting / roosting)
Decreased Precipitation	▪ Reduction of freshwater lens, affecting carbon uptake and photosynthesis by plants. ▪ Decreased precipitation may result in a change in species composition favouring more salt tolerant species. ▪ Potential loss of savanna vegetation to poorly vegetated hypersaline flats in some locations (?)
Air Temperature	▪ Potential change in species composition favouring more heat tolerant species. ▪ Higher air temperature could cause more arid conditions – drier soils

Climate Change Impacts	Resource		
	Commercial Species	Spawning Aggregations	Back Reef Flats
Sea level rise	▪ Conch: May experience shift in range or habitat loss linked to changes in critical habitat ▪ Snapper / grouper / lobster: Shift in range / habitat loss of both adult and juvenile lobster – linked to inundation of mangrove, shift in seagrass distribution, changes in coral reef	▪ Potential changes in water currents affecting viability of spawning aggregation sites	▪ Possible change in hydrodynamics – alteration in currents
Sea surface temperature rise	▪ Conch: Temperature may affect spawning (spawning has been shown to increase as a linear function of bottom water temperature, but decline once a temperature threshold is reached ▪ Lobster: Possible effects on larval and adult lobsters and reproduction. ▪ All the above: Loss of critical habitat ▪ May affect physiological process. ▪ Possible impacts from new invasive species and algal blooms. ▪ Disease may become more prevalent. ▪ Changes in currents and larval dispersal	▪ Decrease of upwelling currents - decrease in ocean productivity with potential loss of spawning aggregation sites.	▪ Increased water temperature may be sufficient to alter species composition – species migration to cooler waters. (not considered likely to be significant).
Increased frequency and intensity of storms	▪ Habitat destruction and increased sedimentation ▪ Possible impacts on larval dispersal / survival (potential for wider dispersal of larvae)	▪ Greater frequency of water swells in upwelling areas, with increasing nutrients. ▪ Lengthened storm season may reduce spawning period.	▪ Re-suspension of sediments – increased sedimentation. ▪ Re-distribution of flats
Ocean acidification (corals, lobster / conch)	▪ Habitat loss (impacts on reef). ▪ Impacts on larval viability and adult growth rates ▪ Weakening shell structures. ▪ Possible increase in seagrass productivity	▪ Unknown how fish respond to changes in pH balance	▪ Unknown...may affect smaller crustaceans / molluscs. ▪ May be some dissolution of dead reef. Not majorly significant.

Climate Change Impacts	Resource		
	Commercial Species	Spawning Aggregations	Back Reef Flats
Decreased Precipitation	▪ Possible changes in salinity impacting larval dispersal. ▪ Lobster migration patterns and times will change. ▪ More frequent, higher salinity pulses before equalization with main seawater body. ▪ There is a hypothesis that the increased algal bloom may be attributed to reduced precipitation	▪ Probably no impacts, due to currents, location of SPAG sites	
Air Temperature	▪ Potential impacts on mangroves as a nursery habitat		▪ Probably no impacts unless they become exposed faster than sea level rise, at which point, benthic organisms of the intertidal zones will migrate somewhere cooler

NB: Sport fishing species will have similar effects as commercial species or back reef flats, dependent on species.

Climate Change Impacts	Resource	
	Sea turtles	Parrotfish
Sea level rise	▪ Inundation of nesting beaches	▪ Shift in range / habitat loss of both adult and juvenile parrotfish – linked to inundation of mangrove, shift in seagrass distribution, changes in coral reef
Sea surface temperature rise	▪ Effects on food sources – shifts in distribution / abundance of seagrass, decreased health of coral reef. ▪ Extended nesting season, with earlier onset of nesting. ▪ Higher incidence of disease	▪ Shifts in distribution / abundance of seagrass, decreased health of coral reef, ▪ Distribution shift into deeper, cooler waters
Increased frequency and intensity of storms	▪ Habitat destruction and increased sedimentation; ▪ Possible impacts on dispersal / survival. ▪ Inundation of nests from higher groundwater	▪ Habitat destruction - seagrass and mangroves; sedimentation, ▪ Possible impacts on larval dispersion / survival
Ocean acidification (corals, lobster / conch)	▪ Habitat loss (impacts on reef). ▪ Possible increase in seagrass productivity.	▪ Habitat loss (impacts on reef). ▪ Impacts on larval viability and adult growth rates. ▪ Possible increase in seagrass productivity
Increased Air Temperature	▪ Female biased sex ratio >31˚C females; 29 -- 30˚C 50:50; <29˚C males. ▪ Warming of beaches, resulting in increased egg mortality, shorter hatching time with smaller average hatching size, reducing survival potential.	

2.5.3 Socio-Economic Impacts

Socio Economic Impacts		
Fisheries	**Tourism**	**Key Environmental Services**
Current Status: ▪ The traditional industry provides employment for over 2,700 fishers in Belize (Myvette, pers. com., 2011). ▪ Capture fisheries export earnings totalled approximately Bz$20.5 million dollars in 2008, primarily from the traditional lobster and conch capture fisheries (Ministry of Agriculture and Fisheries, 2008).	**Current Status:** ▪ Tourism is the third ranking productive sector in Belize, contributing 28.2% (BZ$816.3mn) in 2009, with projections suggesting that this will increase to 31.4% (BZ$1,601.2mn) by 2020. ▪ The tourism sector provided an estimated 34,000 jobs in 2009, 28.3% of total national employment or 1 in every 3.5 jobs. ▪ This is predicted to increase to 53,000 jobs, 31.6% of total employment or 1 in every 3.2 jobs by 2020 (WTTC, 2010).	**Current Status:** ▪ Reefs and mangroves also protect coastal and caye properties from erosion and wave-induced damage, providing an estimated US$231 to US$347 million in avoided damages per year (WRI, 2005). ▪ Turneffe Atoll is particularly important in protecting Belize City, to the west, from on-coming tropical storms.
Predicted Impacts: ▪ Loss of revenues generated from fisheries resources through loss of fishing grounds and of reef-associated species (eg lobster, conch and finfish). ▪ Potential shift to off shore species, requiring more sophisticated equipment / greater economic investment. ▪ Increase in illegal activities due to lack of viable employment opportunities. ▪ Some community economies will be more vulnerable than others – but all will be affected. **Limitations/Barriers:** ▪ The financial market is not favourable to small scale entrepreneurs making access to the level of capital investment required for off shore fisheries inaccessible limiting fishers' ability to invest in livelihood diversification. ▪ No national strategies exist to address increased unemployment.	**Predicted Impacts:** ▪ Loss in revenues caused by loss of aesthetics of reef and charismatic reef species through loss of coral habitats and reef-associated species (eg. parrotfish, corals, colourful fish), and sport fishing species. ▪ Loss in revenue due to loss of sandy beaches which could result in increased dredging pressures or land reclamation. ▪ Declining tourism industry affecting local economies, and resulting in increasing fishing pressures, with increased conflict. ▪ Increased illegal activities with the reduction of viable employment opportunities available. ▪ Some community economies will be more vulnerable than others – but all will be affected. **Limitations /Barriers:** ▪ No national strategies exist to address increased unemployment. ▪ Limited current market demand for inland tours, and limited capacity for implementation	**Predicted Threat:** ▪ Increased risk to coastline and caye infrastructure due to inundation, with potential long term loss of coastal protection functionality if reef can't keep up with sea level rise. ▪ Potential increased wave action on central barrier reef with reduction of wave shadow functionality of atolls with increased sea level. ▪ Possible increased lagoon - open sea water exchange, with reduced sea water temperature. **Limitations / Barriers:** ▪ Limited scientific knowledge / experience of climate change impacts – few models available for successful adaptation.

2.5.4 Climate Change Assessment Outputs

Target	Threat (based on Climate Change phenomena)	Certainty : The certainty that the effect of Climate Change will occur or the cause of the described impact will affect the target	Severity: Level or damage to this key element, which can destroy it in **50 years**	Scope: Geographical coverage of the target that will be impacted in **50 years**	Irreversibility : The impact is permanent or cannot be reversed naturally or through human action
Turneffe Atoll (General) Coral Reefs Lagoon Systems Back Reef Flats Terrestrial Ecosystems Spawning Aggregations Commercial Species Sport Fishing Species	Sea level rise	Very High	Medium	Very High	Very High
	Sea temperature rise	Very High	High	Very High	Very High
	Increased strength of storms	High	High	Very High	High
	Ocean acidification	Very High	High	Very High	Very High
	Decreased Precipitation	Very High	Medium	Very High	Very High
	Increased Air Temperature	Very High	Medium	Very High	Very High

Table 36: Climate Change assessment of Turneffe Atoll based on TNC criteria

Threats Across Targets	Coral Reefs	Lagoon System	Terrestrial Ecosystems	Seagrass	Spawning Aggregations	Commercial Species	Back Reef Flats	Sport Fishing Species	Overall Threat Rank
Project-specific threats	1	2	3	4	5	6	7	8	
Climate Change	Very High	Low	Very High	Low	High	Very High	Medium	Very High	Very High
Fishing Pressure / Unsustainable Fishing Practices (gear types, undersized)	Very High	Low			High	Very High	High	High	Very High
Unsustainable Development	Medium	Low	Very High		Medium	High	Medium	Very High	Very High
Dredging / removal of habitats	Very High	Low		Low			High	Very High	Very High
Illegal Fishing					Medium	Very High			High
Invasive species - Lionfish	High	Low							Medium
Anthropogenic fires			Medium						Low
Extraction of NTFP			Medium						Low
Boat impacts (wash / fuel / anchors / groundings)							Low	Low	Low
Improper Sport Fishing Practices							Low	Low	Low
Tourism / recreation impacts	Low			Low					Low
Threat Status for Targets and Project	Very High	Low	Very High	Low	High	Very High	High	Very High	Very High

Table 37: Turneffe Atoll MAP workbook Threats Summary with integration of Climate change

Threats Across Targets	Coral Reefs	Lagoon System	Terrestrial Ecosystems	Seagrass	Spawning Aggregations	Commercial Species	Back Reef Flats	Sport Fishing Species	Overall Threat Rank
Project-specific threats	1	2	3	4	5	6	7	8	
Increased Strength of Storms	High	Low	Very High	Low	Medium	High	Medium	Very High	Very High
Sea Level Rise	-	Low	Very High	Low	Medium	Low	Medium	High	High
Sea Temperature Rise	High	Low	-	Low	High	High	Medium	High	High
Ocean Acidification	High	-	-	-	-	Very High	-	-	High
Decreased Precipitation	-	Low	Very High	-	-	-	-	-	High
Increased Air Temperature	-	Low	Very High	-	-	-	-	-	High
Threat Status for Targets and Project	High	Low	Very High	Low	Medium	High	Medium	High	Very High

Table 38: Turneffe Atoll MAP workbook Threats Summary of Climate change impacts

When Climate Change is assessed as a threat on its own, the results suggest that the highest risk Management Target is the **Terrestrial Ecosystems** (Table 38)**.** With the low lying land at Turneffe, these are at high risk from inundation, with the critically under-represented Littoral Forest being threatened by not only sea level rise, but also increasingly strong storms, reduced precipitation and increased air temperatures. These risks also apply to all residential developments at Turneffe – whether high end tourism resorts, educational facilities or fishing camps, with the long term predictions suggesting that most of the Atoll will be inundated by the end of the century.

Three Management Targets have risk ratings of **HIGH – Coral Reef, Commercial Species** and **Sport Fishing Species.**

2.5.5 General Strategies

Because of the global nature of climate change, the strategies needed to address impacts go beyond the level of intervention available to the Management Board. Successful interventions will require collaboration with government and civil society partners to address a wide range of socio-economic issues. However there also needs to be adaptation to local changes through identified general strategies.

- Increase institutional expertise and capacity for addressing climate change issues and management of adaptation strategies.
- Active participation in national and regional planning for climate change adaptation
- Build stakeholder awareness and understanding of climate change and the potential to increase reef resilience, by reducing impacts of identified threats
- Increase stakeholder capacity to participate in climate change adaptation strategies
- Identify, build and strengthen partnerships with organizations targeting reduction of watershed threats (including transboundary efforts)
- Establish a policy framework and identify a funding mechanisms specific to implement climate change adaptation strategies

2.5.6 Targeted Strategies

Fisheries

- Implement managed access for traditional fishermen to address fishing impacts
- Identify resilient areas within Turneffe Atoll and in the national MPAS context
- Identify and increase protection of resilient reefs, source populations and key larval dispersal routes
- Establish monitoring protocols that inform management for building reef resilience
- Engage caye landowners in climate change adaptation strategies – including shoreline protection through conservation / re-planting of mangroves
- Investigate mechanisms for direct interventions – eg. coral nurseries, shading of key sites, promoting higher herbivore densities
- Build awareness of fishermen on the impacts of climate change and how it will affect their fishing
- Collaborate with partners to develop supplemental / complimentary income generation opportunities for fishing stakeholders
- Develop and strengthen partnerships with the Ministries of Human Development, Health, Education and Agriculture and Fisheries to identify and implement climate change adaptation strategies in stakeholder communities

Tourism

- Ensure infrastructure is in place to minimize tourism impacts on the reef – signs, mooring buoys, designated dive sites
- Ensure effective management and monitoring of low impact tourism development
- Increase surveillance and enforcement effort against tourism and tourism development infractions, particularly in identified resilient areas
- Engage the tourism sector in climate change adaptation planning
- Educate visitors about the impacts of climate change
- Collaborate with partners in lobbying for passing of the revised mangrove legislation

Key Environmental Services

- Identify resilient reef and mangrove areas within Turneffe Atoll and in the national MPAS context
- Identify and increase protection of resilient reefs, source populations and key larval dispersal routes
- Establish monitoring protocols that inform management for building reef resilience
- Engage caye landowners in climate change adaptation strategies – including shoreline protection through conservation / re-planting of mangroves
- Investigate mechanisms for direct interventions – eg. coral nurseries, shading of key sites, promoting higher herbivore densities
- Strengthen protection of trophic structure - maintenance of top predators and key herbivores

3. Management Planning

3.1 Management Goals

Turneffe Atoll Marine Reserve is being established under the Fisheries Act Chapter 210 of the Laws of Belize Revised Edition 2000-2003 which states that the purpose of a Marine Reserve is to:

> "*afford special protection to the aquatic flora and fauna …and to protect and preserve the natural breeding grounds and habitats of aquatic life*".

The vision for the proposed Marine Reserve was defined through stakeholder consultation as:

"Turneffe Atoll is a model of effective planning and management that ensures that the unique ecological values and associated social and economic benefits are used sustainably for future generations through active stakeholder stewardship"

Workshop One, Management Action Planning (MAP), July, 2011

Management activities are structured under five Management Programmes:

- **Natural Resource Management**
- **Science**
- **Education and Outreach**
- **Infrastructure**
- **Administration**

...each of which has an associated series of management strategies, guided by the eight objectives developed during the Management Action Planning process, and incorporation of MAP strategies to provide a framework for the development of annual Operational Plans.

Objective One: Maintain and improve healthy, resilient, biodiverse reefs of Turneffe Atoll at or above the 2010 IRHI status of FAIR up to and beyond 2022.

- Develop and implement reef use guidelines and training based on best practices for resorts, boat captains, guides and tourists using Turneffe Atoll (Medium)
- Identify the primary stakeholder fishing communities and increase knowledge of coral reefs, sustainable fishing practices and the marine environment through implementation of a Turneffe focused education programme targeted at primary level (Medium)
- Identify resilient coral sites and work with stakeholders to develop and implement zoning for protection (Medium)
- Increase international awareness of the high biodiversity values and global importance of Turneffe Atoll towards exploration of potential for designation as a biosphere reserve (Medium)

Objective Two: By 2017, Turneffe Atoll will be a model for ecologically sustainable tourism, with 100% of tourism industry and research stakeholders certified as Best Practices users of the Atoll.

- Develop and implement Turneffe-specific guidelines and best practices certification programme and training for tourism industry and research users, based on established criteria (eg. CORAL, BAS, WCS, BTB) (Medium)
- Implement strategies to ensure Turneffe Atoll is a world class sport fishing destination, based on scientifically sound management and ecologically sound practices (Medium)

Objective Three: By the end of 2012, a documented, weekly multi-agency patrol has been established that includes the Belize Fisheries Department, Belize Coast Guard and Stakeholder group (TBD), with effective patrolling covering the entire proposed Turneffe Atoll Marine Management Area.

- Assess the surveillance and enforcement needs for Turneffe Atoll and identify sustainable financial mechanisms to achieve this.
- Generate monthly and annual patrol reports, based on the SEA model
- Determine the composition of the multi-agency surveillance and enforcement team
- Establish an education and public awareness campaign that targets fishers and consumers

Objective Four: By 2016, reverse the decline in commercial production demonstrated at Turneffe Atoll over the last five years by 50%

- Determine the percentage decline in commercial production over the last 5 years at Turneffe Atoll
- Establish an education and public awareness campaign that targets fishers and consumers
- Assess current population of commercial species
- Develop a seasonal monitoring plan (using LAMP protocol)
- Establish Fisheries Replenishment Zones at reproductive sites

Objective Five: By the end of 2013, a Fisheries Management Plan is adopted and implemented for the Turneffe Atoll through active participation of fisheries resource users, which would consider options such as managed access, size limits, gear management, diversification and catch quotas.

- Conduct an assessment of current fishing efforts and methods used at Turneffe Atoll
- Establish Fisheries Management Plans and Policies for Turneffe Atoll in collaboration with the fisheries sector
- Educate fishers on policy regulations and the long term advantages
- Establish monitoring measures for the policy to be reassessed every 5 years

Objective Six: By 2017, the population of invasive lionfish at Turneffe Atoll has been reduced by 50% from the 2010 baseline.

- Collaborate with partners to develop national markets (restaurants, Chinese) and locate international markets for lionfish fillet and other products (Low).
- Engage commercial fishermen and tour guides in lionfish extermination as a management intervention at Turneffe Atoll (Low)
- Collaborate with partners to develop and implement mechanisms for increasing national awareness of the impacts lionfish is having on the reef fish (Low)
- Develop and implement a research and monitoring plan for lionfish (Low)

Objective Seven: By 2013, adopt and implement the TACAC Management guidelines and Best Practices for development at Turneffe Atoll

- Develop a baseline for current extent and condition of terrestrial ecosystems (estimate 10% damaged, or less)
- Update 2003 TICAC Land Use Map
- Implement habitat restoration in areas identified where habitat replanting and/or restoration could take place
- Lobby for increased protection status for national lands - incorporation of national land into the managed area
- Identify and map sensitive areas that would be severely damaged by dredging and inform GPD, BFD, DOE, FD re. those areas
- Limit dredging on Turneffe Atoll to small-scale non-mechanical operations (artisanal permits only), and for access purposes only, with a more robust assessment process to include strengthened environmental clearance process for dredging permit applications
- Strengthen and implement guidelines for sustainable development for any new developments emphasizing low-impact high-end development
- By the end of 2013 ensure that new development activity is accomplished in a low-impact, eco-friendly manner (to be defined – DOE/IUCN/certification, etc) and minimizes impacts to the natural environment
- Ensure surveillance of developments on Turneffe Atoll and lobby for enforcement where necessary
- Lobby for stronger penalties

Objective Eight: By the end of 2014 establish and implement sustainable financial mechanisms to finance operations and management of Turneffe Atoll Managed Area.

- Conduct a financial needs assessment
- Identify income generating mechanisms (e.g. fees)
- Establish guidelines for administration of funds

3.2 Management and Organizational Background

The Turneffe Atoll Marine Reserve, established in 2012 under the Minister of Forestry, Fisheries and Sustainable Development, is managed by the Fisheries Department. For the proper and efficient management of the Reserve, the Fisheries Department may enagage into a Co-management agreement with an NGO as has been the case with Gladden Spit Marine Reserve and Port of Honduras Marine Reserve.

Protected areas management in Belize has been most successful when it has involved stakeholders in all pertinent areas of management. This co-management arrangement provides adequately for the inclusion of all key stakeholder groups and offers the ability to provide talented and dedicated individuals to manage the Turneffe Atoll Marine Reserve.

Under the TAMAR Regulations, the Fisheries Deparment will establish an Advisory Coomittee which will be comprised of a broad base of stakeholders and other components.

Composition of the Turneffe Atoll Marine Reserve Advisory Committee

1 representative of the Fisheries Department selected by the Fisheries Administrator;
1 representative of the Forestry Department selected by the Chief Forest Officer;
1 representative of the Coastal Zone Management Authority and Institute selected by the Director of Coastal Zone Management Authority & Institute;
1 representative of the Turneffe Atoll Sustainable Association selected by the Board Chairman;
1 representative of the Turneffe Atoll Trust selected by the Board Chairman;
1 representative of the Association of Protected Areas Management Organizations selected by the Executive Director of APAMO;
1 representative from the Protected Areas Conservation Trust selected by the Executive Director of PACT;
1 representative of the Ministry responsible for Tourism selected by the Minister of Tourism;
1 representative of the Ministry responsible for Natural Resources selected by Administrator of the Department of Natural Resources;
1 representative of the Environmental Research Institute of the University of Belize selected by the Director;
1 representative of an International Non-Government Organization selected by the Fisheries Administrator;
1 representative from the Belize Fishermen Federation selected by the Chairman of BFF;
1 representative from the Belize Fishermen Cooperative Association selected by the Chairman of BFCA;
1 tourism representative with primary tourism business located at Turneffe selected by the Fisheries Administrator;
1 resident representing the private landowners of Turneffe selected by the Fisheries Administrator; and any other person as agreed by the committee.

3.3 Previous Management

Turneffe Atoll has long been identified as a critical gap in the National Protected Areas System, and in the national tools being employed for sustainable fisheries management. However designation as a Marine Reserve did not occur until 2012, when multiple stakeholders expressed the recognition that the area lacked management in any form. A limited enforcement presence by the Belize Coast Guard was established in 2011 through a collaborative agreement with the Fisheries Department and Turneffe Atoll Trust.

Photo: Turneffe Atoll Trust

The Management Planning (TAT) and Management Action Planning (TNC) initiatives implemented in 2011 set the foundation for effective management for Turneffe Atoll, with the establishment of the Marine Reserve, managed by the Fisheries Department being advised by an Advisory Committee largely composed of Turneffe Atoll stakeholders. The identification of management targets and integrated conservation planning is targeted at improving the biodiversity viability of the Atoll, and supporting development of greater sustainability for the fishery, through stakeholder engagement and participation, effective surveillance and enforcement, and adaptive management informed by research, monitoring and evaluation outputs.

3.4 Management Strategies

3.4.1 Management Constraints, Limitations and Priorities

Until recently, Turneffe Atoll has not had the management presence, infrastructure and human resources for effective site-level management. A series of recent initiatives (Belize Fisheries Department et al., 2008; TACAC / CZMAI, 2011; MAP outputs, 2011) have identified a number of priority issues and requirements that have to be addressed if effective management is to be established at Turneffe Atoll. These include:

- A permanent patrol presence on the Atoll, with effective surveillance and enforcement of Fisheries and Forest Department, tourism and development regulations
- Effective stakeholder engagement, with active participation in management, through the establishment of the Management Board, and through participation in surveillance and monitoring activities
- A staffed and equipped Marine Reserve headquarters, and two manned outlying rangers stations
- Strengthened coordination of research and monitoring at the Atoll through the University of Belize – Environmental Research Institute
- Addressed logistical and communication constraints through adequate transport and improved communications
- An effective and transparent fee collection process as the first step towards sustainability

Whilst significant public consultation of resource users – both tourism and fishing - took place before the Marine Reserve concept was tabled with Cabinet, the implementation of a number of the strategies will cause some conflicts with resource users To address this, it is suggested that:

- Zones should be phased in over the first year, with patrol activities relating to incursions being targeted at increasing awareness in the year leading up to the start of enforcement of zones in the second year.
- Stakeholder engagement, participation and awareness activities should target fishermen, as the most vulnerable sector, and ensure that they are fully informed as to the rationale for the zones and boundaries, and the associated regulations.
- The Fisheries Department & the Advisory Committee should ensure that there are visible results from recommendations arising from community consultations, and feedback on areas of concern.

- A series of meetings between fishermen, the rangers of the patrol units and the Belize Coastguard should be held, to develop a code of conduct is developed for stopping and searching boats and fish camps.
- A communication mechanism should be developed to keep all stakeholders informed of management decisions and implementation.

3.4.2 Rules and Regulations

Turneffe Atoll is a multi-use Marine Protected Area, with zoning for management purposes (General Use Zone, Conservation Zones and Preservation Zone) to allow spatial regulation of activities on the Atoll, particularly tourism and commercial fishing activities.

A series of legislated regulations under Fisheries Department provide a mechanism for management of commercial marine resources (Figure 54), as do Statutory instruments such as SI 161 of 2003 and SI 49 of 2009 (Annex Two and Three). Regulations specific to the Turneffe Atoll are incorporated into the Statutory Instrument that defines the Marine Reserve (Annex One).

Some General rules and regulations applicable through out the Marine Reserve in Belize include:

- No person shall be permitted to use long lines, fish traps, seine nets or gill nets in the Reserve unless authorized by the Fisheries Administrator for scientific research purposes only;
- No person shall engage in commercial fishing, sport fishing or recreational fishing within the reserve without a valid fisherman licence issued in accordance with these Regulations.
- Fishermen catching lobster shall possess lobster with its carapace, tailed but not as fillet while in the Reserve;
- Fishermen catching conch shall possess conch as whole or market clean but not as fillet or diced while in the Reserve;
- No person shall cast or drag any anchor in any manner which may damage coral or any other sensitive habitat;
- Any activity with potential negative environmental impacts on species, habitats or ecosystems shall require written approval from the Fisheries Administrator; and
- No person shall engage in water-skiing or jet-skiing, except in areas that may be designated by the Fisheries Administrator;

CORAL:

- It is Illegal for any person to take, buy, sell or have in his possession any type of coral.
- An exception is made in the case of Black Coral (Order ANTIPATHARIA) which may only be bought, sold or exported with a licence from the Fisheries Administrator.

SPORT FISH:

- No person shall have in his possession any bonefish, permit fish or tarpon or any of its product forms, save and except in the act of catch and release.
- No establishment shall have in its possession any bonefish, permit fish or tarpon or any of its product forms.

CONCH (*Strombus gigas*)**:**

- Shell length should exceed 7 inches.
- Market clean and fillet weight should exceed 3 and 2.75 ounces respectively.
- Closed season is from 1st July to 30th September.
- No fisherman shall buy, sell or possess diced conch meat

LOBSTER (*Panulirus argus*):

- Minimum cape length is 3 inches.
- Minimum tail weight is 4 ounces.
- Closed season is from 15th February to 14th June.
- No fisherman shall buy, sell or possess fillet or diced lobster tail, soft shell berried lobster or lobster with tar spot

MARINE TURTLES:

- No person should interfere with any turtle nest
- No person should take any species of marine turtle
- No person shall buy, sell, or have in his possession any turtle or articles made of turtle parts.

NASSAU GROUPER:

- No person shall take in the waters of Belize, buy, sell, or have in his possession any Nassau Grouper (*Epinephelus striatus*) between 1st December and 31st March
- No person shall take, buy, sell, or have in his possession any Nassau Grouper which is less than 20 inches and greater than 30 inches
- All Nassau Grouper are to be landed whole

GRAZERS:

- No person shall take in the waters of Belize, buy, sell, or have in his possession any grazer (of the genera *Scarus* and *Sparisoma*, commonly known as parrotfish) and *Acathuridae* Family, commonly known as surgeonfish and tangs

FISH FILLET

- All fish fillet shall have a skin patch of at least 2 inches by 1 inch.

SEA CUCUMBER:

- No person shall fish for sea cucumber (donkey dung) without a special permit issued by the Fisheries Administrator and from July 1st to December 31st in any one year

GENERAL

- No person shall set traps outside the reef or within 300 feet of the Barrier Reef
- No fishing without a valid fisher folk or fishing vessel license
- No one should fish with scuba gear

Figure 54: General Fisheries Department Regulations

3.4.3 Management Zones

Boundaries

Turneffe Atoll Marine Reserve encompasses a total area of 131,690 hectares (325,412 acres/ 1,317 square kilometers). The SI lays out the location of the boundaries, and the rules and regulations for each of the nine zones (Map 16).

Turneffe Atoll Marine Reserve Management Zones

General Use Zone

Zone VIII: General Use Zone

Conservation Zones

Zone I: Maugre Caye
Zone II A: Dog Flea
Zone IV: Blackbird Caye
Zone V: Long Bogue
Zone VI: Caye Bokel

Special Management Areas

Zone II B: Cockroach – Grassy Caye
Zone III: Vincent's Lagoon

Preservation Zone

Zone VII: Preservation Zone

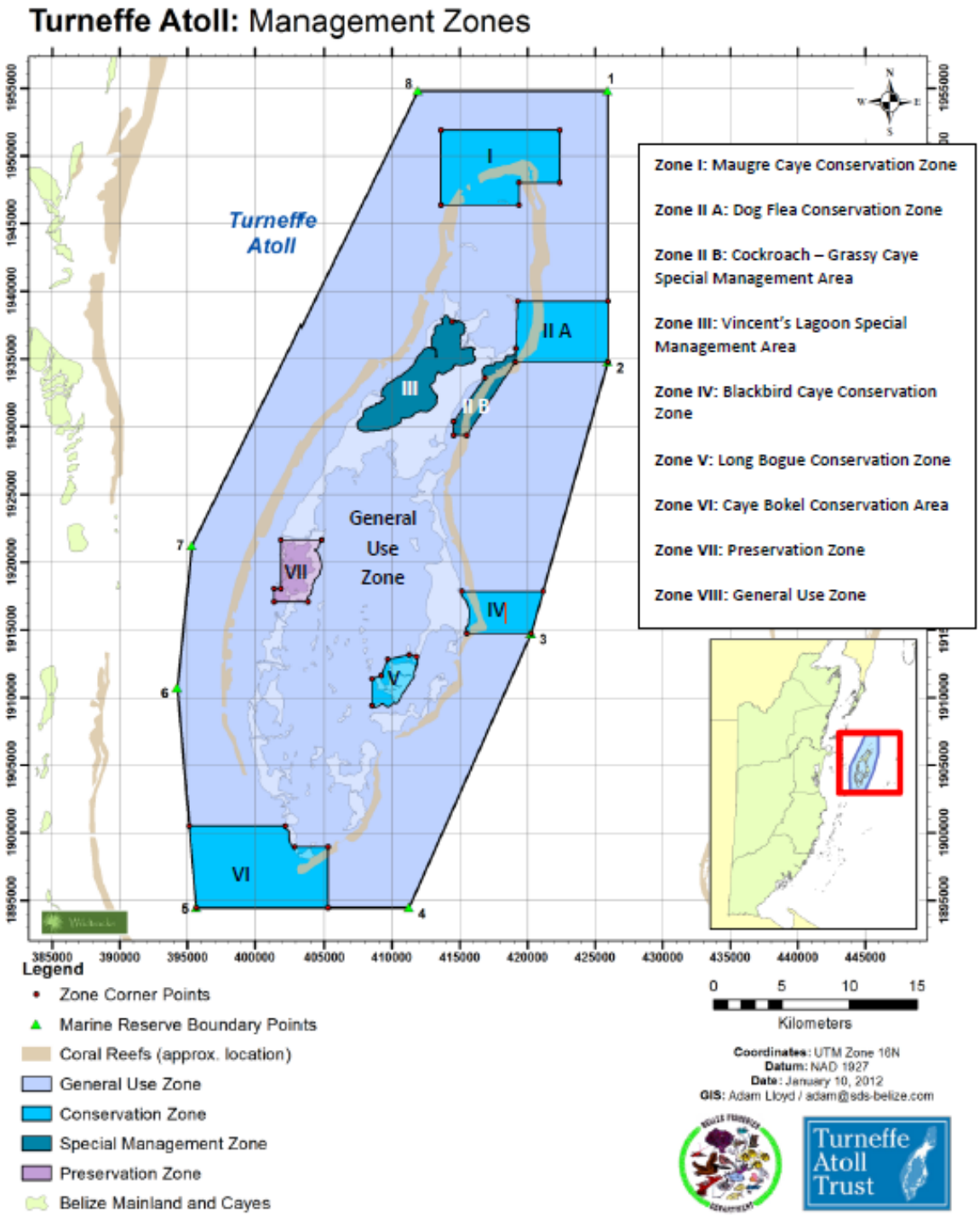
Fisheries Department, 2012

The Marine Reserve also has two previously designated fish spawning aggregation sites – Caye Bokel and Dog Flea Caye - defined under SI 161 of 2003, with established regulations (Annex 2). Maugre Caye, a third site, is not fully protected, but has some regulation under SI 49 of 2008. A Public Reserve exists in the Cockroach range, specifically for the protection of critical nesting and nursery sites for American crocodiles. These three previous protected areas can be considered to be incorporated within the zoning of the Marine Reserve.

Of the four types of zone established at Turneffe Atoll, the General Use Zone is the largest, covering 84.7% of the Marine Reserve. The five Conservation Zones combined represent 11.7% of the area, and the Preservation Zone, with the strictest regulations, covers 0.9% (Map 16; Table 39).

Zone Types	Hectares	Acres	%_MPA
General Use Zone	111,577.32	275712.45	84.7%
Conservation Zones	15,424.05	38,113.51	11.7%
Special Management Area	3,499.39	8,647.15	2.7%
Preservation Zone	1,189.30	2,938.80	0.9%
TOTALS	**131,690.06**	**325,411.91**	**100.00**

Table 39: Turneffe Atoll Marine Reserve Zone types and areas



Map 16: Turneffe Atoll Marine Reserve – Management Zones

Snorkelling, diving and sport fishing shall be allowed in the all zones within the Reserve with the exception of the Preservation Zone, with the following regulations in place for diving and snorkelling:

- All dive boats shall fly the "divers down flag" when they have divers in the water (a flag with a white diagonal stripe upon a red background);
- Only certified scuba divers, or divers undergoing a training course conducted by a recognized instructor shall be allowed to use SCUBA equipment in the Reserve;
- Dive guides or tour guides shall be required to explain the rules of the Reserve to all divers, snorkelers or visitors within the Reserve;
- All motor boats are to observe the low wake boat way when approaching snorkelers or divers;

General Use Zone

Objective: To provide opportunities for established uses and activities (fishing for conch, lobster and finfish; recreational activities etc.) to be continued in a sustainable manner.

The General Use Zone allows for the sustainable management of existing uses, with the focus being on commercial fishing and recreational activities. This zone lies outside the more critical protection zones, and is relatively accessible to established fishers (both those based from fish camps and those using sailboats), who use the area for commercial fishing. The existence of high connectivity between reef, seagrass and mangrove, presence of the two spawning aggregation sites and a number of fishing banks and nearby replenishment areas make the General Use Zone a valuable and fertile fishing grounds.

The largest of the zones, the **General Use Zone**, covers approximately 84.7% of the area and provides opportunities for established uses and activities. Regulated extractive activities such as commercial, recreational and subsistence fishing are permitted within this area. However, fishers are required to have a valid license, and gear restrictions are in place (the use of gill nets, long lines and beach traps is prohibited). Snorkelling, diving and sport fishing regulations are enforced throughout this and the other zones.

Rules and Regulations for General Use Zone.

- Only persons with commercial, sport, subsistence and recreational fishing license shall be permitted to fish within the Turneffe Atoll.
- No person shall be permitted to use beach traps, seine or gill nets, or long lines in the Marine Reserve
- No person within the Marine Reserve should cast or drag any anchor in any manner that may damage coral reef formation.
- Fishermen catching lobster shall possess such lobster while in the Marine Reserve as tails within the carapace but not as fillet, and conch as whole or market clean, not filleted or diced.
- No clearing of mangroves shall be conducted without the approval of the Forest Department.
- No collection of flora and fauna shall be conducted except with permission from the relevant permitting authorities.
- No dredging shall be conducted without the approval of the Fisheries Department.
- All proposed tourism development must go through the EIA process, and be conducted following relevant guidelines and legislation, with adequate monitoring.

Rules and Regulations for Conservation Zones

Conservation Zones follow the same regulations as those for the General Use Zone, but are more restricted in terms of activities, with additional regulations in place primarily ensuring a no-take regime and guiding tourism activities

- No extractive fishing is allowed within the Conservation Zones
- Spear fishing shall not be permitted within the Conservation Zones

The **Conservation Zone** covers 11.7% of the Marine Reserve and incorporates five separate areas:

Zone I: Maugre Caye Conservation Zone

Zone II A: Dog Flea Conservation Zone

Zone IV: Blackbird Caye Conservation Zone

Zone V: Long Bogue Conservation Zone

Zone VI: Caye Bokel Conservation Area

The Conservation Zones have identical management regimes, and provide areas free from commercial fishing, undisturbed replenishment areas for recruitment of commercial and other species, and enhance the value of the area for recreational and tourism activities. No-take recreational activities, such as snorkelling SCUBA diving, and kayaking, are permitted within this zone. Sport fishing is also allowed within the Conservation Zone, guided by the Sport Fishing Regulations, but only with a valid license, and only as catch and release.

The **Preservation Zone** covers approximately 0.9% of the Marine Reserve and incorporates a number of the shallow lagoon / inundated mangrove areas critical for replenishment. The objective of the zone is to preserve an area within Turneffe in an entirely natural state and with a recognised recruitment functionality as an important area for commercial (and non-commercial) species. Entry to the Preservation Zone is strictly prohibited for anyone, except in an emergency or with prior written permission from the Fisheries Administrator.

Rules and Regulations for the Preservation Zone

The Preservation Zone follows the same regulations as those for the Conservation Zones, but are more restricted in terms of access

- No extractive fishing is allowed within the Preservation Zone
- No fishing, sport fishing, diving or any other water activity shall be permitted within the Preservation Zone.
- No motorized boats shall be permitted within the Preservation Zone except in cases of emergency or with prior written permission from the Fisheries Administrator
- No research activities will be conducted within the Preservation Zone unless for management purposes

The **Special Management Zones** cover 2.7% of the Marine Reserve, and have been established to protect important conch nursery areas in the shallow waters of the back reef flats. Two Special Management areas have been designated:

Zone II B: Cockroach – Grassy Caye Special Management Area

Zone III: Vincent's Lagoon Special Management Area

Rules and Regulations for the Special Management Areas

The Special Management Areas follow the same regulations as those for the General Use Zone, but with the following exceptions:

- Zone IIB Harvesting of conch is not permitted
- Zone III Extractive fishing is allowed in Zone III, but shall be limited to defined traditional users of the area as defined by the Fisheries Administrator.

3.4.4 Alternative / Supplementary Livelihoods

One of the key objectives of any marine reserve, including that proposed for Turneffe, should be to ensure that stakeholders not only do not lose, but benefit from the establishment and management of the marine protected area - in both the short and long term. It is recognized that of all stakeholders at Turneffe Atoll, the traditional fishermen potentially have the most to lose. With effective management of the proposed Marine Reserve, fishermen should physically benefit from access to increased fish stocks. However they will face a reduction of fishing area through zonation, coupled with the increasing number of fishermen using Turneffe as they become displaced from the adjacent Glover's Reef Atoll following implementation of the Managed Access regime in that area. It is also important to recognize that whereas those in the tourism industry have skills that are marketable and can be transferred to other areas of Belize, the fishermen know that the other fishing areas open to them are already full, and their skills set is not in high demand, with added barriers of limited literacy and in the north, limited spoken English.

Observations / Challenges:

- Alternative livelihood initiatives generally address the need to replace current income levels – this is a challenge for the Belize fishing industry, where the average annual income is greater than that of other industries employing people of a similar educational background.
- Unlike the fishermen originating in Belize City, the northern fishermen have fewer alternative options open to them other than fishing.
- Employment opportunities in and around the fishing communities in the north, particularly Sarteneja, are limited to non-existent.
- Many alternative income opportunities require a shift from a traditional way of life – away from one that focuses entirely on the marine environment and promotes a high level of independence.
- Whilst many co-management organizations in Belize have investigated alternative livelihood options to assist resource users and reduce pressure on the marine resources, only those focusing on tourism in coastal areas with easy access to reef have been even moderately successful (eg. Placencia, Dangriga, Hopkins, Punta Gorda).
- NGOs seeking to assist alternative livelihood programmes in the northern communities seldom communicate or collaborate with each other, resulting in repetition and missed cost effectiveness opportunities
- It should never be assumed that all fishermen are interested in opportunities in tourism or would like to leave fishing.

- Unless carefully researched, alternatives based on natural resource extraction or mari-culture in the marine environment may result in similar pressures on new marine products as those facing the traditional products (lobster, conch and shallow water finfish)
- The northern communities also face other pressures – increasing poverty levels, and are at high risk from climate change impacts, particularly reduced rainfall, affecting potential agricultural alternatives
- Without a cap on the number of fishermen using Turneffe, assisting individuals to leave fishing through alternative livelihood options will not result in a reduction of the number of fishermen using the Atoll, as others will move in to take their place.

Supplementary livelihoods are a more viable option than fully replacing fishing as an income, reducing the amount of time individual fishermen need to spend fishing, rather than removing them from the fishing population, and allowing for a gradual shift into other income options. Switching even part time to an alternative livelihood can be a difficult decision for a fisherman to take, particularly when supporting a family - especially when the success of past alternative livelihood projects within these communities has been short term and limited.

Some options do already exist, including pig rearing, tilapia farming, tour guiding, and development of guest houses, but these address alternatives for individuals. With an estimated 180 to 200 northern sailboat fishermen using Turneffe, however, individual alternatives may not be sufficient. In the case of Sarteneja, where the majority (estimated at over 85%) of households are directly dependent on fishing, the problem will not be solved by small scale Alternative Livelihood projects alone, but needs to address the larger scale development needs of the community, particularly in the areas of improved access and supporting its tourism development potential.

Chunox and Copper Bank, with their more diversified income base as part of the cane farming belt and easier access to employment opportunities in the district center, Corozal Town, and the Corozal Free Zone, have more options beyond fishing. However 2011 figures show that northern communities have the highest increase in poverty levels in Belize, with levels now second to Toledo District (Ministry of Economic Development, 2009).

The northern fishermen have a footprint that extends throughout the entire reef system of Belize, and are considered as key stakeholders by the Fisheries Department, the majority of marine protected area managers and other marine-focused NGOs (Southern Environmental Association, Belize Audubon Society, Wildlife Conservation Society, World Wildlife Fund and Sarteneja Alliance for Conservation and Development among them). Structured collaboration and strategic planning by these organizations towards strengthening alternative options and conditions within these communitieswould increase the potential for successful outcomes.

Recommendations

- Lobby in support of initiatives to develop infrastructure in the northern communities, reducing the cost of living and improving quality of life for the fishermen – better access, better medical facilities, and investments in both primary and high schools.
- Partner with other mpa management bodies that identify the northern communities as fishing stakeholders for joint development of an Alternative Livelihoods Programme, coordinated and shared cost of implementation.
- Conduct a needs assessment for each key fishing sector (Belize City, Chunox, Copper Bank and Sarteneja), with the participation of other partner MPA management bodies and fishermen.
- Provide micro-loans for tourism start-up projects in the northern communities.
- Provide incentives for small-scale industries that can provide local employment in the northern communities, whilst maintaining their environmental values.
- Support other initiatives within the northern communities that assist in shifting the income base, identified through the needs assessment.
- Provide technical support for alternative options developed in the communities.
- Invest in supplemental income generation by fishermen's wives / young adults.
- Ensure that all training in the northern communities is in both English and Spanish.

Diversification needs to take into account the costs of distance – for all fishing stakeholders, diversification into opportunities based at Turneffe will have to take into account the cost of transport to the Atoll – some diversification options may be more cost effective closer to home. However, on-site opportunities at Turneffe may also be an important strategy, particularly the camp fishermen based on the Atoll.

- Identify mari-culture options at Turneffe Atoll (eg. seaweed, sponges, sea cucumbers) in collaboration with fishermen, and investigate potential as an on-site alternative, with planning for monitoring, sustainability, minimal ecological impact and market opportunities before implementation
- Investigate options for sustainable small-scale deep sea fishing
- Provide training and information for fishermen wishing to shift to tourism as an alternative at Turneffe
- Develop basic tourism infrastructure at the Turneffe Headquarters (palapas, picnic tables, information) for the joint use of fishermen wishing to shift to tourism as an alternative

Addressing the Next Generation

Many of the next generation of fishermen will also be coming from these communities. In the northern fishing communities, many boys still see fishing as the logical step to take, often after leaving primary school. Whilst the legislation now demands that youths be 18 to be given fishing licenses, traditionally boys as young as twelve or fourteen used to join their fathers

fishing, with the lure of financial gain. A survey of 150 households in Sarteneja has shown, however, that not one (0%) fisherman interviewed wants to see his son as a fishermen, citing the hard work and danger involved (SACD, 2008). When incomes were higher, fifteen years ago, productive fishermen started investing in education for their children, to provide them with an alternative option. The number of students attending Standard Six in Sarteneja, then the largest northern fishing community, rose from an average of 6 per school in 1991 to 25 over a three year period, with the number going on to high school rising from 4 to 15 / 20 per year over the same time frame (Walker, pers. obs.). With the problems of access to secondary level education, these students faced challenges in high school, needing to be accommodated in Corozal or Orange Walk, with little parental supervision, resulting in many dropping out in the first two years and returning to fishing. More recently, two high schools have been established in the northern communities – one academic and one vocational – providing improved access to high school education at a more affordable cost, resulting in a greater percentage of students pursuing education further – at least until 4th Form.

Recommendations

- Seek funding in collaboration with other mpa management partners for scholarships to assist fishing families with the cost of education, to ensure that students have options beyond fishing – high school and university
- Seek funding to invest in the primary and high schools in the northern communities to increase the quality of education
- Provide access to career counselling during secondary schooling – to assist access to information on options and opportunities available

3.4.5 Training of Young Fishermen

There is currently no training programme in place to provide new fishermen with information on best resource extraction practices for sustainability, relevant legislations and the functions of marine protected areas as sustainable fisheries tools. This has been highlighted as a problem by older fishermen, and suggested as a strategy.

Recommendations

- Provide an annual short course for Turneffe fishermen (new and old) at Calabash Caye that covers sustainable fishing practices, best practices for working around coral reefs, legislation, rules and regulations of Turneffe Atoll
- Investigate incentives for encouraging fishermen to attend the course

3.4.6 Limits of Acceptable Change

At present there are no carrying capacities set for tourism activities within Turneffe Atoll. It has been recognized that this needs to be addressed, particularly in key dive sites and on the cayes themselves. It is suggested that a Limits of Acceptable Change assessment and recommendations be implemented in Year 3 of the five year management plan.

3.5 Management Programmes and Objectives

Management programmes are a means of grouping management objectives within related areas – for example, those related to natural resource management, or to public use. The strength of the combined programmes is greater than the sum of the individual programmes, as each supports the others over space and time, with synergies that strengthen the overall management of the protected area.

Five Management Programmes have been identified for effective management of Turneffe Atoll Marine Reserve:

A. **Natural Resource Management Programme**
B. **Science Programme**
C. **Education and Outreach Programme**
D. **Infrastructure Programme**
E. **Administration Programme**

The conservation strategies outlined for Turneffe Atoll in the conservation planning section of this management plan are integrated into the management programmes, as are the outputs of the climate change planning. These contribute towards the adaptive management process ensuring that Turneffe Atoll fulfils its future role within the National Protected Areas System.

Turneffe Atoll Management Programme Areas				
Natural Resource Management Programme	**Science Programme**	**Education and Outreach Programme**	**Infrastructure Programme**	**Administration Programme**
Surveillance and Enforcement	Research	Stakeholder engagement	Operational Infrastructure and Equipment	Administrative Policies and Procedures
Fisheries Management	Monitoring	Alternative livelihoods and training	Maintenance	Human Resource Management
Tourism Management	Climate Change Adaptation	Education and dissemination of information	Measuring Success	Accounting and Auditing
Coastal /Caye Development Management	Data Management and Dissemination of Information	Measuring Success		Financial Sustainability
Species /Ecosystem Management	Collaboration with local / national / international partners			Measuring Success
Measuring Success	Measuring Success			

Table 40: Turneffe Atoll Programme Areas

3.5.1 Natural Resource Management Programme

The Natural Resource Management Programme focuses on ensuring the maintenance of healthy, functional ecosystems in the face of current and future threats, including climate change, through surveillance and enforcement, direct biodiversity management interventions and visitor management. This Programme falls under the responsibility of the Fisheries Department, and is administered under five sub-programmes:

- **Surveillance and Enforcement**
- **Fisheries Management**
- **Visitor Management**
- **Coastal / Caye Development Management**
- **Species / Ecosystem Management**

The Programme also includes a **Measuring Success** sub-programme, to ensure effective implementation and outcomes of Natural resource Management strategies.

The **Surveillance and Enforcement Sub-Programme** at Turneffe Atoll is focused on patrols of the area to uphold the Marine Reserve zones and regulations, and to ensure that fishing, tourism and development regulations are enforced. The sub-programme falls under the remit of the Manager, and is currently implemented through a collaborative partnership with the Belize Coastguard.

Specific activities to address identified limitations under this programme include:

- Establishing an effective surveillance and enforcement presence in the Turneffe Atoll, with an optimum of three patrol units based from a reserve headquarters and two rangers stations
- Employment of a Reserve Manager and rangers
- Engagement of fishermen in surveillance and enforcement activities
- Visitor impact mitigation through enforcement of BTB and sport fishing regulations
- Surveillance and enforcement of development regulations

The **Fisheries Management Sub-Programme** focuses on ensuring a continued, sustainable fishery for the benefit of traditional fishermen using the area, and contributing towards the sustainability of the Belize fishing industry, through effective management of the fish stocks, diversification of fishing effort, and addressing the need for alternative livelihoods.

The **Visitor Management Sub-Programme** focuses primarily tourism management and safety. Under current legislation, visitor management and safety is, to some extent, the responsibility of the tour guides and tour operators, with BTB regulations covering the need for certified guides and dive instructors, for tour guides/operators to ensure that all visiting divers are

adequately qualified, and the expectation that boat captains and dive guides will explain the rules of the Reserve to a diver. These regulations need to be enforced at site level, through the development of collaborative mechanisms with the Belize Tourism Board, and training of rangers in enforcement of BTB regulations. Ongoing training of snorkel and dive tour guides in best practices has also been shown to mitigate visitor damage to the reef and for marine resource sustainability (McField et al., 2010).

Physical management of the natural resources, particularly those highlighted as conservation targets and of their threats, is the responsibility of the **Conservation Target Management Sub-Programme,** in close collaboration with the Science Programme, with implementation of management activities targeted at maintaining and improving the viability of conservation targets and reducing threats identified during the management planning and adaptive management review processes.

Natural Resource Management Programme		
Surveillance and Enforcement		▪ Ensure marine reserve staff numbers are sufficient for effective management of Turneffe Atoll. At minimum: ▪ Headquarters: 1 Reserve Manager, 1 Head Ranger, 3 Rangers, 1 boat captain (on rotation); ▪ Ranger Station One: 1 Head Ranger, 3 Rangers, 1 boat captain (on rotation); Optimal would also include: ▪ Ranger Station Two: Reserve Assistant Manager, 3 Rangers, 1 boat captain (on rotation) ▪ Ensure all patrol staff are trained in Reserve regulations and development restrictions relevant to each zone and the spawning aggregation sites, and to regulated fishing methods, gear and zonation ▪ Investigate potential for developing volunteer ranger programme – local fishermen and tour guides
	▪ **Patrols – surveillance and enforcement**	▪ Determine the composition of the multi-agency surveillance and enforcement team, and investigate the option of integrating an observer (fisherman, on a stipend basis) into each patrol to provide stakeholder monitoring of enforcement ▪ Ensure patrol units are fully trained in natural resource policies and legislation ▪ Ensure patrol unit(s) are fully trained and equipped for effective enforcement, with functional boats and ranger stations ▪ Ensure patrol unit(s) are fully trained for incident reporting, handling of evidence and chain of custody towards effective prosecution ▪ Implement effective patrols (sufficient patrol hours, adequate and appropriate scope, night patrols, equipment) for maximum effectiveness ▪ Effectively enforce regulations in all zones ▪ Effectively patrol all legislated spawning aggregation sites ▪ Effectively patrol against illegal transboundary incursions – especially in the deep sea environment ▪ Ensure surveillance of developments on Turneffe Atoll and lobby for enforcement where necessary by the relevant regulatory agency ▪ Investigate mechanisms for effective on-site enforcement of mangrove legislation, development and tourism regulations, with training of rangers for taking on these enforcement duties ▪ Enforce research regulations ▪ Ensure fair enforcement of regulations across all fishermen and fishing sectors ▪ Develop mechanisms in collaboration with fishermen for addressing issues of corruption at all levels, and impacts on effective protected area management ▪ Lobby for stronger penalties for all enforcement issues ▪ Develop conflict resolution mechanisms and in-house skills for dealing with public use conflicts

Natural Resource Management Programme / 2		
Surveillance and Enforcement	▪ **Safety**	▪ Ensure enforcement of visitor regulations designed to provide visitor safety ▪ Ensure all rangers are trained and boats/ranger stations are equipped for protection of life and property from natural disasters / accidents at Turneffe Atoll (eg. first aid training and equipment, CPR, good communications, basic fire fighting skills and equipment, effective communication, training in hurricane evacuation policies etc.) ▪ Ensure there is an effective evacuation plan for medical emergencies
	▪ **Zoning and boundaries**	▪ Install demarcation buoys to clearly demarcate zones, where feasible (particularly in shallow water areas), with well anchored posts ▪ Ensure all stakeholders (especially those involved in resource extraction) are aware of zones, zone functions and regulations, before and during implementation
	▪ **Collaboration / Participation**	▪ Strengthen collaboration and communication with Belize Coastguard for effective surveillance and enforcement ▪ Strengthen links and collaboration with Department of the Environment for rapid response to anthropogenic impacts (illegal activities, boat grounding, oil spills etc.) ▪ Strengthen collaboration with Forest Department for effective enforcement of Mangrove Legislation ▪ Establish collaboration with Belize Tourism Board for effective enforcement of tourism standards and regulations at Turneffe ▪ Strengthen collaboration with the Department of the Environment for effective enforcement of caye development and Environmental Compliance Plans ▪ Strengthen collaboration with stakeholders for reporting of illegal transboundary incursions ▪ Develop mechanisms for integrating participation and support of fishermen, tourism operators and tour guides in surveillance and enforcement
	▪ **Reporting**	▪ Maintain log books - number of patrols, zones patrolled, number of boats checked, infractions noted, warnings given, and arrests made ▪ Maintain log of fishing and tourism boat presence at Turneffe Atoll ▪ Identify other items to be included in the patrol logs ▪ Produce quarterly reports, and submit to the Fisheries Administrator ▪ Produce annual reports and submit to the Fisheries Administrator

Natural Resource Management Programme / 3		
Fisheries Management	▪ **Fisheries Regulations**	▪ Establish and disseminate clear regulations relating to fishing methods, gear and zonation to fishing stakeholders
	▪ **Permitting and licensing**	▪ Review status of Turneffe spawning aggregations, identify those to be closed to commercial fishing and develop and implement an effective traditional fishing license system for those open to fishing

	▪ **Sustainable Fisheries Management**	▪ Develop and implement an effective sustainable fisheries management plan for Turneffe Atoll and in adjacent open sea, integrating mechanisms including:
		  ▪ Enforcement of Fisheries legislation and zone regulations
		  ▪ General education of fishers on policies and regulations and long term benefits
		  ▪ Training of first-time fishing permit applicants in best fishing practices, policies and regulations and long term benefits
		  ▪ Catch monitoring,
		  ▪ Strategy evaluation and adaptation, etc.
		  ▪ Catch shares, quotas and permits
		▪ Establish monitoring measures for the management plan and policies, with review and assessment every 5 years
		▪ Investigate feasibility for active rehabilitation and restoration of traditional and non-traditional commercial species
		▪ Investigate potential for diversification into other marine resource use /extraction activities

	▪ **Alternative Livelihoods**	▪ Develop and implement a supplemental / alternative livelihood programme targeting traditional users of Turneffe Atoll, focused both at Turneffe and in stakeholder communities, to reduce reliance on natural resource extraction at Turneffe ▪ Support poverty alleviation initiatives focused on reducing fishing pressure through alternatives in key stakeholder communities
	▪ **Improve fishermen conditions**	▪ Investigate feasibility of securing fish camp tenure for long-term camps established by traditional fishermen at Turneffe ▪ Develop emergency support mechanisms for fishing community and fishermen initiatives at Turneffe Atoll (eg. communication, fuel, water, evacuation)

Natural Resource Management Programme / 4		
Visitor (Tourism) Management	▪ **Regulations**	▪ Ensure tourism operators and guides (including liveaboards and day cruise ship operators) are aware of tourism and zone regulations at Turneffe ▪ Enforce recreational regulations including: ▪ Number of divers / snorkelers per licensed guide (in collaboration with BTB) ▪ Flying 'divers down' flags when divers are in the water ▪ Exclusion of jet ski and water-ski use at Turneffe ▪ Promotion of 'catch and release' sport fishing in Marine Reserve General Use Zone and enforcement of catch and release regulations in Conservation Zones ▪ Mooring buoy-use regulations at dive sites and designated safe harbours
		▪ Implementation of Limits of Acceptable Change regulations for effective visitor management ▪ Ensure effective collection and reporting of tourism fees, with accurate visitor records - origin, number..
	▪ **Tourism Best Practices**	▪ Develop and implement guidelines and training based on best practices, for resorts, boat captains, tour guides, sport fishing guides, tourists and educational groups using Turneffe Atoll ▪ Provide training for tour operators and guides in tourism best practices (including boat use at Turneffe, diving, snorkelling, guiding around marine mammals and sport fishing) ▪ Ensure compliance with TACAC / CZMAI tourism and recreation guidelines
	▪ **Tourism as an alternative**	▪ Support fishermen interested in entering tourism at Turneffe Atoll through mechanisms such as training, infrastructural support, microloans
Coastal / Caye Development	▪ **Regulations**	▪ Ensure effective surveillance and enforcement against illegal development activities at Turneffe Atoll – eg. non-permitted clearance of mangroves, overwater / seawall construction, dredging
	▪ **Sustainable Development**	▪ Develop, adopt and promote Turneffe Atoll development guidelines, with input from TACAC / CZMAI guidelines ▪ Identify and map sensitive areas that would be severely damaged by dredging or vegetation clearance and inform Geology and Petroleum Department, Belize Fisheries Department, Forest Department, Department of the Environment ▪ Limit dredging on Turneffe Atoll to small scale non-mechanical operations (artisanal permits only) and for access purposes only, with a more robust assessment process to include strengthened environmental clearance process for dredging applications in consultation with the Fisheries Administrator.

Natural Resource Management Programme / 4		
Coastal / Caye Development	▪ **Sustainable Development**	▪ Strengthen and implement guidelines for sustainable development for any new developments, and ensure that new development activity is accomplished in a low-impact, eco-friendly manner (to be defined – DOE/IUCN/certification etc.) and minimizes impacts to the natural environment ▪ Ensure development guidelines are followed in the construction and operation of the Headquarters and rangers stations ▪ Encourage caye-based residents / education / tourism developments to adopt and follow Turneffe Atoll development guidelines ▪ Ensure all EIAs for Turneffe Atoll developments are fully vetted and approved, and take into account zoning recommendations and regulations, Turneffe Atoll and TACAC / CZMAI guidelines
		▪ Investigate potential of environmental levies on caye development within Turneffe Atoll towards monitoring costs ▪ Ensure enforcement of effective waste management policies developed for the Atoll ▪ Lobby for exclusion of Turneffe Atoll from oil exploration / extraction areas ▪ Adopt guidelines from WIDECAST Technical Report No. 9: Best Practices for Sea Turtle Nesting Beaches
Species / Ecosystem management	▪ **Coral Reef**	▪ Designate and enforce specific mooring sites and boat access channels to reduce mechanical impacts on corals by boats ▪ Ensure adequate protection of key herbivores to maintain live coral cover and ecological functions ▪ Enforce Limits of Acceptable Change regulations
	▪ **Terrestrial Ecosystems**	▪ Identify nationally owned land that could be allocated or purchased to protect key littoral forest and fringing mangrove ▪ Ensure inundated mangroves at Turneffe are not considered 'allocatable land' by Lands Department ▪ Investigate mechanisms for protection of key turtle and crocodile nesting beaches ▪ Protect key nesting and roosting bird cayes, in collaboration with fishermen and tour guides
	▪ **Sport Fish Management**	▪ Implement strategies to ensure that Turneffe Atoll continues to be a world class sport fishing destination, based on scientifically sound management and ecologically sound and sustainable practices
	▪ **Invasive species management**	▪ Increase awareness in staff, residents and tour guides of the potential impacts of lionfish ▪ Collaborate with partners to develop and implement mechanisms for increasing national awareness of the impacts lionfish are having on the reef, in collaboration with Ecomar

Natural Resource Management Programme / 5		
Species / Ecosystem management	▪ **Invasive species management**	▪ Engage commercial fishermen and tour guides in lionfish extermination as a management intervention at Turneffe ▪ Collaborate with partners to develop national markets (restaurants, Chinese) and locate international markets for lionfish fillet, ground meat, and other products ▪ Monitor *Casuarina* presence, and assess whether removal is necessary – if so, develop and implement removal plan
	▪ **Crocodile management**	▪ Enforce protective legislation for American crocodiles and the crocodile reserve at Cockroach Caye ▪ Train patrol units in response to problem crocodile incidents at Turneffe, in collaboration with the Forest Department and ACES
	▪ **Dolphins / manatees**	▪ Train patrol units in response to marine mammal / turtle strandings – necropsy and recovery – in collaboration with Marine Mammal Stranding Network ▪ Enforce protective legislation for dolphins and manatees
	▪ **Response to impacts on the reef and other ecosystems (anthropogenic and natural)**	▪ Train rangers for response to natural and anthropogenic impacts (eg. responding to boat groundings, oil spills, hurricane response)
Measuring Success		▪ Conduct annual Measures of Success assessment (both implementation and results) for the Natural Resource Management Programme

3.5.2 Science Programme

The establishment of the Science Programme, and an integrated, comprehensive Research and Monitoring Plan with collaborative input from science stakeholders of Turneffe Atoll is essential to ensure informed, effective management, and to assess the effectiveness of the marine reserve in achieving its objectives. Management responsibility for Programme implementation falls under the Fisheries Department, and is administered under five sub-programmes:

- **Research**
- **Monitoring**
- **Climate Change Adaptation**
- **Data Management and Dissemination**
- **Collaboration with National / International Partners**

The Programme also includes a **Measuring Success** sub-programme, to ensure effective implementation and outcomes of research and monitoring strategies.

The **Research Sub-Programme** focuses on those areas identified as information gaps during the management and conservation planning processes. Many of the research activities can be effectively met through engaging research partners for targeted project areas - particularly important in research for informing climate change adaptation. The sub-programme calls for a more standardized focus for independent researchers, with priority given to research meeting identified research gaps, and research proposals reviewed by the Fisheries Department.

The **Monitoring Sub-Programme** is the main focus of the Science activities, and is guided in part by the regional monitoring protocols and goals under the MBRS synoptic monitoring programme, as well as indicators developed during the Management Action Planning process and Measures of Success framework. Whilst this is comprehensive in terms of current monitoring protocols, there is still a need to incorporate a mechanism to assess the resilience of Turneffe Atoll to climate change and identify critical source areas, and ensure the integration of these into future planning.

The development of a Limits of Acceptable Change programme will also require monitoring of indicators at key visitor snorkle, dive and sport fishing sites, to be integrated into the overall Reearch and Monitoring Plan.

Effective management of conservation targets under the Surveillance and Enforcement Programme is guided by the research and monitoring outputs - the **Data Management and Dissemination of Information Sub-Programme** ensures that information from research and monitoring is available for guiding management decision making and adaptation. Dissemination of the results is also identified as key, as effective management depends on

ensuring clear understanding of the reasons behind targeted management or enforcement strategies by stakeholders.

The **Collaboration Sub-Programme** recognizes that communication, cooperation and coordination with other conservation organizations, national and international research partners involved in management, research and monitoring on the Belize reef is critical, as Turneffe Atoll does not exist in isolation.

Priority Areas

Several areas have been identified as priorities for research and monitoring activities, either through the development of conservation planning actions, or in response to specific research or monitoring requirements:

1. To develop specific research and monitoring activities and strategies to address climate change issues

2. To develop standards for the Limits of Acceptable Change (LAC) Programme and implement a dedicated LAC monitoring programme

3. To increase knowledge on connectivity and recruitment of corals and key commercial species in the marine environment

4. To increase information and understanding to input into strategy development towards greater sustainability of the fishery at Turneffe Atoll

5. To ensure effective dissemination of results in formats that are accessible to a wide variety of stakeholders

6. Assess ecological and behavioural impacts of sport fishing on sport fishing species and their ecosystems, to guide management and policy decisions

Science Programme		
General	▪ **Establish the Science Programme for Turneffe Atoll**	▪ Establish a fully functional, equipped and staffed Science Programme, for effective programme management, and strategy implementation ▪ Develop a Research and Monitoring Plan focused on providing information for management decisions and informed adaptive management, that engages all science stakeholders of Turneffe Atoll, coordinated by the Environmental Research Institute ▪ Integrate monitoring of MBRS, Healthy Reefs, Conservation Planning, Limits of Acceptable Change and Measures of Success indicators into the Research and Monitoring Plan
Research	▪ **General**	▪ Ensure collaboration and liaison between Fisheries Department and the Turneffe Atoll Management Board / ERI during the process of granting research licenses ▪ Develop and enforce best guidelines for research, monitoring and educational research activities at Turneffe Atoll ▪ Identify priority research and gaps based on the National Environmental and Natural Resource Management Research Agenda, Turneffe Atoll Management Planning outputs and adaptive management needs ▪ Identify research partners and funding opportunities for effective implementation of key research activities at Turneffe and disseminate list of priority research areas to research stakeholders active at (or interested in) Turneffe Atoll
	▪ **Identified Research Gaps**	▪ Promote research that develops an understanding of climate change and evaluates climate change adaptation strategies for Turneffe ▪ Promote research that provides an understanding of species and ecosystems of the open sea ▪ Implement an extensive survey of terrestrial mammals of Turneffe Atoll ▪ Implement an extensive survey of birds of Turneffe Atoll – resident and migratory ▪ Continue to update all baseline species lists for Turneffe Atoll ▪ Develop a baseline for current extent and condition of terrestrial ecosystems ▪ Identify and map key terrestrial ecosystems ▪ Investigate functionality of Vincent's Lagoon

Science Programme / 2		
Research	▪ **Identified Research Gaps**	▪ Update and standardise ecosystem mapping of Turneffe Atoll ▪ Update 2003 TICAC Land Use Map ▪ Increase knowledge of occupancy - status of land (private property / leasehold) ▪ Strengthen data collection on extractive use of the area (legal and illegal) ▪ Ensure effective data collection, management and analysis of fishing boats and fishermen active in the area ▪ Investigate the effectiveness of the conservation zones and marine reserve boundaries in meeting the goals of the Management Plan ▪ Strengthen information on fishing and tourism use of the spawning aggregation sites (both legislated and unlegislated) ▪ Strengthen information on the population dynamics, habitat use, movement patterns and reproduction of key sport fishing species (tarpon, permit and bonefish) ▪ Develop a baseline on large parrotfish status at Turneffe Atoll – particularly that of the rainbow parrotfish ▪ Strengthen information on distribution, abundance and impacts of lionfish in Turneffe Atoll (including confirmation of species)
	▪ **Sustainable Fisheries**	▪ Conduct an assessment of current fishing efforts and methods used at Turneffe Atoll ▪ Determine the percentage decline in commercial production over the last 5 years at Turneffe ▪ Assess current populations of commercial species ▪ Strengthen information on the population dynamics, habitat use, movement patterns and reproduction of key commercial species (conch, lobster, snapper and grouper) ▪ Promote research to determine the sustainable level of marine resource harvest ▪ Promote research into mechanisms for active replenishment of commercial species ▪ Promote research into viable alternative marine products ▪ Integrate research needs identified under the Sustainable Fisheries management sub-programme into the list of research priorities ▪ Investigate feasibility of restoration / replenishment mechanisms for conservation targets ▪ Characterise un-legislated spawning aggregation sites (species, physical characteristics)

Science Programme / 3		
Research	▪ **Tourism**	▪ Ensure effective data collection and analysis of tourism boats and activities ▪ Investigate the impacts of sport fishing, with particular focus on ecosystems of the back reef flats and impacts on juvenile conch nursery areas ▪ Investigate use and impacts of cast nets for bait collection, and sustainability ▪ Investigate the impacts of snorkelling and diving on key visitor sites of Turneffe Atoll ▪ Establish a Limits of Acceptable Change for major tourism use areas (dive, snorkel and sport fishing sites)
	▪ **Connectivity**	▪ Prioritise research into water currents adjacent to Turneffe Atoll ▪ Prioritise research into connectivity as related to commercial species and coral recruitment
Monitoring	▪ **Long term monitoring**	▪ Continue implementation of the MBRS monitoring programme (UB/ERI) ▪ Continue implementation of the AGGRA monitoring programme (Oceanic Society) ▪ Continue long term monitoring of dolphins, manatees, crocodiles and sharks (Oceanic Society) ▪ Continue monitoring for coral bleaching, in collaboration with the Mesoamerican Coral Reef Watch Programme (through ECOMAR) (UB/ERI and Oceanic Society) ▪ Establish monitoring of fish catch in collaboration with Fisheries Department, and with the participation of traditional fishermen ▪ Develop and implement effective water quality monitoring programme (including wells) ▪ Establish monitoring programme for sport fishing species in collaboration with sport fishing guides and the sport fishing industry of Turneffe Atoll ▪ Monitor presence of lionfish within the marine protected area ▪ Monitor turtle activity and turtle nesting at Turneffe Atoll ▪ Implement effective water quality monitoring programme for Turneffe Atoll ▪ Monitor Limits of Acceptable Change indicators ▪ Develop a socio-economic monitoring programme of key stakeholder communities and Atoll residents, with effective integration of baseline information from Conservation International (CI / Catzim et. al. 2009)

Science Programme / 4		
Monitoring	▪ **Long term monitoring**	▪ Maintain and update accurate socio-economic data on Turneffe Atoll stakeholder communities (eg. using SOCMON protocols) ▪ Maintain and update accurate socio-economic data on Turneffe Atoll fish camps and other residential properties (including number of residents, occupation, community of origin, waste disposal, drinking water source, construction materials etc.)

Monitoring – Conservation Target Indicator	▪ **Conservation Target Indicators**	▪ Water quality – turbidity, temperature, salinity, nutrients, light intensity
		▪ Simplified Healthy Reef Indicators:
		  ▪ live coral cover,
		  ▪ macroalgal cover,
		  ▪ herbivorous fish biomass,
		  ▪ commercial fish biomass
		▪ Recent coral recruitment

	▪ **Commercial Species**	▪ Densities, size and catch composition of lobster ▪ Density of conch ▪ Characterization of fish using spawning aggregation sites (species, size, maturity) ▪ Average catch per boat / trap fisherman (conch, lobster, finfish) ▪ Grouper and snapper spawning population abundance
	▪ **Surveillance and Enforcement Interventions**	▪ Number of day/ routine patrols ▪ Number of night and daytime patrols monitoring SPAG sites during spawning peak ▪ Number of arrests per year / % of illegal fishing cases presented that are successfully prosecuted / year ▪ Number of fishing infractions as a % of total number fishing boats / year ▪ Weight of illegal product ▪ # of fishers caught fishing illegally at SPAGs ▪ Number of incidents of poor development practices reported and confirmed / year

Science Programme / 5		
Monitoring – Conservation Target Indicator	▪ **Ecosystems and Species**	▪ Area of Littoral Forest ▪ Area of littoral forest – natural and impacted ▪ Extent of red mangrove – natural and impacted ▪ Condition of red mangrove – density of seed trees ▪ Extent and condition of seagrass ▪ Extent of back reef flats ▪ Extent of sport fishing habitat non-impacted by anthropogenic causes ▪ Density of sport fishing species ▪ Abundance of sport fish prey species ▪ Number of successful turtle and crocodile nests ▪ Biomass of reef fish ▪ Biomass of juvenile fish in mangrove areas ▪ Abundance of sharks ▪ Number of shark species and individuals using Turneffe Atoll ▪ Density of lionfish ▪ Total number of lionfish caught in tournaments per year ▪ % of Turneffe fishermen engaged in lionfish removal per year
Monitoring	▪ **Assessment and Monitoring of Threats**	▪ Monitor lionfish populations at Turneffe Atoll, in both mangrove and reef ecosystems ▪ Develop rapid assessment mechanisms that engage stakeholders, for assessing and monitoring impacts such as ship groundings, disease outbreaks, oil spills etc. ▪ Ensure post impact assessment protocols are developed, implemented and reports produced and disseminated, for all natural events – eg. earthquakes and hurricanes, for both terrestrial and marine

Science Programme / 6		
Climate Change Adaptation		▪ Ensure adequate baseline is available for management decisions related to climate change adaptation ▪ Integrate monitoring for climate change into the Turneffe Atoll monitoring framework ▪ Identify priority research activities for Turneffe Atoll from climate change assessment and planning, and identify partners / locate funding for implementation ▪ Continue monitoring for coral bleaching and disease, with input into Mesoamerican Coral Reef Watch Programme (through ECOMAR) ▪ Identify resilient coral sites and work with stakeholders to develop and implement zoning for protection ▪ Review and re-evaluate MPA boundaries and zoning in the Turneffe Atoll based on climate change research outputs ▪ Identify coral recruitment sources for Turneffe Atoll, and identify mechanisms to ensure that these are adequately protected, if necessary ▪ Characterize water currents critical for coral recruitment at Turneffe Atoll ▪ Establish monitoring protocols that inform management for building reef resilience ▪ Investigate mechanisms for direct interventions – eg. coral nurseries, shading of key sites, promoting higher herbivore densities ▪ Work closely with national and international partners to monitor climate change effects and identify and promote implementation of appropriate national and regional management strategies

Science Programme / 7		
Collaboration with local / national / international partners		▪ Strengthen collaborative relationship between UB / ERI, Oceanic Society, TAT and other research partners towards increased, coordinated, effective of research, monitoring, data management and dissemination of outputs ▪ Strengthen communication and collaboration with other researchers and research institutions for filling critical information gaps ▪ Build collaboration with local fishermen and tour guides for training and participation in research and monitoring activities ▪ Build collaboration between programme areas – ensure all marine reserve staff understand the reasons behind research and monitoring, and can articulate key research and monitoring outputs
Data Management and Dissemination of Information		▪ Maintain database of GIS data, and available research and monitoring information to help identify gaps in information, and to provide a platform from which the results can be communicated to a wider audience ▪ Present research and monitoring results of data in quarterly and annual reports summaries, with mechanisms in place for easy access ▪ Integrate research and monitoring results into the adaptive management cycle ▪ Use available opportunities for dissemination of results (eg. workshops, conferences) ▪ Ensure data on coral reef health, spawning aggregations, turtles etc feeds into national and regional efforts (eg. Healthy Reefs, Belize Spawning Aggregation Working Group, ECOMAR etc.) ▪ Ensure research and monitoring results inform national planning (eg. Shark Action Plan) ▪ Develop mechanisms for effective dissemination of research and monitoring information to the relevant stakeholders
Measuring Success		▪ Conduct annual management effectiveness assessment based on national indicators ▪ Develop Measures of Success indicators per management programme ▪ Conduct annual Measures of Success assessment for the Science Programme ▪ Provide an annual assessment of management success per Programme and overall, based on analysis of management programme Measures of Success indicator outputs

3.5.3 Education and Outreach Programme

Turneffe Atoll is located far from the mainland, with key stakeholders identified as the fishing, tourism and caye development sectors. It is critical for the success of management implementation that Turneffe has informed and supportive stakeholders, knowledgeable of the underlying threats to the Atoll, management challenges, and the strategies being employed to address these threats (including the need for implementation of regulations, replenishment areas and Conservation Zones). Management responsibility for Programme implementation falls under the Fisheries Department, with administration under three sub-programmes:

- **Stakeholder Engagement**
- **Alternative Livelihoods and Training**
- **Education and Dissemination of information**

The Programme also includes a **Measuring Success** sub-programme, to ensure effective implementation and outcomes of education and outreach activities.

Creating an environment of stakeholder stewardship should be a priority strategy, with integrated stakeholder participation in surveillance and enforcement, and research and monitoring. This should be matched with training for fishermen, the major extractive resource users, in alternative livelihood skills, financial incentives, investment in supplemental income generation mechanisms and investigation of innovative potential marine resource opportunities.

Engaging land owners and developers is also of importance, with the potential impacts poorly managed coastal development can have on the Atoll – clearance of the critically under-represented Littoral Forest ecosystem, impacts on key turtle nesting beaches, and dredging, with its associated sedimentation impacts on adjacent reefs and seagrass ecosystems - reducing the viability of already pressured conservation targets.

Broader environmental education is addressed through the development of booklets, leaflets, brochures, posters and audio visual materials for the Marine Reserve.

Education and Outreach Programme		
Stakeholder engagement	▪ **General**	▪ Develop a Stakeholder Engagement Plan to guide activities within a framework of goals, objectives and targets aligned to target audiences, with input from other programmes ▪ Identify and implement mechanisms that will increase stakeholder economic benefits from the marine reserve ▪ Encourage active participation Advisory Committee in attending meetings and advise the when necessary, on management decisions to the Fisheries Administrator ▪ Develop a Stewardship Programme with engagement, training and participation of fishermen and tour guides in surveillance, research and monitoring activities ▪ Engage and train fishermen in use of practices that increase sustainability of fish stocks within Turneffe Atoll ▪ Engage lighthouse keepers in surveillance activities under the Stewardship Programme ▪ Promote best tourism practices for resorts, companies, tour operators, tour guides, live aboard operators etc. using Turneffe Atoll
Awareness	▪ **General**	▪ Increase national and international awareness of the high biodiversity values and global importance of Turneffe Atoll towards exploration of potential for designation as a biosphere reserve ▪ Ensure ongoing production of multimedia outputs (brochures, posters, videos etc) that provide information to the general public on key biodiversity and ecosystem values, vision, threats and challenges and rules and regulations ▪ Increase awareness of Turneffe Atoll through participation in national events – displays and exhibits at Earth Day, the Agriculture and Trade Show etc. ▪ Promote guidelines and best management practices among staff, resource users, visitors and residents ▪ Identify the key stakeholder fishing communities and increase knowledge of coral reefs, sustainable fishing practices and the marine environment through implementation of a Turneffe focused education programme targeted at primary level ▪ Establish an education and public awareness campaign on the need for sustainable use of marine resources and the Fisheries legislation being implemented to achieve this, that targets fishers, retailers and consumers

Education and Outreach Programme / 2		
Awareness	▪ **Turneffe Atoll stakeholders**	▪ Ensure Turneffe Atoll stakeholders (fishermen, tour guides, tourism resorts, land owners/ developers, lighthouse keepers, Belize Coastguard etc) are knowledgeable on the location, regulations and rationale for each of the management zones, the Fisheries regulations and the role of the rangers in surveillance and enforcement ▪ During the first two years of management implementation, organise regular meetings with stakeholders to address surveillance and enforcement and other management issues ▪ Ensure regulations are disseminated to all stakeholders - tour guides, Atoll residents and fishermen ▪ Disseminate information on the national and regional importance of Turneffe Atoll, and the rationale for its establishment as a Marine Reserve
	▪ **Land Owners**	▪ Identify and implement best means of liaising with caye developers and landowners - areas of conflict and mutual assistance ▪ Increase awareness among land owners of the biodiversity value, role and importance of mangroves, littoral forests, seagrass and corals, and encourage protection for these ecosystem, especially in identified key areas ▪ Increase awareness among land owners of the national and management goals for protection of littoral forest ecosystems and the importance of Turneffe for its continued viability ▪ Engage landowners in management, protection and restoration of littoral forest, mangrove and beach vegetation ▪ Raise awareness among land owners / developers of methods of limiting development impacts (sedimentation - erosion following land clearance; wastewater, sewage and solid waste disposal) ▪ Ensure all land owners are aware of the laws and permitting procedures pertaining to EIAs, ECPs, mangrove clearance, dredging, over-the-water structures etc. ▪ Lobby with land owners, leaseholders and developers for stakeholder management of turtle nesting beaches, with implementation of WIDECAST Best Practices

Education and Outreach Programme / 3		
Awareness	▪ **Boat Captains**	▪ Increase awareness among boat captains (fishing and tourism vessels) of the impacts of oil on the environment through poorly disposed oil / lube containers, fuel leaks, and poor ▪ fuel transfer and storage methods ▪ Engage boat captains for best practices in mooring / anchor use ▪ Ensure boat captains are aware of recommended mooring/anchoring areas at Turneffe Atoll, and of marked passes through reefs
	▪ **Tour Operators / Tour Guides**	▪ Develop and implement Turneffe-specific guidelines and best practices certification programme and training for tourism industry and research users, based on established criteria (eg. CORAL, BAS, WCS, BTB) ▪ Offer annual skills training and refresher courses on rules, regulations and tourism policies, and development and dissemination of best practices information for tour guides using Turneffe Atoll
	▪ **Visitor Information**	▪ Provide opportunities for visitor education through: ▪ Establishing an Interpretive Centre at the Headquarters ▪ Providing tour guides with information on the value and biodiversity of Turneffe Atoll ▪ Providing talks to liveaboard passengers, educational study groups and to resort guests
	▪ **Environmental Education**	▪ Give presentations targeting primary and secondary schools in stakeholder communities on Turneffe Atoll and its environmental and socio-economic benefits ▪ Liaise and collaborate with local NGOs and other partners for joint educational outreach to schools in stakeholder communities ▪ Provide ongoing field trips for students to the reef, to invest in the engagement of future decision-makers ▪ Build reputation of Turneffe Atoll as an educational resource for national and international schools and universities
	▪ **Dissemination of Information**	▪ Produce and distribute brochures on Turneffe Atoll, incorporating key biodiversity and ecosystem values, goals and rules and regulations ▪ Establish a website for dissemination of information on Turneffe Atoll

Education and Outreach Programme / 4		
Awareness	▪ **Dissemination of Information**	▪ Ensure all awareness documents relevant to Turneffe Atoll are available for download from the website (brochures, leaflets, regulations, posters etc.) ▪ Produce an annual flier summarizing activities and achievements, to be distributed to residents, tour guides, tour operators and fishermen, and include income and expenditures information for increased awareness and transparency
Sustainable livelihoods and training	▪ **Alternative / Sustainable Livelihoods**	▪ Develop an Alternative Livelihood Strategy in collaboration with fishers to identify effective mechanisms for reducing fisher dependence on marine resources ▪ Implement mechanisms identified in the Alternative Livelihood Strategy, with training, investment, facilitation and medium-term support for the development of viable alternatives ▪ Lobby in support of initiatives to develop infrastructure in the northern communities, reducing the cost of living and improving quality of life for the fishermen – better access, better medical facilities, investment in both primary and high schools ▪ Partner with other mpa management bodies that identify the northern communities as fishing stakeholders for joint development of an Alternative Livelihoods Programme, coordinated and shared cost of implementation ▪ Conduct a needs assessment for each key fishing sector (Belize City, Chunox, Copper Bank and Sarteneja), with the participation of other partner mpa management bodies and fishermen ▪ Provide micro-loans for tourism start-up projects in the northern communities ▪ Provide incentives for small-scale industries that can provide local employment in the northern communities, whilst maintaining their environmental values ▪ Support other initiatives within the northern communities that assist in shifting the income base, identified through the needs assessment. ▪ Provide technical support for alternative options developed in the communities ▪ Invest in supplemental income generation by fishermen's wives ▪ Identify mariculture options at Turneffe Atoll (eg. seaweed, sponges, sea cucumbers) in collaboration with fishermen, and investigate potential as an on-site alternative, with planning for monitoring, sustainability, minimal ecological impact and market opportunities before implementation

Education and Outreach Programme / 4		
Sustainable livelihoods and training	▪ **Alternative / Sustainable Livelihoods**	▪ Investigate options for sustainable small-scale deep sea fishing ▪ Provide training and information for fishermen wishing to shift to tourism as an alternative at Turneffe ▪ Develop basic tourism infrastructure at the Turneffe Headquarters (palapas, picnic tables, information) for the joint use of fishermen wishing to shift to tourism as an alternative ▪ Support scholarships for students from fisher families, to increase education opportunities and career options, and reduce recruitment into fishing sector ▪ Collaborate with other NGOs that have identified the northern fishermen as stakeholders ▪ Seek funding to invest in the primary and high schools in the northern communities to increase the quality of education ▪ Provide access to career counselling during secondary schooling – to assist access to information on options and opportunities available
Measuring Success		▪ Conduct annual Measures of Success assessment for the Education and Outreach Programme

3.5.4 Infrastructure Programme

The **Infrastructure Programme** is managed under two sub-programmes:

- **Operational Infrastructure and Equipment**
- **Maintenance**

The Programme also includes a **Measuring Success** sub-programme, to ensure effective implementation and outcomes of Programme activities. Management responsibility for Programme implementation falls under the responsibility of the Fisheries Department.

Priority Areas:

In the initial phase, the priority is to:

- Establish a fully equipped, functional headquarters located on the east facing coastline (provisionally Calabash Caye) and the first of two ranger stations
- Purchase equipment and fuel for two functional patrol units, for effective surveillance and enforcement
- Purchase administration equipment (communications, computer, office equipment)
- Establish and implement green building and operation policies for all infrastructure, with use of solar / wind powered electricity generation, following best practices guidelines during construction of infrastructure and operation of boats

Infrastructure Programme		
Operational Infrastructure and Equipment	▪ **Reserve Management Infrastructure**	▪ Finalise location of Reserve Headquarters and Ranger Stations, and complete necessary MoU / agreements for long term use ▪ Seek short term agreement for lease/use of a building until facilities can be constructed ▪ Construct and equip a fully functional Reserve Headquarters, following best development practices for the Atoll, with provision for bedrooms, kitchen, bathroom, office and equipment / fuel storage, dock ▪ Construct and equip two manned Ranger Stations following best development practices for the Atoll, with provision for bedrooms, kitchen, bathroom, equipment / fuel storage and docks ▪ Ensure development guidelines are followed in the construction and operation of the Headquarters and rangers stations ▪ Investigate green options for power, water and sewage management ▪ Ensure all buildings are constructed to withstand hurricanes ▪ Ensure all operational facilities are equipped with adequate communication (cell phone, VHF) ▪ Ensure all boats are equipped with navigational equipment (maps, compass and GPS), safety equipment (life vests, first aid kit, fire extinguisher etc.) and communication equipment ▪ Purchase and install zone demarcation buoys for effective marking of zone boundaries ▪ Ensure the Fisheries Department has the equipment and infrastructure to effectively support the Marine Reserve
	▪ **Operational Logistics**	▪ Provide patrol units with fully equipped, operational boats for effective surveillance and enforcement of both lagoon and open sea, and for day and night patrols ▪ Ensure the Reserve Headquarters is fully equipped for effective operations, with a functional office, communications, and safety / first aid equipment ▪ Ensure fuel availability for effective operations

Infrastructure Programme / 2		
Operational Infrastructure and Equipment	▪ **Science**	▪ Provide a fully equipped, operational boat for the Science Programme ▪ Equip the Science Programme with snorkelling and diving equipment ▪ Equip the Science Programme with research and monitoring equipment
	▪ **Communication**	▪ Ensure Headquarters, ranger stations and boats are equipped with adequate communication equipment (cell phone, VHF) ▪ Lobby for installation of a cell tower for improved cell coverage for Turneffe Atoll ▪ Investigate feasibility of internet access to increase effective communication with Advisory Committee and Fisheries Department
Visitor Infrastructure		▪ Establish an interpretive area at the Headquarters that provides information on the values and management targets of Turneffe Atoll to visitors (tourists, tour guides, fishermen, students etc.) ▪ Identify other visitor infrastructure requirements for the Headquarters site (picnic areas, barbecue pits, bathroom facilities) for more effective visitor management ▪ Designate and enforce specific mooring sites and boat access channels to reduce mechanical impacts on corals by boats
Maintenance		▪ Develop and implement a Maintenance Programme for buildings, equipment and visitor facilities at Turneffe Atoll, to guide effective and timely maintenance activities ▪ Train staff in maintenance of infrastructure and equipment ▪ Ensure mooring and demarcation buoys are adequately maintained
Measuring Success		▪ Conduct annual Measures of Success assessment for the Infrastructure Programme

3.5.5 Management and Administration Programme

The Administration Programme activities fall under three sub-programmes:

- **Administration Policies and Procedures**
- **Human Resource Management**
- **Financial Sustainability**
- **Timeline, Evaluation and Review**

There is also a **Measuring Success** sub-programme, to ensure effective implementation and outcomes of administration activities.

The Programme sets in place the Administration Policies and Procedures for the staff employed by the Management Board, and all human resource issues and evaluation. It also seeks, in the first five years, to develop financial sustainability mechanisms to provide long term security for management activities. Management responsibility for Programme implementation falls under the responsibility of the Fisheries Department.

Priority Areas:

In the establishment phase, it is important to:

- Build the capacity of the Management Board to take on the management role
- Ensure there are sufficient staff members employed, including a Reserve Manager and two patrol units
- Ensure an effective, transparent accounting system is established
- Plan for future financial sustainability

Administration Programme		
Administration	▪ General	▪ Ensure adequate equipment and trained staff for effective administration
	▪ Policies and Procedures	▪ Develop a Policies and Procedures Manual for Turneffe Atoll based on Fisheries Department policies, with integration of site-specific policies and procedures ▪ Ensure the members of the Management Board and all staff are aware of the contents of the Policies and Procedures Manual
	▪ Planning	▪ Build the capacity of the Management Board to be able to effectively take on the role of protected area management. ▪ Conduct management effectiveness assessment (based on national indicators -Young et al., 2005), and Measures of Success monitoring annually, and integrate output recommendations into annual workplan /operational plan ▪ Preparation of annual workplan / operational plan and budget in October of each year ▪ Produce monthly, quarterly and annual reports and submit to Management Board, based on the SEA model and Fisheries Department reporting procedures ▪ Conduct review of management plan strategy implementation every two years with stakeholder input, and adapt management plan as required, as part of the adaptive management cycle ▪ Ensure an effective Emergency Plan is in place (to include natural and anthropogenic disasters, medical evacuation etc.), and staff are trained in implementation
Human Resource Management	▪ Staff	▪ Ensure all staff are familiar with Fisheries Department and Reserve management policies, including job descriptions, employee policies, transport policies, and gender issues ▪ Equip staff with uniforms ▪ Ensure the Reserve Manager is trained in marine resource management ▪ Ensure administrative staff have sufficient administrative training for effective general and financial management ▪ Ensure rangers have sufficient surveillance and enforcement training to be effective ▪ Ensure rangers and other staff are trained in natural resource policies and legislation ▪ Ensure staff members are trained in operation and maintenance of reserve equipment (boat handling, basic outboard repair etc.) ▪ Ensure Science staff have sufficient training in monitoring protocols for effective monitoring

Administration Programme / 2		
Human Resource Management	▪ Staff	▪ Ensure staff are trained in conflict resolution, consensus building and communications skills ▪ Ensure staff are trained in CPR, First Aid and use of the oxygen kit ▪ Ensure on-site staff have adequate support ▪ Annual evaluation of staff performance ▪ Annual review of staff capacity and training requirements
Accounting		▪ Develop an internal financial accounting system that links expenditures to programme areas and aligns with Fisheries Department financial reporting policies ▪ Establish guidelines for administration of funds and ensuring transparency
Financial Sustainability		▪ Investigate and implement mechanisms for effective fee collection and harmonize with national legislation ▪ Conduct a financial needs assessment for management of Turneffe Atoll ▪ Develop and implement a Financial Plan that identifies viable financial sustainability mechanisms ▪ Assess the surveillance and enforcement needs for Turneffe Atoll and identify sustainable financial mechanisms to achieve this ▪ Investigate potential for financial support from the tourism sector focused on Turneffe Atoll for alternative livelihood training and investment targeting fishermen ▪ Locate funding to fully implement the Management Plan and Financial Plan activities ▪ Investigate options for reducing operational costs through strategic partnerships in all programme areas ▪ Investigate options for volunteer assistance / participation from fishermen, tour guides and students on the Atoll in surveillance and enforcement / research and monitoring ▪ Investigate options for skilled international volunteer assistance in technical areas (grant proposal writing, research...) ▪ Investigate potential of options for use non-skilled national / international volunteer assistance from environmental clubs etc. for construction / maintenance projects ▪ Assess and plan for potential liability issues ▪ Increase profile of Turneffe Atoll nationally and with funders
Measuring Success		▪ Conduct annual Measures of Success assessment for the Administration Programme

Once the Turneffe Marine Reserve is established, one of the first tasks will be the development of an Administration and Policies Manual to ensure that all staff and members of the Advisory Committee are aware of the administrative procedures and policies of the organization.

On-site staff trained as Fisheries Officers also follow the policies of the Belize Fisheries Department. These include the Fisheries Department Weapons Policy, and the Enforcement Plan - an official Fisheries Department policy to guide Fisheries Officers through standardized procedures for approaching and apprehending offenders in contravention of the protected area regulations.

Timeline, Evaluation and Review

It is suggested that the activities of each programme area be expanded to form an implementation matrix, including present and desired status, responsible parties, a timeline based on the 5-year implementation period, and highlighting any limitations or context conditions that would need to be taken into consideration for successful implementation, as shown in the following example (Table 41).

Monitoring and evaluation are integral components of any management system and annual evaluations of protected area management are recommended. In the development of this management plan, the action areas are relatively specific, simplifying the process of monitoring success of implementation, and providing a mechanism for continual tracking of management activities, through annual review by the Fisheries Department.

The management plan should not be considered static, and the annual review should ensure that strategies and activities are still relevant for the changing socio-economic and climatic contexts. Some management strategies may become obsolete, whilst new management activities may need to be included.

A. Natural Resource Management Programme									
Management Actions	**Present Status**	**Desired Status**	**Year**					**Responsible Party**	**Limitations/Requirements**
Surveillance and Enforcement Sub-Programme - Staff			1	2	3	4	5		
▪ Ensure marine reserve staff numbers are sufficient for effective management of Turneffe Atoll.	No marine reserve staff are currently employed to manage Turneffe Atoll	Headquarters: 1 Reserve Manager, 1 Head Ranger, 3 Rangers, 1 boat captain Ranger Station One: 1 Head Ranger, 3 Rangers, 1 boat captain Ranger Station Two: Assistant Manager, 3 Rangers, 1 boat captain						Fisheries Department	Requires establishment of management board and operational funding. At minimum, there should be: Headquarters: 1 Reserve Manager, 1 Head Ranger, 3 Rangers, 1 boat captain (on rotation); Ranger Station One: 1 Head Ranger, 3 Rangers, 1 boat captain (on rotation);
Ensure all patrol staff are trained in Reserve regulations and development restrictions relevant to each zone and the spawning aggregation sites, and to regulated fishing methods, gear and zonation	No marine reserve staff are currently employed to manage Turneffe Atoll	All staff trained in Reserve regulations / restrictions relevant to each zone and the spawning aggregation sites, and to regulated fishing methods, gear and zonation						Fisheries Department	Requires employment of marine reserve staff. Training in Fisheries Legislation (Fisheries Department), Green Laws (Forest Department), Environmental Laws relevant to Turneffe (Department of the Environment)
Investigate potential for developing volunteer ranger programme – local fishermen and tour guides, and implement	Fishermen have expressed an interest but there is no current structure or funding to establish the programme	Fishermen and tour guides play an active part in resource protection with a mechanism in place for reporting infractions						Fisheries Department	Requires a management structure to be in place and engagement of fishermen and tour guides
Surveillance and Enforcement Sub-Programme – Patrols			1	2	3	4	5		
Determine the composition of the multi-agency surveillance and enforcement team	Current surveillance and enforcement is conducted by Belize Coastguard	Dedicated Turneffe Atoll rangers, Belize Coastguard and other agencies collaborate in effective surveillance and enforcement						Fisheries Department	Requires collaborative agreements between agencies, with clearly defined roles and responsibilities

Table 41: Example of Implementation Table, for integration into Annual Operational / Workplan

A. Natural Resource Management Programme									
Management Actions	**Present Status**	**Desired Status**	**Year**					**Responsible Party**	**Limitations/Requirements**
Surveillance and Enforcement Sub-Programme - Patrols			1	2	3	4	5		
Ensure patrol unit(s) are fully trained and equipped for effective enforcement, with functional boats and ranger stations.	An agreement between Belize Coastguard, Fisheries Dept. and TAT provides some patrol coverage by Coastguard, but there is no dedicated patrol unit(s)	Three patrol units are active at Turneffe, based from the Headquarters and the two rangers stations						Fisheries Department	Requires employment of rangers and equipping of the patrol teams - operational funding
Ensure patrol unit(s) are fully trained for incident reporting, handling of evidence and chain of custody towards effective prosecution	An agreement between Belize Coastguard, Fisheries Dept. and TAT provides some patrol coverage by Coastguard, but there is no dedicated patrol unit(s)	All rangers trained in incident reporting, handling of evidence and chain of custody towards effective prosecution						Reserve Manager	Requires employment of rangers. Fisheries Department to conduct training, with annual review
Implement effective patrols (sufficient patrol hours, adequate and appropriate scope, night patrols, equipment) for maximum effectiveness	An agreement between Belize Coastguard, Fisheries Dept. and TAT provides some patrol coverage by Coastguard, but there is no dedicated patrol unit(s)	Patrols are effective (sufficient patrol hours, adequate and appropriate scope, night patrols, equipped etc.)						Reserve Manager	Requires establishment of equipped, trained patrol units and fuel allocation
Enforce Fisheries Regulations in all zones (including General Use Zone and equipment restrictions (eg. no gill / seine nets, no long lines) and anchor-use regulations) and Conservation / Preservation Zone regulations	Current surveillance and enforcement is conducted by Belize Coastguard – enforcing Fisheries Regulations is only one of its tasks at Turneffe	Dedicated Turneffe Atoll rangers effectively enforce all Fisheries Legislation (Conservation and Preservation Zones are functional, gear and harvest restrictions are maintained)						Reserve Manager	Requires establishment of equipped, trained patrol units and fuel allocation

A. Natural Resource Management Programme									
Management Actions	**Present Status**	**Desired Status**	**Year**					**Responsible Party**	**Limitations/Requirements**
Surveillance and Enforcement Sub-Programme - Patrols			1	2	3	4	5		
Effectively patrol all legislated spawning aggregation sites	An agreement between Belize Coastguard, Fisheries Dept. and TAT provides some patrol coverage by Coastguard, but there is no dedicated patrol unit(s), with limited enforcement of SI 161 of 2003	Spawning aggregation sites are adequately patrolled during spawning periods						Reserve Manager	Unrestricted fishing occurs at all SPAGs at Turneffe. Decisions need to be made on which spawning aggregations are closed, and which can be fished by traditional fishermen through a permitting system
Ensure surveillance of developments on Turneffe Atoll and lobby for enforcement where necessary	There is no formal surveillance targeted at ensuring development activities are legal and meet DoE standards	Patrol units note all new development activity and ensure the permits are in place and ECPs are followed						Reserve Manager	Requires employment of rangers. Department of the Environment and Geology and Petroleum Department to conduct training, with annual review. Management Board has responsibility for follow-through
Investigate mechanisms for effective enforcement of mangrove legislation, development and tourism regulations, with training of rangers for taking on these enforcement duties	No dedicated patrol units are currently active Turneffe Atoll. Fisheries Officers are not able to enforce Forest Department legislated regulations	Patrol units maintain an active watch on mangrove clearance (or potential mangrove clearance) activities (including cutting of survey lines) to ensure all permits are in place, and report infractions						Reserve Manager	Requires establishment of equipped, trained patrol units and fuel allocation Training by Forest Department May be through rangers being trained as Special Constables
Enforce research regulations	No dedicated patrol units are currently active Turneffe. No guidelines exist for research activities at Turneffe	Patrol units are trained to enforce Turneffe research guidelines / best practices						Reserve Manager	Requires establishment of equipped, trained patrol units and fuel allocation Training by ERI

It is suggested that a monitoring and evaluation tracking matrix be developed for the activities under the management programme, and using the following criteria (Table …), and following the outline example (Table 42).

Criteria	Score	Criteria Description
Not Started	1	Activities for achieving this result have not been started
Ongoing (-)	2	Whilst project activities are ongoing, implementation is slower than planned, with delays and limitations, and the result has not yet been achieved
Ongoing (+)	3	Activity implementation towards these results is ongoing as planned, but with some limitations, with partial result achievement
Completed / On schedule	4	Activity implementation is on schedule and/or activities have been completed successfully and achieved the relevant result

Table 42: Criteria for tracking implementation

Management evaluation is also achieved by an assessment of management effectiveness. A baseline should be established at the end of the first year of operation using the national indicators for management effectiveness.

Tracking of Management Action Implementation							
Management Actions	**Present Status**	**1st Year**	**2nd Year**	**3rd Year**	**4th Year**	**5th Year**	**Desired Status**
Ensure marine reserve staff numbers are sufficient for effective management of Turneffe Atoll.	No marine reserve staff are currently employed to manage Turneffe Atoll						Headquarters: 1 Reserve Manager, 1 Head Ranger, 3 Rangers, 1 boat captain Ranger Station One: 1 Head Ranger, 3 Rangers, 1 boat captain Ranger Station Two: Assistant Manager, 3 Rangers, 1 boat captain
Ensure all patrol staff are trained in Reserve regulations and development restrictions relevant to each zone and the spawning aggregation sites, and to regulated fishing methods, gear and zonation	No marine reserve staff are currently employed to manage Turneffe Atoll						All staff trained in Reserve regulations / restrictions relevant to each zone and the spawning aggregation sites, and to regulated fishing methods, gear and zonation
Investigate potential for developing volunteer ranger programme – local fishermen and tour guides, and implement	Fishermen have expressed an interest but there is no current structure or funding to establish the programme						Fishermen and tour guides play an active part in resource protection with a mechanism in place for reporting infractions
Ratings: 1: Not started 2: Started, but some limitations to implementation				3. Ongoing but behind schedule 4. On schedule			

Table 43: Criteria for tracking implementation

3.6 Financing

Turneffe Atoll Marine Reserve is currently in the first phase of establishment with full funding yet to be located. Some potential funders have been identified.

The Reserve Manager is responsible for preparing the annual budget for the Marine Reserve and submitting it to the Fisheries Department consideration and possible approval. The Fisheries Department or co-manager is responsible for sourcing funds for implementation. The first funding source will likely be through grants for implementation of the Reserve or for specific Marine Reserve activities.

The Turneffe Atoll Marine Reserve will develop a diverse portfolio of funding sources to achieve sustainable financing. These sources will likely include direct subventions from government, entrance fees, grants from national and international sources, funding from Turneffe Atoll Trust, and others.

A major source of funding will be grants from both national and international agencies. For example, PACT (the Protected Area Conservation Trust) has been a contributor to many marine reserves in the past. Proposals to international donors will need to be prepared and submitted as early as possible after establishment of the Reserve. Collaboration with other marine reserves and NGOs through joint proposals will also be considered. Donations from visitors, tour operators or from established resorts may be important for early funding. Other possibilities include developing partnerships with the private sector, primarily with the tourism businesses. Hotels or tour operators operating within the Atoll depend on the health of the resources within the marine reserve for their livelihood, and they may be sources for funding.

Cost sharing mechanisms

In an effort to reduce costs and yet achieve good management, the Reserve Manager will explore possibilities of sharing certain management responsibilities with stakeholder groups through special agreements. For example, the maintenance of mooring buoys may be shared with dive or tour operators in the reserve. Collaboration with caye and resort owners in monitoring activities, will also assist in sharing the financial burden, as will the involvement of fishermen in enforcement and catch data collection. This type of sharing of responsibility will also foster a greater sense of ownership by the users of the reserve. This could also be expanded to include sharing of specialized equipment and expertise of reserve staff within the national MPA network.

Optimal funding would include 3 patrol units and construction of one Ranger office and two Ranger Stations, as well as funding for scientific monitoring and stakeholder programmes.
First year funding required for a fully functional Turneffe Atoll Marine Reserve is as follows:

Staff	$US
Reserve Management: Reserve Manager, Finance Director, Operations Manager, Development Director, Outreach Director, Data Technician, Administrative Assistant	168,200
Community Researchers	12,000
Rangers Salaries	75,000
Watchman for Rangers Station	13,000
Travel & Conferences	10,000
Website Development	4,000
Subsistence	24,000
Infrastructure	
Reserve Headquarters	100,000
2 Rangers Stations	100,000
Three equipped patrol boats and outboards	122,000
Solar / wind powered generation systems	12,000
3 Generators	12,000
Equipping Office and Ranger Stations	89,100
Cables and buoys for demarcation of reserve	5,000
Operational Funding	
Fuel	88,900
Building, engine and boat maintenance & Cleaning	11,000
Uniforms	8,000
Communication	14,000
Staff Training	14,000
Awareness materials	14,000
Community Meetings and Exchanges	62,000
Professional Fees	26,000
Insurance	17,000
Postage & office expenses	12,000
Other expenses	34,000
Total	**US 1,047,200**

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Annex One

Fisheries

BELIZE:

STATUTORY INSTRUMENT
NO. _____ OF 2012

FISHERIES (TURNEFFE ATOLL MARINE RESERVE) REGULATIONS, 2012

ARRANGEMENT OF REGULATIONS

B E L I Z E:

STATUTORY INSTRUMENT

No. _____of 2012

REGULATIONS **made by the Minister responsible for Fisheries in exercise of the powers conferred upon him by section13of the Fisheries Act, Chapter 210 of the Substantive Laws of Belize, Revised Edition, 2000 – 2003; and all other powers thereunto him enabling.**

(*Gazetted*……, 2012.)

PART I
PRELIMINARY

Citation.

1. *These Regulations may be cited as the*

FISHERIES (TURNEFFE ATOLL MARINE RESERVE) REGULATIONS, 2012.

Interpretation.

2. **In these Regulations,**

"advisory committee" means the committee established under regulation 4;

"bag limit" means the quantum of fish allowed by the Fisheries Administrator to be caught by a person;

"catch and release" means the act of catching fish and then releasing them back immediately into the waters of Belize in the same state that the fish was landed;

"committee" means the advisory committee;

"conservation zones" means the following zones –

(a) Zone I: Maugre Caye Conservation Zone;

(b) Zone II A: Dog Flea Conservation Zone;

(c) Zone IV: Blackbird Caye Conservation Zone;

(d) Zone V: Long Bogue Conservation Zone; and

(e) Zone VI: Caye Bokel Conservation Area;

"extractive fishing" means fishing other than sport fishing;

"preservation zone" means the Zone VII: Preservation Zone;

"recreational fishing" means fishing for leisure and enjoyment as well as fishing with the intention to eat the fish caught, but shall not include any sale, exchange or bartering;

S.I. No. ___ of 2012.

"reserve" means the Turneffe Atoll Marine Reserve, as declared by the Fisheries (Turneffe Atoll Marine Reserve) Order;

"special zones" means the following zones –

(a) Zone II B: Cockroach – Grassy Caye Special Management Area;

(b) Zone III: Vincent's Lagoon Special Management Area;

"sport fishing" means fishing for the purpose of catch and release only.

Zones to be clearly demarcated.

S.I. No. ___ of 2012.

3. The zones specified in the Fisheries (Turneffe Atoll Marine Reserve) Order shall be clearly demarcated by buoys or some other form of demarcation as determined by the Fisheries Administrator.

PART II
ESTABLISHMENT OF AN ADISORY COMMITTEE

Establishment of an Advisory Committee.

4. (1) The Fisheries Administrator shall establish an Advisory Committee for the purpose of advising on the efficient management of the Reserve.

(2) The Advisory Committee members shall be appointed by the post they hold in their organization.

Composition of the Advisory Committee.

(3) The Advisory Committee shall consist of representatives from the following organizations:

(a) one representative of the Fisheries Department;

(b) one representative of the Forestry Department;

(c) one representative of the Coastal Zone Management Authority and Institute;

(d) one representative of the Turneffe Atoll Sustainable Association;

(e) one representative of the Turneffe Atoll Trust;

(f) one representative of the Association of Protected Areas Management Organizations;

(g) one representative from the Protected Areas Conservation Trust;

(h) one representative of the Ministry responsible for Tourism;

(i) one representative of the Ministry responsible for Natural Resources;

(j) one representative of the Environmental Research Institute of the University of Belize;

(k) one representative of an International Non-Government Organization;

(l) one representative from the Belize Fishermen Federation;

(m) one representative from the Belize Fishermen Cooperative Association;

(n) one tourism representative with primary tourism business located at Turneffe;

(o) one resident representing the private landowners of Turneffe; and

(p) any other person appointed by the Fisheries Administrator.

PART III
CONTROL OF THE ZONES

Prohibitions within the reserve.

5. (1) No person shall –

(a) use long lines, seine nets or gill nets in the reserve unless that person is authorized only for scientific research purpose by the Fisheries Administrator;

(b) engage in commercial fishing, sport fishing or recreational fishing within the reserve without a valid licence issued in accordance with these Regulations;

(c) cast or drag an anchor in any manner which may damage coral or any other sensitive habitat;

(d) engage in water-skiing or jet-skiing, except in areas that may be designated by the Fisheries Administrator.

(2) The Fisheries Administrator may authorize the use of beach traps or fish traps in the General Use Zone only.

(3) No person shall engage in any activity which may cause negative environmental impacts on species, habitats or ecosystems without written approval from the Fisheries Administrator.

Extractive fishing prohibited in the conservation zones.

6. No person shall engage in extractive fishing within the Conservation Zones.

Extractive fishing for conch prohibited in Zone II B.

7. No person shall engage in extractive fishing for conch in the Zone II B: Cockroach – Grassy Caye Special Management Area.

Extractive fishing in Zone III.

8. (1) Only tradition users shall engage in extractive fishing in Zone III: Vincent's Lagoon Special Management Area.

(2) For the purpose of sub-regulation (1), the Fisheries Administrator shall determine who the traditional users are.

Spear fishing prohibited.

9. No person shall engage in spear fishing within the conservation zones, the special zones nor the preservation zone.

Prohibitions in the preservation zone.

10. (1) No person shall engage in extractive fishing, sport fishing, snorkeling, diving or any other water activity in the preservation zone.

(2) No person shall use motorized boats within the preservation zone except in cases of emergency or on prior written permission from the Fisheries Administrator.

Rules for users.

11. (1) Dive Boat Operators shall fly the "divers down flag" when they have divers in the water.

(2) Only certified scuba divers or divers undergoing a training course conducted by an instructor recognized by the Fisheries Administrator shall use scuba equipment in the reserve.

(3) Dive guides or tour guides are required to explain the rules of the reserve to all divers, snorkelers or other visitors.

(4) All operators of motor boats are to observe the low wake boat way when approaching snorkelers or divers.

(5) For the purpose of sub-regulation (1), "divers down flag**" means a flag with a white diagonal stripe upon a red background.**

Report of accidents.

12. Any accident involving personal injury or damage to property shall be reported to the Reserve Manager or his designee, as soon as possible, but neither the Fisheries Administrator nor the Government of Belize shall be liable for such injury or damage.

PART IV
LICENCES

Visitors and boat operators' obligations.

13. (1) Before operating in the reserve, all visitors shall first obtain a ticket or required licences on payment of the appropriate fee specified in regulation 23(1), either from the Reserve headquarters or in a designated location determined by the Fisheries Administrator.

(2) Before operating in the reserve, all boat operators shall obtain required licences or permits for all activities that require such licence or permit in accordance with these regulations.

Commercial fishing licence.

First Schedule.

14. (1) Any person who is desirous of engaging in commercial fishing shall apply for a commercial fishing licence in the form set out as Form I of the *First Schedule* **to the Fisheries Administrator.**

First Schedule.

(2) Within fourteen days of the receipt of an application,the Fisheries Administrator may grant a commercial fishing licence in the form set out as Form II of the *First Schedule***.**

(3) Upon the expiry of a fishing licence granted under these Regulations, the holder of that fishing licence may apply to the Fisheries Administrator for a renewal pursuant to this regulation.

(4) A fee of $25.00 shall be payable upon the receipt of a commercial fishing licence or for the renewal of the same.

Application for scientific research licence.

First Schedule.

15. (1) Where a person desires to conduct scientific research within the reserve shall apply to the Fisheries Administrator in the form set out as Form III of the *First Schedule***.**

(2) A fee of $500.00 shall be payable upon the receipt of a scientific research licence or for the renewal of the same.

Grant etc. of licence for scientific research.

16. (1) Subject to regulation 15, the Fisheries Administrator may, within fourteen days of the date of application, grant or refuse to grant a scientific research licence to an applicant.

(2) A licence granted under sub-regulation (1) shall be subject to such terms and conditions established by the Fisheries Administrator.

(3) The Fisheries Administrator may in his/her discretion, waive or vary the fee payable for a research licence.

Sport fishing licence.

First Schedule.

17. (1) Any person who is desirous of conducting sport fishing within the Reserve shall acquire a sport fishing licence in the prescribed form set out as Form IV of the *First Schedule* **upon payment of the prescribed fee stipulated in regulation 23 (1).**

Recreational fishing licence.

First Schedule.

18. (1) Any person who is desirous of engaging in recreational fishing within the Reserve shall acquire a recreational fishing licence in the form set out as Form V of the *First Schedule* **upon payment of the prescribed fee stipulated in regulation 23 (1).**

Turneffe atoll boat operation licence.

First Schedule.

19. (1) A boat operator who is desirous of engaging in boat operation services shall apply to the Fisheries Administrator for a Turneffe Atoll boat operation licence in the form set out as Form VI of the *First Schedule***.**

First Schedule.

(2) Within fourteen days of the receipt of an application, the Fisheries Administrator may grant a Turneffe Atoll Boat Operation Licence in the form set out as Form VII of the *First Schedule***.**

(3) Upon the issuance of a Boat Operation licence under sub-regulation (2), the applicant shall pay a fee of $100.00.

(4) A person operating a boat for recreational fishing or commercial fishing is exempt from the requirement of this provision.

PART V
GENERAL

Non-transferability, validity, etc. of licences.

20. (1) A licence issued under these regulations, unless specified –

(a) shall not be transferable;

(b) is valid for a period not exceeding one year but shall expire on the 31st December in each year and shall be subject to renewal.

(2) The Fisheries Administrator may set special conditions to any licence granted under these Regulations having due regard to the nature of the licence and the need to protect the environment and natural resources.

Cancellation of licences.

CAP.210.

21. The Fisheries Administrator may cancel any licence granted under these regulations if the license holder breaches any conditions of the licence or contravenes any provision of these regulations or any other Regulations made under the *Fisheries Act.*

Duty to report accidents.

22. Any person involved an accident relating to personal injury, damage to property or damage to the environment shall report such accident to the Fisheries Administrator, the Reserve Manager or his designeeas soon as possible or not later than twelve hours after the occurrence of the accident.

Admission fees.

23. (1) The following fees shall apply on admission to the reserve –

Activity	**Per person/period**	**Rate**
Snorkelling	**Non-Belizean** **Tourist**	**$20.00**

	Per day	**$50.00**
	Per week	**$100.00**
	Per year	
Diving:	**Non-Belizean Tourist**	
	Per day	**$20.00**
	Per week	**$50.00**
	Per year	**$100.00**
Snorkelling	**Belizean Tourist**	
	Per day	**$10.00**
	Per week	**$20.00**
	Per year	**$50.00**
Diving:	**Belizean Tourist**	
	Per day	**$10.00**
	Per week	**$20.00**
	Per year	**$50.00**
Recreational fishing	**Non-Belizean Tourist**	
	Per day	**$30.00**
		$70.00

	Per week	**$150.00**
	Per year	
Recreational fishing	**Belizean Tourist**	
	Per day	**$5.00**
	Per week	**$10.00**
	Per year	**$25.00**
Sport fishing	**Per day**	**$20.00**
	Per week	**$50.00**
	Per year	**$100.00**

(2) For the purpose of sub-regulation (1) –

(a) Belizean tourist shall include CARICOM national and national under Central American integration;

(b) No fee shall be charged to a child under the age of twelve;

(c) No fee shall be charged to a Belizean who enters the reserve either on a Sunday or on a public and bank holiday.

Flora and fauna.

24. (1) No person shall –

(a) remove from its place or disturb any species of flora or fauna, including rocks, dead corals, shells or sand unless authorized to do so in accordance with the Reserve regulations;

(b) have in his possession any flora or fauna, unless authorized to do so in accordance with the Reserve regulations;

(c) discharge or deposit any toxic material, garbage or litter in the reserve;

(d) mark or tamper with any sign, buoy or notice which is installed in the Reserve.

Duty to report the fish caught.

25. A person who engaged in extractive fishing, sport fishing or other recreational fishing activity shall render the catch data or any other information of fish caught within the Reserve to an officer of the Reserve upon request.

General penalty.

26. Any person who contravenes any of the Regulations commits an offence and is liable on summary conviction to the penalty specified in section 15 of the Act.

FIRST SCHEDULE

FORM I

[Regulation 14 (1)]

APPLICATION FOR A COMMERCIAL FISHERMAN'S LICENCE OR RENEWAL THEREOF

Part A to be completed in full and accompanied with the relevant documentation as required under Statutory Instrument No. 1 of 2010.

To: The Fisheries Administrator
Date of application ……

(dd/mm/yy)

PART A

I hereby apply for a first issue/renewal of a Commercial Fisherman's Licence.

Name ..... Age ..... years

Fishing Experience .....years (Full time ..... years; Part time ..... years.)

Home Address:
……
……
……
……....

I am a boat owner ..... (yes/no)
Boat operator ..... (yes/no)
Crewman .....(yes/no)

I am a member of a Fishermen's Co-operative Society.....(yes/no)

Name of Co-operative if a member .....

Membership No. ...…… Previous Fisherman's licence No. …….
Date Issued.....
(dd/mm/yy)

PART B

To be completed in full for the first issue and on renewal only if change in the details given in the first issue application have taken place.

Please specify type of fishing in which engaged and methods and number of units used:

Species harvested: …….

Fishing gears used: ……

Number of fishing gears used: ……..

Other methods (specify) .....

Approximate value of gear .....

Place of normal landing of catch .....

Signature of applicant .....

THIS PART FOR OFFICE USE ONLY:

List of documents received:

Passport No. ….....
Birth Certificate No. ……..
Residence Card No. …….....
Utility Bill type and No. ……..……..
Date application received ……..

Signature of Licensing Officer .....

FORM II
[Regulation 14(2)]

FORM OF COMMERCIAL FISHERMAN'S LICENCE

Licence No .....

Date issued .....
(dd/mm/yy)

This licence is issued to .....
(full name)
of ..... under the provisions of the
(address)

Fisheries Act and Regulations made thereunder. This licence is not transferable and takes effect from the date of issue and remains in force (unless cancelled) until …….....

Photograph of the Licensee

Fees Paid .....

Receipt No . .....

_____
(Licensing Officer's signature and Office Stamp)

This licence must be produced on demand to any Police officer, Customs officer or Fisheries officer and should be carried at all times.

FORM III
[Regulation 15(1)]

APPLICATION FOR A LICENCE TO CONDUCT RESEARCH OR SCIENTIFIC INVESTIGATION WITHIN THE TURNEFFE ATOLL MARINE RESERVE

TO: Fisheries Administrator

Date of application .....
(dd/mm/yy)

Name of Applicant including title or designation.....

Address:

Home Country.....

Whilst in Belize…….....……..

Telephone .....

Name of person who is responsible for ensuring compliance with the conditions attached to the licence:
.....
.....

Institution with whom connection or on whose behalf the work is to be carried out:
.....

Period during which work is to be carried out ……..……

The following documents are to be attached to this application:

1. A list of the names and titles of persons who will be accompanyingthe licensee during the course of the work for whom thelicensee shall be responsible.
2. A list of equipment, in triplicate, which the licensee wishes to bring into the country for scientific purposes and for which atemporary import permit is requested.
3. A detailed programme, in duplicate, of the purpose of the workor expedition including area of work.

I wish to conduct research/an investigation in Belize on my own behalf / as leader of a group of ( ) students / on the behalf of the institution named above for the following purposes:
……
……

……
……

details of which are contained in the attached pages. I will wish to collect specimens for study in Belize and will/will not wish to export these specimens for further study at the end of my stay. I will want to collect specimen of ( ) species for study/and export.

Date: ..... Signature of applicant: .....
(dd/mm/yy)

FORM IV
[Regulation 17(1)]

FORM OF SPORT FISHING LICENCE

Belizean and Non-Belizean Tourist

Licence No: .....

Date issued: ……..
(dd/mm/yy)

This licence is issued to .....……...
(full name)
of…….……...
(address)

This licence is not transferable and is valid for a period of:

One Day	[]	Fees paid:	[$20.00]
One Week	[]		[$50.00]
One Year	[]		[$100.00]

From…….. until …….

Place issued ……

Signature of issuing Officer ……

This licence is subject to the following conditions:-

1. The holder of this licence shall comply with the Fisheries Act and all Regulations made thereunder.

2. The licensee shall not maim or kill any fish caught under this licence and all sport fishing activity shall only be carried out on a catch and release basis.

3. This licence may at any time be cancelled if the licensee is in breach of any of the conditions stipulated above.

N.B. This is an official document of the Government of Belize and must be produced on demand to any Police officer, Customs officer, or Fisheries officer. It should be carried at all times by the licensee during sport fishing activities.

FORM V
[Regulation 18(1)]

FORM OF RECREATIONAL FISHING LICENCE

Licence No: .....

Date issued: ……..
(dd/mm/yy)

This licence is issued to .....……...
(full name)

of…….……...
(address)

This licence is not transferable. The following fees apply:

Belizeans:

One Day	[]	Fees paid:	[$5.00]
One Week	[]		[$10.00]
One Year	[]		[$25.00]

Non-Belizeans:

One Day	[]	Fees paid:	[$30.00]
One Week	[]		[$70.00]
One Year	[]		[$150.00]

From…….. until …….

Place issued ……

Signature of issuing Officer ……

N.B. The holder of this licence is entitled to a daily bag limit determined by the Fisheries Administrator.

N.B.This is an official document of the Government of Belize and must be produced on demand to any Police officer, Customs officer, or Fisheries officer. It should be carried at all times by the licensee during recreational fishing activity.

FORM VI
[Regulation 19(1)]

APPLICATION FOR TURNEFFE ATOLL BOAT OPERATION LICENCE

(1) Name of boat owner .....

(2) Name of boat .....

(3) Belize Port Authority Number .....

(4) Length of boat .....

(5) Width of boat .....

(6) Engine type and H.P .....

(7) Passenger capacity .....

(8) Type of activity (Tick for activity included)

(a) Snorkelling	( )
(b) SCUBA Diving	( )
(c) Glass-bottom viewing	( )
(d) Sport fishing	( )
(e) Other activity	( ) Specify……..….

Date: ……..... (dd/mm/yy) Signature of applicant: ..……

FORM VII
[Regulation 19(2)]

FORM OF TURNEFFE ATOLL BOAT OPERATION LICENCE

Name of boat owner .....

Name of captain .....

Name of boat .....

This boat is registered to carry up to .....passengers and to conduct the following activities in the Turneffe Atoll Marine Reserve:

Type of activity (Tick for activity included)

(a) Snorkelling	( )
(b) SCUBA Diving	( )
(c) Glass-bottom viewing	( )
(d) Sport fishing	( )
(e) Other activity	( ) Specify……..….

Conditions of Licence:

If carrying passengers to dive in Reserve, the captain/guide is responsible for the following:

(a) To acquaint passengers with the rules ofthe Reserve.
(b) To moor at the buoys provided when inthe Conservation and General Use Zones.
(c) To fly the "divers down" flag during alldives.
(d) Only certified SCUBA divers or those undergoing an approved training course will be allowed to use scuba tanks.

If carrying passengers to carry out sport fishing, the captain/guide is responsible for the following:

(a) To submit details to the Reserve Managerwhen requested, of catch and the areawhere fishing took place.
(b) To release fish on a catch and release basis.

To apply the mark/sticker provided in a prominent position on the registered boat.

This licence is not transferable and takes effect from the date of issue and remains in force (unless cancelled) until …….....

Fees Paid .....

Receipt No. .....

_____
(Licensing Officer's signature and Office Stamp)

This licence must be produced on demand to any Police officer, Customs officer or Fisheries officer and should be carried at all times.

Date issued .....
(dd/mm/yy)

MADE **this _____ day of_____, 2012.**

_____

(LISEL ALLAMILLA)

Minister Responsible for Fisheries

Fisheries

B E L I Z E:

STATUTORY INSTRUMENT

No. _____ of 2012

ORDER **made by the Minister responsible for Fisheries in exercise of the powers conferred upon him by section 14(1) of the Fisheries Act, Chapter 210 of the Substantive Laws of Belize, Revised Edition, 2000 – 2003; and all other powers thereunto him enabling.**

(*Gazetted* ……, 2012.)

Citation.

1. This Order may be cited as the

FISHERIES (TURNEFFE ATOLL MARINE RESERVE) ORDER, 2012.

Declaration of Marine Reserve. First Schedule.

2. The area specified in the *First Schedule* **to this Order and demarcated as zones is hereby declared to be a Marine Reserve.**

Map of Marine Reserve. Second Schedule.

3. A map of the Turneffe Atoll Marine Reserve is set out in the *Second Schedule* to this Order, and may be available at the Office of the Fisheries Administrator, Fisheries Department, Belize City for public examination.

FIRST SHEDULE (Paragraph 2)

TURNEFFE ATOLL MARINE RESERVE

ALL THAT PORTION of the Caribbean Sea which is comprised of nine zones described as follows –

Zone I: Maugre Caye Conservation Zone – Commencing at a Point 1, and having scaled UTM Coordinates 413 585 East 1 946 388 North; thence proceeding 5.55 km north to a Point 2, having scaled UTM coordinates 413 585 East 1 951 938 North; thence proceeding 8.8 km east to a Point 3, having scaled UTM coordinates 422 385 East 1 951 938 North; thence proceeding 3.9 km south to a Point 4, having scaled UTM coordinates 422 385 East 1 948 038 North; thence proceeding 3 km west to a Point 5, having scaled UTM coordinates 419 385 East 1 948 038 North; thence proceeding 1.65 km south to a Point 6, having scaled UTM coordinates 419 385 East 1 946 388 North; thence proceeding 5.8 km to the Point of origin, and encompassing 43.89 square kilometers.

Zone II A: Dog Flea Caye Conservation Zone – Commencing at a Point 1 on the coast of Three Corner Caye, and having scaled UTM Coordinates 419 267 East 1 939 277 North; thence proceeding 6.66 km east to a Point 2, having scaled UTM coordinates 425 927 East 1 939 277 North; thence proceeding 4.477 km south to a Point 3, having scaled UTM coordinates 425 927 East 1 934 800 North; thence proceeding 6.814 km west to a Point 4, having scaled UTM coordinates 419 113 East 1 934 800 North; thence proceeding 4.48 km north to the Point of origin, and encompassing 30.16 square kilometers.

Zone II B: Cockroach – Grassy Caye Special Management Area – Commencing at a Point 1, having scaled UTM Coordinates 419 113 East 1 934 800 North; thence proceeding south east at a constant 10m distance east of the reef crest to a Point 2, having scaled UTM coordinates 415 529 East 1 929 396 North; thence proceeding 1 km west to a Point 3, having scaled UTM coordinates 414 529 East 1 929 396 North; thence proceeding 1km north to a Point 4, at the south tip of Caye Bokel, having scaled UTM coordinates 414 529 East 1 933 602 North; thence proceeding north east, following the line of the western edge of the back reef flat to a Point 5, having scaled UTM coordinates 416 844 East 1 933 602 North; thence following the high water mark of the coastline northwards to Point 6, having

scaled UTM coordinates 419 147 East 1 935 799 North; thence proceeding 1km south to the Point of origin, and encompassing 8.88 square kilometers.

Zone III: Vincent's Lagoon Special Management Area – Commencing at a Point 1, having scaled UTM Coordinates 414 431 East 1 937 786North; thence proceeding along the entire perimeter of the lagoon, until the Point of origin.

Zone IV: Blackbird Caye Conservation Zone – Commencing at a Point 1 on the east coast of Blackbird Caye, and having scaled UTM Coordinates 415 154 East 1 917 840 North; thence proceeding 6 km east to a Point 2, having scaled UTM coordinates 421 154 East 1 917 840 North; thence proceeding 3.24 km south to a Point 3, having scaled UTM coordinates 420 276 East 1 914 723 North; thence proceeding 4.77 km west to a Point 4, having scaled UTM coordinates 415 505 East 1 914 723 North; thence proceeding north, following the coast at the high water mark to the Point of origin, and encompassing 16.2 square kilometers.

Zone V: Long Bogue Conservation Zone – Commencing at a Point 1, and having scaled UTM Coordinates 411 784 East 1 913 019 North; thence proceeding westwards to a Point 2, having scaled UTM coordinates 411 244 East 1 913 167 North; thence proceeding south-west, to a Point 3, having scaled UTM coordinates 409 683 East 1 912 826 North; thence proceeding south-east to a Point 4, having scaled UTM coordinates 409 190 East 1 911 630 North; thence proceeding west-south-west to a Point 5, having scaled UTM coordinates 408 489 East 1 911 393 North; thence proceeding south to a Point 6, having scaled UTM coordinates 408 489 East 1 909 393 North; thence proceeding to the Point of origin, and encompassing 8.59 square kilometres.

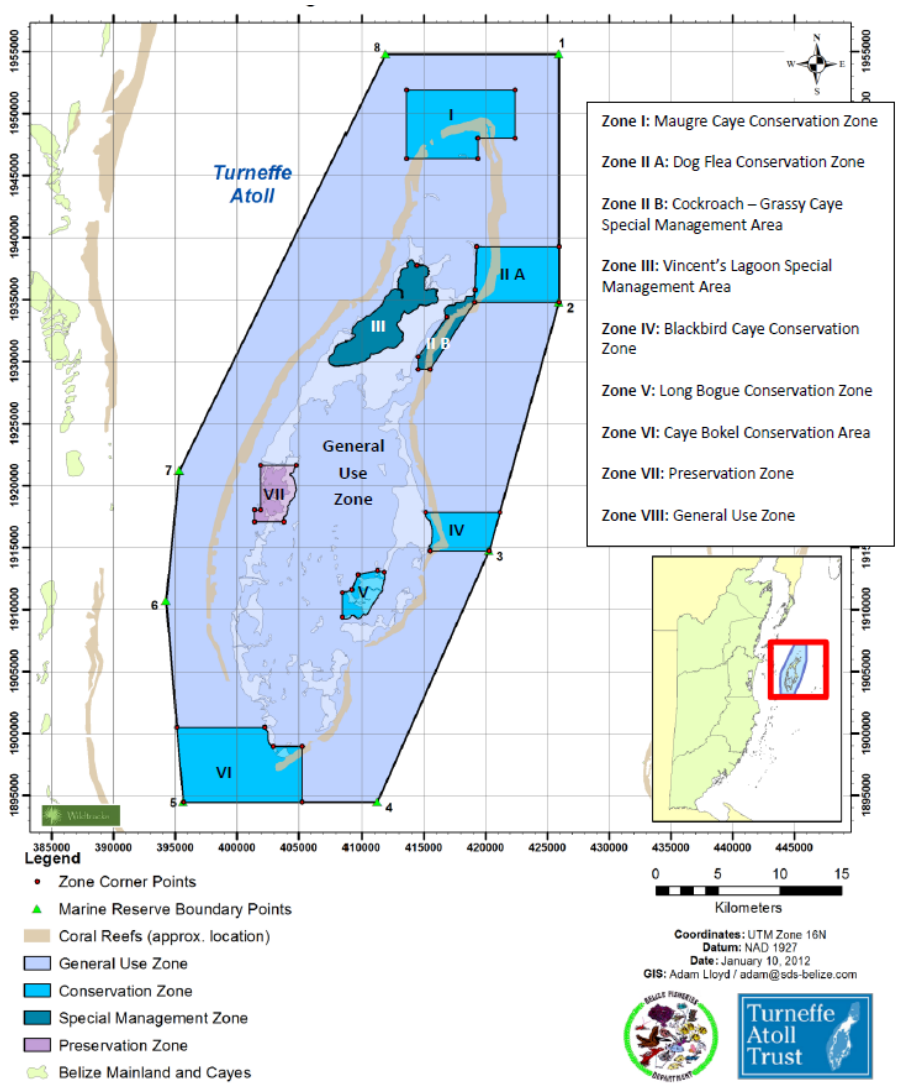
Zone VI: Caye Bokel Conservation Zone – Commencing at a Point 1, and having scaled UTM Coordinates 395 135 East 1 900 527 North; thence proceeding 7.1 km east to a Point 2, having scaled UTM coordinates 402 235 East 1 900 527 North; thence proceeding south-east, following the high water mark of the west coastline to a Point 3, having scaled UTM coordinates 402 914 East 1 898 974 North; thence proceeding 2.35 km east to a Point 4, having scaled UTM coordinates 405 264 East 1 898 974 North; thence proceeding 4.5 km south to a Point 5, having scaled UTM coordinates 405 264 East 1 894 474 North; thence proceeding 9.6 km west to a Point 6, having scaled UTM coordinates 395 664 East 1 894 474 North; thence proceeding 6.07 km to the Point of origin, and encompassing 55.4 square kilometers.

Zone VII: Preservation Zone – Commencing at a Point 1 on the mangrove coastline of the Central Lagoon, and having scaled UTM Coordinates 404 786 East 1 921 646 North; thence following the mangrove coastline south to a Point 2, having scaled UTM coordinates 403 776 East 1 917 086 North; thence proceeding 2.37 km west to a Point 3, having scaled UTM coordinates 401 406 East 1 917 086 North; thence proceeding 0.96 km north to a Point 4, having scaled UTM coordinates 401 406 East 1 918 046 North; thence proceeding 0.48 km east to a Point 5, having scaled UTM coordinates 401 886 East 1 918 046 North; thence proceeding 3.6 km north to a Point 6, having scaled UTM coordinates 401 886 East 1 921 646 North; thence proceeding 2.9 km east to the Point of origin, and encompassing 11.89 square kilometers.

Zone VIII: General Use Zone – Commencing at a Point 1, having scaled UTM Coordinates 411 927 East 1 954 800 North; thence proceeding 20 km in a southerly direction to a Point 2, having scaled UTM coordinates 425 927 East 1 954 800 North; thence proceeding 20.86 km to a Point 3, having scaled UTM coordinates 425 927 East 1 934 800 North; thence proceeding 22.16 km to a Point 4, having scaled UTM coordinates 420 276 East 1 914 723 North; thence proceeding 15.6km west to a Point 5, having scaled UTM coordinates 411 264 East 1 894 474 North; thence proceeding 16.3 km in a northerly direction to a Point 6, having scaled UTM coordinates 395 664 East 1 894 474 North; thence proceeding 10.56 km to a Point 7, having scaled UTM coordinates 394 245.07 East 1 910 709.55 North; thence proceeding 37.47 km to a Point 8, having scaled UTM coordinates 395 312 East 1 921 215 North; to the Point of origin, and encompassing 1,115.77 square kilometers, excluding Zones I to VII.

SECOND SHEDULE (Paragraph 3)

TURNEFFE ATOLL MARINE RESERVE
TURNEFFE ATOLL MARINE RESERVE – ZONING MAP



MADE **this _____ day of_____, 2012.**

_____

(LISEL ALLAMILLA)

Minister responsible for Fisheries

Annex Two

BELIZE:

FISHERIES (SPAWNING AGGREGATION SITE RESERVES) ORDER, 2003

ARRANGEMENT OF PARAGRAPHS

_____
SCHEDULE 1

_____
SCHEDULE 2

BELIZE:

STATUTORY INSTRUMENT

No. 161 of 2003

ORDER made by the Minister of Agriculture and Fisheries in exercise of the powers conferred upon him by section 14 (1) of the Fisheries Act, Chapter 210 of the Substantive Laws of Belize, Revised Edition 2000, and all other powers thereunto him enabling.

(Gazetted 1st November, 2003)

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1. This Order may be cited as the

FISHERIES (SPAWNING AGGREGATION SITE RESERVES) ORDER, 2002

2. The areas specified below, and fully described in Schedule 1 to this Order are hereby declared to be Marine Reserves for the purposes of the Fisheries Act-

Rocky Point, Ambergris Caye
Dog Flea Caye, Turneffe Islands Atoll
Caye Bokel, Turneffe Islands Atoll
Sandbore, Lighthouse Reef Atoll
South Point, Lighthouse Reef Atoll
Emily or Caye Glory
Northern Glover's, Glover's Reef Atoll
Gladden Spit
Rise and Fall Bank, Sapodilla Cayes
Nicholas Caye, Sapodilla Cayes
Seal Caye, Sapodilla Cayes

3. Maps of the Reserves listed in Paragraph 2 above, are set out in Schedule 2 to this Order, and may be seen at the Office of the Fisheries Administrator, Fisheries Department, Belize City.

4. (1) The relevant areas referred to in paragraph 2 shall be closed to all fishing year round in order to protect important fish spawning grounds.

(2) The areas referred to in paragraph (1) shall be zoned as Conservation 1 (No Extraction) Zones. Areas listed above in paragraph (2) that are wholly or partially in marine reserves, but not included within any seasonal closure or conservation zone, may be used for limited fishing by traditional users who are designated by, and to the extent recommended by, the co-managers of the respective marine reserve. Fishermen and the type and quantity of fishing so designated shall be approved by the Fisheries Administrator, who shall grant Special Licenses accordingly.

(3) Details of the catches made in these areas shall be submitted to the Fisheries Administrator as prescribed by the terms of the license issued.

(4) Licenses will be reviewed on an annual basis, and shall be cancelled for non–compliance or if monitoring results determine that no fishing should be allowed.

5. This Order shall come into force on the 21st day of October, 2003.

MADE by the Minister of Agriculture, Fisheries and Cooperatives this 21 day of October , 2002.

(SERVULO BAEZA)
Minister of Agriculture,
and Fisheries

SCHEDULE 1

SPAWNING AGGREGATION SITE RESERVES

ALL THAT PORTION of the Caribbean Sea, reefs and cayes zoned as Conservation Zone 1 and more fully described (using WGS 84 datum) for each site as follows:

Rocky Point – Commencing at a point 1 on the barrier reef with scaled UTM coordinates 413 280 East 2 004 933 North; thence proceeding 0.75 miles east to a point 2, having scaled UTM coordinates 414 484 East 2 004 941 North; thence proceeding 1.69 miles south to a point 3, having scaled UTM coordinates 414 492 East 2 002 244 North; thence proceeding 1.67 miles west to a point 4, having scaled UTM coordinates 411 819 East 2 002 244 North; thence proceeding north 0.75 miles to a point 5, on the barrier reef, having scaled UTM coordinates 411 819 East 2 003 440 North; thence proceeding 0.66 miles in a northeasterly direction on a bearing of 650 (true bearing) to a point 6, on the barrier reef, having scaled UTM coordinates 412 774 East 2 003 882 North; thence proceeding 0.73 miles on a bearing of 260 (true bearing) to the point of origin, and encompassing 2.195 square miles.

Dog Flea Caye, Turneffe Atoll - Commencing on the fore reef at a point 1, and having scaled UTM Coordinates 420 656 East 1 937 720 North; thence proceeding 1.02 miles on a bearing of 900 (true bearing) to a point 2, having scaled UTM coordinates 422 281 East 1 937 717 North; thence proceeding 1.72 miles south to a point 3, having scaled UTM coordinates 422 277 East 1 934 965 North; thence proceeding 1.67 miles west to a point 4, having scaled UTM coordinates 419 605 East 1 934 958 North; thence proceeding 0.29 miles north to a point 5, on the fore reef, having scaled UTM coordinates 419 597 East 1 935 420 North; thence proceeding 0.82 miles on a bearing 390 (true bearing) to a point 6, on the fore reef, having scaled UTM coordinates 420 427 East 1 936 444 North; thence proceeding 0.81 miles on a bearing of 100 (true bearing) to the point of origin, and encompassing 2.20 square miles.

Caye Bokel, Turneffe Atoll: Commencing at point 1, at the steep reef drop-off in southwestern Turneffe Atoll, having scaled UTM coordinates 401 894 East 1 897 817 North; thence proceeding 0.84 miles southeasterly on a bearing of 1200 (true bearing) to a point 2, having scaled UTM coordinates 403 049 East 1 897 140; thence proceeding northeasterly 1.00 mile on a bearing of 620 (true bearing) to a point 3, having scaled UTM coordinates 404 458 East 1 897 890 North; thence proceeding south 1.60 miles to a point 4, having scaled UTM coordinates 404 461 East 1 895 326 North; thence proceeding west 1.60 miles to a point 5, having scaled UTM coordinates 401 894 East 1 895 322 North; thence proceeding north 1.56 miles to the point of origin, and encompassing 2.15 square miles.

Sandbore, Lighthouse Reef – Commencing at a point, 1, on the fore reef in northern Lighthouse Reef Atoll, and having scaled UTM coordinates 451 192 East 1 930 118 North; thence proceeding east for 1.40 miles to a point 2, having scaled UTM coordinates 453 438 East 1 930 118 North; thence proceeding south for 1.90 miles to a point 3, having scaled UTM coordinates 453 438 East 1 927 071 North; thence proceeding west for 1.01 miles to a point 4, on the fore reef, and having scaled UTM coordinates 451 817 East 1 928 071 North; thence proceeding on a bearing of 50 (true bearing), along the reef, for 0.94 miles along the reef to a point 5, having scaled UTM coordinates 451 954 East 1 928 572 North; thence proceeding on a bearing of 3340 (true bearing) for a distance of 1.08 miles along the reef to the point of origin, and encompassing 2.00 square miles.

South Point, Lighthouse Reef Atoll – Commencing at a point 1, on the steep reef drop-off near southern Lighthouse Reef Atoll, having scaled UTM coordinates 433 229 East 1 894 507 North; thence proceeding

0.82 miles on a bearing of 1140 (true bearing) to a point 2, having scaled UTM coordinates 434 429 East 1 893 978 North; thence proceeding 1.68 miles on a bearing of 780 (true bearing) to a point 3, having scaled UTM coordinates 437 055 East 1 894 545 North; thence proceeding 1.05 miles south to a point 4, having scaled UTM coordinates 437 055 East 1 892 863 North; thence proceeding 2.39 miles west to a point 5, having scaled UTM coordinates 433 229 East 1 892 863 North; and thence proceeding 1.03 miles north to the point of origin, and encompassing 2.10 square miles.

Emily or Caye Glory - Commencing at a point 1, having scaled UTM coordinates 393 586 East 1 890 786 North; thence proceeding 1.52 miles east to a point 2, having scaled UTM coordinates 396 010 East 1 890 782 North; thence proceeding 1.84 miles south to a point 3, having scaled UTM coordinates 396 010 East 1 887 845 North; thence proceeding 0.95 miles west to a point 4, on the barrier reef, having scaled UTM coordinates 394 486 East 1 887 837 North; thence proceeding 0.82 miles on a bearing of 50 (true bearing) to a point 5, on the barrier reef, having UTM scaled coordinates 394 602 East 1 889 141 North; thence proceeding 0.82 miles on a bearing of 3090 (true bearing) to a point 6, on the barrier reef, having scaled UTM coordinates 393 586 East 1 889 970 North; thence proceeding 0.51 miles north to the point of origin, and encompassing 2.10 square miles.

Northern Glover's, Glover's Reef Atoll - Commencing at a point 1, having scaled UTM coordinates 426 566 East 1 868 812 North; thence proceeding east for 1.21 miles to a point 2, having scaled UTM coordinates 428 494 East 1 868 816 North; thence proceeding south for 1.58 miles to a point 3, having scaled UTM coordinates 428 494 East 1 866 294 North; thence proceeding 1.75 miles west to a point 4, having scaled UTM coordinates 425 687 East 1 866 290 North; thence proceeding north for a distance of 0.79 miles to a point 5, having scaled UTM coordinates 425 687 East 1 867 557 North; thence proceeding on a bearing of 620 (true bearing) for a distance of 0.56 miles, to a point 6, having scaled UTM coordinates 426 472 East 1 867 974 North; thence proceeding on a bearing of 60 (true bearing) for 0.53 miles to the point of origin, and encompassing 2.78 square miles.

Gladden Spit – Commencing at a point 1, within the Gladden Spit Marine Reserve, having scaled UTM coordinates 396 150 East 1 826 714 North; thence proceeding east for 1.28 miles to a point 2, having scaled UTM coordinates 398 197 East 1 826 714 North; thence proceeding south for a distance of 1.62 miles to a point 3, having scaled UTM coordinates 398 167 East 1 824 130 North; thence proceeding west 1.28 miles to a point 4; having scaled UTM coordinates 396 150 East 1 824 130 North; thence proceeding north for a distance of 1.62 miles to the point of origin and encompassing 2.00 square miles.

Rise and Fall Bank, Sapodilla Cayes – Commencing at a point 1, having scaled UTM coordinates 358 517 East 1 778 594 North; thence proceeding east for a distance of 2.75 miles to a point 2, having scaled UTM coordinates 362 914 East 1 778 600 North; thence proceeding south for a distance of 2.45 miles to a point 3, having scaled UTM coordinates 362 920 East 1 774 686 North; thence proceeding west for 2.75 miles to a point 4, having scaled UTM coordinates 358 517 East 1 774 686 North; thence proceeding north for 2.44 miles to the point of origin, and encompassing 6.64 square miles.

Nicholas Caye, Sapodilla Cayes – Commencing at a point 1, on the fore reef, and having scaled UTM coordinates 365 615 East 1 783 053 North; thence proceeding east for a distance of 1.13 miles to a point 2, having scaled UTM coordinates 367 425 East 1 783 038 North; thence proceeding south for a distance of 1.75 miles to a point 3, having scaled UTM coordinates 367 430 East 1 780 245 North; thence proceeding on a bearing of 2710 (true bearing) for a distance of 2.15 miles to a point 4, on the east side of Lime Caye, having scaled UTM coordinates 363 984 East 1 780 313 North; thence proceeding on a bearing of 420 (true bearing) for a distance of 1.18 miles to a point 5, having scaled UTM coordinates 365 245 East 1 781 729 North; thence proceeding on a bearing of 160 (true bearing) for a distance of 0.86 miles to the point of origin, and encompassing 2.60 square miles.

Seal Caye, Sapodilla Cayes – Commencing at a point 355 111 East 1 789 940 North; thence proceeding 1.24 miles east to a point 2, having scaled UTM coordinates 357 100 East 1 789 940 North; thence proceeding south for a distance of 2.04 miles to a point 3, having scaled UTM coordinates 357 100 East 1 786 683 North; thence proceeding west for a distance of 1.24 miles to a point 4, having scaled UTM coordinates 355 111 East 1 786 683 North; thence proceeding north for 2.04 miles to the point of origin, and encompassing 2.50 square miles.

BELIZE:

STATUTORY INSTRUMENT

No. 49 of 2009

REGULATIONS made by the Minister responsible for Fisheries in exercise of the powers conferred upon him by section 13(1) of the Fisheries Act, Chapter 210 of the Substantive Laws of Belize, Revised Edition 2000-2003, and all other powers thereunto him enabling.

(Gazetted 11th April, 2009.)

1. These Regulations may be cited as the **FISHERIES (NASSAU GROUPER & SPECIES PROTECTION) REGULATIONS, 2009.** — Short title.

2. In these regulations, unless the context otherwise requires — Interpretation

'nassau grouper' means the fish commonly known in Belize as grouper, the scientific name of which is Epinephelus striatus;

'grazers' means any fish of the scaridae family, including the genus scarus and spariisoma; any fish of the acanthuridae family

'total length' means the measurement of a fish from the most forward point of the head, with the mouth closed, to the farthest tip of the tail with the tail compressed or squeezed, while the fish is lying on its side;"

'whole fish' means any fish with the viscera completely removed.

Restriction

3. (1) No person shall take in the waters of Belize, or buy, sell or have in his possession, any nassau grouper between the 1st December and the 31st March inclusive in any year, except for the nassau grouper taken from the sites of Maugre Caye at Turneffe Islands and Northern Two Caye at Lighthouse Reef, descriptions of which are provided in Schedule 1.

Schedule

(2) No person shall take in the waters of Belize, or buy, sell or have in his possession, any nassau grouper which is less than 20 inches in total length or greater than 30 inches in total length.

(3) Every nassau grouper caught in the waters of Belize shall be landed whole.

Traditional fishing during closed season

4. (1) A person desirous of engaging in traditional fishing at Maugre Caye at Turneffe Islands or at Northern Two Caye at Lighthouse Reef, during the closed season shall apply to the Fisheries Administrator for a special licence to fish.

(2) A licence issue pursuant to subregulation (1) shall be issued subject to catch data required to be sent to the Fisheries Administrator as stipulated on such license.

Fish fillet to have skin patch

5. Every fish, other than the Nassau grouper and the grazers, caught in the waters of Belize landed as fillet fish shall have a skin patch of 2 inches by 1 inch.

Prohibition on parrot fish

6. No person shall take in the waters of Belize, or buy, sell or have in possession any grazers.

Offence and penalty

7. (1) A person who contravenes any of these Regulations is liable on summary conviction to a fine not exceeding five hundred dollars or to imprisonment for a period not exceeding six months, or to both fine and imprisonment.

(2) A person found guilty of taking or possessing any undersized fish during the closed season, or taking any prohibited fish, is liable, in addition to any other penalty that may be imposed, to a fine of thirty dollars in respect of each such fish.

8. The Fisheries (Nassau Grouper Protection) Regulations, 2003 (S.I. No. 162 of 2003) are repealed. Repeal of SL 162/2003.

9. These regulations shall come into force on the 1st day of April, 2009. Commencement

MADE by the Minister responsible for Fisheries this 1st day of April, 2009.

Minister of Agriculture and Fisheries

(Rene Montero)
Minister of Agriculture and Fisheries

SCHEDULE I

[Reg. 3]

ALL THAT PORTION of the Caribbean Sea, reefs and cayes and more fully described (using WGS 84 datum) for each site as follows:

Maugre Caye, Turneffe Atoll: Commencing at a point 1 with scaled UTM coordinates 418 701 East 1 950 997 North; thence proceeding east for a distance of 1.99 miles to a point 2, having scaled UTM coordinates 421 890 East 1 950 997 North; thence proceeding south for a distance of 1.82 miles to a point 3, having scaled UTM coordinates 421 885 East 1 948 085 North; thence proceeding west for a distance of 1.09 miles to a point 4, having scaled UTM coordinates 420 145 East 1 948 085 North, thence proceeding on a bearing of 350° for a distance of 0.66 miles to a point 5, having scaled UTM coordinates 419 957 East 1 949 124 North; thence proceeding on a bearing of 278° for a distance of 0.79 miles, to a point 6, having scaled UTM coordinates 418 705East 1 949 291 North; thence proceeding north for a distance of 1.07 miles to the point of origin.

No. 665

Ministry of Natural Resources,
Belmopan, 16th November, 2005.

DECLARATION OF A PUBLIC RESERVE COCKROACH BAY, TURNEFFE ISLAND, BELIZE DISTRICT

By the powers vested in me under Section 6 subsections (1) and (3) of the National Lands Act, Chapter 191 of the Laws of Belize, Revised Edition. 2000-2003, I JOHN BRICEÑO, Minister of Natural Resources, Local Government and the Environment, hereby declare all those pieces or parcels of land described in the Schedule hereto to be a public reserve, viz. Crocodile Reserve.

Date 8th November 2005.

(HON. JOHN BRICEÑO)
Minister of Natural Resources, Local Government and the Environment.

SCHEDULE

ALL THOSE PIECES or parcels of land situate in the Cockroach Bay, Turneffe Island, Belize District, comprising 19.988 acres of land and more particularly bounded and described as shown in Entry No. 8100, Register No. 20 lodged at the Office of the Commissioner of Lands and Surveys in Belmopan.