

Belize MMAS Synthesis Report  
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**MMAS Node Synthesis**

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## Introduction

One approach to the development of better coastal and marine policy and management is the concept of marine managed areas (MMAs). A MMA is an area of ocean, or a combination of land and ocean, where all human activities are managed toward common goals. MMAs are a form of ecosystem-based management, where all elements—biophysical, human, and institutional—of a particular system are considered together.

There are several overarching principles under which MMAs should be developed: All human uses and their subsequent impacts on the defined area should be considered and their management integrated.

Policy and management should be based on the best natural and social science available. All stakeholders in the defined area should be consulted and fully involved in the policy and management development and implementation processes concerning the MMA's conditions and uses.

When such principles are fully implemented, the uses of the resources and habitats and the resulting benefits both to the environment and to humans can be optimized.

The Marine Management Area Science (MMAS) program was established in 2005 with seed funding from the Gordon and Betty Moore Foundation to identify the best ways to use marine management areas to sustain ocean health. The mission of MMAS is to harness the power of science to provide conservation solutions. MMAS studies key aspects of the ocean ecosystem to reveal critical insights for conservation. The program has partnered with policy makers, resource managers, and other decision-makers at local to global levels to facilitate successful, science-based conservation.

As part of the MMAS program, work was conducted in four Focus Areas (also known as Node Areas): Belize, Brazil, Fiji and Panama. These locations represent a range of environmental, cultural, and socioeconomic conditions, and they offer significant conservation opportunities. MMAS-funded scientists conducted a coordinated program of natural and social science research and monitoring in each Focus Area. A MMAS Science to Action (S2A) Coordinator was based in each Focus Area. The S2A Coordinator fostered connections among scientists, managers, and other stakeholders to identify science needs and to provide scientific information for management. These local efforts were supported by a MMAS Science Advisory Committee and the MMAS headquarters staff in Alexandria, Virginia.

Surveys were conducted in each of the Node Areas to examine the human well-being effects of MMAs. Much of the research was conducted in the Focus Areas, but was informed by more than 50 studies and 100 scientists in 23 countries around the world since 2005.

In general, results indicate that community members whose livelihood is directly tied to the MMA have higher income, more diversified livelihoods and greater appreciation for

the biodiversity and socioeconomic benefits of the MMA. These findings represent a milestone for marine conservation efforts worldwide – further proof that sustainable ocean management is as crucial for human survival as it is for the thousands of other species reliant on the natural system covering 70 percent of our planet's surface.

Building on these results, the Science-to-Action researchers have proposed a series of recommendations for stakeholders, including expanding local community engagement, improving law enforcement and continued ecosystem monitoring. Ultimately, though, more research is needed to inform how we can best protect and manage our ocean and its many benefits for years to come.

## **The National Context**

Belize, like most other countries, realized the importance of managing its marine resources, even before becoming an independent country. Today the resources exploited in Belize might seem insignificant compared to the large scale fisheries industry from other developed and undeveloped countries, but the values of Belize's natural marine resources are invaluable to its people and the world.

The Belize Barrier Reef, the second longest in the world and the largest in the western world, form the largest portion of the Mesoamerican Barrier Reef System (MBRS), which is shared between Mexico, Belize, Guatemala and Honduras. The importance of this World Heritage site is not only to these countries, but in a much larger scale. Even though reefs throughout the world are on a decline, there are some areas of the MBRS that are doing average, considering their location and all the direct and indirect anthropogenic factors affecting them. Belize has several areas within its reef system that still attract large aggregation of fish and tourists, making it vulnerable if not properly managed.

But how much use is having marine managed areas (MMAs) and not knowing if these are serving the purpose they were created for? The MMAS was a unique research study because it tried to quantify the effects of marine protected areas (MPAs) by having different subprojects that complemented each other to better attain the goals of the study. Each node had specific areas that could be addressed, according to the biophysical characteristics of the node.

Belize had five major study areas, Ecological Monitoring, Cross-shelf Connectivity, Inter-Reefal Habitat Mapping, Socio-economic and Governance, and Economic Valuation. These subprojects were intended to complement each other and create a comprehensive project that looks at the MPA system and how it affects the biotic and abiotic components of the ecosystem. What makes the MMAS different from most studies is that it encompasses not only understanding how MPAs are connected to the larger reef system but also how it affects its different users and the country's economy.

**Seven marine managed areas** were included, to various extents, in the MMAS program in Belize. Each of these MPAs are briefly described below. More information is provided in

Sections – to – (Biophysical Setting, Socioeconomic and Cultural Setting, and Institutional/Governance Setting).

### ***Laughing Bird Caye National Park***

With 4,300 ha designated as national park and the entire park a strict no-take area, Laughing Bird Caye is well known for the lagoon faro that attracts many seagoing enthusiasts to explore this unique geological and coral formation. This MMA was part of the impetus for the creation of the local NGO, Friends of Nature (FON), which signed a Memorandum of Understanding with the Government of Belize to co-manage the reserve. FON also manages whale shark tourism at Gladden Spit. From its inception, FON's Board was established with active stakeholder representation from buffer communities and demonstrated a commitment to ensuring local participation in the management of the MMA. With a vision towards organizational efficiency, FON recently merged the Toledo Association for Sustainable Tourism and Empowerment (TASTE) to bring 3 MPAs under the management of a new NGO, the Southern Environmental Alliance (SEA). This institutional merger is expected to enhance management, optimize the use of resources and reduce operational costs overall.

### ***Lighthouse Reef Atoll***

The Lighthouse Reef atoll is one of three atolls found in Belize, the other two atolls being Glover's Reef and Turneffe Atoll. The two MMAs found on Lighthouse Reef atoll that are selected to be part of the MMAS program are: the Blue Hole Natural Monument and the Half Moon Caye Natural Monument.

World famous for the over 400 foot deep marine sink hole, **Blue Hole Natural Monument** remains one of the highly visited offshore geological features in Belize. Enclosing only 4100 acres in a strict no-take area, the Blue Hole is of tremendous value to the dive tourism industry in Belize. Established in 1996, species of sharks have been documented in the Blue Hole, including hammerhead shark, lemon sharks and black tips (PfB, 2001). Recently, illegal practice of chumming for sharks has increased the need for supervision of dive operators.

The **Half Moon Caye Natural**, which lies less than 7 miles south of the Blue Hole was established in 1982 due to the Red-footed Booby (*Sula sula*) that roost throughout the year with over 1,300 nests recorded during nesting season. The rich and endangered vegetation type, littoral forest, stands on a small 1.8 hectare caye. The MMA encloses 3,900 hectares of marine area including one caye and is also popular for wall and cavernous fringing reefs that offers a spectacular experience to the more than 8,000 annual visitors

Both Half Moon Caye and Blue Hole are managed as a cohort under the Belize Audubon Society through a co-management agreement with the Forest Department of the Government of Belize.

### ***Glover's Reef Marine Reserve***

Encompassing 30800 hectares, the Glover's Reef MMA is the largest MMA in Belize. It is also the only MMA that has a 20% of its total area as strict no-take and continues to be the model that most other MMAs strived to replicate. Similar to the other MMAs in this study, Glover's Reef also includes management zones that allow extractive and non-extractive uses in the General Use and Conservation Zones, respectively.

### ***South Water Caye Marine Reserve***

The South Water Caye Marine Reserve is the second largest MMA unit in Belize encompassing 47,703 hectares (117, 877 acres) with 22 named cayes within its perimeter. Teeming with marine animal diversity and vegetative habitat including a large number of mangrove caye and extensive seagrass beds, this MMA remains an unpolished gem with the suite of MMA of the Belize Barrier Reef System, World Heritage Site. Managed primarily by the Fisheries Department (FiD) of the Government of Belize, a major challenge continues to be generating local stewardship interest and engaging local partners in meaning partnerships to manage the MMA. However, the international institutions such as Smithsonian Institute recognized the wealth of un-mined data and research potential of the area and the Smithsonian established a marine research station back in 1972. The research team for the MMAS' new discoveries continues to build the interest in South Water Caye.

### ***Sapodilla Cayes Marine Reserve***

The Sapodilla Cayes Marine Reserve covers an area of approximately 125 square kilometers and includes fourteen sand and mangrove cayes along the southernmost tip of the Belize Barrier Reef, nearly 40 miles due east of Punta Gorda. The numerous and deeply grooved fringing reefs mixed with numerous deep channels leading out to the deep, blue sea make the Sapodilla Cayes important geologically and rich with biodiversity and is considered the second most important Hawksbill turtle (*Eretmochelys spp.*). One of the major threats to biodiversity comes from trans-boundary pressures that include Guatemalan and Honduran fishers entering Belize illegally to fish. More recently, the incidence and volume of floating garbage washing up on Belizean shores has increased. Such large volume of garbage that originated outside Belize creates a serious threat to the turtle and seabirds and has become a major challenge for local resource managers. These are just some of the border issue that frequently overwhelms local enforcement in this MMA. Through a co-management agreement (2009) with the Fisheries Department, the Sapodilla Cayes is now under the management of the Southern Environmental Alliance (SEA).

### ***Port Honduras Marine Reserve***

Declared in 2000, the Port Honduras Marine Reserve covers one of the largest coastal areas along the mainland within 140 km<sup>2</sup> of MMA. It also receives a large quantity of flow from seven rivers that empty into the reserve. This MPA is managed by the Toledo Institute for Development and Environment (TIDE) via a co-management agreement with the Fisheries Department.

Covering the Snake Cayes and important coastal mangrove habitat along the coast, the Port Honduras is important to the local fishing industry and subsistence fishers in local

coastal communities. Port Honduras lies within the southernmost region of Belize and has not experienced the heavy pressure from coastal development. This provides an opportunity for managers to pre-empt unsustainable development practices with sound development guidelines and policies. However, not being popular tourism destination in Belize has challenged managers with identifying sustainable income generating mechanisms. The site continues to be exposed to trans-boundary fishing pressure and effluent and solid waste threats originating from neighboring countries. In spite of the threats, the Port Honduras continues to be a productive fishing contributing as much as 575,000 lbs of lobster, conch and fin fish annually in the past.

### ***Gladden Spit & Silk Cayes Marine Reserve***

The Gladden Spit and Silk Cayes Marine Reserve (GSSCMR) was designated in 2000, although management was not active until 2003. It falls under the IUCN category IV, which means it is a habitat management area managed mainly for conservation, but with some extraction allowed. GSSCMR is under the jurisdiction of the Fisheries Department of the Government of Belize. They have entered a co-management agreement with the Southern Environmental Alliance (previously Friends of Nature) who is responsible for day-to-day management of the reserve, such as patrols and fee collections. The Gladden Spit Marine Reserve lies 36 kilometers offshore from the village of Placencia, which is the third most popular tourist destination in Belize (Belize Tourism Board, 2007). There are three times as many tourists as local residents during high seasons in December, January and March to June.

The GSSCMR is a multi-use reserve, of 105.1 km<sup>2</sup>, which is relatively large for a coral reef MPA, but below the average size for MPAs in Belize. The reserve has a small no-take area of 16.2 km<sup>2</sup> where fishing is prohibited, which surrounds the silk islands, where tourists are usually taken for picnic lunches. The rest of the reserve has minimal fishing regulations and the conch restoration zone is not enforced. The whale shark zone (outlined in yellow) at the reserve elbow and is the site of spawning aggregations for over 25 species of fish, including several endangered species of snapper (*Lutjanus*) and grouper (*Epinephelus*). Here a sloping shelf drops steeply from 40 meters to over 2000m, within 10km of the reef. This area has been known to fishers for many generations, who have come to take advantage of the good catches at these times. Whale sharks (*Rhincodon typus*) come to this area, to feed on spawn for ten days around the full moon, in March, April, May and June (40 days per year). Tourist access to this area is limited during this time, but tours to see these whale sharks are extremely popular.

The GSSCMR was chosen as it was in many ways typical of marine reserves elsewhere, in that it contains several zones, most with minimal regulations concerning extraction and use, and also a small no-take area. Importantly, Friends of Nature, the organization managing the reserve, requested an economic valuation. This site was also of interest due to the unique presence of whale sharks and its importance as a traditional fishing area.

This Node Synthesis Report synthesizes the results of the MMAS studies in Belize.

## **General Background of Coastal and Marine Management in Belize<sup>1</sup>**

Although Belize is a small country with a population of approximately 230,000 inhabitants, it is home to some of the most important marine resources in the Caribbean - Central American region. The significance of the coastal zone to Belize is highlighted by the fact that over 50% of the national territory is marine (23,657 km<sup>2</sup> of territorial sea from a total of 46,620 km<sup>2</sup>; Hartshorn et al., 1984). Belize is well known for having the longest barrier reef in the western hemisphere. The barrier reef extends for approximately 250 km along the edge of the continental shelf and lies 13 to 48 km off the mainland coast. In addition, there are three off-shelf atolls, unusual inner-shelf rhomboid shoals, numerous patch and fringing reefs, extensive mangrove forests, seagrass beds and estuarine systems, and over 1000 islands or cayes (McField et al., 1996).

The reef complex actually extends as an ecological and geological unit along the Yucatan Peninsula of Mexico for approximately 450 km (Craig, 1966). The Bay Islands and Cayos Cochinos reefs of Honduras represent “upstream” reefs that are also thought to be ecologically connected to Belizean reefs. Belize is also connected to reefs in the wider Caribbean via the Guiana Current that flows northwest from Brazil and becomes the Yucatan current flowing northwards into the Gulf of Mexico. Such gross oceanographic patterns have led to a high similarity among biological communities throughout the region. These patterns also provide a conduit for facilitating the spread of waterborne larvae, as well as pollutants and pathogens.

The location and extent of Belize's marine resources also have important implication for supplying larvae to “downstream areas”. Although there is little hard data available, Cortés (1997) suggested that Belize is probably among the most important source areas of fish, coral and other invertebrate larvae in the region. Roberts (1997) also indicated that Belizean reefs were strategically located in terms of reef connectivity. However, a study of the lobster *Panulirus argus* (Glaholt and Seeb, 1992) found that Belizean lobsters are genetically different from those in Florida, indicating that they could be a self-sustaining population or linked to another reef system. The significance of these ecological linkages has been recognized by the region's governments, which have signed a joint stewardship agreement for this shared “Mesoamerican Barrier Reef System”<sup>1</sup>. In addition, international organizations like Conservation International, the World Wildlife Fund and the World Bank have recognised the ecological value of the reef system and have made long-term commitments to its conservation.

### ***Description of Belize Reefs***

#### ***Mainland fringing reefs***

Reef growth along the Belize mainland is limited by fluctuations in salinity, high

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<sup>1</sup> Source: Dotherow-McField, M.. 2001. The Influence of Disturbance and Management on coral reef community structure in Belize. Doctoral Dissertation. College of Marine Science. University of South Florida. 155pp.

turbidity and nutrients. Perkins (1983) reports some reef development along the mainland between Placencia and Punta Ycacos, and fringing reefs are also known around the Snake Cayes. The mainland fringing reefs are species poor and support primarily resistant genera such as *Siderastrea* and *Porites*. Very little work has been conducted on these reefs.

#### Patch reefs and faroes

Throughout the Belizean shelf lagoon there are numerous patch reefs from small collections of coral heads to areas 80 m across (James and Ginsburg, 1979). These reefs are more abundant in the southern lagoon than the northern lagoon. They support a wide variety of coral communities depending on shelf position, wave and current energy, and depth (Precht, 1993). Within the deeper southern shelf lagoon, there are a series of rhomboid-shaped shoals, called faroes, which may be formed by submerged sand or rubble cayes (James and Ginsburg, 1979). They have similar zonation patterns to the patch reefs, with often steeply sloping sides, deep (15-30 m) channels and central lagoons (Miller and Macintyre, 1977). Patch reefs in the northern lagoon, like Mexico Rocks off Ambergris Caye, formed on topographic highs under static sea level conditions with predominantly lateral coral growth (Mazzullo et al., 1992).

#### Belize Barrier Reef

Belize's barrier reef exhibits the classic barrier reef zonation pattern as described by Rützler and Macintyre (1982)'s reef profile transect at Carrie Bow Cay. The barrier reef includes an emergent reef crest (within 20 cm of sea level) along 57% of the total 257 km outer continental shelf platform (Burke, 1982). Burke (1982) and later Macintyre and Aronson (1997) have described three distinct reef provinces. The northern province contains approximately 46 km of shallow-water reef from Reef (Rocky) Point to Gallows Reef Point. This region has well-developed, nearly continuous reefs with intermittent channels along Ambergris Caye to the south end of Caye Chapel. The central province contains approximately 91 km of shallow-water reefs from Gallows Reef Point to Gladden Spit and is considered to have the most well-developed, continuous reef structure. The southern province contains only 10 km of shallow-water barrier reef from Gladden Spit to the Sapodilla Cayes, and is the least continuous and developed. A major influence on the forereef structures within these provinces is the wave energy reaching them after attenuation by the atolls.

#### Atolls

Belize's three atolls, located between 7 and 45 km from the barrier reef, are Glovers Atoll (132 km<sup>2</sup>), Lighthouse Reef (126 km<sup>2</sup>) and Turneffe Atoll (330 km<sup>2</sup>) and have been described by Stoddart (1962). Glovers and Lighthouse have deep, well-circulated lagoons with numerous patch reefs and land area covering less than 3% of the atoll. In contrast, Turneffe has a land area of 22%, a shallow, poorly circulated lagoon and few patch reefs, except in the north of the atoll. All the atolls have sides sloping into abyssal waters. Wave exposure plays a key role in shaping reef communities and development, both between atolls and within the atolls (on windward versus leeward reefs).

## ***Human Activities Affecting the Coastal Zone***

The indigenous Maya used cayes in the lagoons as fishing stations, ceremonial centers and burial sites and utilized a range of fisheries, including conch, finfish, turtle eggs and manatees, during their civilizations peak 300 BC and 900 AD (Perkins, 1983). The first Europeans arrived in the late 1500's to harvest logwood and then mahogany, with some subsequently shifting to piracy. Garifuna also arrived from Roatan (Honduras) in the 17<sup>th</sup> century to fish and harvest timber. Belize, formerly known as British Honduras, became a British colony in 1862 and gained independence in 1981.

The population of Belize in 1997 was estimated at 228,700 (EIU, 1998-99) giving a density of approximately 10 persons km<sup>-2</sup>. Belize City is the largest population centre and an order of magnitude larger than any other town. Table 1.1 shows the main towns and cities in the coastal zone and highlights the reduction in the proportion of the population in the coastal zone due to immigration and increased growth in the interior (McField et al., 1996). The majority of the population lives in rural areas. Most of the cayes support only shifting fishing populations or small tourist resorts. However, larger cayes and tourist centers like San Pedro Town, Ambergris Caye, are rapidly growing as a result of increased tourist-based economic activity. Nevertheless, less than 50% of the population lives in the coastal zone, which is considered unusual compared to global averages and is a key factor assisting coastal zone management (McField et al., 1996).

The population of Belize has continued to place modest pressure on the coastal zone, with the principal uses being an export and artisanal fishery, aquaculture, tourism, small-scale shipping and oil exploration. However, independence from the UK in 1981 has increased the need to attain economic viability, including expanding pressure on the country's natural resources in order to produce foreign exchange. Exploitation of these resources seems particularly likely through tourism, which will place heavy demands on the coastal zone. Cortés (1997) lists the major threats to the reefs of Belize as fishing, sedimentation, tourism, agro-chemicals, sewage, solid wastes and dredging. Tourism and its associated demands, such as dredging and waste disposal, can exacerbate other detrimental factors, including global and regional processes. Thus there are different spatial scales of threats superimposed upon each other, resulting in cumulative stress on some reefs. Differentiating the seriousness of these threats for any given reef is difficult. However, more attention is now being focused on larger-scale issues like land-use, pollution, watershed management and regional fisheries management in recognition of the importance of these larger-scale issues.

## ***Coastal Zone Management Efforts***

Management of Belize's coastal zone has evolved from the sectoral management of commercial fisheries and conservation of important bird species to the broader approach of ecosystem management and integrated coastal zone management. The following description of this integrated approach is summarized from McField et al. (1996), Gibson et al. (1998), and Harborne et al. (2000).

Conservation of the reef ecosystem and sustainable management of marine resources has traditionally been supported by the general population, the many non-governmental

organizations involved in resource management in Belize, and by most government departments. This broad-based approach is largely responsible for the successes to date. However, new conflicting views and a general impatience with the slow pace of “sustainable development” are fostering a shift in the business climate that now appears focused on quick profits through massive development initiatives.

Protection of Belize’s marine resources is the shared responsibility of several governmental and non-governmental agencies. In 1990 a Coastal Zone Management Unit was established within the Fisheries Department, later assisted by the Coastal Zone Management Project in 1993. The Coastal Zone Management Act of 1998 consolidated these efforts within the autonomous Coastal Zone Management Authority (CZMA), assisted with implementation and research by an affiliated institute. Although no regulatory powers have yet been developed within the CZMA, it serves as the focal point of marine conservation planning, monitoring and research.

Several integrated committees provide broad-based platforms to discuss policy development and the implementation of key programs. The board of the CZMA includes senior government representatives and the larger Coastal Zone Advisory Council has wide representation from government, NGOs, and stakeholders including business interests. Similarly, the Barrier Reef Committee was established as a national platform for oversight of the World Heritage Sites and World Bank's Conservation and Sustainable Use of the Meso-American Barrier Reef System Project. A Marine Protected Areas Committee fosters communication and exchanges among protected areas managers and advisory committees. Finally, a National Coral Reef Monitoring Working Group was formed to integrate and co-ordinate various reef monitoring efforts throughout the country.

Belize’s relatively recent introduction to international tourism and commercial development enables managers to benefit from the experiences and mistakes of other countries, tailoring successful models into the Belizean context to promote sustainable development. However, as developmental pressures increase so does the potential for serious environmental degradation. Belize has adequate environmental legislation but lacks enforcement and monitoring capacity. For example, under the Environmental Impact Assessment (EIA) regulations of 1995, the Department of Environment enforces regulations and screens projects that may require EIA’s. Similarly, the Land Utilisation Authority is responsible for Special Development Areas, which are forms of strategic planning that provide zoning of land-use. A zoning plan for Belize’s marine waters will ultimately be developed by the CZMA/I within an overall Coastal Zone Management Plan.

The Belize Tourism Board regulates the tourism industry, including the expanding cruise industry, which many view as a growing threat to ecologically sensitive areas. The Tourist Guide Regulations require that all tour guides meet standard levels of professional training and licenses can be revoked for non-compliance with environmental or other regulations. Many experienced dive guides are quite effective at “self-regulation” although new guides are in need of further conservation training. Dive operators have

played a major role in the installation and maintenance of mooring buoys. However, these initiatives may be jeopardized by new pressure within the industry to accommodate the mass-tourism market rather than the traditionally small-scale eco-tourism market.

The Fisheries Department manages the fisheries industry, which includes aquaculture. No fishing is allowed on SCUBA and there are other gear restrictions, size limits, and closed seasons. However, government resources are inadequate to patrol the waters of Belize or to fully enforce these regulations. Eight marine reserves have been established under the Fisheries Act to assist fisheries management by replenishing heavily exploited stocks, while also protecting essential habitats (coral reefs, seagrass beds, and mangroves).

The Environmental Protection Act of 1992 provides the framework through which the Department of Environment enforces regulations preventing pollution. Regulations for Environmental Impact Assessments and Industrial Effluents offer specific controls in industrial developments. Although enforcement manpower is severely limited, the small scale on Belize's industrial sector aids the identification and control of potential sources of pollution.

### ***Marine Protected Areas***

The establishment of marine and coastal protected areas has been an essential component of marine conservation efforts in Belize. There are currently twelve Marine Protected Areas (MPA's) in Belize, summarized in Table 1-2, including seven World Heritage Sites. This includes eight designated Marine Reserves, administered by the Fisheries Department or local NGO's. Additionally there are two Natural Monuments, one National Park, and one Wildlife Sanctuary with significant marine habitat. In addition, there are seven Crown Reserves, which are essentially bird sanctuaries on small cayes, and seven coastal protected areas. The role of NGO's and local community-based management is slowly expanding and more advisory committees are being established.

MPAs are a useful tool for addressing a number of threats to coral reefs, particularly those related to tourism, development, and over-exploitation of commercial species. Zoning schemes enable multiple uses in these areas, including recreational diving, sports-fishing, and traditional small-scale fishing and full protection (no-take zones) in key areas. Overly successful tourism in parks can be a concern, as in Hol Chan, which receives over 30,000 visitors a year. The value of protected areas in promoting sustainable fisheries and in regulating tourism and other activities is now well documented and the Hol Chan Marine Reserve has been cited as an international model. Research at Hol Chan and Half Moon Caye has illustrated that MPA's can result in fish populations with significantly greater abundance and larger-sized individuals (Polunin and Roberts, 1993; Carter and Sedberry, 1997). MPAs also support the potential ecological benefits of increasing herbivory on reefs, thereby reducing competition from macroalgal growth. About 16% of Belize's marine territory (based on a 3 mile limit) lies within MPAs (Coastal Zone, 2000). It has been suggested that 30% of the coastal zone should be closed to fishing to adequately provide these ecological benefits. Currently the percent of the marine territory (based on a three-mile limit) established as "no-take"

zones is only 1.3% (Coastal Zone, 2000) and some of these areas are not adequately enforced.

### ***Ecological Status***

The reefs of Belize only became the focus of serious investigations in the 1960s-70s. As argued by Jackson (1997), Caribbean reefs in the 1960's were far from pristine and that real baseline data from "pristine Caribbean reefs" are thus not available. Nevertheless, a brief review of some of the major historical studies provides insight into the current ecological status. The earliest expedition on this reef was the 1959-60 Cambridge Expedition (Stoddart et al., 1959), which focused on the cayes. This project also produced the first description of reef zonation and dominant species from the area around Rendezvous Caye. Stoddart continued his studies in Belize, describing the structural formations of the three atolls (Stoddart, 1962) and the effects of Hurricane Hattie on the cayes and reefs (Stoddart 1963, 1974). Wallace (1974) described coral-dominated patch reefs with 80% live coral cover in Glovers Reef atoll, and sampled lagoonal sediments and foraminifera populations. Purdy et al. (1975) described the Belize continental shelf in relation to hydrographic regions, sediments, basic reef development and molluscan assemblages. James and Ginsburg (1979) provided an early description of the morphology, sediments and biota of the outer reef wall. The Smithsonian Institution's research station on Carrie Bow Caye opened in 1972. Burke (1979) provides the first comprehensive descriptions of reef sites, with seven transects from Gallows Point reef to the Queen Cayes, in which bottom profiles, zonation of substrates and organisms were recorded. Rützler and Macintyre (1982) provide a compilation of early research conducted at the station, including descriptions of the reef at Carrie Bow Caye and taxonomic inventories. Although these early studies provide useful general descriptions of the reefs, they did not typically include what would now be considered standard quantitative ecological data. Thus, it is difficult to assess modern ecological changes relevant to these early studies. Macintyre and Aronson (1997) provide a more recent description of Belize's reefs, geologic setting, and compilation of research to date.

Prior to 1998, Belize's reefs were thought to be in relatively "good" condition (McField et al., 1996, Kramer et al., 2000). However, escalating threats, including coral bleaching, disease and a major hurricane in 1998, have adversely affected Belize's reefs in recent years. Kramer and Kramer (2000) surveyed damages from hurricane Mitch and the 1998 coral bleaching event throughout the Mesoamerican barrier reef system and found that the majority of Belize's reefs had suffered significant damages, with coral losses generally the highest in the region. Kramer et al. (2000) describe the current status of reefs in Northern Central America, including Belize.

While the percent live coral cover is only one measure of a reef's ecological status, it is the most commonly used indicator or "dip-stick" of reef health (McClanahan, 1997). The following studies can only be compared in a broad sense, as methods and depth ranges sometimes varied. Decreased coral cover has been noted at the few sites in Belize where long-term data are available. The earliest major declines are recorded from shallow patch reefs in Glovers reef atoll, which changed from 80% coral cover in 1971, to 20% in 1996 (McClanahan and Muthuga, 1998), to 13% coral cover in 1999 (McClanahan, et al.,

2001). The inner fore reef region at Carrie Bow Caye had 30-35% coral cover in the 1970s and declined to 12-21% in 1995 (Koltjes et al. 1995). The fore reef at Channel Caye (3-15m depth), an inner-shelf faroe, declined from 85% live coral in 1986 to 60% in 1996, attributable primarily to disease and loss of *Acropora cervicornis*, with partial replacement by *Agaricia tenuifolia* (Aronson and Precht, 1997). Subsequently, the bleaching event of 1998 devastated this reef reducing live coral cover to approximately 5% in 1999 (Aronson et al., 2000).

Young (1994) surveyed several barrier reef sites in 1992, finding 25% live coral off Ambergris Caye (Tackle Box site) and 20% live coral at Gallows Reef (Point 2) in 1992. The shallow Mexico Rocks patch reef off Ambergris Caye had 84% live coral cover in 1993, which dropped to 66% in 1995, attributed primarily to the 1995 coral bleaching event (Burke, 1996).

Prior to 1998, most reef impacts in Belize were thought to result from diseases, although regional nutrification, sedimentation, loss of *Diadema*, moderate over-fishing, and bleaching are also likely contributors. The 1998 multiple disturbance event (mass coral bleaching and a catastrophic hurricane) amplified these ongoing declines.

The live coral cover in Belize is now similar to that of many other sites in the Caribbean. Aronson and Murdoch (1997) found the percent of live coral in the Florida Keys (13-19m depth, spur and groove habitat) ranged from approximately 20% in the Dry Tortugas to less than 5% at Tennessee Reef, with most sites around 10%. Fringing reefs of the Exuma Cayes, Bahamas, have coral cover ranging from 8-37% (Chiappone et al. 1997). Likewise, Jamaica has many areas with less than 5% coral cover (down from over 50% in the 1970s), although there is at least one reef in Jamaica with up to 20% live coral (Woodley et al., 1997). The regional CARICOMP monitoring project provides another means of comparing a reef in Belize with other reefs in the Caribbean, using equivalent methods in a depth range of 7-13m. In this study the Belize site (Carrie Bow Caye) had 17% live coral, compared to 30% in Bonaire, 36% in Curacao and 22% in Nicaragua, 19% in Cayman and 6% in Cuba (CARICOMP, 1997). The sites compared are not necessarily equivalent, due to differences in the depth/physiography of the zone of highest reef development at each site. Thus, the regionally prescribed depth range could include the zone of best reef development in one location, while in other locations the best zone may be just outside this range.

### ***Conservation Value***

The Belize Barrier Reef Complex (BBRC) includes seven sites declared as World Heritage Sites by UNESCO. It is essentially the backbone of the Mesoamerican Barrier Reef Ecosystem. These reefs, along with the associated seagrass, mangrove, and wetland ecosystems provide a diverse array of marine habitats.

The biodiversity is regarded as high for the region with, for example, at least 94% of the zooxanthellate scleractinian species known from the Caribbean having been found in Belize (Fenner, 1999). Several endangered or threatened species inhabit the coastal waters. Belize supports the largest population outside of Florida of the endangered

manatee, *Trichechus manatus* (O'Shea and Salisbury, 1991). In contrast, Platt and Thorbjarnarson (1997) found densities of the saltwater crocodile, *Crocodylus acutus*, are among the lowest reported for the region, probably caused by over-exploitation, habitat quality and competition with the more abundant *C. moreletti*. Green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*) and loggerhead (*Caretta caretta*) sea turtles are also known to nest in Belize and there is anecdotal evidence of leatherback (*Dermochelys coriacea*) and Kemp's ridley (*Lepidochelys kempi*) turtles being seen in Belize (McField et al., 1996).

DRAFT

# Biophysical Setting

## *General*

Coral reefs around the world are in decline (Gardner et al. 2003, Bruno and Selig 2007). Reef decline has been caused by a variety of global scale factors attributed to climate change including mass bleaching events (Williams and Bunkley-Williams 1990, Hoegh-Guldberg et al. 2007, Kleypas et al. 2008), and increased frequency and intensity of tropical storms (Gardner et al. 2005, Saunders and Lea 2008). On smaller scales, overfishing (Jackson 1997, Hughes et al. 2006), eutrophication (Grigg 1994, McClanahan et al. 2003, Fabricius 2005, Gruner et al. 2008), and direct physical disturbance (McClanahan et al. 2006) have also contributed to reef decline. While all of these stressors can potentially contribute to reef decline, synergistic effects among these stressors further exacerbate the situation (Hughes and Connell 1999, Porter et al. 1999). Alleviation of these stressors requires management on appropriate scales with the potential to deal with overfishing, eutrophication, and physical disturbance on a much smaller, local scale than thermal stress and hurricane impacts. Thus, an important area of study considers the relative contribution of local versus global scale stressors to the overall decline of coral reefs and if the alleviation of local stressors can potentially slow or reverse the current downward trajectory of reef systems.

One common method of managing local impacts to coastal marine ecosystems is the establishment of Marine Managed Areas (MMAs) or Marine Protected Areas (MPAs) which attempt to spatially manage or exclude human activities from a defined section of habitat (Lubchenco et al. 2003, Halpern 2003). This method of ecosystem-based management has advantages over other more traditional species-specific approaches to resource management as it has the potential to provide a refuge for commercially-targeted fish species and simultaneously preserve unique or critical habitats and regions of biodiversity. Also, MMAs are often logistically easier to enforce than catch limits or fishing quotas, and do not require fishermen to change fishing technologies (Appeldoorn 2008). MMAs are often established as a refuge for depleted fish stocks with the goal of stabilizing fish populations and enhancing fecundity (Allison et al. 1998).

However, many MMAs are established with the strategic goal of conserving entire ecosystems and their services. Despite the widespread use of MMAs intended for mitigating local effects, evidence for MMAs benefiting reef ecosystems beyond the direct effect of recovering target fish populations is still scarce (Dulvy et al. 2004, Mumby et al. 2007a). An effective no-take fishing zone functions as a human exclusion experiment, removing fishing and other direct human impacts but allowing for indirect human impacts like pollution and habitat loss in adjacent, connected ecosystems. Thus, an effective no-take zone, coupled with reef monitoring data from within the no-take zone, the immediately adjacent reefs (kilometers away) and neighboring reef systems (10's and 100's of kilometers away) allow resource managers to partition reef dynamics into local direct, local indirect and regional indirect anthropogenic impacts.

The Ecological Monitoring (EcoMon) project for Belize was designed to establish ecological datasets for the reef systems of five marine managed areas in central and southern Belize with the intent of assessing the effectiveness of existing no-take fishing zones and establishing baseline datasets for locations where no-take fishing zones were planned but not yet implemented. The goals of the project were twofold: first, provide resource managers and government agencies with data on the effectiveness of their management and second, record the state of reef communities in different areas relative to adjacent reef systems by taking consistent, quality data across the five MMAs, allowing managers to discern local versus regional ecological patterns and trajectories. The biophysical setting of each of these MMAs is described below.

### ***Specific MMAs***

#### **Placencia Lagoon**

Placencia lagoon was an ideal coastal habitat to better study the effects of tourism, industrial development and urbanization on critical habitats for marine species. Over the years there have been several initiatives that have studied how the Placencia lagoon has changed over the years. The adverse effects on the lagoon have been at different levels and have directly or indirectly affected the biotic and abiotic components of system. It is well known that estuaries are an integral part in the management of a country's fisheries industry, but how much importance is given to this critical habitat varies from one location to the next. Just a few miles to the east of Placencia is Gladden Spit, one of the most important spawning aggregation sites in Belize. If there are millions of commercially important species being spawned and there is gradually less suitable habitat for the larvae to settle, then eventually the fisheries industry will collapse. This is only one of the ways estuary habitats like Placencia lagoon can affect species that do not necessarily spend their entire life in the estuary. The lagoon also has large areas of mangrove that give a different type of service to the local community. If it was not for the mangroves, the Peninsula would have long been washed away by yearly storms and other natural causes. The lagoon also serves as a habitat for endangered species like the Goliath grouper and the West Indian Manatee.

Placencia is an old fishing community that like San Pedro Town shifted most of its workforce to tourism over the years. Fishers first concentrated in exploiting the resources in the lagoon and eventually ventured offshore, mostly Laughing Bird Caye and Gladden Spit. Like any fishing community, the importance of having a fishing cooperative was soon realized and the Placencia Fishing cooperative was formed. The cooperative was targeted to the extraction of fin fish, lobster and conch, the main exploited resources from Belizean waters.

#### **Laughing Bird Caye**

Laughing Bird Caye National Park, is one of the few marine national parks within the network of marine protected areas in Belize. This MPA is unique in its location, protecting a small portion of the lagoonal reefs, which is known to have several endemic species. There is still little known about the structural composition of the lagoonal reefs, its habitats and species, something that the Inter-reefal mapping project started mapping.

Recent water movement models suggests that there is little mixing of lagoonal and oceanic water; this would give the water from the lagoonal reefs a unique water chemistry and allow for high levels of endemism.

Because this is a national park, it is entirely closed to any form of resource exploitation. The only use this park gets is that of tourism and different research teams that have been monitoring the habitat and its species as well as trying to restore some of the lost coral species like acropora palmate. The Southern Environmental Association (SEA), previously Friends of Nature (FoN), is the NGO that co-manages the park along with the Belize Forestry Department. Laughing Bird National Park is known to have an abundance of fish and invertebrates, which can be attributed to the closed area.

The EcoMon project found that LB is one of the few MPA's that has a high coral recruit and also fish biomass. To what this is attributed may be a combination of management and enforcement. The coral cover is also higher than other MPA's, which was not expected if being closer to populated areas negatively affects coral cover. Not only was the fish biomass of the adult fish larger but also there is also a high abundance of commercially important fish species in the late juvenile and early adult stages (CSC project).

With only two of the field base projects of the MMAS at Laughing Bird, there is already a clear picture of how important this park is to the proper management of the BBRS. This is not even considering the other studies have been done in the park over the years, which include monitoring of bleaching events, coral framing, commercial species monitoring among other, mainly conducted by the Biologists of SEA.

### **Port Honduras**

Port Honduras Marine Reserve (PHMR) is another reserve that protects a lagoonal reef habitat. Co-managed by the Toledo Institute of Development and Environment (TIDE), PHMR is slightly different from the other MPA's in that it has a general use zone, conservation zone and preservation zone. This type of zoning is a means to better manage the resources within the MPA. Most of the conflict with fishermen is their perception of what an MPA is created for. By allowing access to fishermen to certain parts of the MPA, the fishermen can better understand the benefits from them.

The location of PHMR puts the reserve in a position where certain problems, not seen in other parks/reserves, are common. These are the illegal resource extraction by Guatemalans and Hondurans, and the constant influx of polluted water from some major rivers in Guatemala and Honduras. This creates two major problems, 1) the water chemistry, which is very difficult to control and even address; and 2) the enforcement necessary to deal with the illegal fishing. Both problems require some type of tri-national negotiation which in itself is a problem. Even though with all these problems, the EcoMon project showed that PHMR has one of the best enforcement among the MPA's in Belize and the low fish biomass and coral cover are due to different factors such as water quality.

## **Sapodilla Cayes**

Sapodilla Cayes Marine Reserve (SCMR), also co-managed by SEA, is the southernmost MPA along the BBRS with similar problems like Port Honduras, but with the added pressure of tourism. This reserve like many along the BBRS was known to have large spawning aggregation sites of snappers and groupers, but this has drastically changed over the years. Constant pressures from unsustainable and illegal fishing have significantly affected the entire area.

One of the biggest problems not only found at SCMR is the lost of the predator and grazers. Not long ago, the fin fish fishing industry was primarily based off snappers and groupers, but as the numbers of these species went down, other species started to be targets. One such group of fish is the parrotfish, which are now protected until recently. This along with the issue of polluted waters from the watersheds has significantly affected the water chemistry of the southern reefs and help in the bloom of some fleshy algae. This has lead to a deterioration of the reef over the years, not only on its coral cover but also on its fish biomass and overall productivity.

## **Gladden Split**

Gladden Split & Silk Cayes Marine Reserve (GSSCMR) co-managed by SEA, is one of the few MPAs with a large yearly spawning aggregation, but still nothing close to what it is was decades ago. The unique reef structure known to be preferred by aggregations of spawning fish is one of the unique features of GSSCMR. The reserve has yearly large spawning aggregations of several species of snapper and grouper, both families being important to the fishing industry of Belize. Gladden Split's spawning aggregations also attracts Whale sharks, now one of the most successful tourism managed activity. The small islands of Silk Cayes are not spawning aggregation sites but are definitely a popular tourist destination both for diving and leisure cruises.

The reserve is not entirely closed to exploitations, but open and closed seasons are important in maintaining a balance on level of exploitation. Fin fish and tourism are not the only benefits from GSSCMR, there is the conch and lobster extraction too. One of the good things about many of the fishing communities is that most of them are part of some sort of cooperation that helps to regulate along with the Fisheries Department, the number of fishermen, boats operating, appropriate size of catch and enforcement of open and close seasons.

Several factors may have assisted the success, when compared to other MPAs with spawning aggregation sites, such as constant consultation with the fishing communities, tour guide operators and rigorous enforcement, or simply good management.

## **Glover's Reef**

Encompassing 30,800 hectares, the Glover's Reef Marine Reserve is the largest MMA in Belize. It is also the only MMA that has a 20% of its total area as strict no-take and continues to be the model that most other MMAs strived to replicate. Similar to the other MMAs in this study, Glover's Reef also includes management zones that allow extractive and non-extractive uses in the General Use and Conservation Zones, respectively.

## **South Water Caye**

Of all the areas the MMAs targeted by the program, South Water Caye Marine Reserve (SWCMR), the second largest MPA in Belize, is the only one that does not have a co-management agreement or partnership with any NGO. The reserve is completely managed by the Fisheries Department, in consultation with its stakeholders, which are mostly comprised of some fishing communities and several tourism operators. Until recently the entire reserve was a general use zone, but with the help of the EcoMon project's principal investigator, the reserve has been zoned. The zoning scheme has been legally established with only the final phase (marking and proper enforcement) to be completed.

The most significant contribution of SWCMR is to the tourism industry. The reserve has several hundred mangrove islands, many on which some sort of tourism operation is present. What makes SWCMR unique is its diverse habitats, which consist of mangrove islands, small sandy beaches, shallow and deep coral reefs, shallow shoals and its lagoonal reefs. Even though SWCMR has not been the center of research, one institution – the Smithsonian – has constantly been conducting monitoring in the area based at Carrie Bow Caye. The Smithsonian Institution has been present at SWCMR for many years now and has one of the most comprehensive monitoring databases of the area.

## **Lighthouse Reef**

Lighthouse Reef Atoll is the most remote, and probably the most pristine, reef system offshore Belize. The Blue Hole and the Half Moon Caye MPAs are natural monuments located within the boundaries of the Atoll. Half Moon Caye Natural Monument (HMCNM), is co-managed by the Belize Audubon Society (BAS), which started off protecting the Red Footed Boobies more than four decades ago. HMCNM is by far the oldest MPA, even though its initial purpose was not specifically to protect marine species directly. Over the years the income generated by the reserve has significantly shifted from the bird (boobies) watching tourism to diving and fishing to some degree.

The entire Atoll is not a protected area but includes spawning aggregations sites which are protected by separate fisheries regulations. The Atoll is located approximately 80km east south east of Belize City. Being far offshore definitely helps to maintain the reefs relatively good health, although there are other factors like sea surface temperature rise and ocean acidification that are not easily avoided. Overall the reefs and fish biomass of HMCNM are significantly higher than the other reserves studied. One new and significant change proposed for Lighthouse Reef Atoll is the establishment of the first private marine reserve at Long Caye. This should only add to the better protection of the Atoll and help it retain its high diversity.

## Socio-economic and Cultural Setting

### *General*

Socioeconomic monitoring is now recognized as a critical function for coastal and ocean resource managers, who can use socio-economic data to determine the impact and effectiveness of their management programs. The Socio-economic and Governance Study was designed to assess the socio-economic and governance conditions that impact on management effectiveness in the selected MMAs.

Like at the global level, Belizean studies have tended to focus more on the biophysical condition of coral reefs and the ecological functions of marine management areas. However, there is growing recognition that the bio-physical characteristics of marine management areas do not provide a comprehensive picture of coral reef health nor address the links between socio-economic and governance conditions and management effectiveness. It does little good to understand the health of coral reef and other coastal resources without understanding how people are interacting with those resources or knowing what those resources are worth to local communities.

At the site level, MMAs are used to manage human impacts on the marine environment by limiting fishing, reducing user conflicts, and promoting marine recreation. Establishment of an MMA is often accompanied by extensive surveying of marine habitat conditions but less often by surveying socioeconomic conditions. Yet, information on the socioeconomic foundation and governance aspect of communities reliant on coastal resources is as critical as understanding the migration patterns and habitat requirements of the marine ecosystems. But given the paucity of socioeconomic data available, there is an increasing demand, from MMA managers, decision-makers, resource users, scientists and others to understand the socioeconomic conditions of MMAs.

In particular, socio-economic and governance monitoring provide information for facilitating stakeholder involvement by gaining a greater understanding of community perceptions and needs; and, tailoring management to the local situation, such as developing education programs based on community members understanding of resources conditions and threats.

The (Socio-economic and Governance) SocEG study was implemented over a two year period in an attempt to collect and analyze baseline, monitoring and impact data as well as determine critical factors for success of marine management areas. Local researchers of the Belize ISIS Enterprises Limited conducted the study in collaboration with technical input from other consultants in Belize.

The SocEG study assessed the baseline social and economic conditions of marine managed areas in Belize in terms of their impact on factors such as economic development, quality of life, livelihoods, environmental awareness, and stakeholder

participation. The results are expected to contribute to the design and implementation of other socio-economic studies.

More specifically, the study was designed to:

1. Determine how marine managed areas have affected socioeconomic conditions. This examines the objectives of five marine managed areas and which types of management regimes are most effective at meeting their objectives.
2. Evaluate how socio-economic (e.g., demographics) characteristics impact on the management effectiveness of marine managed areas (e.g., are wealthy communities correlated with more or less successful marine managed areas?).

### ***Specific MMAs and associated Human Communities***

One of the most critical aspects of effective marine resource management is an understanding of the socio-economic characteristics of local stakeholder communities and how the establishment of marine managed areas impacts on these characteristics.

The twelve communities studied span across three districts in Belize: the Corozal, Stann Creek and Toledo Districts as follows:

- Chunox, Copperbank and Sarteneja in the Corozal District;
- Dangriga Town, Sittee River, Hopkins, Placencia, Seine Bight and Independence in the Stann Creek District; and
- Monkey River, Punta Negra and Punta Gorda Town in the Toledo District.

Based on the literature review, Chunox in the Corozal District, and Sittee River, Seine Bight and Independence in the Stann Creek District were not considered users of the five MMAs included in this study but are similar in geographic location and other socio-economic characteristics. Chunox is a Mestizo community, Sittee River is a Creole community, Seine Bight is a Garifuna community and Independence is a mixed community. They represent the ethnic composition of other similar communities in the study. These four communities were selected as control communities to be able to compare socio-economic characteristics and changes with marine protected areas stakeholder communities.

Overall, of the twelve communities, the Southwater Caye Marine Reserve had the highest reported numbers of marine resource users (1,515 users), compared to the other two marine reserves. The Sapodilla Cayes Marine Reserve had a total of 450 users while the Port Honduras Marine Reserve had 430 users. The Lighthouse Reef Atoll had 921 users and the Laughingbird Caye National Park had 936 users.

Community	Lighthouse Reef		LBCNP		SWCMR		SCMR		PHMR		Others	
	#	%	#	%	#	%	#	%	#	%	#	%
<b>Corozal District</b>												
Chunox =529	69	13.2%	0	0	0	0	0	0	0	0	0	0
Copperbank = 222	110	49.2%	10	4.6%	0	0	0	0	0	0	14	6.2%
Sarteneja=973	165	17%	200	20.6%	324	33.3%	7	0.7%	0	0	234	24%
<b>Stann Creek District</b>												
Dangriga =6,699	413	6.2%	315	4.7%	946	14%	146	2.2%	121	1.8%	4,150	62%
Hopkins=548	37	6.7%	16	3%	79	14.3%	10	2%	0	0	462	83.8%
Sittee River =189	0	0	0	0	7	3.7%	0	0	0	0	63	33.3%
Placencia =560	6	1%	202	36%	104	18.6%	52	9.3%	6	1%	282	50.5%
Seine Bight = 513	10	2%	5	1%	0	0	0	0	0	0	30	5.8%
Independence=1,633	9	0.5%	87	5.3%	17	1%	17	1%	0	0	323	19.8%
<b>Toledo District</b>												
Monkey River = 100	0	0	37	37%	0	0	49	48%	63	63%	63	63%
Punta Negra=16	0	0	0	0	0	0	2	14.3%	9	57%	16	100%
Punta Gorda=2,932	102	3.5%	64	2.2%	38	1.3%	167	5.7%	231	8%	1,614	55%
<b>Total # users by MPA</b>	921		936		1,515		450		430		7,251	

### Resource users across communities

Resource users of the Lighthouse Reef Atoll were primarily from Dangriga Town and the northern communities of Chunox, Copperbank and Sarteneja. Furthermore, 102 users of this marine protected area were from Punta Gorda and 37 were from Hopkins.

Resource users of the Laughingbird Caye National Park were primarily from Dangriga Town, Placencia, Sarteneja, Independence, Punta Gorda and Monkey River while resource users of the Southwater Caye Marine Reserve were mostly from Dangriga Town and Sarteneja, followed by Placencia, Hopkins and Punta Gorda.

Resource users of the Sapodilla Cayes Marine Reserve were mostly from Dangriga, Punta Gorda, Placencia and Monkey River, with a few users from Hopkins and Independence. Resource users of the Port Honduras Marine Reserve were mainly from Punta Gorda, Dangriga, Monkey River and Punta Negra. Other marine areas are used by all communities, except for Chunox.

This patterns shows that communities do not confine themselves to using one marine area. They tend to use marine areas all along the coast. To illustrate, marine resource users from Dangriga and Punta Gorda use all five marine protected areas as well as other marine sites. Furthermore, resource users from Sarteneja use the Lighthouse Reef Atoll, the Laughingbird Caye National Park, the Southwater Caye Marine Reserve and other marine areas. Users from Placencia use the Laughingbird Caye National Park, the Southwater Caye Marine Reserve, the Sapodilla Cayes Marine Reserve as well as other marine areas.

The data also demonstrated that not all resource users of the marine protected areas and other marine sites are engaged in fishing and fishing related activities or other marine related economic activities. Rather, marine resource users come from a wide range of occupational categories.

## **Linking MPAs and socio-economic changes**

To examine the effects of the marine protected areas on the socio-economic situation of respondents, they were first asked to state whether their economic situation had changed over that ten year period since 1998. They were asked to consider whether their economic situation has gotten much better, better, neither better nor worse, worse or much worse over that time frame. They were later asked if they thought that this change, whether better or worse, was directly related to the establishment of the marine protected areas. A majority of respondents indicated that their situation was worse (43.4%) or did not change over the past 10 years (24%). Another 10% of respondents felt that their economic situation became much worse over the last ten years. Only 17% and 6% of respondents stated that over the last ten years their situation became better and much better, respectively. Therefore, for every one respondent who said that his or her situation had improved, there were more than two who reported that their economic situation had gotten worse or much worse. There were no differences by gender.

At the level of marine protected areas, a majority or 73% of resource users indicated that their economic situation had worsened over the last ten years. However, users of the Lighthouse Reef Natural Monument were most negative about their economic situation in 2008 compared to ten years ago.

Resource users of the Laughing Bird Caye National Park, the South Water Caye Marine Reserve and the Port Honduras Marine Reserve reported a similar pattern regarding the change in their economic situation over the last ten years. While approximately one-half or 50% of resource users indicated that their situation had worsened, approximately 30% indicated that it had gotten better over the last ten years. This was compared to approximately one-tenth or 12% of users of the Lighthouse Reef Atoll who indicated an improved economic situation.

Approximately 30% and 25% of users of the Sapodilla Cayes Marine Reserve and “other” marine areas, respectively, indicated that their economic situation had improved or remained the same over the last ten years.

Therefore, approximately 50% of users of all sites, except for the Sapodilla Cayes Marine Reserve (39%), and the Lighthouse Reef Atoll (73%) reported a worsened economic situation.

### **MPA links across communities**

Across communities, approximately one-half or 50% of respondents from Punta Negra indicated that a change in their economic situation was linked to the establishment of marine protected areas. One in three or 33% of respondents from Monkey River and Sittie River also indicated a link. All three of these communities are traditional fishing communities which, for over 10 years, have experienced significant migration of their working age populations.

In Sarteneja, one in five respondents or 20% reported a link with the establishment of marine protected areas while approximately one in five or 20% of respondents from

Hopkins did so. Less than 20% of all other communities reported a link, including Placencia with 18%.

### **MPA links across marine resource users**

Across marine protected areas, 42% of users from the Sapodilla Cayes Marine Reserve said that the change in their economic status was linked to the establishment of the marine protected areas. This was followed by 29% of users of the Port Honduras Marine Reserve, 26% of users from the Lighthouse Reef Atoll, 23% of users of the Laughingbird Caye Marine Reserve and 20% of users of the Southwater Caye Marine Reserve. Of those who used other marine areas, 14% of those who reported a change in their economic status linked this to the establishment of marine protected areas.

Of those who reported a much improved better economic situation, one-quarter (25%) of users of the Sapodilla Cayes Marine Resource, one-third (32%) of users of the Southwater Caye Marine Reserve and almost one-half (48%) of users of the Laughingbird Caye National Park attributed this change to the establishment of marine protected areas. This was followed by resource users of “other” marine areas (19%) and users of the Port Honduras Marine Reserve (14%). Among resource users of the Lighthouse Reef Atoll, only 10% of those who said their economic situation had gotten much better linked this to the establishment of marine protected areas.

Among those who said that their economic situation had gotten better over the last ten years, 40% of users from the Port Honduras Marine Reserve linked this to the establishment of marine protected areas. Among users from the Southwater Caye Marine Reserve, the Sapodilla Cayes Marine Reserve and the Laughingbird Caye National Park who reported a better economic situation, approximately 15% each linked this to the establishment of marine protected areas. However, only 8% each of users from the Lighthouse Reef Atoll and “other” marine areas linked their better economic situation to marine protected areas.

Across marine protected areas, except for the Sapodilla Cayes Marine Reserve, less than 20% of resource users who reported a worse economic situation linked this to the establishment of marine protected areas. Only 1% of resources users of the Port Honduras Marine Reserve who indicated a worse economic situation linked this to marine protected areas while 44% or almost one-half of resource users of the Sapodilla Cayes Marine Reserve who reported a worse economic situation linked this to the establishment of marine protected areas.

Similarly, of those who reported a much worse economic situation, 97% or almost all resource users of the Sapodilla Cayes Marine Reserve linked this to the establishment of marine protected areas. This was followed by users of the Port Honduras Marine Reserve (67%), Laughing Bird Caye National Park (44%), Lighthouse Reef Atoll (29%) and South Water Caye Marine Reserve (26%).

**The above pattern reveals that most resource users of the Sapodilla Cayes Marine Reserve and the Port Honduras Marine Reserve tended to link their worsened**

**economic situation with the establishment of marine protected areas. Meanwhile, most resource users of the Lighthouse Reef Atoll and South Water Caye Marine Reserve tended to link a much worsened economic situation with other factors.**

**Approximately equal percentages of resource users of the Laughing Bird Caye National Park, the South Water Caye Marine Reserve and users of “other” marine areas tended to link both their improved as well as their worsened economic situation with the establishment of marine protected areas.**

The establishment of marine protected areas was therefore reported to have an effect on the economic situation of 9% of respondents with another 5% not sure about the link. Among those who reported a positive effect, a majority were engaged in tourism related activities. Adversely for those who reported a negative effect, a majority were engaged in agricultural labor or fishing and fishing related activities. Consistent with these findings is the report of a much worsened economic situation by users of Lighthouse Reef Atoll, who were mostly Mestizo commercial fishers with low levels of education from Sarteneja, Chunox and Copperbank in the Corozal District.

### **Socio-economic changes since 2000**

According to statistics<sup>2</sup> from the Fisheries Department, 2,267 fishing licenses were issued in 2008. Those captured in the survey account for 61% of these licenses.

Overall, the numbers of households that indicate that fishing and fishing related activities were their main source of income increased across all three districts. However, the most notable increases were in the Corozal District in Chunox and Copperbank. A decline in the sugar industry and in agriculture production in the Corozal District is believed to be contributing to the re-entry of Chunox in the fishing industry as well as the increase in households from Copperbank who are engaging in fishing activities. These two communities, under economic pressure, are reverting to fishing, particularly of conch and lobster, as a viable alternative source of household income.

Of all twelve communities across the three districts, Punta Gorda demonstrated the highest percentage of respondents with tertiary level education in 2008. Punta Gorda Town has a university campus which provides residents with access to tertiary education which may account for this great improvement in completion of tertiary level education in that community.

According to key informants, the decline in agriculture production in the Corozal District over the last 10 years, has created the urgency for diversification of economic activity in that District. The situation was reported to be more urgent for Chunox which in 2006 was reported to have a poverty rate of 66% and an indigent rate of 40%.<sup>3</sup>

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<sup>2</sup> Department of Fisheries. (2008). Statistics of Fishing Licenses Issues (2002-2007).

<sup>3</sup> Ministry of National Development. National Human Development Advisory Council (NHDAC). Poverty Mapping Study. (2006).

## Marine-related economic activities across communities

Of the twelve communities, Sarteneja reported the highest percentage of persons engaged in commercial fishing activities (77%), followed by Monkey River (63%), Copperbank (53%), Hopkins (31%) and Placencia (27%). This means that whereas three in every four employed persons were engaged in commercial fishing activities in Sarteneja, approximately one in four were engaged in commercial fishing activities in Placencia.

Community	Commercial Fishing	Recreational Fishing	Aqua-culture	Tour Guiding	Boat Captain/Driver	Taxi Driver	Diving	Hotel/ Resort Worker	Restaurant Worker
<b>Corozal District</b>									
<b>Chunox = 97</b>	14.4%	0	0	0	0	0	0	0	0
<b>Copperbank = 161</b>	53.4%	0	0	0	0	0	0	0	0
<b>Sarteneja=745</b>	76.7%	0	0	2%	0	0	0	1%	0
<b>Stann Creek Distict</b>									
<b>Dangriga = 3664</b>	6.6%	6%	0	2%	3.3%	0	4%	2.6%	2.6%
<b>Hopkins=325</b>	30.7%	19.4%	0	16%	9.5%	1.5%	14.5%	24%	8%
<b>Sittee River =63</b>	0	11%	0	11%	11%	11%	11%	22%	0
<b>Placencia =455</b>	26.5%	17.2%	0	31.6%	30.2%	7.6%	12.7%	28%	11.4%
<b>Seine Bight = 316</b>	4.7%	4.7%	0	0	1.5%	1.5%	1.5%	26.5%	6.3%
<b>Independence=1258</b>	0.7%	4%	0	0.7%	0.7%	0	0	3.4%	2%
<b>Toledo District</b>									
<b>Monkey River = 71</b>	63.3%	42.2%	5.6	52%	36.6%	0	42%	0	0
<b>Punta Negra=16</b>	12.5%	56.2%	0	0	0	0	0	0	0
<b>Punta Gorda=1908</b>	7.3%	5.3%	0	0.6%	1.4%	0.6%	2.7%	0.6%	3.3%

Regarding absolute numbers, most commercial fishers in the sample were from Sarteneja (572). Though a small community Sarteneja accounted for twice the number of commercial fishers in the more densely population Dangriga Town (243). This was followed by commercial fishers from Punta Gorda (141), Placencia (121) and Hopkins (100). All other communities reported less than 100 commercial fishers, except for Sittee River which did not report any commercial fishers.

Regarding tour guiding activities, Placencia (144 or 32%) and Monkey River (37 or 52%) stand out as the two communities with the highest percentage of tour guides. However, Dangriga and Hopkins also reported high numbers of tour guides (73 and 52, respectively). These same communities also accounted for a majority of boat captains/drivers and divers. Again, the northern communities of Chunox and Copperbank and Sarteneja did not having any boat captains/drivers or divers. Only 2% of employed respondents from Sarteneja indicated being tour guides and 1% stated that they worked in a hotel or resort.

Communities with at least one in four employed persons working in a hotel or resort were Placencia (127 or 28%), Seine Bight (84 or 27%), Hopkins (79 or 24%) and Sittee River (14 or 22%). Though small in percentage (2.6%), Dangriga also had a high number of respondents working in a hotel or resort (97 or 3%). All of these communities are in the Stann Creek District, where tourism related investments have been made.

Placencia, the community with the highest levels of tourism related investments, also reported the highest percentage of restaurant workers (52 or 11%) compared to the other eleven communities. However, the community with the highest number of restaurant workers was Dangriga (97 or 3%).

This demonstrated that the communities with the least diversified marine related economic activities were Chunox, Copperbank and Sarteneja in northern Belize. The most diversified were Placencia, Hopkins and Monkey River as well as Dangriga Town. In Placencia and Hopkins this diversification has been supported by the development of the tourism industry and the building of large hotels and resorts. Issues of carrying capacity<sup>4</sup> and the increased human footprint on marine resource due to tourism related activity has raised the issue of whether the rapid rise of the tourism industry in Belize has reduced pressures on marine resources, or simply added another set of pressures to be managed.

### **Economic Reliance of Communities**

The community with the highest levels of reported economic reliance on activities conducted within marine protected areas is Sarteneja, where 62% of employed respondents indicated that 100% or all of their income is reliant on activities conducted within marine protected areas. Monkey River also reported high levels of full economic reliance on activities conducted within marine protected areas (32%), followed by Hopkins (21%) and Copperbank (19%). Though small in percentage due to population size, 128 respondents and 121 respondents from Punta Gorda and Dangriga reported that they were fully reliant on activities conducted within marine protected areas.

In Placencia, there was mostly partial economic reliance on activities conducted with marine protected areas. Of these, approximately 15% reported that between 25% and 75% of their income was reliant on activities conducted within marine protected areas whereas only 6.3% stated that all of their income was reliant on activities conducted with marine protected areas.

### ***Economic Valuation – GSSCMR***

The GSSC Marine Reserve is frequented by fishermen from local mainland communities as well as Sartenejan fishers, whose income is largely dependent on fishing the length of the Belizean coast. The reserve also draws dive guides and their clients with its large schools of reef fish and with spectacular seasonal gatherings of whale sharks. Research was conducted to measure the economic values for the most important environmental services generated in 2007 at the GSSCMR. This study went beyond estimating financial impacts of the MPA, to include welfare estimates for consumers and producers related to the case study site, using extensive primary data. This study used research methods which have been developed in the field of environmental economics to measure both producer

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<sup>4</sup> ----- (2008). Protecting Belize's Natural Heritage: An Action Plan for Shared Stewardship of a Cruise Destination. Ministry of Tourism and Civil Aviation, Conservation International, Belize Tourism Board, Oak Foundation.

and consumer surpluses for a variety of stakeholders. Values measured relate to the following stakeholder groups: visitors, non-visitors, local community residents, Belizean fishers, and local tour operators and hotels.

The local recreational and non-use values derived by these stakeholder groups were measured. Non-use values are associated with simply knowing an area exists and will remain for future generations. Non-use values held by foreign visitors to Belize who did not choose to visit this particular reserve were also calculated. Field data for all the valuations conducted by the study team were gathered in 2007-2008.

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## **Institutional (Governance) Setting**

### ***General***

To maintain coastal marine resources at sustainable levels, Government agencies have developed official co-management arrangements with local non-government and community based organizations. The co-managers of MMA sites have, since their establishment, advocated for improvements in environmental policies and laws, documented and monitored resource use patterns, enforced national policies and laws, conducted environmental education programmes, and developed networks and partnerships with key stakeholder groups.

More recently, the managers of protected areas have formed themselves into an association called the Association of Protected Areas Managers Organizations (APAMO), which organized to strengthen the Protected Areas Network in Belize. Through APAMO, it is expected that protected areas management will evolve to focus more on a systems approach to conservation and sustainable management rather than placing emphasis solely on individual protected areas.

Both Government and Non-Government agencies as well as stakeholder groups such as APAMO, recognize that the dearth of existing data regarding the socio-economic and governance aspects of coastal marine resource management creates challenges for effective planning, especially when taking a system level approach to coastal marine resource management. As a result the managers of at least three of Belize's Marine Managed Areas have begun to collect this type of data and use it in planning for more effective resource management.

The study was implemented over a two year period in an attempt to collect and analyze baseline, monitoring and impact data as well as determine critical factors for success of marine management areas. Local researchers of the Belize ISIS Enterprises Limited conduct the study in collaboration with technical input from other consultants in Belize.

The study assessed the baseline governance conditions of marine managed areas in Belize in terms of their impact on factors such as stakeholder participation and policy enforcement. The results are expected to contribute to the employment of more effective marine management practices in Belize.

More specifically, the study was designed to:

1. Determine how marine managed areas have affected governance conditions. This examines the objectives of five marine managed areas and which types of management regimes are most effective at meeting their objectives.
2. Evaluate how socio governance (e.g. institutional frameworks and processes) characteristics impact on the management effectiveness of marine managed areas.

## ***Specific MMAs***

Protected areas in Belize are governed by a set of distinctly different laws. As outlined by Meerman (2005), these laws allow for various categories of protected areas, including the establishment of:

- Nature reserves, national parks, natural monuments, wildlife sanctuaries and forest reserves under the National Parks Systems Act (1981) and the Forests Act;
- Marine reserves under the Fisheries Act (1980 and 1983); and
- Archeological reserves under the Ancient Monuments and Antiquities Act (1972) which has been replaced by the National Institute for Culture and History Act.

Of the MMAs included in the SocEG study, three are marine reserves, one is a national park and one is an atoll which has two natural monuments.

The marine management areas are part of a much larger, complex network of protected areas in the country. To assess the management effectiveness of these sites, the national legislative, financial and operational framework for protected areas must be examined.

The Fisheries Department (Ministry of Fisheries), the Forest Department (Ministry of Natural Resources) and the Institute of Archeology (Ministry of Culture and the National Institute for Culture and History in the Ministry of Culture) each have authority for the establishment, regulation and management of specific categories of protected areas.

Of the MMAs included in this study, the South Water Caye Marine Reserve, the Sapodilla Cayes Marine Reserve and the Port Honduras Marine Reserve fall under the jurisdiction of the Fisheries Department and the Fisheries Act. The Laughing Bird Caye National Park, the Blue Hole Natural Monument and the Half Moon Caye Natural Monument all fall under the jurisdiction of the Forest Department and the National Parks Systems Act.

Based on the National Parks Systems Act, the Blue Hole Natural Monument, the Half Moon Caye Natural Monument and the Laughing Bird Caye National Park are complete no-take zones but can be used for recreation, science and education purposes. This contrasts with the designation of marine reserves. Marine reserves are divided into multi-use zones, each with a different level of protection. These are usually general use ones, conservation zones, preservation zones, and special development areas. Only the preservation zone is considered a complete no-take zone.

Under the Fisheries Act, most rules and regulations cover the entire marine environment. Within marine reserves, allowable activities depend on the type of zone within each marine reserve as well as the specific ecological and biological characteristics of each area.

In general, a number of licenses are issued to permit fishing, research and other types of activities in marine environments, including within marine reserves. This includes annual licenses for commercial and recreational fishers, licenses for fishing boats and licenses to conduct scientific or research activities involving the taking, killing and

capturing of fish. The Act also allows for the commercial exploitation of all species of marine or fresh water animal or plant life, in marine and inland waters and rivers and outlines methods of fishing, net sizes, fish size and weight and closed seasons for specific species like conch and lobster. (*Fisheries Act, Chapter 174, 210. Revised Laws of Belize 1980-90, 2000, SI 1 of 1993, SI 10 of 1986*)

To qualify for a fishing license, the Fisheries Act, Section (3) states that the person must be “*Belizean and must present any of the following documents at the time of application: (a) a valid Belizean Passport; (b) a valid Voters I.D.; or (c) a Belizean I.D. (with photograph) along with a birth certificate*”. As will be demonstrated later, the Belize Immigration Act contains loopholes, which impact negatively on achieving the objectives for which these requirements were established.

Five of the six marine protected areas in this study are included in the list of seven marine protected areas which comprise the Belize Barrier Reef System World Heritage Site declared in 1996 (UNESCO, 1996). The seven sites include:

Included in study	Not included in study	Included in study but not a part of the World Heritage Site
<ul style="list-style-type: none"> <li>• Half Moon Caye Natural Monument</li> <li>• Blue Hole Natural Monument</li> <li>• Laughing Bird Caye National Park</li> <li>• Southwater Caye Marine Reserve</li> <li>• Sapodilla Cayes Marine Reserve</li> </ul>	<ul style="list-style-type: none"> <li>• Bacalar Chico Marine Reserve and National Park</li> <li>• Glovers Reef Marine Reserve</li> </ul>	<ul style="list-style-type: none"> <li>• Port Honduras Marine Reserve</li> </ul>

### The Two Natural Monuments

Declared in 1982, the **Half Moon Caye Natural Monument** was Belize’s first marine protected area. The Half Moon Caye Natural Monument covers 9,700 acres defined as “*ALL THAT PIECE or parcel of land and sea lying and being part of Light House Reef and the Caribbean Sea and containing Halfmoon Caye*” (S.I. 30 of 1982).

The **Blue Hole Natural Monument** was declared in 1996. The Blue Hole Natural Monument covers “*ALL THAT portion of the Caribbean Sea comprising approximately 1,023 acres and situate within the Lighthouse Reef Atoll being part thereof*”(S.I. 96 of 1996).

Both the Blue Hole and the Half Moon Caye Natural Monuments are natural monuments located within the boundaries of the Lighthouse Reef Atoll. The entire Atoll is not a protected area but includes spawning aggregations sites which are protected by separate

fisheries regulations. The Lighthouse Reef Atoll is located approximately 80km east south east of Belize City.

According to the Management Plan (2007-2012) for the Blue Hole and Half Moon Caye Natural Monuments, the Lighthouse Reef Atoll is one of four unique atolls in the region and considered one of the highest priority areas in Mesoamerican Caribbean Reef System (Wildtracks, 2006). These two natural monuments provide protection for fifteen species of concern under the IUCN Redlist programme, rated as critically endangered, endangered or vulnerable. (Wildtracks, 2005).

Both the Blue Hole and the Half Moon Caye Natural Monuments are co-managed by the Forest Department and Belize Audubon Society, Belize's largest non-government co-manager of protected areas. Co-management agreements were signed in 1995 for the Half Moon Caye Natural Monument and 1999 for the Blue Hole Natural Monument. An updated management plan for both MMAs was developed for the 2007-2012 period.

### **The National Park**

The **Laughing Bird Caye National Park** was first declared in 1991 to include only the 1.4 acre island and shingle island located on the windward rim of the Faro about 14 miles east of Placencia Village on the coast and 9 miles from the Barrier Reef Platform. (Friends of Laughingbird Caye, 2000) (S.I. #167 of 1991). Placencia Village lies at the tip of a long peninsula along the coast in the southern half of Belize.

In 1996 the Park boundaries were extended to include the Faro. The Laughing Bird Caye National Park is now legally defined as: *“ALL THAT portion of the Caribbean Sea comprising approximately 10,119 acres in the Stann Creek District, situate within and surrounding the Laughing Bird Caye Faro and being part thereof”* (S.I. 94 of 1996).

This marine protected area was first co-managed by the Forest Department and Friends of Laughingbird Caye which later evolved into Friends of Nature. More recently, since 2008, it is now co-managed by the Forest Department and the Southern Environmental Association (SEA). SEA is a merger of Friends of Nature and the Toledo Association for Sustainable Tourism Education (TASTE). The first co-management agreement was signed in 1996 and the first management plan was developed in 2000.

### **The Three Marine Reserves**

The **South Water Caye Marine Reserve** is the largest of the three marine reserves in the SocEG study. It covers 117,878 acres, including 32 cayes within its boundaries (S.I. 118 of 1996). However, this Reserve does not include any of these terrestrial areas which remain under the jurisdiction of the Lands Department in the Ministry of Natural Resources.

According the South Water Caye Management Plan, over the last several years, marine fish landings have declined due to the impact of hurricane and storms, but also due to overfishing, illegal fishing, economic circumstances, destructive fishing methods and lack of enforcement” (2000). Its first management plan was developed in 1993 and

updated in 2004 and 2009. However until 2009, no specific regulations were enacted to legally enforce the proposed zoning schemes for this reserve (S.I. # -- of 2009). Of the six marine protected areas, this is the only protected area which is managed by the Fisheries Department and does not have a non-government co-management partner.

The **Sapodilla Cayes Marine Reserve**, declared in 1996, covers 38,594 acres (S.I. 117 of 1996). Like the South Water Caye Marine Reserve, until 2009, no specific regulations had been enacted to enforce a proposed zoning scheme necessary for effective day-to-day management of the reserve (S.I. of 2009). The day-to-day management was the responsibility of the Fisheries Department which, from 2001 to 2008, had a collaborative co-management agreement with the Toledo Association for Sustainable Tourism Education (TASTE). In 2009, the Fisheries Department entered into a co-management agreement with the Southern Environmental Association (SEA) which has now assumes responsibility for the day-to-day management of the reserve.

The **Port Honduras Marine Reserve** is managed using a zoning scheme which was also legislated in 2000 (S.I. #9 of 2000). This reserve covers 96,731 acres and is divided into general use zones, conservation zones and preservation zones. This marine reserve is co-managed by the Fisheries Department and the Toledo Institute for Development and the Environment (TIDE). The co-management agreement for the Port Honduras Marine Reserve was signed in 2000.

## **Outcomes/Changes Resulting from Specific MMAs**

### ***Biophysical***

#### **Laughing Bird Caye National Park**

Laughing Bird Caye National Park (LBCNP) is a 100% non-extractive reserve located offshore central coast of Belize. It is co-managed by the Southern Environmental Association (SEA) and the Forest Department. Its lagoonal reefs enjoy a high level of environmental protection. Existing long-term data is high for this site. It is largely used for recreational diving and fishing. Its water quality is threatened by onshore shrimp farming. Sampling for the study occurred both inside and outside the reserve as follows: permanent site sampling (Winter 2007, Summer 2007 and Winter 2008), random surveys (Winter 2007, Summer 2007, Winter 2008 and Summer 2008).

Laughing Bird Caye National Park, is one of the few marine national parks within the network of marine protected areas in Belize. This MPA is unique in its location, protecting a small portion of the lagoonal reefs, which is known to have several endemic species. There is still little known about the structural composition of the lagoonal reefs, its habitats and species, something that the Inter-reefal mapping project started mapping. Recent water movement models suggests that there is little mixing of lagoonal and oceanic water; this would give the water from the lagoonal reefs a unique water chemistry and allow for high levels of endemism.

Because this is a national park, it is entirely closed to any form of resource exploitation. The only use this park gets is that of tourism and different research teams that have been monitoring the habitat and its species as well as trying to restore some of the lost coral species like acropora palmate. The Southern Environmental Association (SEA), previously Friends of Nature (FoN), is the NGO that co-manages the park along with the Belize Forestry Department. Laughing Bird Caye National Park is known to have an abundance of fish and invertebrates, which can be attributed to the closed area. The EcoMon project found that LBCNP is one of the few MPAs that has a high coral recruitment and also fish biomass. To what this is attributed may be a combination of management and enforcement. The coral cover is also higher than other MPA's, which was not expected if being closer to populated areas negatively affects coral cover. Not only was the fish biomass of the adult fish larger but also there is also a high abundance of commercially important fish species in the late juvenile and early adult stages (CSC project).

With only two of the field base projects of the MMAS at Laughing Bird, there is already a clear picture of how important this park is to the proper management of the BBRs. This is not even considering the other studies have been done in the park over the years, which include monitoring of bleaching events, coral framing, commercial species monitoring among other, mainly conducted the Biologists of SEA.

In the Cruise Ship Ecological Monitoring study, Laughing Bird Caye was categorized as a high visitation site where some of the operators are likely to be employing best practices. Recent coral mortality was high in 2008 (3.5%) and much lower in 2009 (<0.5%). In 2008, the most common visitor impact was broken coral followed by disease then knocked down coral and fin marks. In 2009, the only visitor impact recorded was diseased coral. A total of 13 surveys were done in the visitor behavior survey. There was a marked decrease in both intentional and unintentional behaviors from 2008 to 2009. Behaviors observed included: touching fish, touching coral, standing on coral, standing on sand, breaking coral, fin brushing, and stirring sediments.

The Laughing Bird Caye has also been impacted by shrimp trawling in the inter-Reefal channels and lies just south of the South Water Caye MMA. These results and new species discoveries has immediate and important implication for fisheries management in the channels that are adjacent to Laughing Bird Caye MMA. The management of Laughing Bird Caye will have information that suggests that management should update its management plans and fisheries managers should factor this new information and higher biodiversity and ecological into the areas that buffer the Laughing Bird Caye MMA.

- **Outcome and Changes**

Expert assessment at Laughing Bird Caye show that the park remains in good condition and the results from the MIDAS tool will serve as an important benchmark that will serve as a standard for other MMA managers. Every MMA will have varying governance, socio-economic and ecological conditions; however, in areas such as managing fishing pressure and management of non-extractive use, Laughing Caye serves an example. MMA managers can look at the Laughing Bird Caye's case and study the 'critical defining factors' and adapt strategies that are relevant to their sites. The MIDAS tool has shown that the Lighthouse Reef Atoll should continue to strive to establish a management framework similar Glover's Reef, for example. Experts modeled the worst case scenario for Lighthouse Reef Atoll which showed that it potentially can deteriorate to a "bad" state in the near future if important management measures are not instituted. It can be considered a borderline case that requires strong, strategic, and immediate action.

### **Gladden Spit & Silk Cayes Marine Reserve**

Gladden Spit & Silk Cayes Marine Reserve (GSSCMR) co-managed by SEA, is one of the few MPAs with a large yearly spawning aggregation, but still nothing close to what is was decades ago. The unique reef structure known to be preferred by aggregations of spawning fish is one of the unique features of GSSCMR. The reserve has yearly large spawning aggregations of several species of snapper and grouper, both families being important to the fishing industry of Belize. Gladden Spit's spawning aggregations also attracts Whale sharks, now one of the most successful tourism managed activity. The small islands of Silk Cayes are not spawning aggregation sites but are definitely a popular tourist destination both for diving and leisure cruises.

The reserve is not entirely closed to exploitations, but open and closed seasons are important in maintaining a balance on level of exploitation. Fin fish and tourism are not

the only benefits from GSSCMR, there is the conch and lobster extraction too. One of the good things about many of the fishing communities is that most of them are part of some sort of cooperation that helps to regulate along with the Fisheries department, the number of fishermen, boats operating, appropriate size of catch and enforcement of open and close seasons.

Several factors may have assisted the success, when compared to other MPAs with spawning aggregation sites, such as constant consultation with the fishing communities, tour guide operators and rigorous enforcement, or simply good management.

- **Outcome and Changes**

The conclusion that noise pollution created by boat has minimal impact on the activities of fish, suggests that the other 12 MMAs managed for spawning aggregations (SPAGs) are not vulnerable to this noise pollution. While Gladden Spit is the only site that has heavy boat traffic due to an associated aggregation of whale shark, other sites are seriously being considered for dive tourism. This may provide an important source of revenue for MMA management, especially those MMA that remain paper parks and lack fisheries enforcement which make those MMA's vulnerable to overfishing especially the SPAG sites at Turneffe Atoll. Gladden Spit also continues to serve as a successful case study that has demonstrated an ability to institute management controls to regulate dive tourism activity related to SPAGs. This should be seen as work in progress. The results of this study can help to support existing management activities that are essential sources of income through accepted sustainable tourism activities. The data serves as important baseline that is needed to improve and update management. This hard scientific evidence may stimulate the necessary monitoring of and continued research would build on this initial study and target the other 12 SPAG MMAs in Belize that may be used for tourism.

The training of local research counterparts is an important aspect of the SPAG study, since other sites may be interested in repeating this study in the other MMAs. However, this methods and equipment used in this study is not cost intensive and not readily available in Belize. This will have to be considered as other MMA's consider engaging in dive tourism at SPAG sites. The researchers recommend continued monitoring. The development of a monitoring protocol is still needed.

### **Lighthouse Reef Atoll**

The Lighthouse Reef Atoll is an oceanic reef system located in the easternmost territorial waters of Belize. The two MMAs located within the Atoll are non-extractive reserves with medium to high protection. Long term data levels are medium to low. Recreational fishing and diving are allowed. However, the MMAs are now threatened by cruise ship tourism. Sampling did not occur at Lighthouse Reef Atoll. A random survey was substituted at Glover's Atoll in Winter 2008.

Lighthouse Reef Atoll is the most remote reef system offshore Belize and probably the most pristine. Being far offshore definitely helps to maintain the Atoll's relatively good health, although there are other factors like sea surface temperature rise and ocean acidification that are not easily avoided. Overall the reefs and fish biomass of HMCNM

are significantly higher than the other reserves studied. One new and significant change proposed for Lighthouse Reef Atoll is the establishment of the first private marine reserve at Long Caye. This should only add to the better protection of Atoll and help it retain its high diversity.

- **Outcome and Changes**

With visitation to Blue Hole and Half Moon Caye Natural Monuments exceeding 10,000 divers per year in the recent past, the potential for one of the 3 SPAGs being used as a strategy for spreading visitor usage is very high. With the Nassau Grouper SPAG site in Northern Lighthouse Reef being assessed as a control site since there is no dive tourism at the sites sets will set a baseline of fish behaviour prior to most anthropogenic influences. With the acoustic data being analyzed, the expected results will serve as important reference for the behaviour observed at Gladden Spit. The results of this site may also serve as proxies for most of the other SPAG sites that are not being used for tourism.

The Lighthouse Reef Atoll MMAs were established for the management of land based biodiversity in the case of Half Moon Caye and unique geological features in the case of Blue Hole. With the most recent revision of its management plan for Half Moon Caye and Blue Hole, the MIDAS tool allows managers for these MMA to assess the effectiveness of management strategies. Through the use of the MIDAS tool, managers can integrate the factors across the MIDAS themes and predict outcomes that would allow managers to amend their strategies. These models were developed with expert advice including local managers. Two workshops for MMA users served to validate the utility of this MIDAS tool. A major accomplishment is the incorporation of socio-economic factors that, in general, remain a weakness in management planning across MMAs in Belize.

### **Port Honduras Marine Reserve**

**Port Honduras Marine Reserve** is located in Southern Belize. The reserve is zoned with one no-entry and three extractive zones within a patrolled region. It is co-managed by Toledo Institute for Development and the Environment (TIDE) and the Fisheries Department. Its lagoonal reefs also enjoy a high level of protection. It is being considered as a future MBRS site. Recreational diving and fishing occur in the reserve but it is faced with water quality issues. Sampling occurred inside and outside the zones as follows: permanent site sampling (Summer 2006, Winter 2007, Winter 2008), and random surveys (Winter 2007, Winter 2008 and Summer 2008).

Port Honduras Marine Reserve (PHMR) is another reserve that protects a lagoonal reef habitat. Co-managed by the Toledo Institute of Development and Environment (TIDE), PHMR is slightly different from the other MPAs in that it has a general use zone, conservation zone and preservation zone. This type of zoning is a means to better manage the resources within the MPA. Most of the conflict with fishermen is their perception of what an MPA is created for. By allowing access to fishermen to certain parts of the MPA, the fishermen can better understand the benefits accruing to them from the MPA.

The location of PHMR puts the reserve in a position where certain problems, not seen in other parks/reserves, are common. These are the illegal resource extraction by Guatemalans and Hondurans and the constant influx of polluted water from some major rivers in Guatemala and Honduras. This creates two major problems, one, the water chemistry, which is very difficult to control and even address; two, is the enforcement necessary to deal with the illegal fishing. Both problems require some type of tri-national negotiation which on itself is a problem. Even though with all these problems, the EcoMon project showed that PHMR has one of the best enforcement among the MPAs in Belize and the low fish biomass and coral cover are due to different factors such as water quality.

Conch tissue samples were taken from the Port Honduras Marine Reserve (PHMR) in 2007. PHMR is co-managed by Toledo Institute for Development and the Environment (TIDE) and the Fisheries Department. TIDE has assisted with sample collection in the PHMR. The researchers communicate and meet with TIDE representative when they are in Punta Gorda.

The MIDAS tool showed that Port Honduras remains in an “okay” position. However, MMA users need to amend their strategies, especially in response to the results of the studies mentioned above. While enforcement is effective, the stressors to the ecology that originates from outside the park and the national borders demand that different strategies be taken. Thus, MMA managers may choose to invest in governance that targets the pollution and solid waste coming across borders. The MIDAS tool would assist the MMA manager with shifting strategies and balancing effort and investment.

### **South Water Caye Marine Reserve**

South Water Caye Marine Reserve (SWCMR) is located in Central Belize and is managed by the Fisheries Department. Its barrier reef habitats have a low level of protection with light enforcement and no existing zonation. It is a recreational diving site and open to fishing. It is also threatened by shrimp farming and water quality issues. Existing long-term data is low. Sampling occurred inside and outside the reserve as follows: permanent site sampling (Winter 2007, Summer 2007 and Winter 2008), random surveys (Winter 2007, Summer 2007 and Winter 2008).

Of all the areas the MMAS worked at, SWCMR is the only one that does not have a co-management agreement or partnership with any NGO. The reserve is completely managed by the Fisheries Department, in consultation with its stakeholders. The stakeholders of SWCMR are mostly some fishing communities and several tourism operators.

As a result of mapping and ecological monitoring efforts, a portable mapping system was developed, Cobra-Tac, and this portable system should prove useful in future research work for this inter-reefal hard bottom habitat that is found in the turbid waters of Belize. A major find for this study were three (3) new species of fish. This work challenges the notion that the silt-covered, deep water channels in Belize are uninteresting, both from a biodiversity and ecological perspective.

This project created a baseline that can be used in future management and monitoring efforts and conservation value. With presentations made to the Fisheries Department representatives, it updates officials on the value of the environment that should lead to revisions in management plans for the South Water Caye Marine Reserve. Although the deep channel has been used less by the wild catch shrimp trawling industry in recent years, the mapping of the Wee Wee Caye site demonstrates the need for further study and the need for careful consideration for future uses by fisheries and the caye development businesses.

This mapping and the new species discoveries have important implications for the manager of MMAs especially for gear use of fishing vessels within the deepwater channel lagoon areas. This discoveries and mapping has increased the potential for new fish discoveries and has raised researcher interest in the area. The principal investigators of this study are actively engaged enlisting the support from NOAA and this will bring more research effort to the South Water Caye area.

The MIDAS expert model reaffirmed that SWCMR remains one of those parks in urgent need of management. With the MIDAS tool, MMA managers analyze the most viable strategies based on the existing conditions and factors that would increase the chances of success.

### **Sapodilla Cayes Marine Reserve**

Sapodilla Cayes Marine Reserve (SCMR) is co-managed by SEA and the Fisheries Department. This barrier reef site is located in southern Belize. Protection is medium with moderate enforcement but no existing zones. Recreational diving and fishing also occur in this reserve. Water quality is an issue. Sampling occurred inside and outside the reserve as follows: permanent site sampling (Summer 2006, Winter 2007, Summer 2007 and Winter 2008), random surveys (Winter 2007, Summer 2007, Winter 2008 and Summer 2008).

SCMR is the southernmost MPA along the Belize Barrier Reef System (BBRS) with similar problems like Port Honduras, but with the added pressure of tourism. This reserve like many along the BBRS was known to have large spawning aggregation sites of snappers and groupers, but this has drastically changed over the years. Constant pressures from unsustainable and illegal fishing have significantly affected the entire area.

One of the biggest problems not only found at SCMR is the loss of the predator and grazers. Not long ago, the fin fish fishing industry was primarily based off snappers and groupers, but as the numbers of these species went down, other species started to be targets. One such group of fish is the parrotfish, which are now protected until recently. This along with the issue of polluted waters from the watersheds has significantly affected the water chemistry of the southern reefs and help in the bloom of some fleshy algae. This has lead to a deterioration of the reef over the years, not only on its coral cover but also on its fish biomass and overall productivity.

In the Cruise Ship Ecological Monitoring Study, Ranguana Caye within the SCMR was categorized as a medium visitation site where some of the operators are likely to be employing best practices. Recent coral mortality was less than 1.0% in both 2008 and 2009. The most common visitor impacts in 2008 were broken coral followed by knocked over coral and fin marks. In 2009, the only visitor impact recorded was knocked over coral. A total of 14 surveys were conducted in the visitor behavior study. There was also a decrease in tourist behaviors from 2008 to 2009. Behaviors observed included: sediment stirring, fin brushing, standing on sand, touching coral, and touching fish.

The SCMR was the primary site for the queen conch genetics studies. Conch tissue samples were taken at the SCMR in 2006 and 2007. The researchers have a close working relationship with SEA. They have an open line of communication, and share methodologies and data. From a conservation standpoint, the field work at the SCMR has strong potential to test the effectiveness of a marine reserve. There are four years of pre-enforcement data, and there is strong indication that enforcement of the SCMR will begin soon.

The SCMR's SPAG site will benefit from the results of the SPAG study. Tourism continues to grow in southern Belize and this study, in effect endorses the use of these sites for sustainable dive tourism activities. As noted earlier, monitoring using equipment in the SPAG study are cost-intensive and would require local capacity building and access to re-breathers.

The MIDAS tool showed that the Sapodilla Cayes remain in an "okay" state, and worst case scenario places it at the border between "okay" and bad, according to expert opinion. This may suggest to the management organization, SEA, that it has some room to invest effort in areas that would markedly improve management without major investments. This may be some reassurance to SEA as it continues the transition to manage three MMAs.

### **Placencia Lagoon**

Placencia lagoon was an ideal coastal habitat to better study the effects of tourism, industrial development and urbanization on critical habitats for marine species. Over the years there have been several initiatives that have studied how the Placencia lagoon has changed over the years. The adverse effects on the lagoon have been at different levels and have directly or indirectly affected the biotic and abiotic components of system. It is well known that estuaries are an integral part in the management of a country's fisheries industry, but how much importance is given to this critical habitat varies from one location to the next. Just a few miles to the east of Placencia is Gladden Split, one of the most important spawning aggregation sites in Belize. If there are millions of commercially important species being spawned and there is gradually less suitable habitat for the larvae to settle, then eventually the fisheries industry will collapse. This is only one of the ways estuary habitats like Placencia lagoon can affect species that do not necessarily spend their entire life in the estuary. The lagoon also has large areas of mangrove that give a different type of service to the local community. If it was not for

the mangroves, the Peninsula would have long been washed away by yearly storms and other natural causes. The lagoon also serves as a habitat for endangered species like the Goliath grouper and the West Indian Manatee.

Placencia is an old fishing community that like San Pedro Town shifted most of its workforce to tourism over the years. Fishers first concentrated in exploiting the resources in the lagoon and eventually ventured offshore, mostly Laughing Bird and Gladden Split. Like any fishing community, the importance of having a fishing cooperative was soon realized and the Placencia Fishing Cooperative was formed. The cooperative was targeted to the extraction of fin fish, lobster and conch, the main exploited resources from Belizean waters.

### **Glover's Reef Marine Reserve**

Glover's Reef Marine Reserve is the only one of Belize's three Atolls that is entirely protected, although the reserve is divided into different types of uses as prescribed by its management plan and zoning scheme. The reserve is managed by the Fisheries Department, but is greatly assisted by the Wildlife Conservation Society (WCS). Like some other reserves GRMR has been divided into a conservation zone, general use zone and wilderness zone (similar to preservation zone). Having the entire reserve under some type of protections has allowed the management to better address some issues like the extraction of shark and some grazers like parrotfish. The entire reserve has a ban on gill nets, which helps to avoid the continued loss of catch of several species of sea turtles. Apart from these zones in the reserve it also has a few spawning aggregation sites that are closed during specific time of the year to protect the spawning Nassau grouper.

The importance of GRMR is not only on the resource extractions and not to mention the tourism, but also for research. Countless research groups and individuals have been conducting some type of study in the reserve making it one of the most studied sites in Belize. The studies conducted range from primary production to invertebrates to fin fish and even large predatory fish (sharks). The presence of WCS might be one factor for this but they have also been doing a lot of their own monitoring. Even though WCS cannot co-manage any MPA or other reserve in Belize, because it is an international NGO, this fact has not stopped them from assisting in the management of GRMR. WCS is to be credited for the fact that the GRMR is still one of the better studied MMAs and also where baseline data is readily available for new studies.

### **Ecological Monitoring**

#### **Cruise Ship Ecological Monitoring**

#### **Genetic Connectivity in Queen Conch**

## Effects of Eco-tourism on Spawning Fish

Belize has been proactive in protecting aggregations by placing 11 such sites into marine reserves. The availability of funding for enforcement and compliance has been varied to date, although Gladden Spit Marine Reserve remains the best-protected aggregation in the country. This is due, in part, to the extensive tourism operations based there; resulting in links between the spawning aggregation, resource protection efforts and the income flow from a seemingly responsible tourism industry. Some ex-fishermen are involved with the research, monitoring, enforcement, and tourism operations there. This involvement reduces the community level negative economic impact of closing the banks to fishing. As a result of the economic opportunities, there is pressure in Belize to open all protected spawning aggregation sites to diving. It is critical, therefore, to determine the possible impacts of ecotourism to ensure that the industry helps to conserve the aggregations, rather than disturb them.

*The main objective of this study was to determine the ecotourism impacts of dive tourism, on commercially important coral reef fish during their spawning aggregations.*

One of the sites selected for study was the Lighthouse Reef Atoll which has one of the largest Nassau Grouper aggregations at the Northern Two Caye spawning aggregation site. This site was compared with data collected from the Gladden Spit Marine Reserve which has relatively high dive tourist visitation during the whale shark (*Rhynchodon typus*) feeding aggregation. The whale shark aggregation at Gladden Spit is associated with spawning aggregations of Mutton, Dog and Cubera Snappers.

Spawning aggregations are being used or considered for ecotourism in a variety of places around the world including Belize, the Bahamas, the Cayman Islands, the Great Barrier Reef in Australia, and Indonesia. It appears that divers are willing to pay more to see the large breeding individuals that use spawning sites. Given the high cost of marine reserve management and the relative adventurous nature of diving on spawning aggregation sites, a steady stream of eco-tourists is considered a possible way to raise funds to support protection of these sites. Additionally, providing services to the eco-tourists can be an economic alternative for fishermen and a way to generate funds lost due to closure of fishing. If, however, tourism activities damage the resources and negatively affect the breeding fishes, the strategy fails and the spawning aggregation remains at risk.

Initial surveys of dive tourists conducted at Gladden Spit in Belize during May 2006 indicated that tourists have an interest in spawning aggregation tourism. Several dive guides who presently offer whale shark tourism at Gladden (including Brian Young) and in Belize it was found that diving tours targeting spawning aggregations is not a common practice yet. Several respondents thought that it might be worth trying dive tours for spawning aggregations. Fishermen were generally wary of the idea – as they believe that the divers do disrupt spawning behavior and chase the fish away. Some fishermen were interested in the idea of limiting sport fishing at aggregation sites – another economic alternative to commercial fishing.

Phil Lobel recorded the sounds of boats and divers on the aggregation site with the Lobel's custom video-acoustic underwater recorders and also recorded were the courtship sounds of Cubera snapper. He collected these data using a state-of-the-art re-breather to eliminate his own bubble sounds. He recorded fishes while they were gathered in pre-spawning groups near the bottom at depths of about 100ft and while they were spawning up in the water column nearer the surface. He found that the snappers did produce two distinctive sounds. One sound appears associated with the startle response to a diver and the second is a pulsed-series sound that may be associated with the courtship behavior. The data indicate that Cubera do indeed make courtship sounds – a new finding. The acoustic data are presently being analyzed and characterized for publication.

Sounds were collected underwater while three boat engine types/sizes operated overhead. These were dive or research boats that are commonly use the area. The findings suggest that courtship sounds from pre-spawning fishes may be masked by the sounds of engines from boats on the surface. However, underwater visual observations of suggest that spawning seems to be either unaffected, or only marginally affected. The acoustic data associated with these boats are presently being analyzed in relation to the sounds of courtship.

### **Inter-Reefal Habitat Mapping**

The mapping of the nature and extent of the constituent habitats and occupant species in and around MMAS is important for understanding the biodiversity and potential management concerns for benthic disturbance. Using a portable and easily deployable Side-Scan Sonar and Acoustic Doppler Topographic mapping survey devices, the team was able to map and profile a site within one of the least managed planning zones delineated by the Coast Zone Management Authority of Belize, the Dangriga/Tobacco Caye Zone. The study area was located in the inter-reefal mangrove caye and lagoon complex, and focused on a site the **South Water Marine Reserve** in southern part of Belize located in the Meso-American Barrier Reef (MABR). Inter-Reefal being the term used by the team to refers to the area that lies between the forereef and the mainland and mangrove habitat that has little coral reef if any.

As a result of mapping and ecological monitoring efforts, a portable mapping system was developed, Cobra-Tac, and this portable system should prove useful in future research work for this inter-Reefal hard bottom habitat that is found in the turbid waters of Belize.

A major find for this study were three (3) new species of fish. This work challenges the notion that the silt-covered, deep water channels in Belize are uninteresting, both from a biodiversity and ecological perspective.

The products of this study were the following:

- i. Three (3) new reef fish species discovered in a small, site-specific study of the Belize inter-reefal habitat that suggests high potential of more discoveries. This work has contributed to five (5) published papers to date with several more in press. Three additional new fish species from this area are in the process of being

described. There is the strong possibility of the discovery of additional undescribed fishes in this same unique habitat in Belize.

- ii. This research assembled a unique portable “suitcase” deployable mapping system named Cobra-Tac (side-scan sonar and acoustic Doppler with features for remote field operations). This system may now be used from any small boat to map areas of interest for marine conservation. A working Standard Operating Procedure manual was also developed.
- iii. A bathymetry map of bottom and slopes was generated from surveying the area of particular interest. This is a deep stretch of lagoon between the coast and the first ridge of mangrove cays (e.g. Blue Ground Range) in the Southwater Marine Reserve Area. The discoveries and mapping success has raised the team’s interest in pursuing further research in this area.

Deliverables included:

- Guidelines for assembling appropriate data acquisition technologies for mapping inter-reefal environments.
- Presentation on Inter-reefal mapping that can be broadly used by MMAS practitioners.
- Publication or product to communicate the value of inter-reefal areas and the need for the inclusion of these areas with MMAs.
- A database of the mega-habitat details which would be made available for all MBRS participants, by depositing the data with Belize Coastal Zone Management and the University of Belize, and by sharing the results with other organizations working in this region(see stakeholder described above).

Other Activities and Deliverables

- A GIS based data-base and hard-copy images of structural characteristics of inter-reefal environments of the Abrolhos region and digital and hard copy maps of shallow water corals derived from aerial photography.
- Detailed GIS maps with the main ecosystems, protected areas and fishing territories indicated. These will be used for MMA planning and design.
- The maps and data were to be used guides for guide the ecological monitoring and base habitat maps for GIS analysis of the resulting data.
- Deliver presentations to given to local fishers, tour guides and other non-technical audiences e.g. Tourism, Fishing. This presentation was also intended to be distributed widely and used in stakeholder consultations.

Key MMA management organizations were consulted regarding the project plans and goals. The government institutions consulted included the Fisheries Department (FD), the Coastal Zone Management Authority and Institute and the Belize Tourism Board. Local NGO MPA co-managers include Friends of Nature (FON), Toledo Institute for Development and Environment (TIDE) other key organizations consulted were Association of Protected Areas Management Organizations (APAMO), an important national policy advocacy organization; fishing cooperatives and the University of Belize.

## **Marine Integrated Decision Analysis System (MIDAS)**

Belize has 13 % of its lagoonal area under some form of protection, but this is less than 5% of its territorial marine areas. In the recent past, the Government of Belize placed a moratorium on the creation of more MMAs, suggesting a loss of confidence in the utility of MMAs. Management effectiveness assessment is critical for demonstrating to policymakers and other stakeholders the advantages and disadvantages of MMAs. Understanding the performance of MMAs is not only important to gaining stakeholder support, but also enables managers to improve management. If managers are to be effective in meeting their objectives, they need to know how well they are doing and how they can improve design and management. In addition, as more information becomes available on the effectiveness of MMAs, policy-makers, managers, and community members need convenient access to that knowledge base as they consider the development of new MMAs.

The tools in this study follow are preceded by similar of tools such as the MARXAN which was applied and integral to the analysis and long term planning for Belize's protected areas system. MARXAN contributed to the development of the National Protected Area Policy and System Plan for Belize in 2005. MIDAS builds on the use of spatial and statistical tools for management planning by providing a user friendly tool that can be used by MMA managers. This contrast with previous tools that required advanced technical expertise in spatial and statistical modeling.

The main objectives of this study were to:

1. determine the socioeconomic, governance and ecological effects (outcomes and outputs) of MMAs;
2. determine the critical factors (ecological, socioeconomic and governance) affecting MMA outcomes and outputs, as well as the impact of the timing of those factors on the outcomes and outputs of the MMA;
3. provide management tools for predicting MMA outcomes based on ecological, socioeconomic and governance variables.

The research team at Boston University used quantitative and qualitative data (gathered by other team members) and incorporated them into two versions of a model, which provides MMA managers with valuable tools for predicting the effects of MMAs under different circumstances. The Marine Integrated Decision Analysis Software (MIDAS) is a piece of software that captures the insights gained from the Global Management Effectiveness (GME) activity (factors that influence how successful an MMA will be) in the form of a laptop decision tool for managers. The second model (the "research model") is a research tool at the very core of the MMAS Program as a whole: a GIS based integrated modeling environment that is essential for both measuring and predicting how local management action can make a difference in marine conservation.

With expert input on the statistical model from the research team (Bob Pomeroy/Tammy Campson/Craig Dalhgren), more theoretically/scientifically valid relationships between indicator variables and MMA outcomes were developed. The analysis of survey and ecological data determined coefficients which represent the incremental effect of a

change in an independent variable (a ‘critical determining factor’ (CDF) or other variable) on a dependent variable (an outcome). This analysis helped create more accurate models. Another feature is the availability of user defined variables that can be changed to allow a user to input values based on more accurate or current data. This allows the user to more accurately predict outcomes based on recent changes in conditions.

Key components within the software are CDFs that form variables under the three major themes: Governance, Ecological (condition) and Socio-Economic (condition). MIDAS helps MMA users and managers in understanding the critical factors that influence MMA effects. This empowers managers to plan accordingly and helps managers to estimate likely MMA effects based on the ecological, socioeconomic and governance conditions. These predicted outcomes will help advise management plan revisions that will result in optimization of outcomes and outputs.

The team integrated a spatial model (the “research model”) developed by Suchi Gopal and her team that was particularly useful in illustrating the harmful effects potential an oil spill in Belize. This demonstrated the accessibility of the software in terms of the ease of use and operating software. It also reinforced effectiveness of MIDAS products as communication tools.

### ***Socio-economic and Cultural [3pp]***

Of the three marine reserves in the study, 53% of users of the the Sapodilla Cayes Marine Reserve, 46% of users of the Southwater Caye Marine Reserve and 42% of users of the Port Honduras Marine Reserve use these to earn an income. The main use of the Port Honduras Marine Reserve was stated as recreational (71%), followed by to obtain food for the family (15%). For the other two marine reserves, 49% and 15% of users of the Southwater Caye Marine Reserve and the Sapodilla Cayes Marine Reserve stated that they used the marine resources to obtain food for the family.

The above resource use pattern shows that the marine resources are used for their non-monetary and existence value as well as for their direct economic value. Direct economic value comes from using the resources for food self-sufficiency as well as a source of income. Based on the current trend, resource users across the five marine protected areas have a high level of reliance on resources within marine protected areas to both earn a living and obtain food for the family. However the marine protected area with the highest levels of economic reliance was the Lighthouse Reef Natural Monument.

### **Changes in Marine Resource Use Patterns since 1998**

Resource users reported an increase in the use of the fisheries in all five marine protected areas, except for the Laughingbird Caye National Park. There was also an increase in the use of the fisheries in other sites not included in this study. Similarly, there was a reported increase in the use of the beaches, mangroves, plants and corals across sites, including the Laughingbird Caye National Park.

Although there were mainly increases in uses of the marine resources, there was a slight change in the pattern of resource use across marine protected areas. There was a shift in daily fishing to seasonal fishing for all sites studied.

Local fisheries users of the Lighthouse Reef Natural Monument reported fishing more on a weekly, monthly and seasonal basis than daily as they did ten years ago. However, this resource use pattern still shows an overall increase in the number of fishers using this marine protected area. Those engaged in weekly fishing increased by 50% while those engaged in monthly and seasonal fishing increased by 42% and 32%, respectively, over the last ten years. This change is attributed to an increase in commercial fishers from Sarteneja, Chunox and Copperbank.

The respondents reported a dramatic reduction in daily fishing of the Southwater Caye Marine Reserve compared to ten years ago. There was no change reported in weekly fishing and a slight increase in monthly fishing. However, there was an increase in seasonal fishing by 21% or 121 fishers. There was more than a doubling of fishers who fish annually (from 20 to 49 fishers).

The respondents reported a significant decrease in their daily use of the Laughingbird Caye National Park and a slight reduction in weekly use. However, there was also a slight increase in monthly and seasonal fishing within the National Park. There was no change in annual fishing.<sup>5</sup>

The respondents reported no daily use of fishing in the Sapodilla Cayes Marine Reserve. They also reported decreases in weekly and monthly fishing and a slight increase in seasonal fishing. There was no notable change in annual fishing patterns. Users of the Port Honduras Marine Reserve indicated that a reduction in daily, weekly and monthly fishing and an increase in seasonal fishing from 4 to 41 fishers. There was no reported change in annual fishing patterns.

Fishers using “other” sites not included in this study reported a reduction in daily and monthly use and an increase in weekly, seasonal and annual use of the fisheries.

Overall the number of fishers using the five marine protected areas and in other sites has not decreased since 1998. However, fishing patterns changed from daily use to more weekly, monthly and seasonal use. This change may be partially attributed to the adoption of fisheries regulations for the fishing of conch and lobster. These regulations

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<sup>5</sup> The Laughingbird Caye National Park is a no-take zone. However this legally covers only the Laughingbird Caye and not the marine waters surrounding the cayes. Therefore, fisheries extraction can legally take place within the one mile radius of the Caye, even though in practice, this is to be observed as a part of the National Park.

placed seasons or specific dates within with lobster and conch can be fished within and outside of marine protected areas.

### Current Fisheries Extraction Patterns

Across the five marine protected areas, snapper stood out as the fish most harvested by those who use marine protected areas. Almost equal numbers of users of the Lighthouse Reef Natural Monument harvested snappers, conchs and lobsters. Users of the Laughingbird Caye National Park harvested mainly snappers, lobsters, conchs, and to a lesser extent goliath groupers. The pattern for the harvesting of sharks, mackerels and sea crabs was similar for these two marine protected areas.

<b>Marine Resource Users Engaged in Fishing by Type of Fish Harvested</b>									
<b>Community fisheries resource users</b>	<b>Snapper</b>	<b>Conch</b>	<b>Lobster</b>	<b>Goliath Grouper</b>	<b>Snook</b>	<b>Shark</b>	<b>Turtle</b>	<b>Mackerel</b>	<b>Sea Crab</b>
<b>Corozal District</b>									
<b>Chunox =264</b>	153	195	188	0	0	7	0	7	0
<b>Copperbank=113</b>	113	113	113	0	0	0	0	0	0
<b>Sarteneja=593</b>	483	558	558	338	90	69	0	62	200
<b>Stann Creek District</b>									
<b>Dangriga =1,893</b>	1820	655	558	510	437	849	194	1019	1019
<b>Hopkins=299</b>	299	131	121	163	110	136	37	210	142
<b>Sittee River=63</b>	56	0	0	7	42	7	0	28	0
<b>Placencia=207</b>	202	161	161	46	29	12	6	121	52
<b>Seine Bight=89</b>	89	30	30	20	59	39	20	69	20
<b>Independence=262</b>	218	9	9	17	61	26	17	96	26
<b>Toledo District</b>									
<b>Monkey River=71</b>	71	60	64	34	41	4	4	34	15
<b>Punta Negra=11</b>	11	5	5	5	7	2	5	7	0
<b>Punta Gorda=512</b>	512	90	90	51	218	90	26	167	77
<b>Totals</b>	<b>4,027</b>	<b>2007</b>	<b>1897</b>	<b>1191</b>	<b>1094</b>	<b>1241</b>	<b>309</b>	<b>1820</b>	<b>1551</b>

Because Southwater Caye Marine Reserve is the largest of the five marine protected areas and has the largest population of resource users, it also has the most respondents engaged in fisheries extraction. Within this reserve, the primary harvest was snappers, followed by lobsters and conchs. There were similar extraction patterns for goliath groupers and mackerels, followed by sea crabs, sharks and snooks.

Within the other two marine reserves, the fishing extraction patterns for snappers, conchs, lobster, goliath grouper and snooks were similar. However, there were slightly higher numbers of resources users from the Sapodilla Cayes Marine Reserve than the Port Honduras Marine Reserve, who reported fishing mackerels, shark and sea crabs.

There was some turtle extraction reported by users of all five marine protected areas, although only 2 users from the Sapodilla Cayes Marine Reserves stated that they fished turtles. Those who extracted turtles were mostly users of the Port Honduras Marine Reserve (57 resource users) and the Southwater Caye Marine Reserve (49 resource users). Within the Lighthouse Reef Natural Monument and the Laughingbird Caye National Park, turtles were being harvested by 37 and 34 resource users, respectively.

Overall, Dangriga had the largest number of respondents who use the fisheries resources (1,893 respondents). The second and third largest groups of fisheries extractors came from Punta Gorda and Sarteneja with over 500 respondents each who engage in fisheries extraction. Chunox, Hopkins, Placencia and Independence all have over 200 respondents who engage in fisheries extraction practices.

Fishers from Chunox and Copperbank reported that they only harvest snappers, conchs and lobsters, while Sarteneja fishers harvested these as well as goliath groupers and sea crabs. To a lesser extent, Sarteneja fishers also indicated that they harvest snooks, sharks and mackerels. None of these northern communities reported harvesting turtles. Fishers from Dangriga and Hopkins reported similar fishing patterns. They harvested all types of fish but focused primarily on snappers, mackerels, sea crabs and sharks. To a lesser extent, they fished conchs, lobsters, goliath groupers and snooks. Fishers from both communities also reported harvesting turtles as do fishers from all the participating communities from the Stann Creek and Toledo District, except for Sittee River.

Placencia and Monkey River fishers stated that they fished mostly snappers, conchs, lobsters and mackerels. To a lesser extent, they harvested goliath groupers, snooks and sea crabs. A few fishers also reported harvesting shark and turtle.

Seine Bight, Punta Negra and Punta Gorda fishers fished mostly snappers. They also harvested mackerel and snooks and to a lesser extent all the other types of fisheries resources.

While fishers in most communities harvested mostly snapper, fishers from Chunox, Copperbank, Sarteneja, Placencia and Monkey River also reported that they focus of harvesting conchs and lobsters. Although fishers from Dangriga do not harvest mainly conchs and lobsters, they still remain the single largest group of conch fishers in the survey sample. Dangriga and Sarteneja reported equal numbers of lobster fishers.

### **The Effect of the Marine Protected Areas on Marine Resource User Patterns**

Based on the data, the establishment of marine protected areas has not had any major effect on the marine resource use patterns of marine users in the twelve stakeholder communities. The findings indicate that:

- Contrary to the objectives for the establishment of marine protected areas, either as conservation areas or as sustainable use zones, marine resource users of the five marine protected areas report a higher level of economic reliance on activities conducted within marine protected areas than “other” areas. Resource users also indicated a high a level of reliance on resources within the five marine protected to either earning a living or for food self-sufficiency compared to “other” sites.
- One of the stated objectives<sup>6</sup> of engaging in tourism related development activities is to reduce fishing pressure on marine resources while providing local communities

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<sup>6</sup> Key informants from Sarteneja, focus group interviewees from the Toledo Institute for Development and the Environment (TIDE) and the Toledo Association of Sustainable Tourism Education (TASTE)

with access to alternative sources of income. While tourism related economic activities have contributed to a reported improved economic situation for tour guides, boat drivers, divers, and hotel and restaurant workers, this has not necessarily reduced human pressure on marine resources. Tour guides report that they continue to use marine protected areas for tourism as well as for fishing to supplement their income. Furthermore, the increased traffic of tourism in marine protected areas has, instead of reducing the human footprint, added a new set of pressures that must also be managed.

- Furthermore, none of the five marine protected areas have demonstrated a significant change in marine resource use patterns, except for a change from daily to mostly seasonal fishing. However, the numbers of fishers who use these sites continue to increase rather than decrease, resulting in increased pressure on marine resources within marine protected areas. This finding is supported by fisheries data that record an increase in the provision of fishing licenses awarded since 2000.

### **Economic Valuation – GSSCMR**

Original economic valuation research conducted in a marine protected area (MPA) in Belize identified and measured the major economic values generated in 2007. Coral reef marine protected areas (MPAs) protect ecosystem services that directly and indirectly contribute to the welfare of people, both nearby and far away. This means they can be a prudent investment in the context of widespread marine pollution, ocean acidification and water temperature increases, which threaten these fragile ecosystems. Economic valuation can be used to inform donor and policy makers of the ranges of values which coral reef ecosystems and their protection generate. Lack of information typically results in under-investment in reef conservation and an under-appreciation of the negative impacts that habitat loss will have on stakeholders, their values, and the local economy.

Management of the GSSCMR has enabled this MMA to support many values which produce welfare gains enjoyed by people in the villages near the reserve, Belizeans in other parts of the country and by the international community. Non-use value constitute a significant part of this value, demonstrating the importance visitors place on making sure these areas persist for future generations, as do local community values. Indeed visitors, whose values are most frequently measured in the literature, only make up 21% of the values measured here. Omitting non-use and local community values, as other research has done, would have led to a serious underestimate of the true value of this reserve, which could result in too little investment.

This reserve generated over US\$4 million in net economic values in 2007, which is equivalent to US\$41-93 million over 25 years (depending on the discount rate applied). These values are likely to be an underestimate of the total economic value, as there are values such as marine life nursery functions, waste assimilation and consumer and producer surpluses gained in other nearby community values which have not been included due to time and budget constraints. Important, over time these, the value of high quality coral reef habitat would be expected to increase sharply, due to increasing wealth and degradation of other reef areas.

Gladden Spit is similar to other MPAs, which could be expected to have broadly comparable economic values. However the spawning aggregations that occur there and the whale shark aggregations that come to feed on the spawn make this area unique and add a significant proportion to the reserve value. This special feature of this case study MPA needs to be protected, with access to fishing and whale shark interactions limited to ensure that future benefits are not lost in the future. Many tour operators are able to remain open and employ staff in part due to the whale shark and day trips to the reserve. The limited access to fishing during spawning aggregations and tour trips during the whale shark season also result is also likely to be a key factor in determining the magnitude of producer surpluses we measured for local fishers and tour operators. The economic impact of the reserve could be extremely large, as it includes revenues from tourism and recreation such as those relating to international and local travel, restaurants, hotels, gift shops, insurance, sales of dive gear, boats as well as materials and labour for tourism development. It also includes revenues from fishing related activities such as fisheries permits, fishing gear and boat equipment. These revenues have a direct and indirect impact on the local and regional economy and supports a large number of jobs, usually to Belizeans. This economic impact is additional to the net values reported in this research.

The values we estimate for the Gladden Spit Marine Reserve should be important when considering policy actions. Whilst demand curves have proven unreliable in practise at some sites, we have demonstrated that current fees do not capture a large proportion of visitor consumer surplus and could be raised if increasing revenues was a primary goal of the MPA (e.g. to improve the self-financing capacity of the reserve). Also, this MPA could raise significant extra funds through an increased departure taxes for non-visitors, who in aggregate have the largest values for this reserve. In 2007, a portion of the user fees collected were being returned to the Belizean government. We demonstrate that the GSSCMR generated almost US\$1million in welfare benefits for Belizeans in 2007 and consumer surplus values that local residents gain per individual are greater than those of tourists. Furthermore, local residents receive many secondary benefits from the tourism and fisheries benefits that are generated by the marine resources in this reserve. The role of the reserve in maintaining community welfare should be used to maintain government support for this area and to justify keeping these funds for management.

Historically, financial support for reserve management has been made possible through government funds (which have been raised partly through a tourist departure tax) and through the support of international NGOs and foundations. In this report we provide evidence that MPAs such as the Gladden Spit Marine Reserve are likely to be a net beneficial use of national and international funds, both in terms of conservation of habitats and biodiversity and in terms of the secondary welfare impacts they produce, since for a relatively small investment they protect resources with large net economic benefits. Currently management costs are only 12% of the values measured for 2007, suggesting that this reserve is an efficient investment of conservation funds and tourist dollars. The survey tools that have been developed here can be easily used elsewhere. We recommend that such studies include both local community and non-use values. This

would help to identify economic values which should be the focus of management actions and of policies to raise funds from beneficiaries or polluters.

Contingent valuation proved to be highly flexible and intuitively simple to understand, especially as existing markets were often used. The methods used here have been successfully applied to enable quantification of these values and they could be used as MPAs elsewhere, to do the same. We have presented the values separately, as the values measured differ in terms of units, time periods and in terms of the level of confidence in their precision. The given precision determines the confidence with which we can specify the magnitude of values. Specifically, non-use values are difficult to measure accurately. Community values were also more uncertain, possibly due to the unfamiliar nature of hypothetical questions and the payments required. The values quantified in this research were all measured net of costs. Gross values (often reported in other studies) are much larger but overstate the true economic value of the resources.

The values measured are unlikely to persist unless effective management remains, since reefs in the Mesoamerica region have suffered serious declines and remain threatened by overdevelopment, pollution and other stressors. Indeed, these estimates make clear the potential economic losses that could occur, which would reduce the welfare of local stakeholders through impacts on tourism and fishing. The maintenance of the current values depends to what extent these reefs are protected from overfishing and overuse, including by tourists, which can also contribute to reef resilience, which will be increasingly tested by warming and acidifying seas. Effective management depends to a large extent on adequate financial support. In addition, further funding would be likely to result in better enforcement, research and community outreach, which could increase the value of this reserve even further.

## **Summary Observations Across the Community Studies**

### **Cultural History**

The most prominent cultural aspect across the four communities is ethnicity: Sarteneja is characterized by Mayan and Mestizo heritage, Hopkins and Seine Bight by Garifuna heritage; and Planencia by Creole heritage. Because of historical circumstance (storms, erosion) Hopkins is a relatively young community compared to the others. Such circumstances (hurricanes) serve as “cultural markers” for the communities. All have local religious and community festivals marking significant cultural and historical concepts and events.

### **Community Structure and Organization**

All four communities have local Village Councils in addition to other civic and commercial organizations, and various ties to the central government and political structure. All have some history of fishing cooperatives, although this varies significantly among the communities and in general the cooperatives have been less than stable. Ethnicity, kinship and religion play a strong role in the social organization of all four communities. Placencia has the strongest involvement with both local and outside marine-related NGOs.

### **History and Practice of Fishing**

Of the four communities Sarteneja is involved the most in migratory fishing all along the Belize coast, and in diving for commercial fishing. Placencia has the shortest social history of fishing, and has undergone the most complete transition from subsistence and commercial fishing to the leisure-tourism economy. Seine Bight has the least historic involvement with commercial fishing. Hopkins lies somewhere in the middle on these parameters. None of the fishers from the four communities except Sarteneja historically travel very far from their home communities to fish, except to fish at Gladden Spit for snapper during the spawning season. Sarteneja is the only community where the number of commercial fishers (although not the number of boats) has increased significantly.

### **Involvement with MMAs**

Fishers from all four communities state that they see the value in MMAs, although they would like to be more included in the decision-making and management process and often differ in how to manage the increased resource provided by the MMAs. Where the community has been involved in the establishment of MMAs, as in Placencia, that involvement is seen as diminishing over time.

### **Changes Accompanying the Establishment of Marine Reserves**

None of the four communities report significant impacts from the establishment of the Laughing Bird or Gladden Spit MMAs. This is largely due to the multiplicity of fishing sites within Belizean waters, the general lack of territoriality that allows flexibility in where to fish, and the ability to “fish the line” just outside of the closed areas. Most fishers commented, however, on the negative cumulative effect of the establishment of so many MMAs in Belize waters. All commented on the importance of the ‘multiple-use’ aspect of Gladden Spit, in particular the allowing of fishing on the smaller spawning aggregation, although there is also some feeling that this is not a good conservation practice.

### **Other Forces affecting the People and Communities**

All four communities have been affected significantly by the development of the leisure-tourism industry; by the development (or lack) of infrastructure such as roads; by the trends in labor alternatives such as timber and fruit; and by in-migration from neighboring countries.

## ***Institutional/Governance [3pp]***

### **The Protected Areas Designation and De-reservation Process**

The arbitrary nature of declaring and de-reserving protected areas was recognized as a major issue the National Protected Areas Policy (2005). All protected areas legislation, including the National Parks Systems Act and the Fisheries Act completely cede authority to the Minister in the establishment of these protected areas. Because no specific objective guidelines were ever developed or provided for in the legislation, the experience of declaring protected areas, including marine protected areas has been ad hoc and subject to the “discretion” of the Minister (Ching, 2005, Horwich, 2005, Young and Horwich, 2007). According to Ching (2005), this ad hoc and subjective process affects

long-term planning and sustainable funding for protected areas in Belize. It can also, at any time, legally strip non-government co-management partners of the very raison d'être for their existence.

### **Co-Management Agreements – Like “Spitting in the Wind”**

In a previous management effectiveness study of marine protected areas in Belize non-government managed protected areas scored higher than those considered “semi-autonomous” and those managed solely by Government authorities (McField, 2000). Management effectiveness was therefore influenced by the type of management structure established to ensure the day-to-day management of the marine protected area. Co-management agreements between government and non-government agencies were therefore a key element of management effectiveness.

Since then, it has been widely accepted among managers<sup>7</sup> that NGO co-management agreements were contracts allowed under existing protected areas legislation. However, the experience of SATIIM, a community based organization exposed the fragile nature of co-management agreements in Belize.

In 2006, SATIIM, a NGO which co-managed a terrestrial protected area under the National Parks System Act, challenged the Government in the issuance of a permit to conduct seismic testing for oil within the boundaries of the National Park.<sup>8</sup> In his ruling the judge observed that under the National Parks Systems Act, an “administrator” may be appointed by the Public Services Commission, for each national park, nature reserve, wildlife sanctuary and natural monument but that no such “administrator” had been so appointed by the Commission. (Marin-Young, 2009). The judge recognized that there was an agreement made between the Forest Department and the SATIIM who acted as a co-management partner but pointed out that this was not grounded in the legislation governing National Parks. (Marin-Young, 2005).

To date there is still no legal foundation for co-management in Belize. In fact, Mrs. Marin- Young’s legal review of the co-management framework concludes that co-management agreements:

*“are loosely and sketchily drafted agreements with ambiguous and perambulatory language, that ill-define the obligations and duties of the parties thereto. The very foundation of the co-management agreements is questionable, since the NPSA envisioned the appointment of an Administrator for each protected area and not the contracting out of the management of protected areas. Some of the provisions in the co-management agreements are ultra vires the NPSA and the FIA and are thus invalid. (Marin-Young, 2009).*

Her review made similar conclusions regarding co-management agreements entitled “Memorandum of Understanding” between the Fisheries Department and their non-

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<sup>7</sup> Interviews with the managers of all six marine protected areas included in this study.

<sup>8</sup> In SATIIM vs. Forest Department, Ministry of Natural Resources, Supreme Court of Belize claim number 212 of 1996

government co-management partners. In this case, the Act empowers the Fisheries Administrator, who is a senior public officer, to administer all marine reserves and “*does not contemplate that the management or administration of these marine reserves would be delegated to any third party or that it would be contracted out*” (Marin-Young, 2005, pg. 15).

More specifically, the review pointed out the need for these “Memoranda” to be framed in more concrete and definitive language to ensure that the roles and responsibilities of the co-management partners are clear. (Marin-Young, 2009). In particular, she demonstrated that responsibility for the day-to-day management of a marine reserve does not mean enforcement “as this would conflict with clause reserving enforcement to GOB” (Marin-Young, 2005).

Most poignant, however, was Marin-Young’s exposure of the fact that although co-management agreements may exist and may be strengthened, the power of the Minister to revoke the declaration of any protected area can frustrate any agreement for the co-management of a protected area, without provision for compensation to the non-government co-management partner and without any clear process for arbitration in case of conflict (Marin-Young, 2005).

With this sobering realization in hand, the Association of Protected Areas Management Organization (APAMO) perseveres in advocating for the strengthening of the legislative framework governing the co-management of protected areas in Belize. (Alonzo, pers. Communication).

### **Jurisdictional Cross-Overs: Compromising the Value of “Protected” Areas**

As stated in Ching (2005), the different Acts that govern protected areas and natural resources make for a disjointed and at times inconsistent legislative framework. Each of the Acts are accompanied by separate regulations developed over a number of years and by different Ministers responsible for the enforcement of these Acts.

There is a resulting high level of interagency dependence due to jurisdictional limitations that almost always overlap. This creates confusion regarding roles and responsibilities as well as creates gaps in protection. This is evidenced in the case of the Southwater Caye Marine Reserve. The Fisheries Department has limited or no legal jurisdiction over development on the cayes within the Reserve as these remain the purview of the Lands Department in the Ministry of Natural Resources. The situation is similar for Forest Department which has legal jurisdiction over natural monuments and national parks but have limited or no jurisdiction over marine waters which are under the legal authority of the Fisheries Department. Still yet, the Forest Department, has no legal jurisdiction over marine dredging which lies with another Department within that same Ministry. The result is that the various laws work at cross-purposes, putting at risk the very resources that were stated to be so much in need of “protection”.

In the case of the South Water Caye Marine Reserve, the 2003 Management Plan states:

*“Some of the many lease and grant holders may clear mangroves on Tobacco Range without realizing the importance of the habitat to fisheries. Lands department may issue licenses without a clear idea of the importance of these mangroves”. ( ? , 2003, pg.40).* Rather than this situation being arrested given the “protected” status of the reserve, it has escalated. Large scale development is now taking place on the Pelican Cayes also located within the boundaries of the Reserve. In fact, according to the Management Plan (2003), the Pelican Cayes were included in the list of threatened sites because of their *“unusually rich biodiversity and the fragility of some of their creatures.” (pg. 1).* Yet, in 2009, this same caye became the focus of international attention as it demonstrated the low level of government support for the Belize Barrier Reef System World Heritage Site which includes the South Water Caye Marine Reserve with all the islands located within its boundaries.

In March 2003, the islands of the Pelican Cayes were covered with mangroves but clearing had already begun. By April, 2006, there were clear signs of increased mangrove clearing to accommodate large scale development and by April, 2007, the situation had become so critical that mangrove clearing and cayes development were listed as one of the three most serious threats to the South Water Caye Marine Reserve (Wildtracks, 2009).

The situation at the Pelican Cayes raised serious concern at the World Heritage Centre regarding the status of the Belize Barrier Reef System World Heritage Property. An IUCN mission to Belize (March 23-28, 2009) reported that:

*“The main impression is that an excessive amount of development has been going on within the mangrove islands of the site. The government appears to be managing mangrove islands as unprotected national public lands, and not as part of the World Heritage Property. As a result, the government has been selling and leasing mangrove islands ...the business-as-usual scenario cannot continue without irremediably compromising the property’s Outstanding Universal Value. This situation is especially clear in South Water Caye Marine Reserve...” (Muller and Patry, 2009, pg. 3)*

In particular, the mission report reiterated the conclusion of those who have reviewed protected areas legislation in Belize since 2000. The current legislative framework and its rate of implementation or enforcement is not adequate for effective protected areas management, including management of the Belize Barrier Reef System World Heritage Property. (Ching, 2005, Horwich, 2005, Marin, 2009, Huller and Patry, 2009)

## **Governance**

Overall, the Natural Monuments and the National Park report having more adequate governance structures than do marine reserves.

Of the sites included in the study, one did not have a co-management partner and so did not have the need for a Board of Directors. The management was being implemented by the Fisheries Department, with the input of an Advisory Committee comprised of local stakeholder representatives.

The management arrangements established for marine reserves require the Fisheries Department to play an active role in the management of marine reserves, even when it has a co-management partner. This is not the case for Natural Monuments and National Parks which have a greater level of devolved responsibility for the overall management of these types of protected areas.

### **Human Resources**

There is limited management capacity or experience within the organizations and in some cases weak governance structures and processes placing unnecessary pressures on already limited resources. Overall, this has had a direct impact on the management organization's capacity to implement its management plans.

The financial limitation at the national level has impacted site level financial stability and this has translated into inability to attract and to retain highly qualified, experienced staff. It has limited the ability to develop and staff much needed programs such as advocacy, education, outreach<sup>9</sup>, and the ability to purchase necessary equipment. In four cases, the management organizations reported that they had between 25% and 50% of the necessary technical, scientific and professional workers available to implement their management plans. As a result, many professional functions could not be carried out.

The management capacity issue (inexperienced staff) has in turn impacted to some extent the organizations' ability to develop and implement highly effective governance structures and processes and limited the organizations' capacity to make informed decisions<sup>10</sup>. It has also affected the organizations' ability to effectively engage communities.

The high staff turnover has resulted in repeated investments in the same training for an ever new staff and has impacted the organizations' ability to maintain strong and healthy working relationships with its stakeholders. High staff turnover has led to:

- A loss in organizational history
- Increased strain on already limited resources to conduct the same training for staff over and over again and;
- Stakeholder communities' mistrust in the managing organizations due to lack of follow up or follow through on projects or activities due to staff turnover

There are cases in which there was a high level of commitment (passion for the job) in staff members that are with their organizations for an extended period of time (usually more than three years).

In two marine reserves, no human resource surveys were conducted to assess the human resource needs required for the effective management of the protected area. In one National Park, a human resource assessment was planned but not executed.

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<sup>9</sup> Community and stakeholder initiatives fall under this program.

<sup>10</sup> It is seldom that management decisions are based on proper data analysis carried out on any type of data collected by the organization, whether it is biodiversity or visitation statistics.

## **Financial and Capital Management**

An organization can have effective financial management systems but they may not lead to achievement of the goals of the management plans. For example, BAS has an effective management system at the organizational level but it is negatively impacting on the site management of the Blue Hole and Half Moon Caye Natural Monuments. Finances derived from those sites go into the organizations finances and only a portion is returned to those sites for management. This is also true of other organizations that manage more than one site.

Because of the nature of the marine reserves, the management bodies are challenged in the implementation of adequate signs that indicate the relevant zones within the reserve and the rules and regulations relevant to those particular zones. Even in cases in which signs are available, these are not adequately maintained. This affects the level of stakeholder compliance with the rules and regulations of the marine reserves

Although some management areas scored themselves high on revenue generation, they indicated their high level of dependence on external funding to cover their core administrative costs as well as their programs. Protected areas management bodies are beginning to explore the development of business plans as a revenue generation strategy. The financial scorecards provide a more comprehensive analysis of revenue generation mechanisms for protected areas in Belize.

## **Enforcement**

The Enforcement study identified the following priority concerns. These are:

- Lack of trained and competent staff
- Lack of financial resources and proper equipment
- Lack of political will to provide the necessary support and enabling environment in which to conduct enforcement
- Political interference in the enforcement process.
- There are some misconceptions about the role of foreign fishers in the management equation. It is widely accepted that foreign fishers are the main contributors to over fishing, fishing during the closed season and fishing undersized individuals.

In general it was felt that managers were doing a good job with the resources available and that there was a general commitment to enforcement. However, there was some difference in that commitment depending on the organization or manager involved. In general it was found that the NGOs had the higher commitment to enforcement but this was largely the result of obligations to donor agencies. Most NGOs had a monitoring and enforcement component as part of the projects that they go funded so they had an obligation to provide some level of enforcement. At the next level was the Fisheries Department which felt that it had an obligation as part of its mandate and as part of its commitment to good management. As a result the Department does its own enforcement as well as partnering with NGO partners and other enforcement agencies. The Forest Department leaves the enforcement to co-management partners and provides institutional and prosecutorial support when requested. There is the general feeling and dissatisfaction with the level of interference in the enforcement process, especially given that most

agencies are working with shoestring budgets and staff. It is felt that this serves to undermine the efforts of the enforcement agency, decrease moral among the field staff and most importantly, in the country's present violent environment, places enforcement personnel at a greater risk of retaliation. Of note is the fact that there is little inter-agency exchange of pertinent information.

The two main points coming out of the focus groups with users were: (i) there is a need to provide more enforcement, particularly in certain strategic areas, (ii) most users are willing to obey the regulations but feel that given the current climate and practice of interference, their efforts will not amount to anything positive for the resource. Other points made include:

- The government needs to provide additional resources for enforcement,
- Technically qualified persons need to be employed
- Fines need to be revised to suit the nature of the offences.
- There is the need to involve the users in the monitoring and enforcement process.

### ***Adaptive Management Results [3pp]***

[Effects of changes in individual MMA policy or management after initiation]

- Regarding the legislative framework, there are at least four pieces of principal legislation, with attendant regulations, that govern the enforcement chain within MPAs and maritime spaces in Belize. The Fisheries Act is the principal legislation for Marine Reserves and is administered by the Fisheries Department. The Forest Act, National Parks System Act and Wildlife Protection Acts are administered by the Forest Department. Finally, detentions, arrests and court procedure are the jurisdiction of the Judiciary. Even though they impact the same resource, there are major inconsistencies in the way the laws are structured and administered between the Fisheries and Forest Department. The good news is that there is an initiative underway to revise the Fisheries legislation. However, there is no indication if this revision will include the Forest Act and the National Parks System Act as well.
- Through a co-management agreement (2009) with the Fisheries Department, the Sapodilla Cayes is now under the management of the Southern Environmental Alliance (SEA). This suggests that the management of this MPA will be elevated to the same high standards in place at Gladden Spit/Silk Cayes Marine Reserve and the Laughing Bird Caye National park.
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## Important Emergent Themes

### *A Legal Framework that undermines the protected areas system*

The National Park Systems Act allows for the establishment of the Lighthouse Reef Atoll and the Laughing Bird Caye National Park. This legislation limits the boundaries of these protected areas to natural monuments and land areas which are designated as no-take zones. Surrounding waters are excluded from protection status. To address this issue, managers of the Laughing Bird Caye National Park lobbied for regulations that extend the no-take zone to include a one-mile radius of marine waters surrounding the Laughing Bird Caye. However, because the parent legislation was not amended to allow for the protection of marine waters, this regulation is not legally binding. Not having legal jurisdiction over surrounding marine waters has limited the effectiveness with which the Southern Environmental Alliance has been able to discharge its duties of enforcing a no-take zone in this one-mile radius.

Without official protection status, fishing continues to be legal within marine waters surrounding natural monuments and national parks. Fishing has therefore continued within the waters of the Lighthouse Reef Atoll and the one-mile radius of the Laughing Bird Caye National Park.

On the reverse, the Fisheries Act which legally establishes marine reserves extends protected area status only to marine waters. Land areas within marine reserves are excluded from protection. As a result, managers of marine reserves such as the South Water Caye Marine Reserve, the Sapodilla Cayes Marine Reserve and the Port Honduras Marine Reserve, have no legal jurisdiction over the cutting of mangroves or large scale development on these land areas. A recently publicized case of large scale development on the Pelican Cayes located within the South Water Caye Marine Reserve, clearly demonstrated the limitations of the existing Fisheries Act in protecting this marine reserve.

Furthermore, the data revealed that non-government co-management partners receive little or no financial incentives for managing protected areas. Yet, they are made even more vulnerable by a Westminster legislative system which confers unilateral powers to Ministers. Because all laws in Belize are subjected to the “discretion of the Minister” and because statutory instruments or regulations can be made by a Minister without consultation with stakeholders, this limits the legal authority of protected areas managers in executing their duties of day-to-day management of marine protected areas. This reality is compounded by the fact that although observed in practice, co-management agreements between non-government bodies and relevant government agencies are not legally binding. The status of a non-government co-management partner is therefore not secure and can be changed by Ministers or those acting on his or her behalf, without legal basis and without the need for compensation to the non-government co-management partner.

Related to this issue is the fact that because fisheries, tourism and tourism related infrastructure development all contribute to human pressure on marine resources, regulations governing these three main economic activities must be harmonized and consistent in promoting and enforcing sustainable marine resource use practices. Currently the onus is on the fisheries sector to develop and ensure rules and regulations that govern fishing practices. However, management effectiveness demands that all sources of pressures be addressed as demonstrated in the recent case of large scale development on the Pelican Cayes located within the boundaries of the South Water Caye Marine Reserve.

Rules and regulations for tourism and large scale infrastructure development along the coast and within marine protected areas must therefore also fully embrace their role as guardians of local marine resources if management effectiveness is to be achieved. If this does not occur as a matter of urgency, then it is recommended that marine management agencies engage in a cost-benefit analysis to determine whether it is worthwhile continuing to manage marine protected areas in Belize.

This fragmented and vulnerable “protected areas” legal framework leads to inefficiencies that impact negatively on management effectiveness of marine protected areas.

### ***Co-managed Responsibilities without Co-managed Resources***

The data presents the scenario of an extremely limited set of national financial mechanisms for natural monuments and national parks in Belize. In the case of the Half Moon Caye Natural Monument and the Blue Hole National Park this has meant a delegation of day-to-day management of these marine protected areas to the Belize Audubon Society without adequate national resources or incentives offered for ensuring management effectiveness. The same is the case for the Laughing Bird Caye National Park managed by Friends of Nature (now SEA).

While the financing mechanism for marine reserves is better than for national parks and natural monuments, some of the same patterns exist in related to alternative livelihood initiatives. In both categories of marine protected areas, this lopsided equation has led to a high dependence on international donor support for financing both the operational and programmatic costs of marine protected areas management.

Socio-economic benefits initiatives, such as environmental education and alternative livelihood interventions, due to a high dependency on donor agency support, tend to be sporadic and project-oriented. Indeed, these short-term livelihood projects, designed to meet international criteria and standards, are largely insufficient to meet the long-term needs of coastal communities. There are two related issues here:

- Stakeholder communities have a misconception regarding the role of non-government co-management partners in guaranteeing them enhanced or alternative livelihoods. Because communities entertain this misperception of the role of non-government co-management partners, when their livelihood needs are unmet or not adequately addresses, the result is community backlash against the non-government co-

management partner. Given this scenario, stakeholder communities fail to recognize that national and local level organizations responsible for community development, economic development and poverty reduction are to be targeted for increased support for alternative livelihood programs.

The experience of TIDE most accentuates this situation. Due to a lack of government support for development initiatives and job creation in Punta Gorda, Monkey River and Punta Negra, the recipients of socio-economic skills training programs remain disillusioned by their inability to use their new skills to enhance their livelihoods. Yet, rather than direct their discontent to the respective government organizations, TIDE becomes the focus of criticism. This limits the effectiveness of TIDE in achieving management effectiveness as well as the effectiveness of local stakeholder communities in achieving community development that is consistent with the objectives of the marine protected areas.

- When national organizations have invested financial resources in the development of alternative livelihood initiatives, it has tended to have a positive effect on local stakeholder communities. The most successful of these programs is the National Tour Guide Training Program offered by the Belize Tourism Board, which is also responsible for the development and marketing of the tourism product. In this case, the non-government co-management partner acted as a coordinator and advocate, rather than an implementer of livelihood programs.

In the case of the Tour Guide Training Program, agencies like Friends of Nature (now SEA) linked local fishers and other marine stakeholders with opportunities offered (by other agencies) for livelihood enhancement. They also assisted in lobbying for “grandfather” policies which allowed traditional fishers (without the requisite formal education) to qualify for training and licensing as tour guides.

Once the tourism market was established in Placencia, Friends of Nature continued to provide opportunities designed to meet the demand generated by increased tourism. This included dive master training programs to accommodate the increased diving generated by whale shark tourism.

While the experience of Placencia was positive, other communities like Punta Gorda, with a limited tourism market was not as positive. And for the northern communities of Chunox, Copperbank and Sarteneja, where no tourism development has taken place, the few socio-economic skills training opportunities offered by non-government co-management partners, has not translated into enhanced livelihoods.

### ***The Double Edged Sword of Tourism Development***

Alongside the establishment and/or expansion of marine protected areas over the last ten years were a simultaneous increase in the cost of living and an exponential growth in the tourism sector, including cruise tourism development. While managers of the five marine protected areas were focused on site level management, they found themselves also

having to address the socio-economic needs of local stakeholders within the context of tourism development.

Not only did protected areas managers see tourism development as a source of financing for protected areas management, but they also saw tourism as providing opportunities for the diversification of economic activity away from fishing. They therefore engaged local stakeholder communities in skills training activities that focused on alternative uses of the marine resources, including tour guiding, sport fishing, fly fishing and arts and craft training. However, investments in these socio-economic benefits programs did not always achieve their intended objectives.

In communities like Dangriga, Hopkins, Placencia and Monkey River skills training provided an opportunity for local stakeholder to diversify their income source. However, because of the tourism attraction to marine protected areas like the Lighthouse Reef Natural Monument, the Laughingbird Caye National Park and the Sapodilla Cayes Marine Reserve, this diversification also required the use of resources within marine protected areas. Furthermore, because of the seasonal nature of the tourism industry, many tour guides report that they continue to fish within and outside marine protected areas to supplement their income.

In the case of Punta Gorda, a lack of socio-economic investments in the tourism industry limited local stakeholders' application of skills acquired through socio-economic benefits programs offered by protected areas managers. Thus neither of the two objectives of these programs could be fully achieved in that community.

As outlined above, the need to manage tourism within marine protected areas introduced a new set of challenges for protected areas managers, who, were caught between local communities demanding socio-economic benefits and the protected areas that required resources for on-site management.

Due to a lack of financial mechanisms for protected areas management, managers began to rely on visitors fees to generate revenue for re-investment in protected areas management. Because marine protected areas were reported to have a greater capacity for income generation compared to other types of protected areas, these were targeted for levying user fees. This raised concern, expressed by community stakeholders, that due to the need for finance, protected areas have turned into tourism attractions rather than areas for conservation (Natural Monuments and National Parks) and sustainable use areas (Marine Reserves), as they were originally intended.

Maintaining a balance between meeting the socio-economic needs of local communities, the need to generate income for on-site protected areas management and ensuring an overall reduction of human pressure on marine resources continues to be an ongoing challenge for protected areas managers.

## ***Balancing Socio-Economic Reliance, Development & Conservation***

The Lighthouse Reef Natural Monument continues to provide resource users from Chunox, Copperbank and Sarteneja, with a source of income and food self-sufficiency. Under pressure from a decline in agriculture activities in the Corozal District, Chunox and Copperbank, (both with low levels of education and income and with limited non-marine related alternate sources of income), see fishing in the Lighthouse Reef Natural Monument as livelihood strategy. Sarteneja, with 62% of households reliant on fishing and fishing related activities and with no other viable alternate source of income at present, also has a heavy reliance on the Lighthouse Reef Natural Monument as well as the Southwater Caye Marine Reserve and the Laughingbird National Park to earn an income and for food self sufficiency. Without targeted socio-economic development programmes in these three northern communities, they will continue to increase fishing pressures on marine protected areas.

However, these three northern communities which are most in need of socio-economic development alternatives (to fishing and fishing related activities), are least targeted for socio-economic programs by both government and non-government agencies. The onus for socio-economic alternatives to fishing and fishing related activities has therefore fallen squarely in the hands of the Belize Audubon Society.

The Belize Audubon Society manages the Blue Hole National Park and the Half Moon Caye Natural Monument located within the boundaries of the Lighthouse Reef Atoll as well as eight other protected areas across the country. With limited human and financial resources and with no sustained government mechanisms to financial support the management of the Lighthouse Reef Atoll, the Belize Audubon Society, has made few limited interventions in these three communities.

This raises the concern by non-government co-management partners regarding their role in the socio-economic development of stakeholder communities. Should they be expected to fill the socio-economic development gap left by government and other non-government development partners?

This gap was well identified by conservation organizations and stakeholder communities in 1998 when they lobbied for the establishment of the Coastal Zone Management Authority and Institute (CZMAI). This Authority was legally charged with the responsibility of policy advice, policy development, inter-agency coordination and integrated planning for development in the coastal zone of Belize. Due to a lack of legal authority to implement the policies it developed and a lack of financial sustainability the CZMAI, by 2003, became a fledgling institution with a significantly reduced capacity for coastal zone policy development and planning. The Integrated Coastal Zone Management Strategy developed prior to 2003, was therefore never implemented. Yet, as demonstrated in this study the need for integrated planning and implementation of a coastal zone development strategy persists. For the three northern communities in this study, the need is most urgent.

## ***Enforcement***

The study has helped to identify several points about the enforcement chain in MPAs in Belize. Most discussions were frank and most stakeholders appeared to be committed to the goal of sustainable resource management and the effective management of the MPA system. While there exists gaps and areas that need strengthening, compared to the other countries in the region (both Central America and CARICOM) the system that is in place functions the way it was intended most of the time. Based on the results obtained the following conclusions were reached:

- All the components required for a functional system are already in place. There are functioning mechanisms and agencies that are responsible for patrols and surveillance, detection, arrest/interception, prosecution, and sentencing.
- While it exists, efficiency and effectiveness can be significantly improved through effective communication of pertinent information, greater collaboration and more efficient coordination. With the recent budget cuts it has become essential the maritime enforcement agencies pool their limited resources. This will be critical for areas that buffer the MPAs.
- Enforcement is an expensive process that has very few immediately tangible results. There is the need to develop indicators or an efficiency index to relate the amount of resources expended on enforcement to the general health of the resource and the effectiveness of management.
- From discussions with resource users there is indication that there is much more illegal activity in MPAs than is being reflected by the number of cases that have been taken to court. Using the conviction rate as an indication of the effectiveness of the enforcement process could be misleading as a violator could be warned and does not make it to court. So a violator could be warned several times for an offence before he/she is finally taken to court by which time several offences have been committed. There is a need to document when warnings are issued and for what offences, and this information needs to be shared in a timely fashion.
- There needs to be more documentation of the enforcement process and proper handling of the documents. While a considerable amount of work appears to have been done, there is no record of it because the documentation cannot be found.
- There is need for standardized procedure for patrolling, detection and arrests. At the moment these are done by a number of different agencies with different levels of authority. It is necessary to have all MPA enforcement personnel following the same procedure and processing information the same way.
- There are several pieces of legislation that govern maritime spaces in the country of Belize. There is jurisdictional overlap and gaps that need to be addressed. There is an Advisory Committee that is undertaking the revision of the Fisheries Laws but there is no indication that this will extend to the pieces of legislation under the Forest Department. This situation is further complicated by the passing of the Coast Guard Act a few years ago. Furthermore, MPAs need to be addressed as one group legislatively, regardless of the designation.
- There has to be a captain for this ship. At present every agency has its own approach to the enforcement problem. Furthermore, with the current crime situation in the country, victimless crimes such as natural resource infractions are not a priority so

managers are not given close scrutiny. A lead agency needs to be identified that will have responsibility for proper surveillance, detection, arrests and prosecution.

- The magistrate's courts are currently overwhelmed with the current situation so there is the need for a new system of dealing with offences that will not take as much time and use as much resources as the current system. A ticket system has been suggested but the mechanics of concept is what is important, as they say "the proof of the pudding is in the eating".
- Some sensitivity training needs to be given to the magistrates who are new to natural resources offences. This will help with the regularizing the trial and sentencing phase.
- Education is a key part of compliance but the information dissemination is fragmented. Information is disseminated by a number of agencies, all with their own agenda. There is a need to collaborate in getting basic information on the regulations for MPAs out to the users on a regular and frequent basis.
- The interference in the process needs to be removed to instill confidence and improve morale in the staff charges with conducting patrols. It would be pointless to improve all the other aspects of the chain and allow this practice to completely undermine any work done.

Despite the challenges, gaps and overlaps, the enforcement chain in Belize works well under the circumstances. There appears to be consensus and commitment to the concept of sustainable natural resource management as it is the basis for a significant portion of the Belizean economy. The challenge is to improve on the results.

## ***Cultural Roles***

### **Theme 1 – The overwhelming effect of general economic development and social change**

It is essentially difficult to see the effects of specific MMAs on coastal communities and people in Belize independent of the general and overwhelming effects of broader social, cultural and economic change. Although specific effects can be pinpointed, they pale in comparison to the effects of these broader changes. In that some of these broader effects, in particular leisure-tourism development, can be traced to the establishment of MMAs overall and the value of MMAs to the leisure-tourism industry, all of these effects are linked together.

### **Theme 2 – Multi-Ethnicity.**

The mix of ethnicities in the Belizean coastal zone – Creole, Garifuna, Maya, and Mestizo in particular – characterize and define the cultural involvement with and effects from MMAs in our research communities. A great portion of the cultural effect of MMAs in the researcher communities is circumscribed by the role of kinship, community and ethnicity.

### **Theme 3 – The Belizean history of colonialism and merchantilism.**

The history of Belize as a British Colony and the associated merchantilist economy, wherein raw goods and natural products are shipped out of the country and processed and

more expensive goods are shipped in, thereby creating a cycle of negative domestic economies and dependence, defined and still defines the character of Belizean economics, including fishing. The link with the 'big international non-government organizations (BINGOs)' is interesting here – is this the new merchantilism, 'exporting' the gross benefits of the use of the marine environment to the leisure-tourism industry and creating low-paying, dependent jobs for local communities? To the extent that local communities are involved in independent business enterprise or skilled job in association with the leisure-tourism industry, this effect may be ameliorated.

#### **Theme 4 – The relative powerlessness of coastal peoples.**

A documented world-wide phenomenon is the relative powerlessness of coastal – in particular fishing – communities because of the physical hazards, low levels and uncertainty of income, and under-representation in the political process. This is generally true of Belizean coastal communities, in particular in the face of powerful economic and political forces such as leisure-tourism and the power of BINGOs .

#### **Theme 5 – Lots of water, lots of reef, small human population.**

One of the reasons that the effect of individual MMAs is difficult to detect is the large availability of fishing space relative to the fishing population. This is probably the reason that formally territoriality is not very much in evidence among fishermen in Belize, and that there has not been more protest over the creation of each individual MMA – there has always been somewhere else to fish. This circumstance changes as more MMAs are created.

#### **Theme 6 – Initial lack of involvement and communication difficulties between local communities and MMA process.**

Although attempts have been made to include all stakeholders and local communities in the MMA establishment process – of particular note is the history of Friends of Nature with Laughing Bird Caye and Gladden Spit – those attempts have been uneven among MMAs and, where the communication and involvement has been full in the beginning, has tended to diminish over time.

#### **Theme 7 – Connections among, and cumulative effect of, MMAs.**

Although the effect of each individual MMA on commercial and subsistence fishers may be small, the cumulative effect of increasing number of MMAs in Belizean waters is large. In general, there does not appear to be any specific overall plan for the siting or function of these MMAs as a group, nor any account taken of the cumulative impact on commercial or subsistence fishers or the opportunity for both more effective conservation (i.e., corridors) or economic and social (i.e., designated areas where commercial or subsistence fishers CAN fish) stability through such planning.

#### **Theme 8 – The role of general fisheries management.**

Topics such as the need for a robust fishing license system; adequate data collection programs; effective monitoring and enforcement; the full use of Traditional Ecological Knowledge in “modern” management; consideration of features such as designated

fishing areas tied with local communities; do not seem to have been fully considered in the establishment of MMAs.

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## **Science to Action**

### ***Ecological Monitoring***

#### ***Cruise Ship Ecological Monitoring***

#### ***Genetic Connectivity in Queen Conch***

#### ***Effects of Eco-tourism on Spawning Fish***

- The investigators recommend that management reduce boat traffic, in part by slowing boat speeds near the aggregation site and conducting “drift dives” for tourists whereby they are tracked with a surface buoy instead of a hovering boat. Based on the data collected, the fish are indeed making courtship sounds and yet there does not seem to be negative effects from fish encounters with the divers. Extensive boat traffic and associated boat engine noises may negatively impact fishes’ courtship communication but this remains untested. We are testing the hypothesis that site fidelity of the aggregation is maintained during normal current conditions but strong south currents moves the aggregation (north).
- The PI’s produced and widely distributed a video showing findings in Belize. This video was entitled “*Disturbing Divers: fishing dive tourism, and the future of Belize’s spawning aggregations.*” This video is expected to raise MMA management organization and agencies awareness about the issue with the hope of putting in place policies that will proactively address the existing threats and potential threats to spawning aggregation areas that have not been used for dive tourism. The data is expected to be incorporated into a “**Code of Responsible Dive Tourism on Reef Fish Spawning Aggregations**” for Belize.
- The PI’s also recommends that management tries to reduce boat traffic, in part by slowing boat speeds near the aggregation site and conducting “drift dives” for tourists whereby they are tracked with a surface buoy instead of a hovering boat.
- Due to the highly technical nature of the diving and the need to control the number of divers in the water to reduce the impact of sound, the PIs found it necessary to build capacity within the monitoring team Friends of Nature (now Southern Environmental Alliance) during fieldwork in May 2008 and 2009 this included extensive training in night navigation using GPS by Will Heyman which may be applied for MMA enforcement purposes.
- Over 13 academics and professional presentations were delivered and four (4) scientific papers were drafted for publication.

#### ***Inter-Reefal Habitat Mapping***

This project created a baseline that can be used in future management and monitoring efforts and conservation value. With presentations made to the Fisheries Department

representatives, it officials update the value of the environment and revise management plans for the South Water Marine Reserve. Although, the deep channel has been used less by the wild catch shrimp trawling industry in recent years, the mapping of the Wee Wee Caye site demonstrates the need for further study and the need for careful consideration for future uses by fisheries and the caye development businesses.

This mapping and the new species discoveries have important implications for the manager of MMA's especially for gear use of fishing vessels within the deepwater channel lagoon areas. This discoveries and mapping has increased the potential for new fish discoveries and has raised researcher interest in the area. The principal investigators of this study are actively engaged enlisting the support from NOAA and this will bring more research effort to the Southwater Caye area.

### ***Marine Integrated Decision Analysis System (MIDAS)***

- This study filled a major gap in providing MMA managers with basic data and tools that illustrate MMA socioeconomic, ecological and governance effects. This remains a major gap in MMA management globally, and local managers in Belize can now assess local effects at the site level.
- Two (2) large consultation meetings were hosted by the research team that allowed participants from MMA management organizations and agencies to test the MIDAS prototype. The last consultation was also used to distribute and copy of the software. Participants also generated suggestions on features they would prefer that would make the model more accurate and user friendly. MIDAS enables conservationists working in existing MMAs to determine the likely effects of alternative strategies and therefore, where they should most effectively focus resources. User groups (such as fishers, tourism operators) and the general public can use MIDAS to understand how and why various ecological, socioeconomic and governance conditions are so critical for positive outcomes. Users and policy makers are encouraged to use the tool in an exploratory way to identify interactions of variables and potential outcomes. MIDAS could also be used as a diagnostic tool to identify specific problems in MMAs that could be further addressed or examined. Allowing users to participate in the revision and testing of the software built interest and support for the use of the software.
- Apart from being a decision and planning tool Marine Integrated Decision Analysis Software (MIDAS) has demonstrated its effectiveness as a communication tool. The modeling of oil spills and its potential impacts on MMA's from an ecological perspective was done during a large gathering in June, 2010. Results generated from this model were used by the "Belize Coalition to Save Our Natural Heritage" to demonstrate the potential impacts of oil spills. This coalition is a large coalition of NGOs, tourism stakeholders and concerned citizen groups that is currently engaged in a heated confrontation with the government of Belize in an effort to ban offshore drilling in Belize. MIDAS served as an effective tool to illustrate the potentially far reaching effects on marine and coastal areas in the event of an oil spill.

## **Conclusions [5pp]**

### ***Biophysical studies***

#### **Ecological Monitoring**

#### **Cruise Ship Ecological Monitoring**

#### **Genetic Connectivity in Queen Conch**

#### **Effects of Eco-tourism on Spawning Fish**

The investigative team cautiously conclude that controlled ecotourism diving may have minimal impact on spawning aggregations. This opens the doorway for tourism allowing for economic benefits generated for local operators and in the case of Gladden Spit fishers who have converted to dive tourism. However, this tourism should follow careful guidelines such as those presently in place at Gladden Spit. These guidelines could be adopted elsewhere in Belize and worldwide using a precautionary, adaptive approach to spawning aggregation ecotourism, based on best available science.

One lasting impact of the world in the building of research skills and capacity in local conservation partners with responsibility for MMAs. This creates the opportunity for future research in collaboration with research institutions that will continue to work in Belize Barrier Reef System.

The findings of this research also underscore and support management's decision to currently allow dive tourism around reef fish spawning aggregations at Gladden Spit. This tourism helps to subsidize management and an important source of revenue for local NGOs. With continued monitoring, adaptation and updating of management techniques and user guidelines, these resources can be used in a sustainable manner for an indefinite period.

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### **Inter-Reefal Habitat Mapping**

Based on the result of this study, the team now hypothesizes that there is a patchwork of scattered hard bottom oasis habitat that fish use to cross the open sand/silt planes. If these oasis habitats are clustered (geological basis?), they may form an important "stepping stone" corridor for migration and, thus, would be important sites for environmental protection. The features detected in the inner lagoon could well be topographic highs of Cretaceous age, which in the outer lagoon provide the antecedent topography on which the rhomboid shoals, or fore reefs, are founded. Remnants of these Cretaceous highs can be seen on the coastal plain of the Belizean mainland as well. Because this area regularly experiences dramatic fluxes in water quality, a key question is how are fishes, coral and other organisms physiologically adapted to this stress? Such adaptations, coupled with the geographic isolation of area (inside of the Meso-American Barrier Reef System) could possibly be one adaptive basis for speciation in this region.

#### ***"Missing" Reef: The importance of Belize's Inter-Reefal Hard Bottom Habitats***

We now know that much of the character, abundance, and diversity of a coral reef owes to its proximity to other marine and terrestrial habitats. For example, the importance of adjacency to mangrove forests and seagrass meadows is well established. However, coral reefs comprise only a minute fraction of the actual surface area of tropical continental shelves, and even after accounting for mangrove and seagrass, the bulk of the shelf remains 'aqua-incognito.'

This greater stretch of shelf waters is too deep, turbid, or seemingly uninteresting to have attracted much attention. Elsewhere in the world, attention to inter-reefal tropical shelf environments yields rich rewards, including, most spectacularly, a lot of previously "missing" reef and associated soft bottom habitat. Our recent studies in Belize indicate that this missing habitat on the Mesoamerican Barrier Reef system can harbor suites of endemic species along with large and spectacular threatened species such as sawfishes. They could also be part of the answer to the mystery of where the nursery habitats are for many commercial snapper and grouper species.

### **Marine Integrated Decision Analysis System (MIDAS)**

MIDAS has demonstrated its usefulness in Belize and has been applied by MMA activists and MMA managers. The user friendly software makes this tool very attractive to MMA managers and it is expected that this will become an important part of

evaluating MMA effectiveness and predicting outcomes as conditions in the governance, ecological and socio-economic environment continues to change.

Strategic involvement of the research team members and current MMA managers generated a viable tool and fostered ownership among MMA managers.

MIDAS builds on the use of spatial and statistical tools for management planning by providing a user friendly tool that can be used by MMA managers. This contrasts strongly with previous tools that required advanced technical expertise in spatial and statistical modeling. Creating an accessible tools increases the probability that MMA users will apply these tools and also increases the chance of developing plans that have considered key factor in deciding on management actions. This tool is driven by the user and their local evaluation of conditions. The tool data inputed into the model allows for the systematic documentation that justifies management strategies and actions by highlighting the suggesting the best distribution of effort to accomplish conservation goals. The documentation of this decision making process is invaluable.

### ***Economic valuation***

It is impossible to perform an accurate cost-benefit analysis of investments in this marine protected area, or any other, based on one year of data. Calculating the value of these resources with and without protection would require that we make many (sometimes questionable) assumptions and collect time series data at Gladden Spit and at unprotected “control” sites.

Nonetheless, by estimating the current value of this marine ecosystem, we get an idea of the value that is at risk in the absence of sound marine protection. This is important given the threats reefs face from coastal development and ship groundings within this region. Indeed, the fragile nature of these resources is underlined by the recent inclusion of this area in the “world heritage at risk sites” list.

Our findings suggest that further investment in MPAs like this one are likely to have an attractive return. Management expenditures of US\$315,000 for 2007 helped to secure net annual benefits of at least US\$4 million. Further, the benefits are widely distributed among both locals and international tourists and business owners. Belizeans enjoy 24% of all the net aggregated value despite the relatively small number of them included in these calculations.

But financing protected areas is a challenge. Fees collected by the reserve currently are insufficient to fully support the level of marine management needed and well below what visitors say they are willing to pay. The entry fee is US\$10, with an added US\$5 charge if the visit includes viewing whale sharks. Visitors willingness to pay is US\$25 generally or US\$40 including the whale shark experience. Increases in reserve entrance fees could be considered to bolster funding for the MPA’s management. In Belize, there is at least one other relatively untapped source of cash: airport departure taxes.

At the time of this research, travelers to Belize paid environmental departure taxes (as part of general airport departure taxes) of US\$3.25 per person. Our surveys suggest that even non-visitors have a significant willingness to pay for the GSSC Marine Reserve's conservation. Earmarked departure taxes would be a convenient mechanism to capture this value. Despite the economic value of marine reserves and the very real cost of providing marine protection, reserve managers have historically operated with little or no economic information and so are unlikely to have maximized management effectiveness. CSF's policy-oriented valuation research can help managers prioritize investments, identify reserve financing strategies, and provide a baseline against which future values, can be compared. Note that measuring local community values, non-use values and costs is essential to producing accurate valuation estimates. Repeated future research at Gladden Spit and similar sites can help better reveal the role of MPAs in providing economic benefits to society.

The values measured are unlikely to persist unless effective management remains, since reefs in the Mesoamerica region have suffered serious declines and remain threatened by overdevelopment, pollution and other stressors. Indeed, these estimates make clear the potential economic losses that could occur, which would reduce the welfare of local stakeholders through impacts on tourism and fishing. The maintenance of the current values depends to what extent these reefs are protected from overfishing and overuse, including by tourists, which can also contribute to reef resilience, which will be increasingly tested by warming and acidifying seas. Effective management depends to a large extent on adequate financial support. In addition, further funding would be likely to result in better enforcement, research and community outreach, which could increase the value of this reserve even further.

Recommendations for management and future research include:

- Raise awareness as the magnitudes of these values and the number of stakeholders that benefit, to justify continued or increased investment, to target fundraising and education;
- Use the values elicited here to build local support for management, through targeted education and outreach initiatives;
- Consider the distribution of costs and benefits when understanding user behavior;
- Consider the ability to pay and values in aggregate when designing revenue raising strategies. Increase protection of the no-take area and ensure fishers observe the closed seasons and minimum sizes for conch and lobster;
- Determine carrying capacity for tourists, both in the reserve in general and during whale shark seasons and use demand curves to set fees around the level that will produce the correct levels of visitation Include both non-use and local community values for conservation in natural resource valuations to support informed decision-making for policies and investment in protected areas; and
- Use net economic values, rather than gross financial values to understand the overall impact of values.

## ***Enforcement***

The Enforcement study has helped to identify several points about the enforcement chain in MPAs in Belize. Most discussions were frank and most stakeholders appeared to be committed to the goal of sustainable resource management and the effective management of the MPA system. While there exists gaps and areas that need strengthening, compared to the other countries in the region (both Central America and CARICOM) the system that is in place functions the way it was intended most of the time. Based on the results obtained the following conclusions were reached:

- All the components required for a functional system are already in place. There are functioning mechanisms and agencies that are responsible for patrols and surveillance, detection, arrest/interception, prosecution, and sentencing.
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- Enforcement is an expensive process that has very few immediately tangible results. There is the need to develop indicators or an efficiency index to relate the amount of resources expended on enforcement to the general health of the resource and the effectiveness of management.
- From discussions with resource users there is indication that there is much more illegal activity in MPAs than is being reflected by the number of cases that have been taken to court. Using the conviction rate as an indication of the effectiveness of the enforcement process could be misleading as a violator could be warned and does not make it to court. So a violator could be warned several times for an offence before he/she is finally taken to court by which time several offences have been committed. There is a need to document when warnings are issued and for what offences, and this information needs to be shared in a timely fashion.
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Despite the challenges, gaps and overlaps, the enforcement chain in Belize works well under the circumstances. There appears to be consensus and commitment to the concept of sustainable natural resource management as it is the basis for a significant portion of the Belizean economy. The challenge is to improve on the results.

### ***Socio-economic Study***

Key findings and conclusions are as follows:

- Since 2000, the only notable demographic changes in the 12 stakeholder communities were education attainment, source of drinking water and employment status. Only Placencia reported a notable positive change in income distribution and other communities reported small changes, some positive and some negative.
- A majority of respondents across communities did not link a change in their economic or health status, whether positive or negative, to the establishment of marine protected areas. Overall, a majority of community respondents attributed changes to other economic and health related factors.
- While marine management bodies contributed to enhancing formal education opportunities through the establishment of scholarship programs, their low coverage within these communities, cannot alone account for the changes in education attainment demonstrated in the study. Rather this change may be attributed more to increased access to primary and secondary schools (more schools and more scholarships from multiple sources) and greater investments of households in the formal education of their children.
- Greater access to potable water and to a private water sources can be attributed to water projects implemented by the Social Investment Fund and the Basic Needs Trust Fund and the Ministry of Rural Development rather than the establishment of marine protected areas.
- However, the marine management bodies investment in leadership training for community stakeholders, may have had a spin-off effect of increasing their lobbying

and negotiation capacity for engaging development agencies in requesting increased education opportunities and potable water for their communities. For example, communities most targeted for socio-economic benefit programs and participation in protected areas advisory and governance structures, most show these changes.

- Those who most linked their economic situation with the establishment of marine protected areas were commercial fishers and those engaged in tourism related economic activities. Commercial fishers linked a negative economic situation with the establishment of marine protected areas while those in marine related economic activities linked their improved economic situation with the establishment of marine protected areas.
- Too many confounding factors make it difficult to state definitively that there is a positive socio-economic impact from the establishment of marine protected areas as this is true only in communities with opportunities for enhanced income from tourism.
- This was the case for communities like Placencia but not for Punta Gorda or Sarteneja. Placencia is now considered the fourth largest tourist destination in Belize. Because tourism in Placencia is centered around activities like whale shark tours and snorkeling around Laughingbird Caye National Park, there is an indirect link between economic improvements in Placencia and the establishment of marine protected areas. However, there is a growing perception that the marine protected areas were established more for tourism development than for conservation or sustainable resource management.

The data reveals that the establishment of marine protected areas has resulted in a change in resource use patterns. This is due to the establishment of rules and regulations such as open and closed seasons for harvesting conch and lobster as well as information dissemination of these rules and regulation and increased patrolling of marine protected areas, compared to non-protected areas. However, the data also shows that:

- Less than 2% of marine areas are no-take zones,
- There is an increase in fishers since 1998
- Guatemalan and Honduras fishers continue to fish in Belizean waters, some with valid fishers licenses from the Fisheries Department
- Illegal fishing, for example, the use of gillnets and fishing in no-take zones continues
- Patrolling, though increased, is still largely inadequate for the needs of the marine protected areas
- There are still high levels of economic reliance (within some communities) on activities conducted with marine protected areas,
- There is growing resource pressure from tourism and from coastal development.

Therefore, the positive impact from the establishment of in rules and regulations and increased patrolling may be nullified and cannot be said to have resulted in sustainable use of marine resources.

Marine management bodies are the result of the establishment of marine protected areas. It is the investment of these management bodies in environmental education programs that leads to greater environmental awareness and knowledge. This includes community

meetings, radio programs, the dissemination of information on brochures and pamphlets and informal verbal communication with stakeholders. The effect is therefore related more to the marine management bodies' capacity to mobilize resources for environmental education programs and to translate effectively transmit this information to marine stakeholders than merely to the establishment of marine protected areas.

The data revealed an overall positive attitude towards marine resources. However, attitudes were more positive regarding the non-monetary values of marine resources than for resource management that impacts on economic livelihoods. This demonstrates that while a greater recognition of the non-monetary benefits of marine resources is a positive achievement for managers, this alone will not influence changes in marine resource practices, if livelihood issues remain unaddressed.

Acceptance of marine resource management initiatives is related to the level of economic reliance of communities on marine resources. There are differences across communities regarding their perception that "organizations that manage the resources are taking the bread out of people's mouths". Similarly, there are differences regarding the proposal to impose a moratorium on the harvesting of conch to allow the conch to re-populate. This demonstrates that while there is widespread recognition of the need to conserve and protect marine resources, economic livelihood needs drive resource users to employ unsustainable resource use practices as a strategy for economic survival. This shows that in this case, a conservation morality or ethic, can blind resource managers to the real economic motivations that drive resource use practices among local stakeholder communities. Discarding the blinders will require a paradigm shift in thinking to a more sustainable economic, than conservation-oriented model for engaging local communities.

### ***Governance***

- Legislative Reform – harmonization, legalize co-management agreement, reduce power of Ministers
- Financial sustainability mechanisms – PACT reform, GOB budgetary allocations, resource mobilization as a PA system rather than as individual sites
- Reduced pressure on resources a.) withdrawal of fishing licenses to non-local fishers, b.) diversification of livelihoods from fishing to other economic activities and c.) addressing carrying capacity issues and d.) minimizing the effects of large scale development (will require multi-sectoral coordination and collaboration)
- Improved management operations eg: planning, information management and dissemination, surveillance and enforcement, socio-economic benefits, advocacy, monitoring and evaluation etc.

The marine management areas are not achieving their goals and objectives as repeated reports indicate that biodiversity is not improving. Therefore it may be important to:

- 1) Go back to the original question of why establish protected areas and then define the role and responsibilities of the key actors based on this discussion. Currently MMA managers and co-managers have taken on multiple responsibilities, including socio-economic benefit programs and capacity building. Yet, they remain weak on basic functions such as research, planning and enforcement, all of

which have a direct effect on the achievement of the goals of biodiversity and conservation.

- 2) Examine the criteria current used to identify “areas of importance” for “biodiversity conservation” and if needed revise or if not in existence, develop the criteria for the establishment of protected areas and finally
- 3) Developing an enabling environment by:
  - a. Establishing an effective national administrative structure for system level management (restructuring and development of national guidelines, policies and procedures to guide site level management);
  - b. Enacting the necessary legislation (rules and regulations, policies) that would make management effective (e.g. address outdated legislation, managers’ inability to enforce, establish the new administrative structure, etc.);
  - c. Building management and program capacities at all levels;
  - d. Developing financial mechanisms that would allow for greater financial sustainability of all the sites within the system.

Strong Governance is the key to effective management – this includes the right structures or processes, the key players, the human resources (capacity) and financial resources. Without these key factors governance is considered to be very weak and weak governance translates into ineffective management.

Belize has a wonderful natural and cultural history. Whether the full benefit in terms of both sustainable natural resources and habitats and sustainable human benefits from and dependence on those resources and habitats will be obtained – through the use of MMAs and other means – will rely in attention to the issued raised in these theme areas, which emphasize the critical role of socio-economic and cultural factors in coastal and marine governance.