4.1.6 Total Living Cover

The total percent cover of benthic organisms at the sites was also determined to provide an indication of health and diversity of the sites. Total living cover was lowest for site 2, 29.7%±2.2 (S.E.), since this site lacked any seagrass communities. The highest total living cover was found at site F5, 64.2%±2.7 (S.E.) (Figure 21). Majority of the sites had greater than 50% total cover (both seagrass and algae).

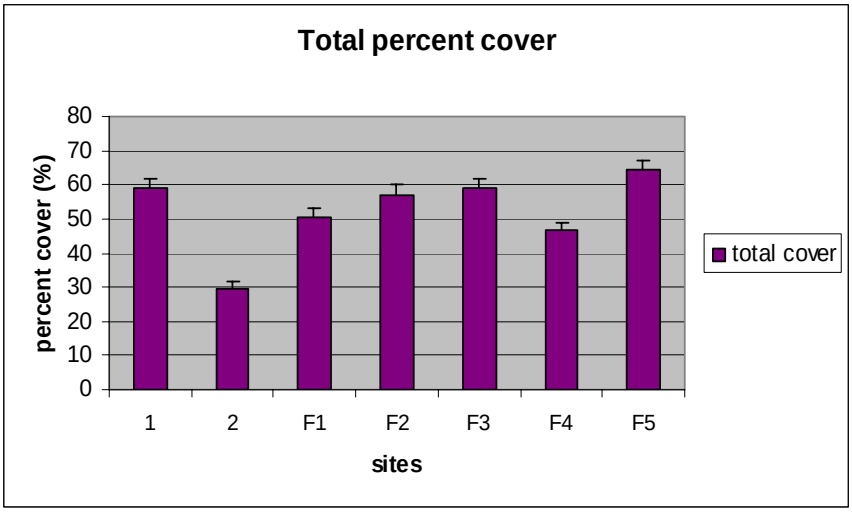

Figure 21

4.1.8 Sediment type

The sediment type of the seagrass beds was determined for each site. There was a wide range of sediment types within each site and across the sites (Figure 22a). Some sites had up to eight different sediment types, while site 2 showed only two sediment types, fine sand/mud and mud. The most common sediment types found in the seagrass beds was mud followed by fine sand and then sand (Figure 22b). A sediment type of mud and fine sand is characteristic of seagrass ecosystems, as these finer fraction sediments indicate a high organic content. The presence of such fine sediments also indicates the significant influence of riverine sediment inputs from the major watersheds that exit into the STMMA.

The seagrass ecosystems in the area are in fairly good health with diversity and abundance that is characteristic of an estuarine influenced system. In addition to the seagrass ecosystems in the area there are also mud flats associated with the delta of the Temash and Sarstoon rivers that are comprised mainly of fine silt and mud from the rivers. This type of habitat supports a population of the marine shrimp which is intensely exploited by both Belizean and Guatemalans fishers.

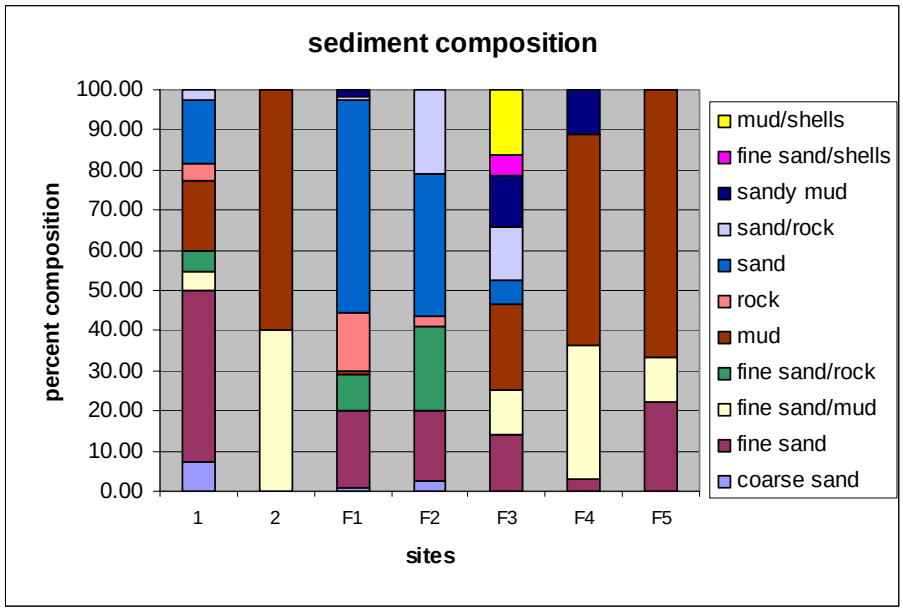

Figure 22a

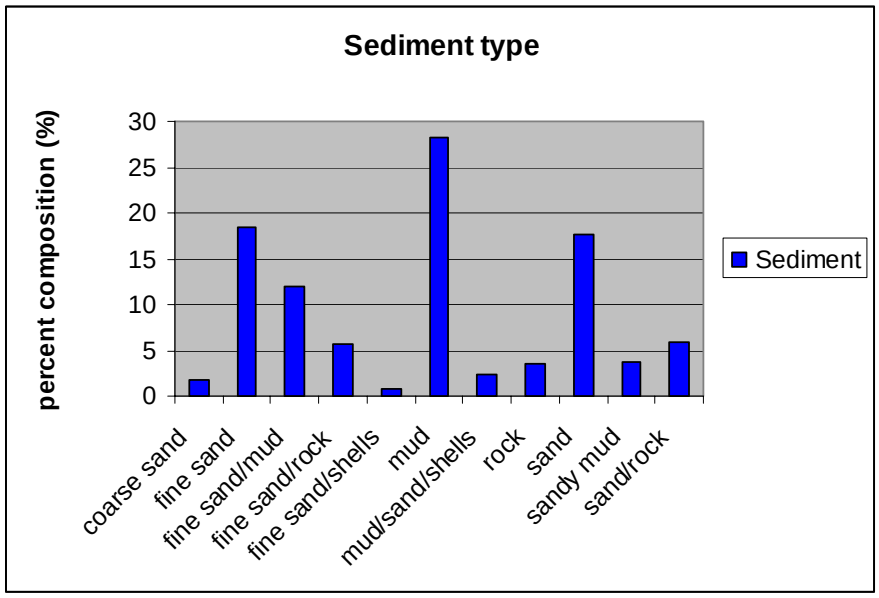

Figure 22b

4.2 Marine Algae

The STMMA can be classified as an estuarine area located in southern most portion of inner lagoon of the Belize Barrier Reef. The marine plants or algae species encountered in the STMMA will therefore be characteristic of lagoonal seagrass communities commonly found in tropical systems. Algae occurring in seagrass beds generally belong to the Phylum Chlorophyta, Rhodophyta and Phaeophyta. Common algal species in tropical seagrass communities include: *Caulerpa* spp. (*C. sertularioides*), *Penicillus* spp., *Halimeda* spp. (often *H. incrassata* and *H. monile*), *Udotea* sp., *Dictyota* sp., *Dasycladus vermicularis*, *Avrainvillea* sp., *Acetabularia* sp., *Wrangelia* sp., Cyanophyta. Due to the sparse density of the seagrass beds in the area, the diversity of algal species will be fairly low as compared to seagrass beds in marine waters, such as those close to the barrier reef. This is due in large part to the high freshwater inputs in the area which affect the seagrass community structure. Detailed phycological surveys are required to obtain an accurate taxonomic listing of the marine algae in the STMMA.

4.3 Echinoderms

Seagrass communities often boast a number of echinoderms belonging to various Classes such as Asteroidea (sea stars), Echinoidea (sea urchins, heart urchins, sand dollars) and Holothuroidea (sea cucumbers). The most commonly found echinoderms include: *Oreaster reticulatus* (cushion sea star), *Echinaster sentus* (spiny sea star), *Diadema antillarum* (long spined urchin), *Lytechinus variegates* (variegated urchin), *Tripneustes ventricosus* (sea egg), *Clypeaster rosaceus* (sea biscuit) and *Holothuria mexicana* (donkey dung sea cucumber). In hard bottom areas that are sometimes found within the seagrass beds brittle stars such as *Ophiocoma echinata* may also be found, hiding under rubble or in crevices.

4.4 Other Invertebrates

In addition to the Echinoderms, there are several other invertebrates which are commonly found in seagrass beds belonging to the Mollusks, Porifera, Cnidarians, Annelids and Crustaceans. A few sponges were observed in the seagrass beds, that are commonly found in seagrass beds: *Holopsamma helwigi* (lumpy overgrowing sponge), *Tedania ignis* (fire sponge), and encrusting sponges such as *Anthiosigmella varians* (brown variable sponge). Cnidarians that dwell in seagrass beds inhabit the substrate, seagrass blades and the water column. These are usually jellyfish, ctenophores and anemones such as *Cassiopea frondosa* (upside down jelly fish), *Viatrix globulifera* (turtle grass anemone), *Mnemiopsis mccradyi* and *Beroe ovata* (comb jellies). A few annelid worms are also common inhabitants of seagrass communities such as: *Hermodice carunculata* (fire worm) which dwell on and among the leaf blades and *Arenicola cristata* (southern lugworm), which burrows in the fine sediments of the seagrass beds.

Crustaceans that inhabit seagrass beds include: *Petrochirus Diogenes* (giant hermit), *Paguristes sericeus* (blue-eye hermit) and *Callinectes sapidus* (blue crab). These organisms were observed from the seagrass transects conducted in the area. A few mollusks common in seagrass beds were also observed and included species such as: *Strombus gigas* (queen conch), *Strombus costatus* (milk conch), *Strombus raninus* (hawkwing conch), *Melongena corona* (crown conch), *Aplysia dactylomela* (spotted sea hare), *Pinna carnea* (amber penshell), *Cerithium litteratum* (stocky cerith), *Lithopoma tectum* (West Indian starsnail) and *Tellina radiata* (tellins).

4.5 Fish

Fish diversity in seagrass communities is significantly lower than that of coral reefs. There are several overlaps of species between coral reefs and seagrass beds based on habitat use. A number of fish species utilize the seagrass beds for feeding and as nurseries for juvenile fish. Such species include those belonging to snappers, grunts and a few jacks. Fish surveys were carried using belt transects in the STMMA which provided some basic information on fish abundance, distribution and diversity. A total of 26 fish species was observed from the surveys. These species included members from common Families such as Carangidae (Jacks), Lutjanidae (Snappers), Scaridae (Parrotfishes), Haemulidae (Grunts) and Gerreidae (Mojarras). A complete listing of the species can be found in Appendix 4.

Overall fish abundance and distribution was fairly low in the STMMA, the highest abundance was observed at sites where there were hard bottom communities comprised of rubble and reef like substrates, such as F1 and F2. Incidentally these sites were the sites identified by fishers, as areas where fish could be found.

From the data collected in the fish transect surveys, there was a total of 7 sites, sites 1-2 and F1-F5. Fish species were observed for different size classes: 0-5 cm, 6-10 cm, 11-20 cm, 21-30 cm, 31-40 cm and >40 cm. For all the sites, there were no fish observed in size classes 21-30 cm and 31-40 cm.

The majority of fish observed fell into the 0-5 cm size class (Figure 23a). A total of 11 species were observed within this size class. These fish were all juveniles based on their size frequency. The most abundant species was the white grunt (*Haemulon plumierii*), an average abundance of 56. French grunts (*Haemulon flavolineatum*), princess parrotfish (*Scarus taeniopterus*) and the yellow tail parrotfish (*Sparisoma rubripinne*) were also fairly abundant in this size class (Figure 23a).

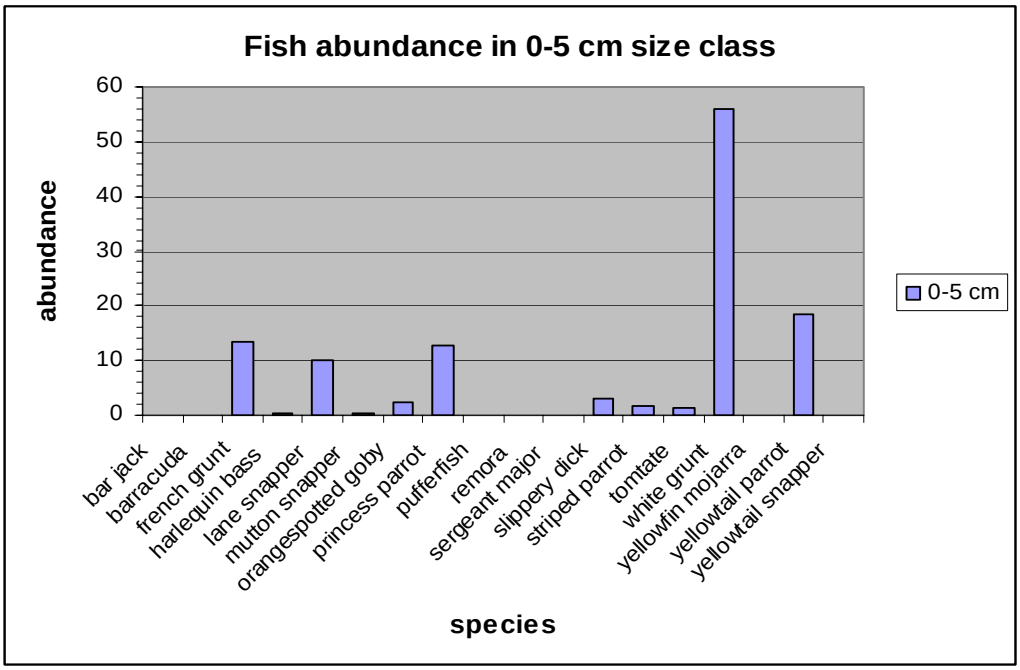

Figure 23a

The next size class was the 6-10 cm category, which had the highest number of species recorded (14). Here the most abundant fish species within this class were lane snappers (*Lutjanus synagris*), striped parrotfish (*Scarus iserti*), white grunts (*Haemulon plumierii*) and harlequin bass (*Serranus tigrinus*) (Figure 23b). Based on the size class these fish were mainly juveniles and sub-adults, with the exception of the harlequin basses, which are classed as adults.

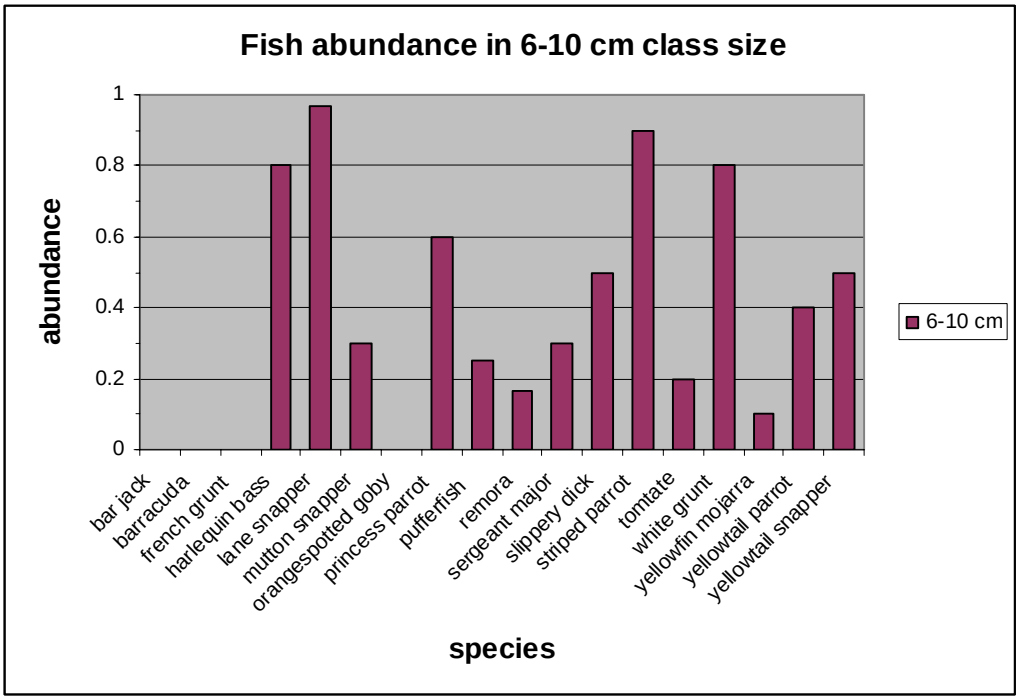

Figure 23b

The 11-20 cm size class had the second highest fish abundance, comprised mainly of adults and sub-adults. A total of 8 fish species were observed within this size class. The most abundant species were white grunts (*Haemulon plumierii*) and yellowtail snappers (*Ocyurus chrysurus*) (Figure 23c). Other noteworthy species encountered included: French grunts, lane snappers and parrot fishes, in relatively low abundance.

Only 1 species was recorded in the >40 cm size class. This was the Great Barracuda (*Sphyraena barracuda*) with a total of 3 specimens observed or an average abundance of 0.3 (Figure 23d).

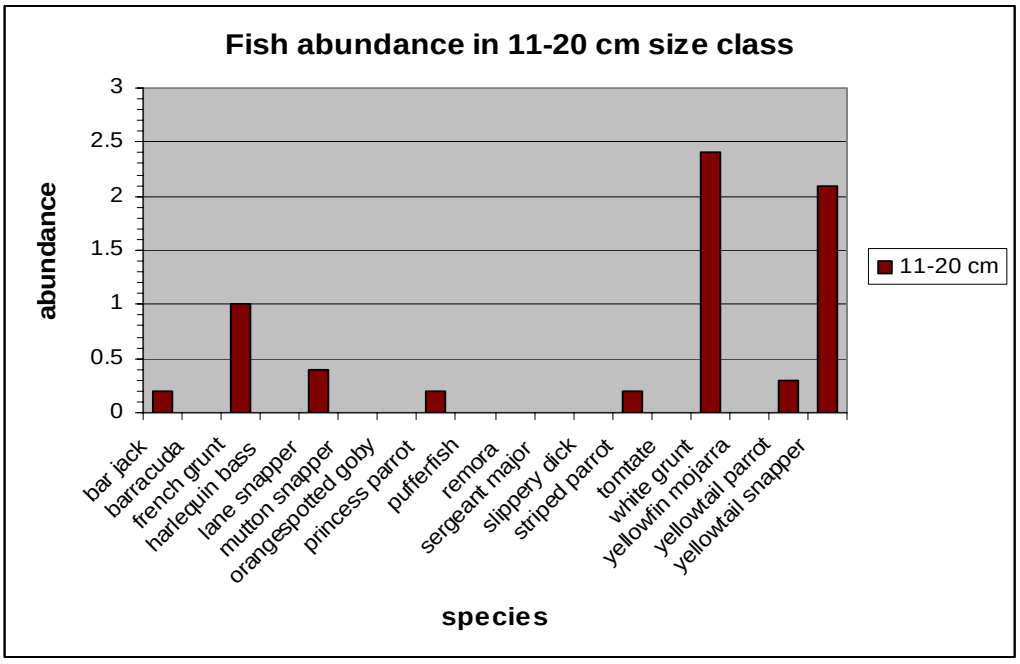

Figure 23c

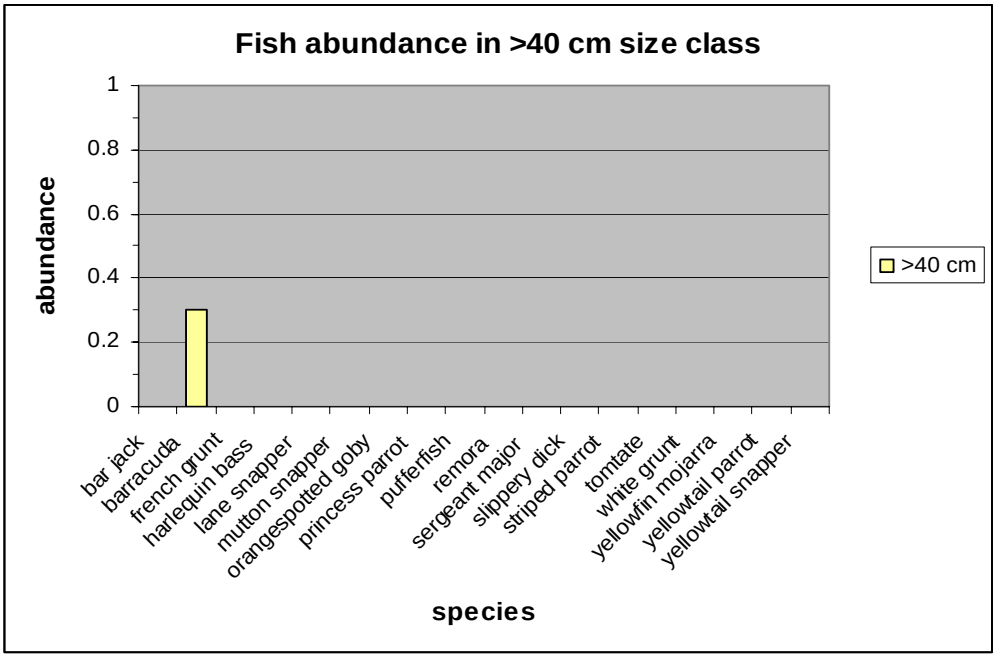

Figure 23d

The entire fish data were analyzed to observe the total abundance per species. White grunts were the most abundant species for all size ranges encountered in the STMMA. They were followed in abundance by the yellowtail parrot fish, French grunt, princess parrot fish and lane snapper respectively (Figure 24, Table 1).

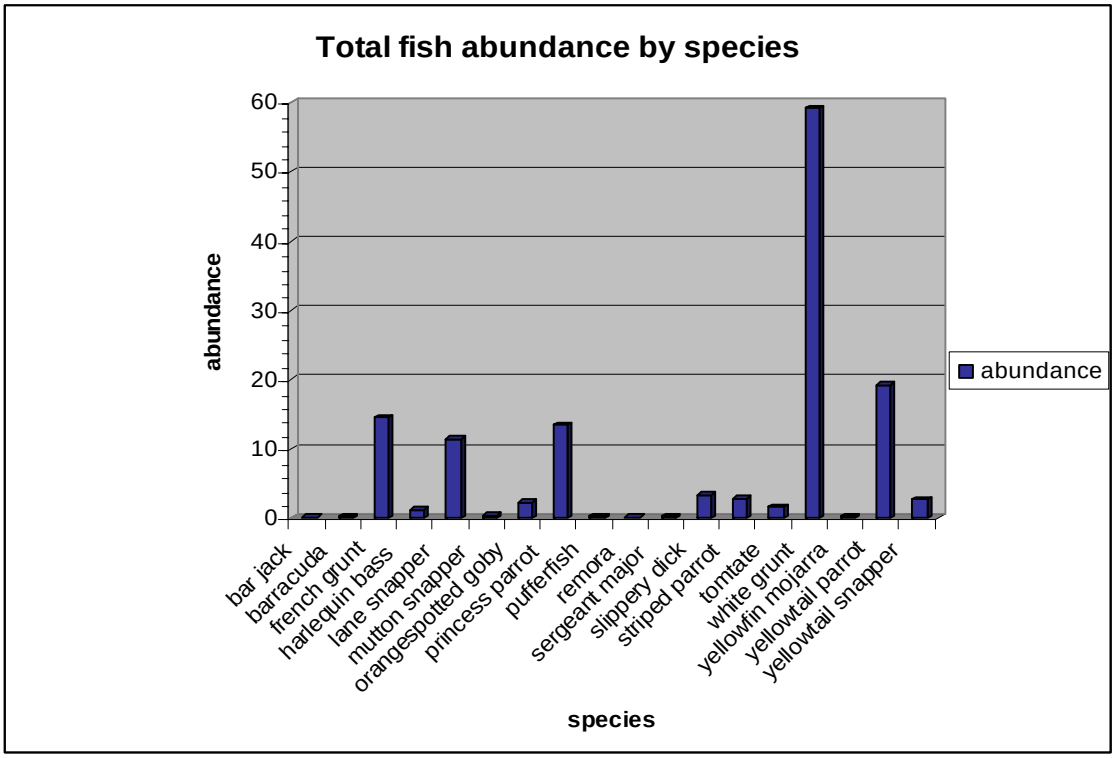

Figure 24

Table 1

fish species	0-5 cm	6-10 cm	11-20 cm	>40 cm	TOTAL
bar jack	0.00	0.00	0.20	0.00	**0.20**
barracuda	0.00	0.00	0.00	0.30	**0.30**
french grunt	13.55	0.00	1.00	0.00	**14.55**
harlequin bass	0.45	0.80	0.00	0.00	**1.25**
lane snapper	10.07	0.97	0.40	0.00	**11.43**
mutton snapper	0.20	0.30	0.00	0.00	**0.50**
orangespotted goby	2.25	0.00	0.00	0.00	**2.25**
princess parrot	12.70	0.60	0.20	0.00	**13.50**
pufferfish	0.00	0.25	0.00	0.00	**0.25**
remora	0.00	0.17	0.00	0.00	**0.17**
sergeant major	0.00	0.30	0.00	0.00	**0.30**
slippery dick	2.90	0.50	0.00	0.00	**3.40**
striped parrot	1.70	0.90	0.20	0.00	**2.80**
tomtate	1.50	0.20	0.00	0.00	**1.70**
white grunt	55.95	0.80	2.40	0.00	**59.15**
yellowfin mojarra	0.17	0.10	0.00	0.00	**0.27**
yellowtail parrot	18.50	0.40	0.30	0.00	**19.20**
yellowtail snapper	0.17	0.50	2.10	0.00	**2.77**

The diversity of fish species varied among the sites. Site 2 had no fish species observed (Table 2b) and site F2 had the highest diversity with a total of 15 species (Table 2d). Sites 1, F3, F4 and F5 all had only 3 species of fish observed, while site F1 had a total of 6 fish species (Table 2a-f). Site F2 had the greatest abundance of fish in the entire area surveyed and also had the most size classes represented (4 out of 6; for size classes 21-30 and 31-40 cm no fish were encountered at all sites). Site 1 and F4 had only the 0-5 cm or the juvenile size class represented, while sites F1, F3 and F5 had two size classes, 0-5 cm and 6-10 cm, juveniles and sub-adults.

Table 2a

Site 1	fish species	0-5 cm	6-10 cm	11-20 cm	>40 cm	TOTAL
	bar jack					**0.00**
	barracuda					**0.00**
	French grunt	0.50				**0.50**
	harlequin bass					**0.00**
	lane snapper	0.33				**0.33**
	mutton snapper					**0.00**
	orange spotted goby					**0.00**
	princess parrot					**0.00**
	pufferfish					**0.00**
	remora					**0.00**
	sergeant major					**0.00**
	slippery dick					**0.00**
	striped parrot					**0.00**
	tomtate					**0.00**
	white grunt					**0.00**
	yellowfin mojarra					**0.00**
	yellowtail parrot					**0.00**
	yellowtail snapper	0.17				**0.17**

Table 2b

Site F1	fish species	0-5 cm	6-10 cm	11-20 cm	>40 cm	TOTAL
	bar jack					**0.00**
	barracuda					**0.00**
	French grunt	0.25				**0.25**
	harlequin bass	0.25				**0.25**
	lane snapper	2.50				**2.50**
	mutton snapper					**0.00**
	orange spotted goby	1.25				**1.25**
	princess parrot					**0.00**
	pufferfish		0.25			**0.25**
	remora					**0.00**
	sergeant major					**0.00**
	slippery dick					**0.00**
	striped parrot					**0.00**
	tomtate					**0.00**
	white grunt	0.75				**0.75**
	yellowfin mojarra					**0.00**
	yellowtail parrot					**0.00**
	yellowtail snapper					**0.00**

Table 2c

Site F2	fish species	0-5 cm	6-10 cm	11-20 cm	>40 cm	TOTAL
	bar jack			0.20		**0.20**
	barracuda			0.00	0.30	**0.30**
	French grunt	12.80		1.00		**13.80**
	harlequin bass	0.00	0.80	0.00		**0.80**
	lane snapper	6.30	0.40	0.40		**7.10**
	mutton snapper	0.20	0.30	0.00		**0.50**
	orange spotted goby	0.00		0.00		**0.00**
	princess parrot	12.70	0.60	0.20		**13.50**
	pufferfish		0.00	0.00		**0.00**
	remora			0.00		**0.00**
	sergeant major		0.30	0.00		**0.30**
	slippery dick	2.90	0.50	0.00		**3.40**
	striped parrot	1.70	0.90	0.20		**2.80**
	tomtate	1.50	0.20	0.00		**1.70**
	white grunt	54.40	0.80	2.40		**57.60**
	yellowfin mojarra	0.00	0.10	0.00		**0.10**
	yellowtail parrot	18.50	0.40	0.30		**19.20**
	yellowtail snapper	0.00	0.50	2.10		**2.60**

Table 2d

Site F3	fish species	0-5 cm	6-10 cm	11-20 cm	>40 cm	TOTAL
	bar jack					**0.00**
	barracuda					**0.00**
	French grunt					**0.00**
	harlequin bass	0.20				**0.20**
	lane snapper	0.60	0.40			**1.00**
	mutton snapper					**0.00**
	orange spotted goby					**0.00**
	princess parrot					**0.00**
	pufferfish					**0.00**
	remora					**0.00**
	sergeant major					**0.00**
	slippery dick					**0.00**
	striped parrot					**0.00**
	tomtate					**0.00**
	white grunt	0.80				**0.80**
	yellowfin mojarra					**0.00**
	yellowtail parrot					**0.00**
	yellowtail snapper					**0.00**

Table 2e

Site F4	fish species	0-5 cm	6-10 cm	11-20 cm	>40 cm	TOTAL
	bar jack					**0.00**
	barracuda					**0.00**
	French grunt					**0.00**
	harlequin bass					**0.00**
	lane snapper	0.33				**0.33**
	mutton snapper					**0.00**
	orange spotted goby	0.33				**0.33**
	princess parrot					**0.00**
	pufferfish					**0.00**
	remora					**0.00**
	sergeant major					**0.00**
	slippery dick					**0.00**
	striped parrot					**0.00**
	tomtate					**0.00**
	white grunt					**0.00**
	yellowfin mojarra	0.17				**0.17**
	yellowtail parrot					**0.00**
	yellowtail snapper					**0.00**

Table 2f

Site F5	fish species	0-5 cm	6-10 cm	11-20 cm	>40 cm	TOTAL
	bar jack					**0.00**
	barracuda					**0.00**
	French grunt					**0.00**
	harlequin bass					**0.00**
	lane snapper		0.17			**0.17**
	mutton snapper					**0.00**
	orange spotted goby	0.67				**0.67**
	princess parrot					**0.00**
	pufferfish					**0.00**
	remora		0.17			**0.17**
	sergeant major					**0.00**
	slippery dick					**0.00**
	striped parrot					**0.00**
	tomtate					**0.00**
	white grunt					**0.00**
	yellowfin mojarra					**0.00**
	yellowtail parrot					**0.00**
	yellowtail snapper					**0.00**

A roving diver survey was also conducted for the sites to record the total number of fish species sighted in the area, which provided an indication of the species abundance. No fish were observed for sites 1, 2 and F4 on the roving diver survey, which recorded fish species noted with a 200 m radius. Site F2 had the highest diversity based on the roving survey, with a total of 14 species similar to the species diversity identified in the belt transects. White grunts were the most abundant species, followed by lane snappers, tomtate, parrot fish and slippery dick (Table 3).

Table 3

Species	F1	F2	F3	F5
white grunt	>100	>100	2-10	2-10
tomtate		11-100		
lane snapper	2-10	11-100	2-10	2-10
yellowtail snapper		2-10		
princess parrot	2-10	2-10		
striped parrot	2-10	11-100		
redtail parrot				
yellowtail parrot	1	2-10		
bar jack		2-10		
atlantic bumper				11-100
yellowfin mojarra	1	1	2-10	2-10
barracuda		2-10		
yellow stingray				1
southern stingray				
checkered puffer	1			
cero		2-10		
dusky damsel		1		
slippery dick		11-100		
sergeant major		2-10		
harlequin bass			2-10	
orange spotted goby			11-100	11-100

In general the fish diversity and abundance at the sites surveyed within the STMMA indicate a low diversity and a limited distribution and abundance of fish in the area. In particular the area appears to be inhabited largely by juvenile fish. The seagrass beds therefore seem to be serving as a nursery and feeding area as previous studies have suggested. The sites with the highest abundance and diversity were those that had hard bottom habitats. Further detailed surveys within seasons relating to particular fish species may provide a more representative illustration of fish diversity and abundance. The surveys conducted were a rapid snapshot of the area.

4.6 Mammals

Only two marine mammal species have been identified to occur in the area. These two species are the West Indian Manatee, *Trichechus manatus manatus* and the bottlenose dolphin, *Tursiops truncatus*. These mammals are generally found feeding in and around seagrass beds in the tropics. Based on data from CZMAI Manatee Aerial Surveys and research conducted by Nicole Auil, the population of manatees in the area is small, being the lowest for the entire country (Figure 25). The animals are not commonly sighted and when they are, sightings are generally in and along the rivers in the area mainly Moho and Temash, with occasional sightings in the Sarstoon. A major hindrance to sightings is the often turbid or murky appearance of the waters in the area which makes it difficult to identify animals from the air (Auil 2003). Manatees often prefer sheltered and protected bays, lagoons or rivers to feed and produce young.

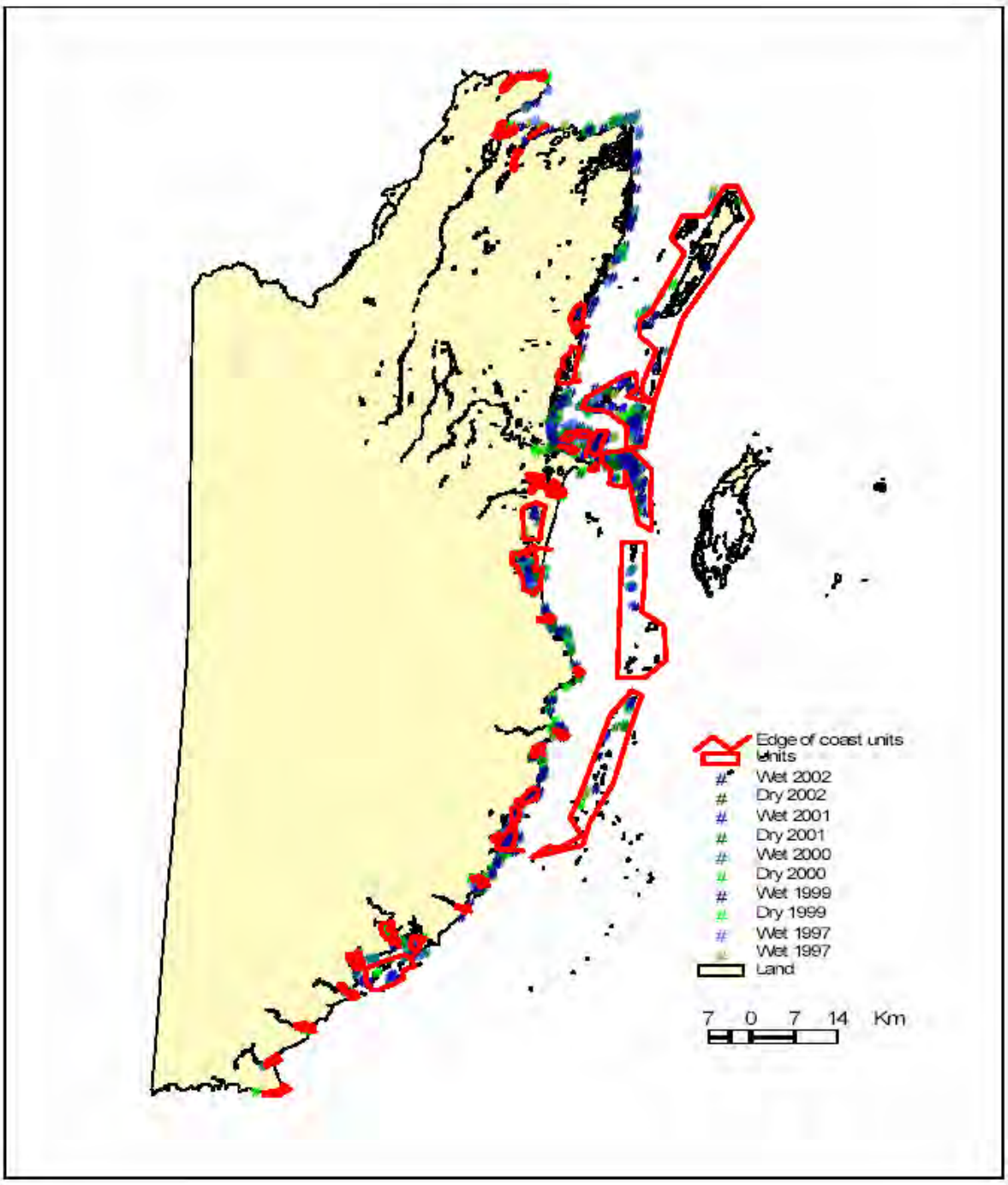

Figure 25

The bottlenose dolphin is a wide ranging marine mammal found in the Atlantic and the Caribbean Sea. They frequent the entire coastal zone of Belize, including the inner coastal areas and the offshore atolls. The animals are frequently sighted on boat trips along the coast in the area. They most likely utilize the seagrass flats for foraging and feeding activities. While there have not been any formal studies on the population of bottlenose dolphins in the area, there have been regular sightings by persons who utilize the area including fishers, researchers, resource managers and tourists.

4.7 Biological Corridors and Trans-boundary Cooperation

The Sarstoon-Temash National Park falls with the Mesoamerican Biological Corridors, which is a continuous wildlife corridor spanning the Central American countries. The recognition of the STMMA, which is adjacent to the National Park, creates landscape-seascape continuity. The area of the STMMA is also recognized as a transboundary area of interest within the Mesoamerican Barrier Reef System (MBRS), as this coastal area is utilized by nationals from Belize in addition to Guatemala and Honduras. The major use of the area is for fishing. There are regular reports of illegal fishing activities and poaching within the area by non-Belizean nationals, who often enter the Belizean waters in pursuit of viable fish stocks due to a paucity of fish stocks in their sovereign waters.

The MBRS Project was created to prepare policies, monitoring programs, training programs, educational awareness and effect change in legislation and transboundary cooperation among Mexico, Belize, Guatemala and Honduras in order to sustainably manage the Mesoamerican Barrier Rees System it its entirety. A key strategy for managing the marine resources in the Gulf of Honduras, of which the STMMA is a part of, is to engage in and promote effective transboundary cooperation amongst government agencies, NGOs, civil society and coastal communities who depend on these resources.

SATIIM should address as priority, transboundary cooperation with NGOs from Guatemala, in particular, and engage in discussions with the Belize Fisheries Department and the CZMAI to foster transboundary cooperation regarding fishing legislation and coastal resource management policy at the government level. SATIIM has already initiated discussions and partnerships with FUNDAECO, a prominent NGO working with the fishers of the Sarstun Community on the Guatemalan side of the border.

4.8 Gap Analysis

There are several critical gaps in data regarding the physical and biological environment of the STMMA. The southern inner coastal area of Belize, along the major estuaries, is lacking in any historical or scientific information whether in reports or publications. It was therefore necessary to collect some baseline data. The Rapid Ecological Assessment was conducted to provide this basic information on the habitats and environments in the area. Due to limited time and restricted funding, a comprehensive assessment of the area was not possible. As such there are still several large an critical data gaps in the available background information on the area.

There is no oceanographic data for the area on current patterns, detailed bathymetry, tidal patterns, siltation/sedimentation rates and estuarine influences, such as flow and ebb of the two major river deltas in the area. There is no water quality information for the area, particularly regarding levels of nutrients (nitrates and phosphates), heavy metals and pesticides which would provide critical information indicating the influence and condition of the watersheds within the Sarstoon-Temash National Park. In addition

zooplankton and phytoplankton data, which can provide information of the health of the ecosystems and productivity of the marine resources, are also lacking.

There needs to be more comprehensive and thorough assessments of the seagrass communities to provide detailed information on community and productivity dynamics for the area. These include shoot density, seagrass biomass, epiphyte community structure, fish distribution, species diversity of the infauna, resurveys of the area during the dry season, mangrove surveys to determine community structure, productivity and diversity, fish catch and effort data from the fishers in the area, fish and shrimp trawls to determine fisheries species in the area and finally fish stock assessments. All this information is critical to be utilized in discussions on sustainable fishing and livelihood techniques and to assist in the decision making process.

5.0 SOCIOECONOMIC SETTING OF THE SARSTOON-TEMASH MARINE MANAGEMENT AREA

5.1 Demographic Profile

5.1.1 Introduction

The coastal zone adjacent to the Sarstoon-Temash National Park is fringed by several coastal settlements and communities. The zone of influence of theses communities extend from Punta Gorda in the North to the Guatemalan side of the Sarstoon River. There are four main communities which depend on the coastal resources of this area. These are largely fishing settlements such as Mother Bush, Moho River and Temash River settlements and also include the village of Barranco. A few fishers from Punta Gorda utilize the area for hand line fishing and bait fishing. The population of this coastal area is small with approximately 250 persons residing along the coast. Barranco Village is the most populated area with approximately 200 residents, but only has 4 active fishers remaining. This village was once a traditional Garifuna fishing village. The other three fishing settlements comprised of naturalized Belizeans having an average population of 16 persons per settlement consisting of a few closely related families. The number of fishers in the area is approximately 30 with about 10 fishers from Punta Gorda. This represents 16% of the total population of the coastal area. The survey results represent 25% of the fishing population or 10 respondents.

The coastal settlements, with the exception of Barranco, had very basic infrastructure with houses constructed from thatch with pit latrines, often over the sea. There was no electricity, water or telephone in these areas. In actuality, these settlements were established as fishing camps, which have become the permanent residential locations for these fishers and their families. At three settlements (Mother Bush, Moho River and Temash) the only access to the communities was by sea with no waste control systems in place as the areas were all remote coastal settlements restricted to the coastline. Since these three settlements were located along the shoreline, there was very minimal clearing of vegetation at all locations. Vegetation has been removed mainly to provide clear area for construction of houses, sheds and storage areas for boats and fishing equipment. Therefore there has been very minimal human impact to the coastal vegetation in this area which range from littoral forest to coastal mangrove forests.

The village of Barranco is a predominantly Garifuna coastal village, the only known traditional Garifuna fishing community in the Sarstoon-Temash Marine Management Area. Barranco has dwindled over time with its population stabilized at around 200 people. Since the last 20 years the Garifuna people have become much more integrated into the Belizean society and are now less dependent on their traditional life styles, often giving up customs and traditions for education and modernization. Most of the buildings in the village are of concrete with the older houses of wood. The village has several government buildings including a Community Centre managed by the Village Council, a Police Station, a Primary School with approximately 53 students and a Health Centre. There is also a Roman Catholic Church in the village.

Boat transportation was historically the primary means of accessing the village. Initially dugout canoes were used for travel. In the seventies the use of outboard motors with dugouts was introduced for public transportation and fishing. Boat access is now largely practiced by fishers and visiting marine interests. An all weather road was completed in 1999 which has become the major means of access to Barranco. There are two telephone lines in the village; one is the BTL Community Phone and the other is for the police station. Barranco is supplied with electricity via lines from Punta Gorda and electricity is accessible by all the house lots in the village.

Potable water in the village is supplied from both hand pumps and a rudimentary water system, comprised of a production well and water reservoir tower. Many of the homes are outfitted and obtain water from the village system. The remainder have stand pipes in the yard. Liquid and sewage waste is primarily disposed of through pit latrines. Flushable toilets with septic tanks can be found in a few homes. The community does not have a solid waste collection system. There is a designated garbage dump which is generally not supervised and garbage is not properly disposed of. The infrastructure to support tourist visits to Barranco is limited. There is currently a small guest house. Development of tourist attractions has not been fully developed although considerable potential exists.

Overall the habitat in the area of Barranco Village is in moderate condition, due to the size of the village and level of clearing that has occurred. However, the fringing coastal vegetation is in relatively good state. Therefore human impact to the coastal habitats here has been moderate to low.

SATTIM held consultation meetings with the residents of Sarstún, Guatemala to obtain information on their livelihood, fishing practices and management threats or issues in the area. A large coastal settlement is situated on the Sarstún Bar, Guatemala occupied by approximately 480 persons, with 125 fishermen. There is basic infrastructure consisting of residential houses, a school and three churches. There is no solid waste management or sewage system in the village. Residents employ the use of latrines most of which empty over and into the river. The major means of access to the village is by sea, with the mode of transportation being boats or skiffs.

5.1.2 Methodology

The information for the human impact survey was collected from interviews with key informants and stakeholder questionnaires. Key informants were major stakeholder groups in the affected area that could provide critical information on the socioeconomic climate of the Sarstoon-Temash Marine Management Area. The stakeholder questionnaires targeted the major stakeholders who utilized the area, in this case the fishermen. Questionnaires were structure to gather basic geographical information, demographic, economic, environmental and social issues. See Appendix 5 for the sample format for the questionnaires and list of questions for key informants. A minimum of 10% of the fishing population was targeted, the survey actually covered 25% of the population.

5.1.3 Fishing Demographics

The majority of fishers surveyed were males with a total of six females who were involved in fishing. These women regularly accompanied their spouses on daily fishing trips. The average age of fishers was 49 years with the majority of fishers between age 30-50 (Figure 26). Only one fisher was below the age of 30.

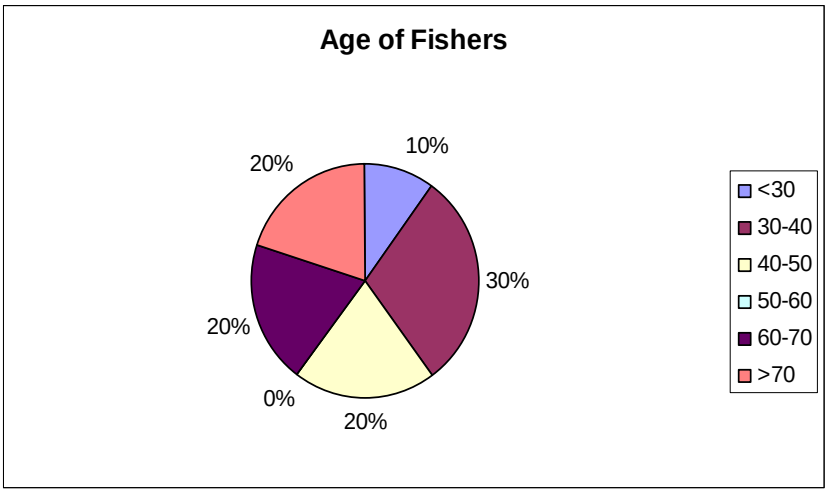

Figure 26

The survey showed that the majority of fishers, 50% have been fishing for 10-30 years. The average time spent fishing as a livelihood was 33 years. Only one person has been fishing for under 10 years while 2 fishers have been active for over 50 years (Figure 27).

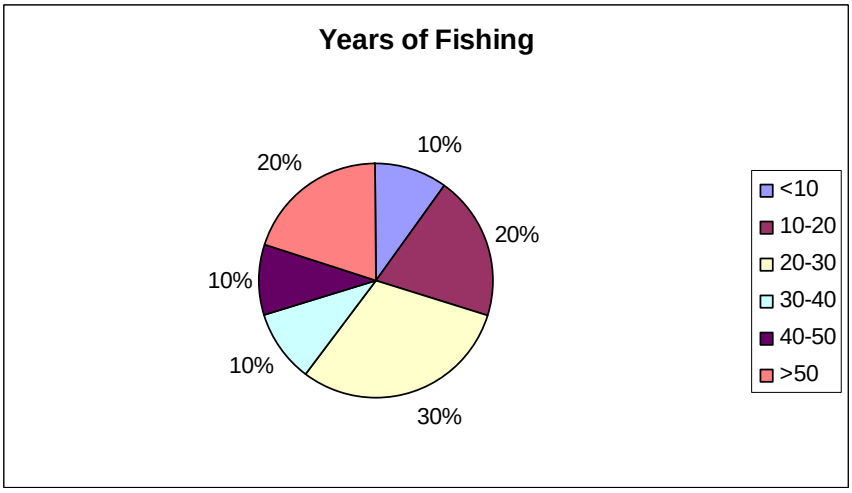

Figure 27

The fishers of Sarstún Village ranged in age from 18 years to >40 years. The majority were over the age of 30. Most of the fishers have been fishing for over 15 years with only one fisher having fished for less than 10 years.

Two types of fish: finfish and shellfish were the fisheries resources commonly harvested in the area. The finfish species commonly harvested in the Sarstoon-Temash Marine Management Area are snappers, jack and snook. The shellfish species harvested was mainly marine shrimp. This trend in fish catch is based on the habitat in the area being dominated by seagrass beds with the absence of coral reefs, which results in a limited range of species available for exploitation.

The type of catch varied among coastal settlements. Fishers from Barranco caught only finfish, while fishers from Mother Bush, Moho River and Temash caught both finfish and shrimp (Figure 28). Sarstún fishers also captured finfish such as jacks, snook, mackerel and snapper but also fished shark. They are major harvesters of the shellfish, marine shrimp.

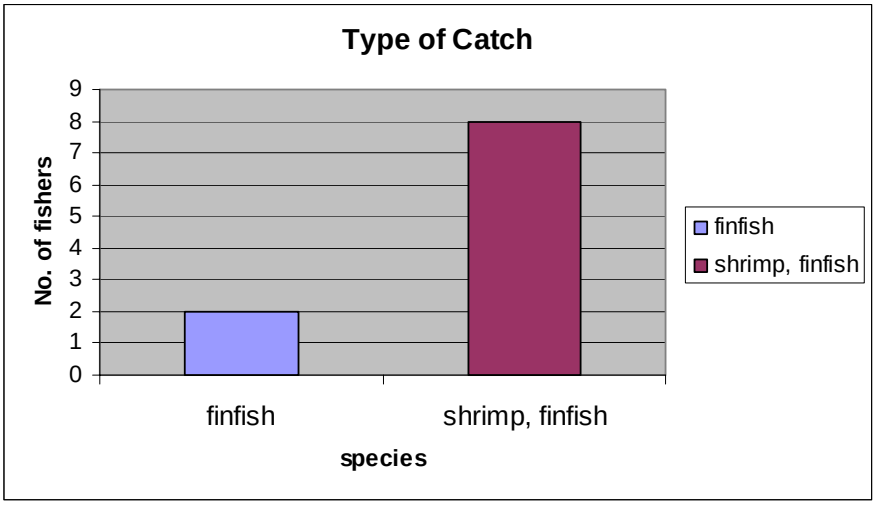

Figure 28

The fishing grounds for all fishers interviewed ranged from Punta Gorda/Orange Point to the Sarstoon. Each fishing community had a particular area that they regularly fished. Fishers of Mother Bush (30% of fishers) frequented the area from Mother Bush up to Orange Point while fishers from Barranco (20% of fishers) fished the coastal area immediately adjacent to Barranco. The majority of fishers (50%) from Moho River and Temash, were the most extensive in their efforts fishing coastal areas as far as Port Honduras Marine Reserve to the Sarstoon (Figure 29). Interestingly all fishers reported that they fished within a 3 mile radius from the coast within the STMMA, which is the limit of Belize's territorial waters in this region of the south.

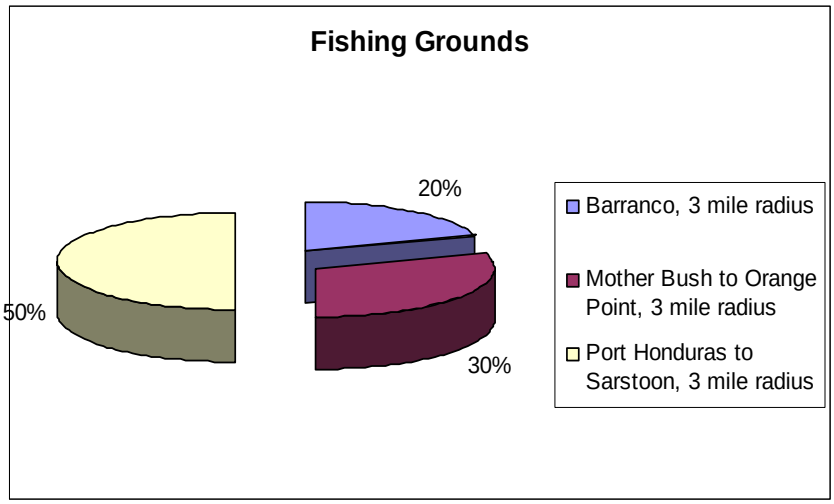

Figure 29

5.2 Livelihood Opportunities

5.2.1 Fishing as a Livelihood

Fishing is the major livelihood in the Sarstoon-Temash Marine Management Area. Ninety percent of the fishers from the area interviewed stated that fishing was their main economic livelihood for themselves and their families (Figure 30). The remaining ten percent fished part-time with farming/agriculture as their main livelihood. However all fishers who depended on fishing as the main livelihood expressed that fishing for a living is hard and economically challenging, and would be willing to explore alternative means of generating a livelihood if presented with viable options.

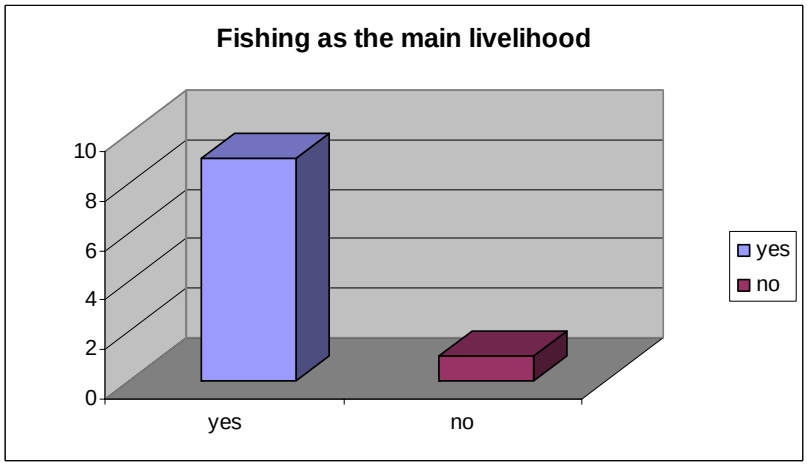

Figure 30

The residents of Sarstún are also major transboundary users of the area. Discussions with them revealed that their primary source of income is fishing, utilizing the marine resources of the STMMA. A few fishers have other sources of income such as agriculture, commerce and labor.

There are currently no other major means of livelihood generation being practiced in the area although there exists the potential for eco-tourism, cultural tourism and agriculture or mariculture. These livelihood opportunities require significant capital inputs and capacity or technology which is presently lacking among the stakeholders of the area.

5.2.2 Fishing Effort

Fishing is largely done using motorized fiberglass vessels, usually between 16' to 23' in length. Unlike other parts of the Caribbean where fishers work from boats owned by other persons, all the fishers in the area own their fishing vessels. 50% of fishers used fiberglass boats greater than 20' (Figure 31). Wooden dories were the main boat type used by 17% of the fishers, with only half of the users having motorized dories. Only 1 fisher possessed more than one boat, a total of three including a 30' wooden dory.

Sarstún fishers indicated that the majority owned their fishing vessels (70%) which were mainly wooden dories (62%), few of them with engines. Stakeholders estimated that there were about 100 dories in the village. Their estimates suggest that there were about 27 skiffs all motorized.

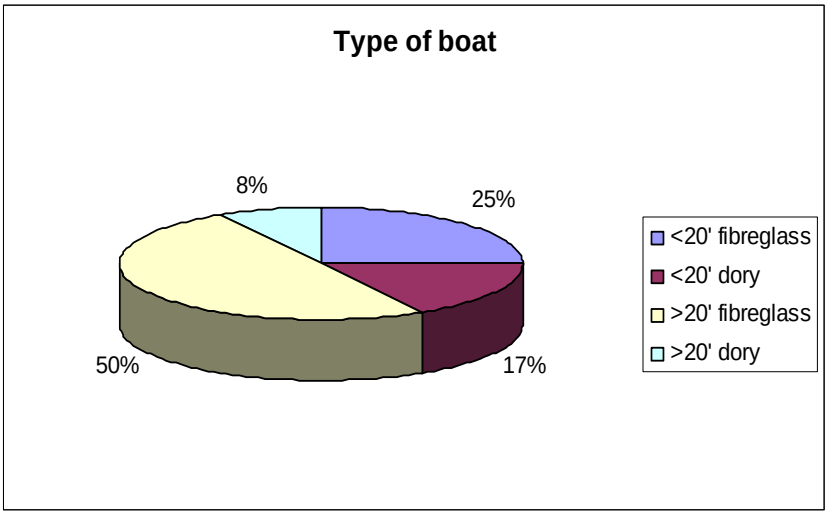

Figure 31

The fishing gears used to harvest the various fish species also varied dependent on location. All the fishers used hand lines to capture finfish. For the harvesting of shrimp two different gear types were used. Fishers from Mother Bush used both the less destructive cast nets and the drag nets (3 fishers), while the fishers from Moho River and Temash used the more destructive drag nets only towed from the back of the boats (5 fishers) (Figure 32). Fishers reported that gill nets are utilized for a variety of fish. These are usually set at nights and collected in the morning along the coast. They also expressed the opinion that Guatemalan fishers at Sarstún deploy gill nets along the coastal area and up into rivers.

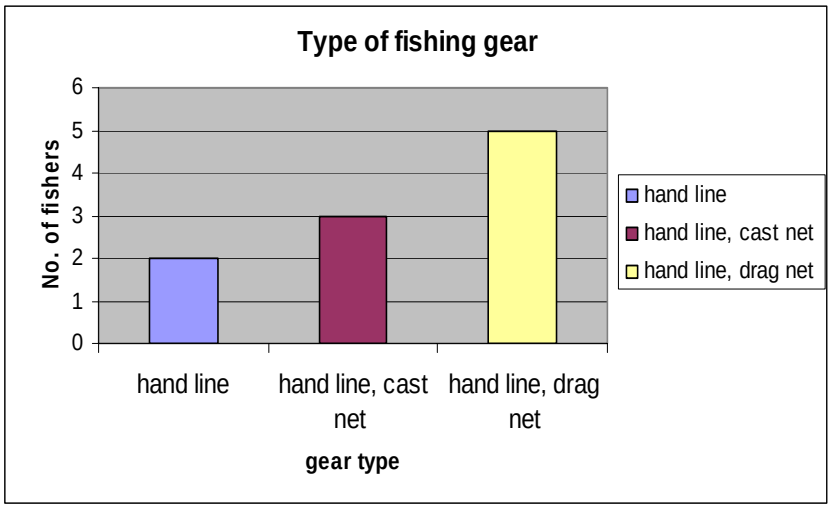

Figure 32

The survey also looked at the level and effort of fishing in relation to income earned, to present trends in overall economic potential. Fishing is regularly conducted 5 days a week throughout the year. The majority of fishers, 60%, fish six days out of every week. Thirty percent fished 5 days a week while only 10% fished one day a week, who had other livelihood options (Figure 33). On analysis of the effort per trip, 7 out of 10 persons interviewed indicated that fishing was conducted by two persons per trip per day. Two of ten fishers had teams of 3-5 persons engaged in fishing per trip, while only 1 person fished alone (Figure 34).

The fishers from Sarstún reported that they fish every day, weather permitting. These daily fishing trips are usually comprised of only 1 person per boat, with 38% having 2 persons on board and only 15% with 3 persons.

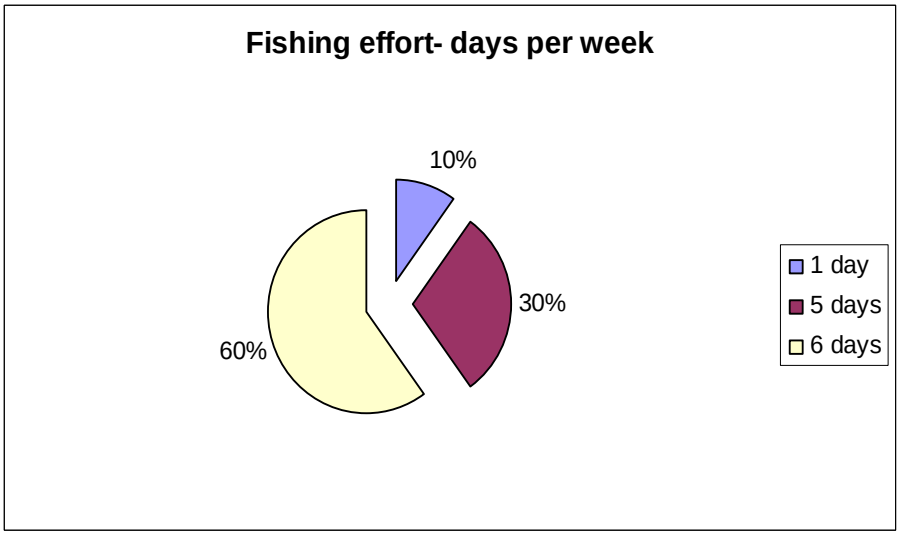

Figure 33

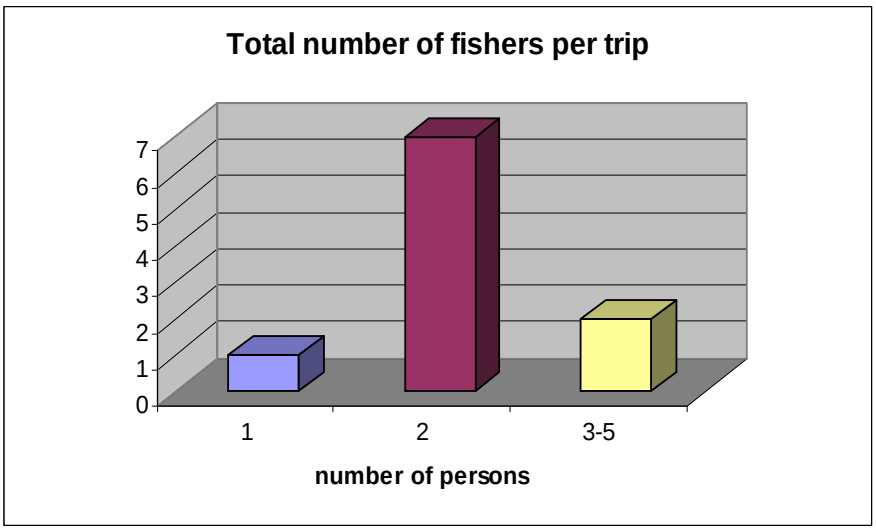

Figure 34

Fishers reported on their average catch per week for finfish and shrimp. Sixty percent of fishers caught on average of 50 to 100 lbs of finfish per week, in a good week. Based on the sale price of $3.00/lb for fish, this weekly catch earned fishers between $180-$300. Only 1 fisher reported a weekly catch less than 50 lbs, which would earn between $50-$150. Thirty percent of fishers interviewed reported that they caught on average over 100lbs of fish per week with one fisher catching as much as 250 lbs for the week. The average earnings for this percentage of fishers were $300-$750 per week (Figures 35 and 36). Overall fishers indicated that the average weekly earnings was $300.

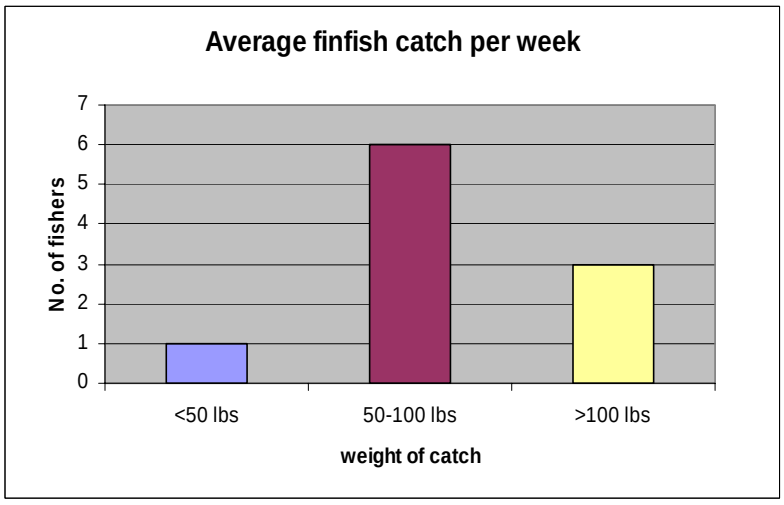

Figure 35

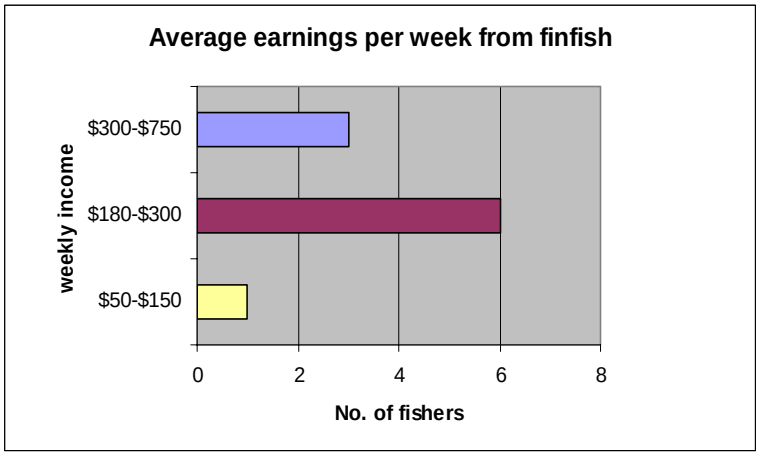

Figure 36

The trend in weekly catch for shrimp was different that that for finfish. Only 5 of the 8 fishers who fished shrimp reported on their weekly catch. These fishers indicated that the sale price for shrimp was $6.00/lb. There was an equal proportion of fishers who caught 50 lbs of shrimp per week versus 100 lbs per week. Only 1 of the 5 fishers reported that he harvested 150 lbs of shrimp per week. The weekly shrimp catch earned fishers between $300-$900 (Figures 37 and 38). Interestingly the largest catch of shrimp was caught by the fishers who used drag nets. However income is based on actual amounts caught which can vary from time to time depending on the season and climate.

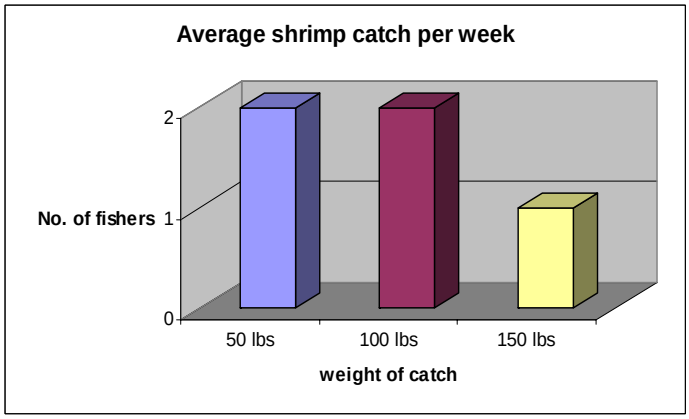

Figure 37

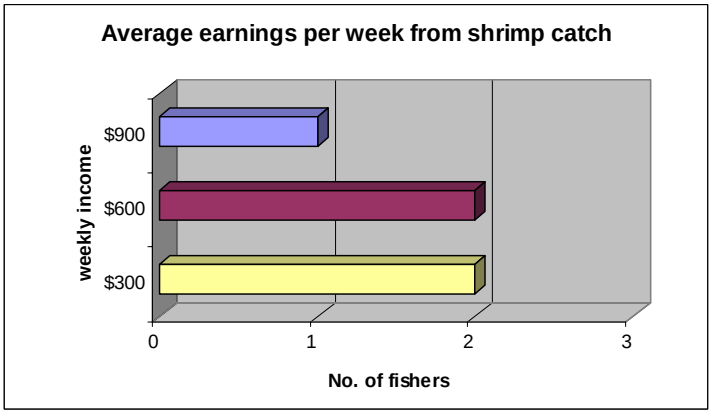

Figure 38

The Sarstún fishers indicated that their average daily harvest was 1 lb in shrimps and 5 lbs of snook. This provided them with earnings of approximately $125 BZ on a good day which was sufficient just to provide food for them.

5.3 Cultural and Traditional Use

The Garifuna people of Barranco have been traditional users of the STMMA for the past 100 years. They have traditionally accessed and exploited the marine resources in the area, particularly fisheries resources. Culturally, fish has been a main stay of the Garifuna diet and fishing efforts were largely geared at dietary supplement and later on become a source of income. Over the past three decades, the Village of Barranco has dwindled in size as its populace has migrated out to more urban areas of Belize, often abandoning their cultural and traditional practices for more modern and trendy means of living.

Fishers from Punta Gorda have also traditionally use the area for subsistence fishing to supplement their diet with periodic supply of fish protein and as a source of bait fish to capture commercial fish species for their artisanal fishing livelihoods. These fishers generally fish in reef areas higher north within the Port Honduras Marine Reserve and the Sapodilla Cayes Marine Reserve.

Aside from the traditional use of the area as means of fishing, the Garifuna have utilized the area for cultural purposes surrounding the celebration of their culture and the arrival of their people to Belize, through various rituals and ceremonies. The Garifuna are a sea-faring people with strong spiritual ties to the sea. However as the Garifuna people become integrated into mainstream Belize they lose touch with the art of navigating the coastal zone, their traditional crafts, and their spiritual practices. As a result the use of the area by the Garifuna for cultural practices has declined over time.

5.4 Status of the Coastal Resources

The human impact survey conducted for the area assessed stakeholders' views on the status of the coastal resources with which they are very familiar and upon which they depend for their livelihoods. These responses provide important socioeconomic indications as to the health and condition of the resources in the STMMA. As such fishers were asked their opinion about the current status of the resources and status 5 and 10 years ago. Key species were targeted for this analysis as outlined in Tables 4-6. Eighty percent of the fishers responded that the resources were currently in a poor condition. The remaining twenty percent believed that the resources were still in a moderate condition. This twenty percent was fishers who utilized more destructive fishing practices, such as drag nets, and whose fishing effort was much greater than the others. Majority of fishers generally felt that the resources are seasonal and indicated that 95% of fish caught are females.

When questioned on their perceptions of the status of coastal resources 5 and 10 years ago, the overall response was that fish stocks were in good condition 10 years ago, but the majority of fishers felt that as recent as 5 years ago stocks were in a poor state (Table 4). Fish species such as Jewfish and sharks were classified as in poor abundance 5 years ago by 100% of the fishers. Seventy-five percent of fishers felt that snook, snappers and shrimp were in poor abundance 5 years ago versus 10 years ago where all fishers were of the opinion that the abundance of these three species was good (Table 4). Fishers were divided equally on the status of bonefish, lane snapper, jacks and mackerel in the last 5 years. Half felt that the stocks were in poor abundance while the other half felt that they were in moderate abundance and were seasonal.

Table 4

	5 years ago	10 years ago
Species	**Poor (%)**	**Good (%)**
Jewfish	100	66.7
Snook	75	75
Bonefish	50	100
Lane "silk" snapper	50	100
Other snappers	75	100
Jacks	50	100
Mackerel	50	100
Shrimp	75	100
Shark (sp)	100	

All the fishers were of the opinion that tarpon stocks were still at a moderate level currently and 5 years ago. They all reported that manatee populations in the area were in excellent form (Table 5 and 6).

Table 5

	5 years ago	10 years ago
Species	**Moderate (%)**	**Good (%)**
Tarpon	100	100

Table 6

	5 years ago
Species	**Excellent (%)**
Manatee	100

The observation of Sarstún fishers on the status of coastal resources of the area generally concurred with the Belizean fishers. They indicated that the fisheries resources are in poor to moderate condition depending on species. Shrimp was the only resource still considered in moderate health. All finfish populations were considered in poor condition. The abundance of these resources has decreased over time, 10 years ago the resources were deemed to be in moderate to good condition. They felt the major cause of the decline was over fishing and trawling.

Based on stakeholders' perceptions and the opinions of the fishers familiar with the area, the status of coastal resources particularly the fisheries resources are in poor health. The fishers' conclusions were made on the frequency and ease with which the various fish species are observed and can be harvested. When asked their opinions on the status of the fisheries resources 10 years versus 5 years ago, the majority of fishers

stated that 10 years ago fish stocks were in good abundance while as recent as 5 years ago, abundance of fish in the area has decreased and was generally in poor abundance. Certain species such as the tarpon were still felt to be in moderate abundance. The population of the marine mammal, the West Indian Manatee, was regarded as being in excellent abundance.

5.5 Stakeholder Recommendations on Management of the STMMA

Stakeholders, both fishers and key groups such as local NGOs, cooperatives and development agencies, were interviewed regarding what they felt were key management issues and recommendations for the sustainable use of the coastal resources of the Sarstoon-Temash Management Marine Area (STMMA). Stakeholders gave a wide range of management actions and recommendations which were seen as necessary to ensure long-term use of the STMMA (Table 7).

When these management actions/recommendations were ranked based on the most frequently identified, four recommendations were ranked as critical. The most frequently identified recommendation was the need for effective enforcement of laws and regulations, followed by the implementation of fishing gear limits and restrictions as management mechanisms against improper fishing practices. Other important recommendations were for the regulation of shrimping to enable more sustainable methods and practices, and the need for education and awareness programs to inform and educate stakeholders on key issues (Table 7).

Stakeholders, particularly the fishers, also recommended the need to develop alternative livelihoods to fishing and capacity building for communities in the area. Key interest groups, including fishers felt that transboundary coordination was a key management intervention needed to address conflicts and sustainably manage the resources in the area. Individual stakeholders made recommendations for strict registration process for fishers, regional policies and laws, fishing quotas and fostering community ownership to name a few (Table 7).

Fishers also indicated that upriver pollution is a concern as they believed that land based pollution, from agricultural runoff (fertilizers and pesticides), has caused an increase in the occurrence of blind or affected fish. All fishers indicated that they are against any form of protection or restriction of fishing activities in the area, whether no-take areas, closed seasons, etc. This indicates a need for education and dialogue of such management interventions become necessary, mainly concerning closed seasons or voluntary no-take areas.

Table 7

MANAGEMENT ACTIONS	TOTAL RESPONSE (14)
Effective Enforcement	**7**
Gear limits and restrictions	**6**
Regulate shrimping	**5**
Education and awareness	**4**
Alternative livelihood options	**3**
Transboundary coordination (TRIGOH)	**3**
Protection of the area	**2**
Riparian management	**2**
More comprehensive regulations	**1**
Address language barrier	**1**
Collaboration with NGOs	**1**
Foster Community Ownership	**1**
Regional policies/laws	**1**
Monitoring programs	**1**
Capacity building	**1**
Sustainable fishing methods	**1**
Strict registration process	**1**
Fishing quotas	**1**

A major positive response on the part of the fishers was their willingness and interest in collaborating with SATIIM for the management of the coastal area. However, several were a bit cautious and skeptic as to whether their best interests would be considered in the management arrangement, based on past experiences with similar projects. The fishers expressed that their support would be conditional based on the actions and strategies employed by SATIIM that would benefit and enhance their livelihoods and provide opportunities and/or support for capacity and enterprise building.

From discussions with the fishers of Sarstún, there were several management recommendations made for the STMMA. These included the control of commercial and illegal fishing at nights and to prohibit the use of small mesh sizes. They felt that there was a need for capacity building such as the establishment of cooperatives, mariculture facilities and mirco-enterprises. These consultations were facilitated by FUNDAECO working in partnership with SATIIM.

6.0 THREATS ANALYSIS AND MANAGEMENT PROBLEMS

The major use of the marine resources within the Sarstoon-Temash Marine Management Area is fishing. Since the area is not inclusive of any coral reef areas but dominated by seagrass communities and mud bottom communities, the major use has been for inshore fisheries and shrimping. Both Belizeans and Guatemalans are frequent users of the resources of the Sarstoon-Temash Marine Management Area. This often creates conflicts between local and foreign users. In addition this characteristic of transboundary use creates issues for legal enforcement of laws and diplomatic relations with Guatemala. While there have been discussions on tourism activity in this region, this use has not been explored to date. However the area is a regular transportation route to Puerto Barrios and Livingston, Guatemala.

SATIIM aims to manage the area with the support of the fishing communities as a marine buffer for the Sarstoon-Temash National Park and to enable sustainable practices within the STMMA. The dependence of local communities within the area for the support of their livelihood and the fact that the STMMA is within a transboundary area, presents several conservation threats and problems for management. In consultations with the stakeholders in the area, both fishing interests and key groups (NGOs, agencies, etc.), several key threats to coastal resources and management issues were identified. These various threats and management problems are outlined in Figure 39, Table 8.

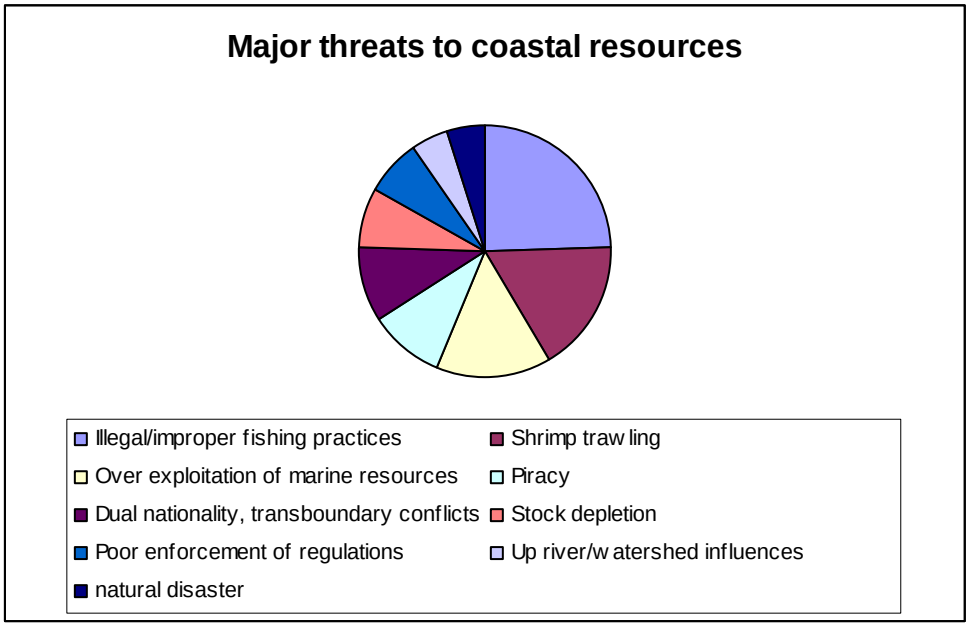

Figure 39

Table 8

Major threats	TOTAL (14)
Illegal/improper fishing practices	**10**
Shrimp trawling	**7**
Over exploitation of marine resources	**6**
Piracy	**4**
Dual nationality, transboundary conflicts	**4**
Stock depletion	**3**
Poor enforcement of regulations	**3**
Up river/watershed influences	**2**
natural disaster	**2**
Habitat destruction	**0**
Inadequate inter-agency coordination	**0**

The three major threats to the coastal resources as seen by the stakeholders, both fishers and key interest groups, were illegal/improper fishing practices such as the use of gill nets and drag nets; shrimp trawling by Guatemalan boats and over exploitation of the marine resources. Other significant management issues indicated by stakeholders interviewed were that transboundary conflicts and issue of dual nationality by Guatemalans, and piracy were also an issue in the area. All the fishers felt that foreign nationals from Guatemala created the most significant threats through their illegal and unsustainable fishing methods and the destructive shrimp trawling industry. Threats and problems such as stock depletion, poor enforcement, watershed influences and natural disasters were seen as minimal.

6.1 Conservation Threats

6.1.1 Overexploitation and Stock Depletion

Based on data collected in the REA Study, the seagrass resources of the Sarstoon-Temash Marine Management Area (STMMA) are in moderate health with low fish abundance, comprised of mainly juveniles. Seagrass cover is sparse to intermediate with fairly low diversity, due in part to the freshwater influences in the area. The current status of the resources may also be due in a large part to the level of fishing effort and fishing practices in the area. A major conservation threat to the STMMA is therefore overfishing or overexploitation of the marine resources and stock depletion. The coastal area is heavily utilized by Guatemalan fishers both, artisanal and commercial, for shrimp trawling. The Guatemalan village of Sarstún has about 125 fishers compared to 40 Belizean fishers. The Guatemalan fishers target the STMMA as their waters have been exhausted of viable fisheries products. There is consensus among stakeholders that this practice has had a significant impact on the health of the resources. Overfishing is generally caused by heavy fishing pressure and poor fishing practices. Once fish stocks have been reduced, subsequent capture of juveniles or gravid females result in the inability of the fish stocks to recover and re-populate as juveniles and females do not get the opportunity to produce offspring thereby replenishing stocks.

6.1.2 Improper and Unsustainable Fishing Practices

As mentioned previously, overexploitation is followed closely by improper or unsustainable fishing practices. In the STMMA these unsustainable practices range from the use of gill nets and drag nets for shrimping with small mesh sizes; to capturing of juveniles or females during breeding seasons; to the setting of nets across rivers or enclosing an entire area. These practices ultimately diminish the fisheries as species are unable to reproduce. A unique characteristic of seagrass beds is the migratory features of many fish species that utilize the beds for feeding and as nursery areas. If these seagrass beds are destroyed or overexploited, this may have a significant impact on the re-stocking of fish to the area and the free movement in and out. Improper and unregulated shrimp trawling is also a serious conservation threat to the STMMA. Current reports indicate that there is illegal and unregulated commercial shrimp trawling conducted within the STMMA. Trawls used in shrimping target the sea bottom and all the benthos that dwell there, removing everything in its path including shrimps (which are demersal organisms), fish and seagrass amongst other benthic organisms. A lack of regulation of such activities to restrict the number of trawlers, gear specifications, geographic area and time of year for shrimp harvesting poses significant threats to the resources that support the shrimp fishery.

6.1.3 Land based Sources

The creation of the Sarstoon-Temash Marine Management Area (STMMA) is in recognition of a marine buffer area for the Sarstoon-Temash National Park (STNP) to enable land-sea connectivity. This is especially important given the potential for impacts from land based sources of pollution. The watersheds within the STNP are vulnerable to agricultural runoffs such as fertilizers and pesticides entering the rivers, creeks and streams. These are all interconnected tributaries that ultimately drain into the Temash and Sarstoon Rivers and enter the southern coastal zone of Belize. In addition milpa farming and other unsustainable forms of agriculture can result in topsoil being lost through rainfall runoff into the waterways. This creates sedimentation which not only affects the freshwater ecosystems within the STNP but also affect the marine ecosystems in the STMMA, particularly through sedimentation and smothering of seagrass beds. Another threat to the coastal zone of the STMMA is the potential impact from sewage pollution arising from inadequate sewage treatment in the numerous villages in the STNP. A recent hydrology report commissioned by SATIIM indicated that there is already some level of eutrophication and elevated coliform of the rivers and creeks in the STNP, not to mention the use of pesticides such as 2-4 D, Folidol and Tamaron mainly phenoxy and organophosphates. During the rainy season the rivers show high levels of turbidity (Morgan 2004). This was supported by the REA data which showed high turbidity levels at the bars of the Temash and Sarstoon. Based on the current setting, strategies must be developed to monitor the water quality of the STNP and STMMA is a continuous system and to provide education and training on more environmentally friendly methods of farming.

6.1.4 Habitat destruction

Habitat destruction is not currently a major threat to the area as there are no significant population centers, industries or activities in the STMMA requiring removal and clearance of coastal vegetation. There is however, some habitat destruction and disturbance to seagrass beds from the shrimp trawling. Destruction of the coastal mangrove ecosystems in the area will result in a lack of buffering and filtration of land based source of nutrients, sediments, etc. Mangroves serve as important buffering systems for the marine environment reducing the level of nutrients or sediments that can affect the health of seagrass ecosystems. Destruction of seagrass beds would result in a loss of habitat for feeding and nurseries for various fish species of commercial importance such as grunts, snappers and jacks, and as a result a subsequent decline of these species in the area. The potential for loss or destruction of coastal and marine habitats in the STMMA is one threat that must be reduced in a proactive manner, through wise development and fishing practices and targeted education and awareness programs.

6.1.5 Natural Disasters

Natural disasters such as hurricanes, tropical storms and flooding provide some minimal threat to the coastal resources in the STMMA. While these occurrences are rare or infrequent, if and when they do occur they can inflict significant impacts through the loss of habitats which results in loss of fish and other wildlife in the area. Flooding from the major rivers in the STNP also can create significant sedimentation and freshwater impacts on the seagrass ecosystems. Seagrass can tolerate a certain level of sedimentation and exist at salinity levels as low as 24 $^{o}/_{oo}$. However excess sedimentation suffocates the seagrass plants and reduces their photosynthetic ability, thereby reducing productivity. In addition, salinity levels below 24 $^{o}/_{oo}$ inhibit the growth of seagrass beds, since this plant is a marine halophyte adapted to high salinity concentrations. In general marine ecosystems can often recover completely from natural disasters once they have not been compromised by anthropogenic (man-made) influences.

6.2 Funding and Coordination

6.2.1 Funding for management

The effective management of natural resources requires significant and sufficient funding to enable a sustained program of management. A critical challenge to the management of the STMMA marine buffer is that of financing the administrative, monitoring, research, education, training and community outreach activities involved in managing such an area. The majority of co-management organizations and NGOs in Belize depend on grant funding to support their management efforts. While these provide critical “seed” funding, a long term financing plan is required and is often the biggest obstacle to effective management of coastal resources in Belize.

6.2.2 Inter-agency and Transboundary Coordination

Managing coastal resources requires a lot of coordination between the co-management body and the relevant agencies involved in resource management, both government and NGOs. Transboundary areas require even further levels of coordination between countries to enable the best and most sustainable use of the coastal resources. In the case of the STMMA, the fisheries resources in particular are heavily utilized by foreign nationals from Guatemala, who often have different fishing practices and views regarding regulations and adherence to them. Belizean stakeholders expressed that there are regular conflicts between Belizean fishers and Guatemalan fishers. Added to this is the fact that Guatemalans possess dual nationality enabling them to fish in Belizean waters, but the privilege is not reciprocated to Belizeans to access Guatemalan waters. Another issue is the differences in regulatory and financial structures between Belize and Guatemala, with Belize having more desirable or accessible resources. Such issues clearly indicate the need for closer transboundary cooperation and coordination at the national or governmental levels and also at community levels. SATIIM has been proactive in establishing partnership with a major Guatemalan NGO, FUNDAECO, to work with and educate the Guatemalan fishers that utilize the Belizean waters.

Within Belize, there is the need to coordinate with agencies such as the Fisheries Department, CZMAI, Forestry, Lands, PACT, environmental NGOs and civil society organizations such as indigenous groups to discuss and agree on the best management strategies to employ for the STMMA. Currently there is little or poor inter-agency coordination occurring to patrol and monitor the use of the area. This demonstrates the critical need to foster more effective inter-agency coordination particularly to control illegal fishing and security issues in the Sartsoon-Temash Marine Management Area.

6.3 Monitoring and Enforcement

6.3.1 Insufficient Monitoring and Patrols

A major obstacle to management of the STMMA and an indirect threat to the coastal resources is the lack of monitoring of fishing activities and patrols of the area to ensure the security of users in the area. This is restricted largely by the government's lack of resources, both financial and personnel, to adequately monitor the area. This deficiency is seen as a major issue affecting the sustained use of the fisheries resources of the area, as there are no checks and balance to the incursions by illegal and often destructive fishing boats from Guatemala. The Belize Defence Force's presence in the area as a transboundary/border area also leaves much room for improvement and is felt to be the reason for the occurrence of regular piracy at sea. This highlights the need for strategies that foster inter-agency coordination to capitalize on existing and available resources that can support such costly operations as patrols and monitoring trips.

6.3.2 Inadequate Regulations and Enforcement

Enforcement is often closely linked with monitoring and patrolling and involves the compliance of activities with the respective regulations. In the case of the STMMA, enforcement is a critical management problem. Users have reported that compliance with and even knowledge of the relevant fisheries regulations is lacking particularly with the Guatemalan fishers. Additionally, even where regulations are known there is no compliance with them. This indicates the need for enforcement of these regulations by the Fisheries Department. A major obstacle to proper enforcement is limited resources. One strategy to address this is the establishment of a network of special fisheries officers and voluntary wardens to assist the Fisheries Department in identifying incursions and illegal activities.

Based on current unsustainable fishing practices there is a need to develop more specific regulations to address these concerns. The lack of adequate regulations in the long term presents an indirect conservation threat to the fisheries resources, as this often leads to overexploitation and stock depletion. Recommendations for improved regulations focus around stipulations regarding the size and use of gill nets, particularly in relation to the setting and siting of the nets. There is also the need to have specific shrimp trawling regulations governing the type and specifications of trawls and the allowable distance from the coast for trawling to occur. Often the shrimp trawlers utilize areas close to shore disrupting seagrass beds which the local fishers utilize as traditional fishing areas and on which they depend for their artisanal livelihoods.

6.4 Stakeholder Perspective

A thorough understanding of the perspective of stakeholders is critical for effective management of any natural resource. A lack of sufficient information and liaison with stakeholders can create major obstacles to effective management of a designated area. The STMMA is not a legally or officially recognized protected area, but rather a special management area identified to serve as a marine buffer for the management of land based influences from the terrestrial Sarstoon-Temash National Park. A critical requirement for the successful management of the STMMA as a marine buffer area will be the cooperation, support and involvement of the coastal communities and stakeholders of the coastal zone along the STNP.

To achieve this cooperation and support, the co-management body, SATIIM, will need to recognize and address stakeholders' perspectives and concerns for the area. Some of the major concerns expressed by fishers of the STMMA are issues of piracy from Guatemalan fishers, displacement as a result of the destruction of habitats arising from shrimp trawling near to shore, lack of enforcement and inadequate rules and regulations regarding fishing. In addition, fishers in the STMMA feel a great inequity based on the ability of Guatemalans to have dual nationality to access our resources but with the economic gains benefiting Guatemala and not Belize, as the products are sold over in Guatemala. Other problems believed to be created by Guatemalans is the impact of their unsustainable fishing practices, such as the use of gill nets across rivers and embayments and trawling close to shore disrupting seagrass habitats.

Another obstacle to management is the perception that SATIIM and Fisheries Department will severely restrict fishing in the area either through protected no-take areas or closed seasons. This can only be addressed through dialogue and educational/awareness building, as in some instances there may be the need for certain fishing restrictions, whether on gear types or for fishing areas. These may often be recognized or established fisheries management measures necessary to enable the sustainable fishing livelihoods in the area. The challenge is to ensure that stakeholders understand these strategies and are willing to support through their involvement.

6.5 Community Involvement

A key management problem is often the insufficient representation of stakeholder interests in the management of coastal resources. In this regard SATIIM has mechanisms for incorporating stakeholders in decision making regarding the use of their natural resources, through its institutional structure that has a Board of Directors comprised of key representatives from the communities affected by the Sarstoon Temash National Park (STNP). In regard to the management of the STNP's marine buffer, the STMMA, SATIIM will need to include the major users of the STMMA in particular fishers. This can be achieved through the creation of a sub-committee of SATIIM's Board that addresses coastal issues and which feeds into the Board's decision making. Through this strategy, the communities that utilize the area will be included in discussions and decisions regarding management recommendations.

Fostering community involvement in the management of coastal and marine resources also aids in reducing conservation threats, through public awareness and education on key management challenges and the strategies to address them. This would ensure that communities are well informed of all activities occurring in the STMMA and can access and interpret information relevant to management decisions. Communities then have greater capacity and are better able to provide constructive advice for the solution of problems or issues facing the area. Community involvement also enables greater unity and organization of stakeholders. This is particularly important for fishers, the group most affected by the various conservation threats and management problems facing the STMMA as they depend directly on the area for their livelihood. Without the involvement of communities, management strategies such as alternative livelihood strategies and conservation areas may not be successful since they may not address the daily needs of users.

7.0 MANAGEMENT STRATEGIES FOR THE SARSTOON-TEMASH MARINE MANAGEMENT AREA

7.1 Strategic Goals and Objectives

There are several strategic goals and objectives identified for the effective management of the STMMA as a marine buffer zone. The vision is to foster community management through voluntary changes in practices both on the terrestrial and marine sides to enable long-term use of the area towards the conservation of the marine resources within the STMMA. Outlined below are the 3 main strategic goals and the objectives necessary to achieve them.

Strategic Goal 1:

To maintain the Sarstoon-Temash Marine Management Area as a marine buffer zone for the Sarstoon-Temash National Park.

Objectives:

1. *To control upstream activities that may degrade or destroy all or part of the value of the area to conservation and sustainable development*
2. *To promote uses compatible with conservation and sustainable development objectives*
3. *To monitor and buffer land based impacts from the Sarstoon-Temash National Park (STNP)*

Strategic Goal 2:

To promote sustainable fishing practices within the Sarstoon-Temash Marine Management Area for the long-term use and access to the fisheries resources of the area.

Objectives:

1. *To maintain the value of the area as a nursery, feeding ground, or other critical habitat for fishery and other species*
2. *To maintain the value of the area to fisheries production*
3. *To provide guidelines on uses to within sustainable levels and to work with the Fisheries Department in regulating fishing activities*
4. *To promote sustainable fishing practices through educational awareness, training and capacity building*
5. *To maintain the ecological integrity and productivity of the area*
6. *To control uses within the area through the enhancement of patrolling and monitoring*
7. *To promote the need for and adoption of regulations to control and reduce destructive impacts from shrimp trawling*

Strategic Goal 3:

To identity and promote alternative livelihood opportunities to communities living in the Sarstoon-Temash Marine Management Area.

Objectives:

1. *To foster community stewardship and participation in the sustainable use and management of the STMMA*
2. *To promote and develop the alternative sustainable livelihoods of the coastal communities*
3. *To promote traditional fishing areas in protection of the fishing rights of the communities in the STMMA*
4. *To promote research, recreation and education which will enhance the livelihoods of fishers and stakeholders of the STMMA*

SATIIM plays an important role in the accomplishment of these goals and objectives. While the organization does not have a legal mandate over the STMMA, they have recognized the need to take the initiative in managing the area as a marine buffer zone for the Sarstoon Temash National Park, for which they are the designated co-managers. Their major role is to provide a linkage with the stakeholder communities that live in and depend on the STMMA with that of relevant government agencies, to effectively manage activities in the STMMA to ensure land-sea interface and sustainable use.

7.2 Boundaries and Zoning

7.2.1 Boundaries of the STMMA

The Sarstoon-Temash Marine Management Area (STMMA) is not a protected area but is recognized as the marine buffer zone to the STNP. As such any boundaries identified are not legally recognized but rather serve as a guide for the co-management body, SATIIM, within which to monitor and promote sound practices to compliment the management strategies within the adjacent National Park. These boundaries will serve primarily as an administrative tool in which to engage the voluntary participation and cooperation of the communities and fishing stakeholders or the area.

The boundary for the STMMA extends from Point A near Legagu Creek having the UTM Coordinates 295015.8 East and 1769852 North; then east to B, 299866.3 East and 1769853 North; then in a southwesterly direction to C, 297162.2 East and 1764301 North; continuing in a general southwesterly path to D, 296574.9 East and 1761962 North; then on to E, 295631.7 East and 1760250 North; then ending at F at the Sarstoon mouth at coordinates 295190.7 East and 1759020. This area falls within the 3 mile territorial limit of Belize's maritime area (Figure 40). The marine buffer zone encompasses approximately 4026 hectares in the western corner of the Gulf of Honduras and is comprised of inshore seagrass ecosystems and deeper mud bottom/basin communities. The use of marker buoys can be employed to formally identify and delineate the marine buffer zone of the STNP and aid in promoting awareness of this management strategy being employed by SATIIM.

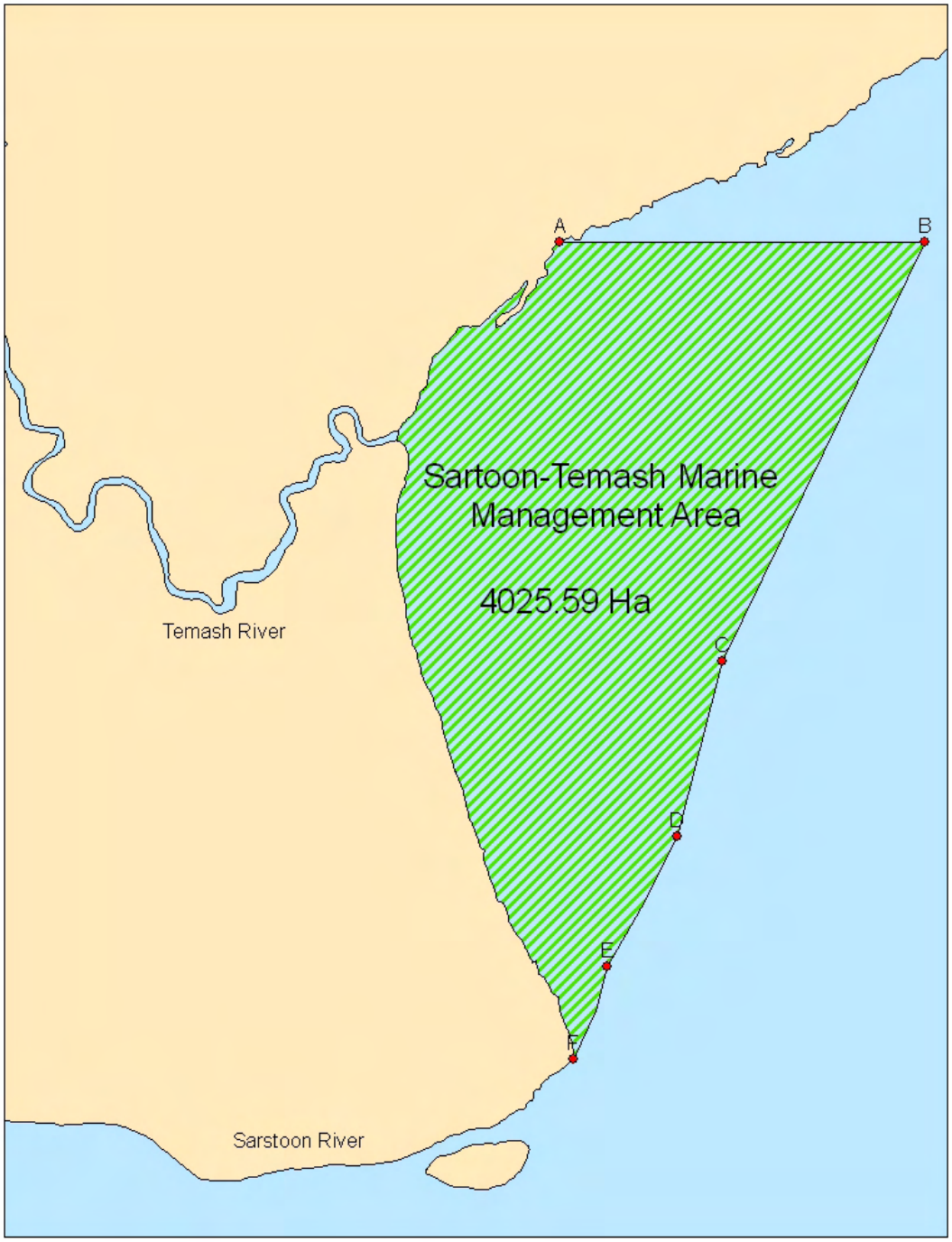
A
B
C
D
E
F
Sartoon-Temash Marine
Management Area
4025.59 Ha
Temash River
Sarstoon River

Figure 40

7.2.2 Zonation of activities within the STMMA

Since the STMMA is not a Marine Protected Area, any provisions for zoning will be based on voluntary compliance by and the recognition of fishers of the area. Such zoning would be two fold to establish and identify traditional ownership and use of key fishing areas and also to identify and separate conflicting uses. The major activities that require zoning are artisanal fishing and commercial shrimp trawling. This results in two major zones involving: (1) the identification and protection of traditional fishing grounds; and (2) the identification and establishment of shrimp trawling zones. These zones should be endorsed and supported by any relevant regulations or policy statements by the Fisheries Department. In addition to these two zones, it is important to identify a third zone: (3) zones of influence from land based sources of contamination. The main function of the zones would be to monitor the quality and health of the biological systems within these areas of influence.

Validation of these zones will require further ecological assessments of the areas and verification of areas by stakeholders to ensure that the zone reflect appropriate areas for the various uses. These zones can be marked or delineated with marker buoys to help identify the areas to fishers and other users. While the zones and boundaries do not legally restrict activities, they serve as management tools to build awareness and support for the strategies being employed. The ultimate goal is to lobby the Fisheries Department to recognize traditional fishing zones and to pass regulations to restrict trawling to the shrimp trawling zones. A standard stipulation in shrimp trawling regulations is to specify the area and trawl activity can occur with regard to depths and distance from shore, per vessel type. The shrimp trawling zone should take this into consideration. Marker buoys can be place using the method created by Environmental Moorings International and utilized in the Marine Protected Areas across Belize. These methods employ environmentally sound placement and durable buoys.

7.3 Administration Support

Management of any area including a buffer zone requires certain basic administrative support and capacity. This often entails personnel, equipment and logistic support such as wardens, managers, boats, monitoring and communications equipment, and planning and office support. SATIIM currently manages the Sarstoon-Temash National Park (STNP) with a park staff of 3 rangers and a manager. The main office has an executive director, science director, financial officer and data/GIS technician. This complement of staff currently executes the activities necessary for management of the STNP. In incorporating the management of the marine buffer zone, the STMMA, the administrative support currently provided by SATIIM will require some enhancement and expansion.

The primary areas of administrative support are personnel and equipment. In addition to the park rangers, there will be the need for at least two marine wardens to patrol and monitor the STMMA and liaise weekly with stakeholders. There will also be the need for a marine biologist and technician to conduct the long-term monitoring and research programs needed to keep track of the status of resources in the STMMA. A point

personnel is needed to oversee daily management activities and operations in the STMMA such as a manager or director of operations. Since a key strategy of managing this marine buffer zone is the support and voluntary compliance with management actions, an environmental educator/outreach officer is required to develop and implement interpretive and educational programs for stakeholders. In regards to equipment, there needs to be a patrol boat outfitted with radios/communications system; monitoring equipment such as dive gears, underwater video camera, multi parameter probe, recording equipment to mention a few. Daily logistic support is needed for patrols and monitoring trips such as fuel, water, stipends, etc. Additional field support can be obtained through voluntary researchers and wardens to assist with research and

Table 9 illustrates the basic personnel and equipment required for the effective administration of the STMMA.

Table 9

Category	**Type**	**Quantity**	**Duration**
Personnel	Marine Wardens	2-3	Full-time
	Marine Biologist	1	Full-time
	Technician	1	Full-time
	Education/Outreach Officer	1	Full-time
	Manager/Director	1	Full-time
Equipment	Dive gears	4	Year round
	Dive tanks	8	Year round
	Boat with engines	1	Year round
	Underwater camera	1	Annually
	Multi parameter probe (CTD probe)	1	Monthly
	Current and flow meters	1	
	Transects, writing slates, quadrats, etc	As needed	Annually
	Corers, mesh bags, other equipment for seagrass and mangrove monitoring	As needed	Annually
	Plastic sampling bottles (water quality)	20	Monthly
	Plankton nets, Niskin bottles	1 each	
	Cast nets, otter trawls, measuring scale and boards	1	

7.4 Surveillance and Patrolling

Several conservation threats to the resources in the STMMA were identified. The reduction of these threats requires various strategies including routine surveillance and patrolling. The STMMA is heavily utilized by Guatemalan nationals and there are many incidences of illegal activities and incursions. This marine area requires daily patrolling and surveillance to detect and control illegal activities. A key strategy in patrolling and surveillance is to enforce respective Fisheries regulations through education, warnings, dialogue and ultimately prosecution if compliance does not occur.

Since the relevant agencies that are responsible for conducting patrols and surveillance are inhibited by limited and inadequate finances, an important strategy is that of deputizing fisheries officers and establishing voluntary wardens. The Fisheries Department has indicated the interest and willingness to deputize SATIIM wardens as Fisheries Officers who will have authority to enforce regulations and make the necessary arrests, etc regarding the fisheries activities in the area. Voluntary wardens can assist in surveillance and patrolling to identify problem individuals or illegal activities and report these to the Fisheries Department and Fisheries Officers in the area. This network of voluntary wardens could be comprised of willing and committed fishers in the area. They would need to undergo a basic familiarization and training program endorsed and presented by the Compliance and Enforcement Unit of the Fisheries Department.

Patrols and surveillance trips should occur daily both on a regular schedule and some impromptu spot checks. Patrol logs should be recorded and kept to aid in maintaining effective patrols through necessary adjustments. Night patrols are also necessary and should be coordinated with BDF personnel or the newly formed Belize Coast Guard, to address illegal fishing activities at night and security issues such as piracy in the area. A key strategy for successful patrols is the collaboration of the relevant enforcement authorities, namely Fisheries Department, Police and BDF with assistance of SATIIM wardens. In developing a system for patrols discussions should focus on optimizing existing finances and human resources. A strong surveillance and patrolling team will be highly effective in reducing threats to resources through enforcement of regulations and reduction in illegal or destructive activities.

7.5 Community Management

The involvement and cooperation of the communities along the STMMA coastline is a crucial component in managing the marine buffer zone. The strategy is to include communities in the implementation of management objectives and decisions for the STMMA. This can be achieved on several levels of participation, policy, monitoring and research and patrolling.

7.5.1 STMMA Management Committee

The most participatory level of community management is on a committee or council where stakeholders, in the case particularly fishers, are represented and make recommendations and decisions for adoption of the various management strategies. It is proposed that a STMMA Management Committee be established to endorse and recommend management actions to SATIIM Board of Directors. This Management Committee should function as a sub-committee of the Board, to provide a linkage to the decision making process. Through the medium the stakeholders will be actively involved in management of the marine buffer zone.

The STMMA Management Committee should be comprised of the following members:

1. Representative from Mother Bush Community
2. Representative from Barranco Village
3. Representative from Moho River Community
4. Representative from Temash Community
5. Representative from the Rio Grande Fisherman Cooperative
6. Fisheries Department Representative
7. Representative from SATIIM (Manager of STMMA)
8. Representative from upriver communities (SATIIM Board Member)
9. Representative of BDF or Coast Guard
10. Representative of environmental NGO

Terms of reference and operating procedures for the STMMA Management Committee, should be prepared by SATIIM in conjunction with the Board and endorsed by the appointed members of the committee. These tools should serve as a guide for the functions and responsibilities of the Committee. The Committee should liaise and compliment the national efforts of agencies such as the CZMAI and their Coastal Planning Program, inclusive of the Development Guidelines for the Southern Coastal Region where appropriate.

7.5.2 Community Researchers

The users of any natural resources are always the most familiar with the location, status and extent of the resources. In the case of the STMMA the fishers of the area are the best sources for the identification of spawning sites, nursery areas, shrimping grounds and best fishing areas. This information is invaluable in structuring and implementing biological monitoring programs. Community researchers are excellent resources as assistants in monitoring programs. Other NGOs, such as Friends of Nature working with The Nature Conservancy, have utilized this strategy which has been quite successful not only in providing personnel and access to traditional knowledge in monitoring fish stocks, but also in "converting" fishers to be champions of sustainable fishing practices and the protection of fisheries resources.

Community researchers can provide assistance to biologists in identifying and accessing sites. In addition they can be provided with basic monitoring training to aid with collection of data, such a fish catch data or abundance data. This function also benefits fishers through education on fish biology and ecology and they have first hand experience and insight into fish stock trends. Through this means information is collected and accessed directly by fishers, rather than handed down by second hand reporting. The involvement of fishers as community researchers will instill confidence in management techniques and data.

7.5.3 Voluntary Wardens

Communities also play a vital role in the monitoring and surveillance of the resources. They are often the parties most aware of activities occurring in the area, through their daily presence at sea and the fact that they often dwell within the area of concern. An excellent means of drawing upon this opportunity and including fishing communities in management efforts is to create networks of voluntary wardens or "watchmen". A committed and well trained fleet of wardens can prove quite effective in assisting Fisheries Officers and rangers in patrolling and enforcing regulations in the area. One of the biggest management problems facing the STMMA is the lack of adequate patrols and enforcement. Regulations exist to control destructive activities, but they are not currently being enforced.

Through discussions with the Fisheries Department, SATIIM plans to establish a network of voluntary wardens comprised of fishers from the four communities in the area. These wardens should demonstrate good character, willingness and commitment to qualify for the program. Often fishers are reluctant to become involved in patrols or surveillance as they are fearful of being recognized and targeted by offenders. The plan for the voluntary wardens is to have them serve as the "eyes and ears" in the area and report illegal activities to the Fisheries Officers, rangers and other relevant authorities. They would not be involved in actual apprehension of offenders. Another useful function that voluntary wardens serve is to educate their fellow fishers on the regulations and proper conduct in the area, which can reduce the need for enforcement or prosecution. Several fishers have already indicated their interest in working with SATIIM as voluntary wardens. The establishment of voluntary wardens is a priority area of focus that SATIIM should follow up in collaboration with Fisheries Department.

7.6 Transboundary Cooperation

Transboundary cooperation is a critical management strategy to be employed in the STMMA which falls within a transboundary area, the Gulf of Honduras. There are several means of fostering transboundary cooperation at both local and national levels. A major means of coordination is that of forging partnerships. Other tools to foster transboundary cooperation include: memberships on regional bodies, exchange programs, joint research or capacity building projects, lobbying and participation in regional policy formulation.

7.6.1 Partnerships

One of the most critical is the establishment of partnerships with other co-management agencies or NGOs working in transboundary communities in other countries. In Guatemala, the NGO FUNDAECO has co-management responsibility for several protected areas and works closely with the Sarstun Community of Guatemala. A partnership between FUNDAECO and SATIIM, which has a similar scope an vision would be ideal in bridging the borders between communities that utilize the resources of the Gulf of Honduras. SATIIM has already taken this crucial step towards cooperation, as they have been in collaboration with FUNDAECO for the past two years. In

particular they have been in discussions regarding the management of the STMMA in its developmental stages. This partnership should be continued and expanded upon as the management plan for the marine buffer zone is implemented.

7.6.2 Memberships on Regional Bodies

Another potentially effective method of enhancing transboundary cooperation for the management of the STMMA is the participation of SATIIM on regional NGOs or management bodies. TRIGOH (Tri-National Alliance for the Gulf of Honduras) is such a body that is comprised of government agencies, NGOs and civil society groups from Belize, Guatemala and Honduras. This organization has its secretariat in Belize, coordinated through TIDE. SATIIM should become a member of this body since its work is focused within the greater Gulf of Honduras. As a participating and voting member on TRIGOH, SATIIM will be able to lobby for, share information and make recommendations for management of coastal resources in the area that will be endorsed and recognized by regional partners and agencies.

7.6.3 Exchange Programs

Exchange programs between local communities and organizations, at both national and international levels are useful management tools. Through such avenues communities get to share experiences and lessons learnt and also learn new methods of fishing or tourism practices that can benefit these communities back home. The best exchange involves first hand experience and encounters with techniques or situations, to re-enforce the effects. SATIIM should conduct such exchange programs in conjunction with other local NGOs, such as TASTE or TIDE and regional NGOs such as FUNDAECO, particularly with regards to sharing of views, experiences and practices among Belizean fisher in the STMMA and fishers from Sarstún and Livingston communities.

7.6.4 Joint Research and Capacity Building Projects

NGOs and co-management bodies that manage linked resources, as in the case of the Gulf of Honduras, should collaborate on joint research or capacity building projects that aim to foster sustainable practices within the area. Access to funding from grant agencies are often most favorable when there is a regional and transboundary component to grant applications. Some key joint projects that SATIIM and FUNDAECO could engage in are: sustainable alternative livelihoods, programs that focus on a shift to gill nets with larger and more sustainable mesh sizes, to name a few. Aside from collaborating on new projects, SATIIM should explore means of collaborating on existing projects in the area that have a similar focus, such as more sustainable methods of trawling, etc both at the national and regional levels. The limited resources in the Gulf require optimal coordination and collaboration to capitalize on opportunities.

7.6.5 Regional Policy Formulation

Where relevant and possible, through membership on regional bodies or lobbying regional projects, SATIIM should strive to be involved in regional policy discussions and or formulations. As a key stakeholder in the region, SATIIM should have the opportunity to provide input and recommendations on the applicability and priorities for Regional Polices with the aim of coordinating management actions. An opportunity that currently exists is that of the Mesoamerican Barrier Reef Project that has as a component the formulation of regional policies that standardize approaches to management strategies such as closed seasons, watershed practices, etc.

7.6.6 Collaboration with Government Agencies

An indirect means of coordination is the collaboration with government agencies regarding fishing practices, tourism practices and training or capacity building. Close collaboration with agencies such as Fisheries Department, Forestry, Belize Tourism Board, Coastal Zone Management Authority and Institute and Agriculture Ministry enables the co-management body to be in tune with government policies and regulations and enable a channel for dialogue on policy or management recommendations from co-management partners to government regulatory bodies.

7.7 Monitoring and Research Programs

An important part of managing resources is the availability of reliable and continuous information on the condition of the resources and communities that depend on them. Monitoring programs fulfill this crucial role in providing necessary information for the formulation of timely decisions regarding the use of the marine resources. Within the STMMA there are several monitoring programs that must be maintained to provide information to both the communities and SATIIM in the management and use of the marine buffer zone. The implementation of the various monitoring programs is the responsibility of the marine biologist.

7.7.1 Monitoring Programs

7.7.1.1 Seagrass and Mangrove Ecosystems

The major ecosystems in the STMMA are seagrass and mangroves. Seagrass beds dominate the marine area of the STMMA, while fringing mangroves can be found bordering the STMMA's coastline. These ecosystems require long-term monitoring to determine their status and to observe changes over time in response to threats or management actions. Since the STMMA falls with the Gulf of Honduras, a transboundary area of focus for the Mesoamerican Barrier Reef System Project, it is recommended that SATIIM employs the use of the MBRS Synoptic Monitoring Protocol for the monitoring of seagrass and mangrove ecosystems. The idea behind standardizing monitoring protocols in the MBRS is to enable comparisons and analysis of ecosystem health across the four countries of the MBRS.

According to the MBRS Synoptic Monitoring Protocol, seagrass and mangrove ecosystems should be sampled in three categories identified by frequency of sampling events. The parameters sampled for seagrass are percentage seagrass cover, abundance, species composition, standing crop and biomass, seasonality, spatial coverage, growth, productivity, leaf area index and C:N:P content. Sites should be monitored at least to the level of category 1 on an annual basis. Mangrove parameters to be sampled are: forest zonation, establishment of plots, trunk dbh and height, community description, abundance and percentage cover, seedling and saplings (growth), increase in spatial cover and biomass, leaf area index, productivity, litter fall, nutrients. Refer to the MBRS Synoptic Monitoring Manual for details on the establishment and conduct of the monitoring programs. The MBRS Project staff, situated in Belize City, provides technical and some logistic support in setting up these programs through training and limited logistic support. Mangrove prop root communities (*Rhizophora mangle*) should also be monitoring on an annual basis, as these roots serve as important fishery nursery areas for fish and shrimps.

7.7.1.2 Physical Oceanography

Monitoring the physical oceanography of the STMMA is important to note changes in salinity, temperature, current patterns and turbidity which are critical physical parameters necessary for the growth and health of organisms. The MBRS Synoptic Monitoring Protocol provides recommendations on parameters to monitor and frequency of monitoring. The basic physical oceanographic sampling involves measurements of: water depth, tides, current speed and direction, water temperature, salinity (conductivity), density, water transparency or light attenuation, sea state. Meteorological measurements recommended by the MBRS Protocol are: wind speed and direction, atmospheric pressure, air temperature, rainfall and river discharge. For detailed information on sampling methods and frequency, see the MBRS Synoptic Monitoring Manual 2003.

Some additional important parameters include chlorophyll, dissolved oxygen, turbidity, plankton biomass and abundance. Chlorophyll, dissolved oxygen and turbidity should be sampled on a monthly basis and can be easily monitored using multi parameter probes equipped with the respective sensors. These devices are highly accurate once properly maintained and calibrated. The sampling sites for these parameters should be the same as those for the physical oceanography monitoring sites under the MBRS protocol. Plankton (both phytoplankton and zooplankton) biomass and abundance should be sampled twice a year to note seasonal abundance changes across sites. Sampling of zooplankton involves the use of plankton nets either towed or hauled from the boat. Phytoplankton sampling is conducted through collection of sea water using Niskin water bottles deployed at depth.

7.7.1.3 Water Quality Monitoring

The monitoring of the water quality of the STMMA is a highly relevant management tool given the riverine influences of the area, with the Temash and Sarstoon Rivers draining in the area bringing potential upriver impacts from the National Park. The water quality monitoring program can adopt the MBRS Synoptic Protocol and sample for sediments,

organochlorine pesticides and polychlorinated biphenyls (PCBs), nutrients (ammonium, nitrates, nitrites and phosphates), total coliforms and fecal coliforms. Sediments, organochlorine pesticides and polychlorinated biphenyls (PCBs) should be sampled at least once a year. Nutrients, total coliform and fecal coliform should be sampled monthly for at least a years and then quarterly or on a seasonal basis (wet and dry). The detailed methodology for the water quality monitoring is outlined in the MBRS Synoptic Monitoring Manual.

7.7.1.4 Fish Diversity and Abundance

Regular monitoring of fish populations is an important tool in identifying status of fisheries resources to serve as a baseline in identifying when the resource is under threat. The MBRS Synoptic Protocol outlines some basic monitoring protocols for fish diversity and abundance for coral reefs, which can be modified for seagrass beds. These methods include standard belt transects and roving diver counts and can provide information on abundance, size and species composition of fish communities in the seagrass beds. The species list as provided in the MBRS Protocol will need to be adapted to reflect seagrass fish species. This monitoring should occur at least twice a year, where possible to overlap with breeding seasons. Refer to MBRS Synoptic Protocol for the detailed methods for fish diversity and abundance. Site selection should be based on local knowledge of fishing areas, fish habits and migration, and guided where relevant by sites sampled in the Rapid Ecological Assessment.

7.7.1.5 Fisheries Catch and Effort Data

Catch and effort data on the fish species exploited by the local fishery is important information in monitoring fish species abundance and diversity. This type of monitoring provides information on the type, age, sex and size of fish being captured and provides useful indications as to the health and condition of fish stocks. For this particular monitoring program, community researchers (fishers) are particularly useful as they will be the data collectors for this monitoring effort. SATIIM staff can conduct verification checks routinely to validate the accuracy of the data. This information should be collected on a monthly basis for all the fishers in the area, visiting fishing boats during capture or collection of fish products. Basic parameters measured in catch and effort data include species, weight, age, size, sex. Fishing effort is also monitored by recording time spent fishing, number of fishers, gear types and fishing area.

7.7.1.6 Socioeconomic Monitoring

Socioeconomic monitoring is a management tool that has recently gained recognition amongst marine resource managers, who realized the need to monitor not only the status of biological resource but also the status and condition of social factors. Often the success of protected areas or management areas depends on the change in habits, behavior and perceptions of communities and stakeholders. However, rarely are such factors monitored in communities to actually observe changes whether positive or negative that can provide critical insight into social management issues.

In the case of the STMMA, which is a marine buffer zone with no formal designation, community behavior and perceptions are key in eliciting cooperation and participation by community members in the management and subsequent use the resources. A socioeconomic monitoring program should be established for the STMMA to record baseline conditions: demographics, economic status, perceptions, current behaviors and practices and to note changes over time as management is implemented. This data will provide a means of checking whether management efforts are being received positively by stakeholders and can indicate when there is a need for intervention or change in management strategies. Such monitoring should be modeled off the SocMon Caribbean Manual, adapted for the criteria unique to the STMMA and surveys conducted as needed, but at least once a year (See SocMon Caribbean Manual 2003).

7.7.2 Research Program

In addition to regular, long-term monitoring programs which establish and track the health and status of the resources, there is also the need for targeted research to address management questions or provide specific information on particular dynamics of life histories or communities. Research should be conducted after the identification of priority research areas, which serve to guide the formulation of research projects. These projects can be developed by SATIIM and grant applications or can be accomplished through invitation and internships of visiting researchers, both national (UB researchers) and international. SATIIM can promote its research priorities through the marketing of research internships to international researchers as a means of revenue generation for the STMMA, and collaborate on research projects with researchers from UB. Through this strategy, the required research is conducted at no cost to SATIIM and also brings in well need funding for management. There is an upcoming opportunity for such a strategy with the planned establishment of a field office for Earth Watch Institute in the Toledo District, which conducts “research tourism” whereby volunteers pay to assist scientists on research projects.

Some initial research areas that should be priority for the STMMA are listed below:

- Mangroves as shrimp production zones of the STMMA
- Distribution, abundance and population dynamics of the shrimp fishery
- Studies on levels of by-catch from the shrimp trawling
- Migratory patterns of fish species within seagrass ecosystems of the STMMA
- Impacts of land based pollution (pesticides) on fish stocks and ecosystems
- Analysis of the heavy metal contamination from across bordering watershed areas, Guatemala
- Distribution and abundance of sport fishing species (snook, tarpon, bonefish, etc) and the potential as viable industry
- Status of manatee populations in the STMMA and associated watersheds of the STNP
- Recruitment and Larval Transport of commercial fisheries species within the STMMA.

7.8 Sustainable Alternative Livelihoods

7.8.1 Promotion of and assessment of alternative livelihoods

During initial consultations with stakeholders, many expressed the frustration of struggling to earn a living from fishing. They were of the sentiment that fishing becomes harder every year and are open to viable alternatives to supplement or replace fishing as the main economic livelihood. Based on the view of fishers, the scarcity of adult fish and sparse to intermediate seagrass cover from the REA, a key strategy in managing the resources of the STMMA is to explore and promote sustainable alternative livelihoods for the fishers of the area. This should involve the investigation of the eco-tourism potential of the area, although preliminary observations and discussions indicate a great potential for tour guiding along the Temash and Sarstoon and sport fishing. Other options to explore are aquaculture ventures such as the rearing of caged fish just off the coast. Promotion of alternatives to fishing entails a lot of public awareness and education on the concepts and options available. SATIIM can draw on experience of other co-management NGOs in the area and region that are applicable to the STMMA.

7.8.2 Capacity Building

Paramount to the promotion of alternative livelihoods, in an effort to improve the economic conditions of stakeholders thereby reducing threats to the marine resources, is the need for capacity building of communities. There is a need for education and training targeted at the building of the knowledge base of stakeholders in reference to new technologies and jobs. One basic capacity building initiative, particularly for the tourism based alternatives is the education of fishers in Basic English Proficiency both oral and written. As tour guides, they will be required to conduct business in English the official language of Belize. Similarly there will be training necessary to obtain a tour guide license, or become a certified scuba diver either as community researcher or dive master. SATIIM will need to establish the baseline capacity and educational levels of the stakeholders of the STMMA to adequately address training and educational issues. Another major capacity building need is training in micro-enterprising or small business operations. Additionally, stakeholders should be familiarized with all information on access to credit or financing options.

7.8.3 Eco-tourism

The STMMA possess excellent mangrove ecosystems and has great conservation value which can be tapped into for eco-tourism. The fishers are intimately familiar with the area and would make the best tour guides to enable maximum visitor experience through knowledge of best sites to spot manatees, dolphins or birdlife. In additional there is undeveloped cultural tourism potential in the village of Barranco. This traditional Garifuna village is one of the few Garifuna coastal settlements and has a rich history of Garifuna traditions and ceremonies particularly, concerning coastal resources. A potentially lucrative alternative for the residents of Barranco is the development of the village as a cultural tourism destination. SATIIM working in conjunction with the village should explore this option.

Sport fishing is a high demand industry attracting many tourist fishers to southern Belize and the Turneffe Atolls in an annual basis. Due to the extensive estuarine areas within the STMMA, there is a high potential for sport fishing operation as alternative options to fishing. Fishermen make ideal sport fishing guides, in fact several southern coastal communities, such as Monkey River, have become involved in this industry. The area is known for snook and tarpon, which are highly sought after game fish species. Sport fishers are willing to pay large sums of money to seek out and capture these game species, a daily sport fishing package can cost as much as $500 US dollars. This is definitely an option for further analysis and discussion for the fishers of the STMMA.

7.8.4 Aquaculture

As fisheries resources decline or become increasing threatened by overexploitation, coastal communities and management agencies often look to aquaculture of viable fish species to supplement the demand for fish products. Majority of aquaculture practiced in Belize is on land in the form of freshwater shrimp farms. However the Draft Aquaculture Policy and Land Use Plan (2003) identified potential areas for cage culture and marine farming within the coastal zone of Belize. The potential of areas within the STMMA in which to conduct trial tests of cage culture should be considered. Species could be wild capture juveniles or larvae obtained from brood stocks. Some potential species previously investigated and reared in other Caribbean countries include: red hybrid Tilapia, sea bass, mutton snapper and white mullet. The more realistic venture would have to involve the rearing of wild captured juveniles, as SATIIM lacks the resources and technology to provide brood stock. In addition, juvenile fish can be herded and reared in enclosure similar to the types traditionally used by the Garifuna.

Another aquaculture activity that can be explored is the cultivation of oysters in the mangrove prop roots for sale to restaurant markets. The species commonly cultivated is the mangrove oyster, *Crassostrea rhizophorae*, which has been widely grown throughout the Caribbean and is valuable commercial commodity. Foreign visitors from Europe and America enjoy the taste of oysters. Such commodities are currently rare or absent in Belizean restaurants. The establishment of a cooperative to provide oysters could have potential for livelihood benefits, especially since there are no national suppliers. There would need to be an evaluation of the species of oysters to rear, but culturing in itself is fairly simple and inexpensive, requiring initial “seeding” of areas to encourage growth and expansion of colonies.

7.8.5 Agriculture

Some fishers may be interested in pursuing organic agriculture practices that are currently being explored and implemented in the Sarstoon Temash National Park. While it may be more difficult for coastal dwellers to access agriculture opportunities, it is an alternative option to fishing that merits further investigation. The advantage to the fishers of the STMMA is that SATIIM is the co-manager of the National Park and is familiar with the challenges and benefits of such a program.

7.9 Fisheries Management

7.9.1 Artisanal and Commercial Fishing

The two major types of fishing occurring in the area are artisanal and commercial fishing. Artisanal fishing is conducted by locals targeting finfish species found in the area and small-scale shrimping, using cast and drag nets. Commercial fishing involves large boats from Guatemala trawling the seabed near to shore, especially at nights. Based on the potential for conflicts between these two types of fishing utilizing the same area, there is a need to develop management strategies to address both.

7.9.2 Fishing Zones

It is proposed that two fishing zones be established in the STMMA. These zones will serve to provide guidance to activities and also to identify and mark traditional artisanal fishing areas. The traditional fishing zone should include all the inshore areas within 2 nautical miles or 3.7 kilometers from shore along the entire length of the STMMA. This area has been identified as the traditional fishing areas. Validation with stakeholders and verification of coordinates must be conducted before this zone is demarcated. Demarcation will be done using marker buoys like those utilized in Marine Protected Areas throughout Belize. This zonaton includes the seagrass beds within the STMMA as these are important fish nurseries and feeding grounds and fall within the 5-10 m bathymetric contour. Artisanal shrimp trawling should be conducted at least 1 nautical mile or 1.8 km from shore within this traditional fishing zone.

The other zone that should be established is a trawling zone where all commercial shrimp trawling should occur. This zone should be at least 3 nautical miles or 5.6 kilometers from shore at depths of 10 m or more, beyond the traditional fishing zone and extending into the territorial sea of Belize. While this zone places shrimp trawling outside the STMMA in certain areas, the action is necessary to protect traditional fishing areas and the ecosystems that support them. These trawlers are highly destructive to seagrass and coral reef ecosystems. In the deeper waters, the communities tend to be comprised of mud bottom communities, good habitats for demersal shrimps. The legal establishment of the limits of this zone prohibiting trawling within shallow inshore areas, should be pursued with the Fisheries Department. While regulations exists under the Fisheries Act for the licensing of foreign vessels, number of vessels, closed season for shrimp trawling, use of TEDs and gear type; there are no stipulations to restrict and control trawling within shallow, sensitive ecosystems. Numerous countries in the Caribbean and Pacific utilize regulations for a minimum allowable distance from the coast or land.

7.9.3 Mesh Exchange Program

The Fisheries Act contains regulations specific to the use and size of gill nets. These stipulate that mesh size should not be less than 3 inches in diameter. Furthermore it is illegal to place these nets in such a manner that they enclose any rivers, bays, estuaries or lagoons so as to restrict the movement of fish and other aquatic life. Despite these laws, there are numerous reports of the illegal use of gill nets in southern Belize. One

fisheries management strategy that should be employed to tackle this problem in a non-combative manner is the establishment of a mesh exchange program. Such types of programs have been utilized in the Caribbean and the Philippines. In Jamaica, in particular, fishers were encouraged to exchange or trade in fish traps with mesh sizes less than 3 inches for new mesh 3-3½ inches, for construction of new traps. This strategy addressed the financial concerns of converting fishing gear to a new mesh size and was quite successful in shifting fishing practices. Fishers saw the benefits of using larger mesh sizes, which resulted in a majority of larger fish being caught versus numerous smaller sized fish. In addition, they recognized that the traps spared younger fish that were then able to grow to maturity and reproduce, replenishing stocks.

A similar program is proposed for the STMMA whereby fishers will be educated on the regulations, which calls for the use of ≥3 inch mesh and sensitized as to the reasons for the use of larger mesh size. Fishers will be encouraged and rewarded for bringing in their old nets by the distribution of new nets. The program should also re-enforce the stipulations regarding the setting of nets and have fishers educated on best methods for deploying the nets.

7.9.4 Sustainable Fishing Practices

The traditional fishers of the STMMA should be educated on sustainable fishing practices and encouraged to employ these practices in their daily fishing trade. Key practices that should be targeted are the use of cast nets or drag nets with larger mesh and outfitted for less dragging on the seagrass beds, for artisanal shrimping within the traditional fishing zone. These methods are more sustainable and less destructive than the current wide spread use of drag nets. There could also be a sub-zone within the traditional fishing zone, explicitly for artisanal shrimp trawling to further control damage to seagrass beds. There have also been recommendations for the exploration of more efficient shrimp traps that can be set for a period of time and retrieved, reducing fishing effort.

Fishers should be educated and sensitized on the importance of capturing adult fish and non-gravid females, to help in reducing the threat or overfishing or stock depletion. In targeting and carefully monitoring catch to ensure that only non-reproducing adults are caught, the fishery can become more sustainable allowing natural re-stocking of fish populations. This is important as fishers indicated that 90% of fish caught were females and majority of this was gravid females. Another strategy to be employed and encouraged is the identification of breeding or nursery areas that would be voluntarily excluded form fishing efforts for a certain period of the year that coincides with spawning seasons and/or juvenile life stages. If fishers are made aware of the need to have some “seeding” areas to continuously replenish their stocks and voluntary commit to such a management action, this would prove much more effective than restricting access to certain areas.

7.9.5 Adoption of Regulations

As mentioned previously, over the course of managing the STMMA, SATIIM may become aware of certain gaps or loopholes in the Fisheries Regulations based on current practices. As a co-management agency faced with the daily challenges of fisheries management, they would be well positioned to dialogue with and lobby for the adoption of new regulations or amendments to old ones. Current examples of the need for new regulations concern the conduct heavy pressure shrimp trawling by large vessels within shallow inshore and seagrass areas. There is a clear need to specify restrictions on the areas of operation of the trawler fleets. This is crucial in order to reduce conflicts between traditional fishers and commercial fishing vessels and provides a means of ensuring traditional fishing areas are protected. There may be the need for other regulations over time. There has been a lot of discussion on the legislation of traditional fishing rights and areas.

7.9.6 Catch and Effort Data

The use of catch and effort data derived from fishers of the area, is a useful fisheries management tool to monitor the health of fish stocks. This information can provide the justification and evidence to control or reduce fishing within certain periods of the year, within certain areas and restrict the capture of certain sizes of fish. This strategy requires the close cooperation of fishers. As discussed previously in section *7.7.1.5 Monitoring and Research*, fishers have a key role to play in the collection and interpretation of the information. With this practice in place, recommendations for changes in fishing habits or efforts should be more easily accepted and endorsed.

7.9.7 Voluntary closed areas and closed seasons

Closed areas and closed seasons are some useful fisheries management techniques. In the case of the STMMA, such strategies would need to be completely vulnerable based on discussions and data to support recommendations for such actions. If fishers see the need or agree to such measures, voluntary no take areas and closed seasons, can be negotiated and implemented within the STMMA. These measures can be offset by the establishment of sustainable alternative livelihoods, to fill the financial gaps during these periods of no fishing.

7.10 Education and Awareness Programs

Education and Awareness programs are important tools for managing natural resources, especially in the case of the STMMA, which is a marine buffer zone with no legal basis of establishment. Therefore the achievement of management objectives relies largely on the understanding, support and cooperation of stakeholders in the area. Every management strategy and implementation component of management in the area, will require targeted awareness and where necessary education of stakeholders.

7.10.1 Education and Training Programs

Based on the management goals and objectives and management programs, there are certain key education and training components that will be required for both SATIIM staff and the communities, to enable the achievement of management objectives. Important training that is required by both staff and fishers are: patrolling and surveillance procedures, knowledge of fisheries regulations and their enforcement, monitoring techniques for the physical and biological resources, and general administrative procedures. There are also several key education and training components necessary for the realization of sustainable alternative livelihoods. This involves English Proficiency education, tour guide training, dive training, training in aquaculture techniques such as cage culture and oyster cultivation and micro-enterprise strategies. SATIIM should regularly evaluate the need for further training or education activities in response to management needs. SATIIM should draw upon partnerships or existing channels at the national level, in an effort to make efficient use of limited resources for capacity building initiatives.

7.10.2 Awareness Programs

Targeted awareness programs should include information on sustainable fishing practices and lessons from other regional countries such as Latin America and the Caribbean. Awareness programs to compliment fisheries management strategies such as the mesh exchange program, zoning within the STMMA and the separation of artisanal and commercial fishing should be designed and implemented in conjunction with these programs. General awareness programs on the STMMA's function, goals and management objectives should be developed and shared with stakeholders and partner agencies to promote the STMMA and its activities. Such awareness programs should also target potential partners and donor agencies that can contribute meaningfully to the management of the STMMA. Promotion of fisher exchanges and forums for the sharing of experiences and discussions on the benefits of such initiatives should also be made to fishers of the STMMA to heighten their awareness on the benefits of such activities. This can create an increased awareness of opportunities that may exist to enhance fishing practices with tangible benefits to fishers.

7.11 Financial Sustainability

Financing the management of natural resources is a highly expensive and financially demanding activity. Many co-managers and natural resource managers around the globe are faced with the mammoth challenge on a daily basis. Most protected area look to user and entrance fees to offset management cost, although the funding generated through fees rarely meets the financial requirements of management. In Belize, protected areas have struggled with the issue of sustainably supporting or financing management of these protected areas.

In the case of the STMMA, this challenge is even more critical as the area is NOT a protected area that can charge fees. SATIIM is faced with the challenge of managing a marine buffer zone, without a guaranteed source of funding. Financing for the

establishment of key management programs and strategies, are fairly easily accessed through donor and grants funding. The funding to purchase equipment and initiate the various monitoring programs and funding of research can be readily funded through project proposals to funding agencies. Likewise, the assessment and establishment of sustainable alterative livelihoods can readily attract funding for the accomplishment of these activities and with this the associated education/training components. The challenge arises when the next phase of implementation of management comes into effect, the long term outlook. This core funding for long-term management programs, such as hiring of staff, awareness programs, patrolling/surveillance and monitoring is where the greatest deficiency exists.

SATIIM should actively and aggressively seek out grant funding for the establishment of initial implementation of management programs within the STMMA. The organization should also develop a 5 year financial plan, which can be incorporated into a project to benefit from technical and financial support that donor agencies can provide. Income generating ventures such as the promotion of research internships, aquaculture projects and production and eco-tourism should be explored as a means of sustaining management of the area. In addition, income generated from the National Park can aid in offsetting the costs of managing it marine buffer zone. While there are no quick solutions to securing financing for the STMMA, it is a priority that should be addressed within the first 3-5 years of management of the STMMA while access to grant funding is available.

8.0 CONCLUSIONS

SATIIM is proposing a strategy to manage a marine buffer zone for the Sarstoon Temash National Park, the Sarstoon-Temash Marine Management Area (STMMA). The management of this buffer zone will reguire key strategic goals and objectives focused around the maintainance of the area as a marine buffer zone to monitor land based impacts; the promotion of sustainable fishing practices among fishers in the STMMA; and the development of sustainable alternative livelihoods for fishers of the area.

There is very little information available on the southern shelf lagoon and inshore coastal waters of the south. As a result SATIIM conducted a Rapid Ecological Assessment to gather some basic information on the coastal and marine resources of the area, mainly seagrass beds, oceanography and fish diversity and abundance. The data revealed that the physical oceanography is normal and indicative of an estuarine area. The seagrass communities are sparse to intermediate and are in a moderate state of health. Fish diversity and abundance was fairly low with the majority of fish in the area being juveniles.

The data indicates that the resources are experiencing impacts which could arise from land based sources from the National Park, such as sedimentation, pollution and also from fishing practices such as shrimp trawling. Based on these trends there is a critical need to employ management strategies and programs to address the threats to the STMMA. These include monitoring and research programs, patrolling and surveillance, community management, fisheries management, sustainable alternative livelihoods, education and awareness, transboundary cooperation and zonation.

Two of the biggest challenges to the management of the area as a marine buffer zone are: the support and involvement of the local communities for the management strategies to be employed and the securing of a sustainable source of funding for management efforts. The full implementation of this management plan for the STMMA should occur with 3-5 years and should be revised every 5 years.

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10.0 APPENDICES

Appendix 1 Part II and III of the Maritime Areas Act, on Belize's territorial sea

PART II

Maritime Areas of Belize

Territorial sea.

3.-(1) Subject to subsections (2) and (3) of this section, the territorial sea of Belize comprises those areas of the sea having, as their inner limits, the baseline of the territorial sea and, as their outer limits, a line measured seaward from that baseline, every point of which is 12 nautical miles from the nearest point of that baseline.

Schedule.

(2) Subject to subsection (3) below, the territorial sea of Belize from the mouth of Sarstoon River to Ranguana Caye comprises those areas of the sea having as their inner limits, the baseline of the territorial sea as measured from the features listed in the Schedule to this Act, and as their outer limits, a line measured seaward from that baseline every point of which is 3 nautical miles from the nearest point of that baseline.

(3) *(a)* For the avoidance of doubt, it is hereby declared that the purpose of the limitation of the territorial sea from the mouth of Sarstoon River to Ranguana Caye as described in subsection (2) above is to provide a framework for the negotiation of a definitive agreement on territorial differences with the Republic of Guatemala.

(b) Any such agreement as is referred to in *(a)* above shall be put to a referendum by the electors for their approval or otherwise, and if approved by a majority vote, shall form the basis for the final delimitation of the territorial sea in the area of the sea from the mouth of Sarstoon River to Ranguana Caye.

(c) In the event any such agreement fails to receive approval by a majority vote in the referendum, the delimitation of the territorial sea in the said area shall be effected on the basis of international law.

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(4) Except as is otherwise provided in subsections (2) and (3) above, wherever the equidistance line between Belize and an adjacent State is less than 12 nautical miles from the nearest point of the baseline of the territorial sea, the delimitation of the territorial sea shall, if possible, be effected by agreement between Belize and the adjacent State; but to the extent that if no such agreement is effected, that equidistance line shall constitute the outer limits of the territorial sea.

Baseline of territorial sea.

4.-(1) Except as otherwise provided in subsections (2), (3) and (4) of this section, the baseline from which the breadth of the territorial sea adjacent to Belize is measured shall be the low water line along the coast of the mainland of Belize as well as the coasts of all islands and cayes that form part of Belize.

(2) For the purposes of this section, a low-tide elevation which lies wholly or partly within the breadth of sea which would be territorial sea if all low-tide elevations were disregarded for the purpose of the measurement of the breadth thereof shall be treated as an island.

(3) *(a)* The baseline from which the breadth of the territorial sea is measured between Ambergris Caye - SE and Sarstoon River - shall consist of the series of loxodromes drawn so as to join successively, in the order in which they are there set out, points situate on the low water line on or adjacent to the features listed in the Schedule to this Act.

Schedule.

(b) The provisions of subsection (3) *(a)* of this section shall be without prejudice to the operation of paragraphs (1) and (2) of this section in relation to any island or low-tide elevation which for the purposes of that subsection is treated as if it were an island, being an island or low-tide elevation which lies to seaward of the baseline specified in subsection (3) *(a)* of this section.

(4) *(a)* In the case of the sea adjacent to a coast off which there are

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fringing reefs, the baseline from which the breadth of the territorial sea is measured shall be the seaward limit of the low water line of the fringing reefs.

(b) Where there is a break or passage through the fringing reefs referred to in subsection (4) *(a)* of this section, the baseline from which the breadth of the territorial sea is measured shall be a straight line joining the seaward entrance points of that break or passage.

(5) For the purpose of delimiting the territorial sea, the outermost permanent harbour works which form an integral part of any harbour system shall be treated as forming part of the coast, but for that purpose offshore installations and artificial islands shall not be considered as permanent harbour works.

Internal waters.

5. The internal waters of Belize comprise any areas of water that are on the landward side of the baseline of the territorial sea.

Exclusive economic zone.

6. Subject to section 7, the exclusive economic zone of Belize comprises those areas of the sea that are beyond and adjacent to the territorial sea having, as their outer limits, a line measured seaward from the baseline of the territorial sea, every point of which is 200 nautical miles distant from the nearest point of that baseline.

Delimitation of exclusive economic zone.

7.-(1) Wherever the equidistance line between Belize and an adjacent State is less than 200 nautical miles from the nearest point of the baseline of the territorial sea, the delimitation of the exclusive economic zone shall be effected between Belize and the adjacent State on the basis of international law in order to achieve an equitable settlement.

(2) Pending the delimitation of the exclusive economic zone pursuant to subsection (1) of this section, the equidistance line between Belize and the adjacent State shall constitute the outer limits of the exclusive economic zone.

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(3) Subject to subsection (4) of this section, for the purpose of implementing any agreement under subsection (1) of this section, the National Assembly may, from time to time, by Resolution supported by a two-thirds majority, declare that the exclusive economic zone shall not extend to any specified area of the sea, seabed or subsoil that would otherwise be included therein by virtue of section 6, and such Resolution, while it remains in force, shall have effect notwithstanding any other provision of this Act.

(4) Any agreement with the Republic of Guatemala made pursuant to subsection (1) of this section which provides that:

(a) Belize shall claim less than what it is otherwise entitled to claim under international law; or

(b) the exclusive economic zone of Belize shall not extend to any specified area of the sea, seabed or subsoil that would otherwise be included therein by virtue of section 6; or

(c) there shall be joint exploitation or participation within Belize's exclusive economic zone:

shall be subject to approval of the electors in a referendum.

PART III

Rights in Respect of Maritime Areas of Belize

Sovereignty in respect of territorial sea.

8. The sovereignty in respect of-

(a) the territorial sea;

(b) the airspace over, and the seabed under, that sea; and

(c) the subsoil of that seabed,

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Appendix 2 SAMPLING PROTOCOL FOR THE RAPID ECOLOGICAL ASSESSMENT OF THE SARTSOON-TEMASH COASTAL AREA

Study area: southern Belize coast bounded by the land from Legagu Creek near Barranco to the Sarstoon, and on the seaward side extending to the 3 mile territorial sea limit of Belize.

The area is characterized by varying density of seagrass beds, as classified under the Belize Marine Habitat Map (CZMAI, 2004) with fringing mangroves along the coast. The REA for the Sarstoon-Temash National Park characterized the mangrove communities alone the coast and therefore do not need an assessment in this coastal REA.
Currently there exists no baseline data on the coastal resources and ecosystems of the southern portion of the Belize coastal zone. Therefore it is of paramount importance to conduct some rapid ecological assessments of the coastal area to determine the marine resources existent in the area.

The key area of focus of the REA includes:

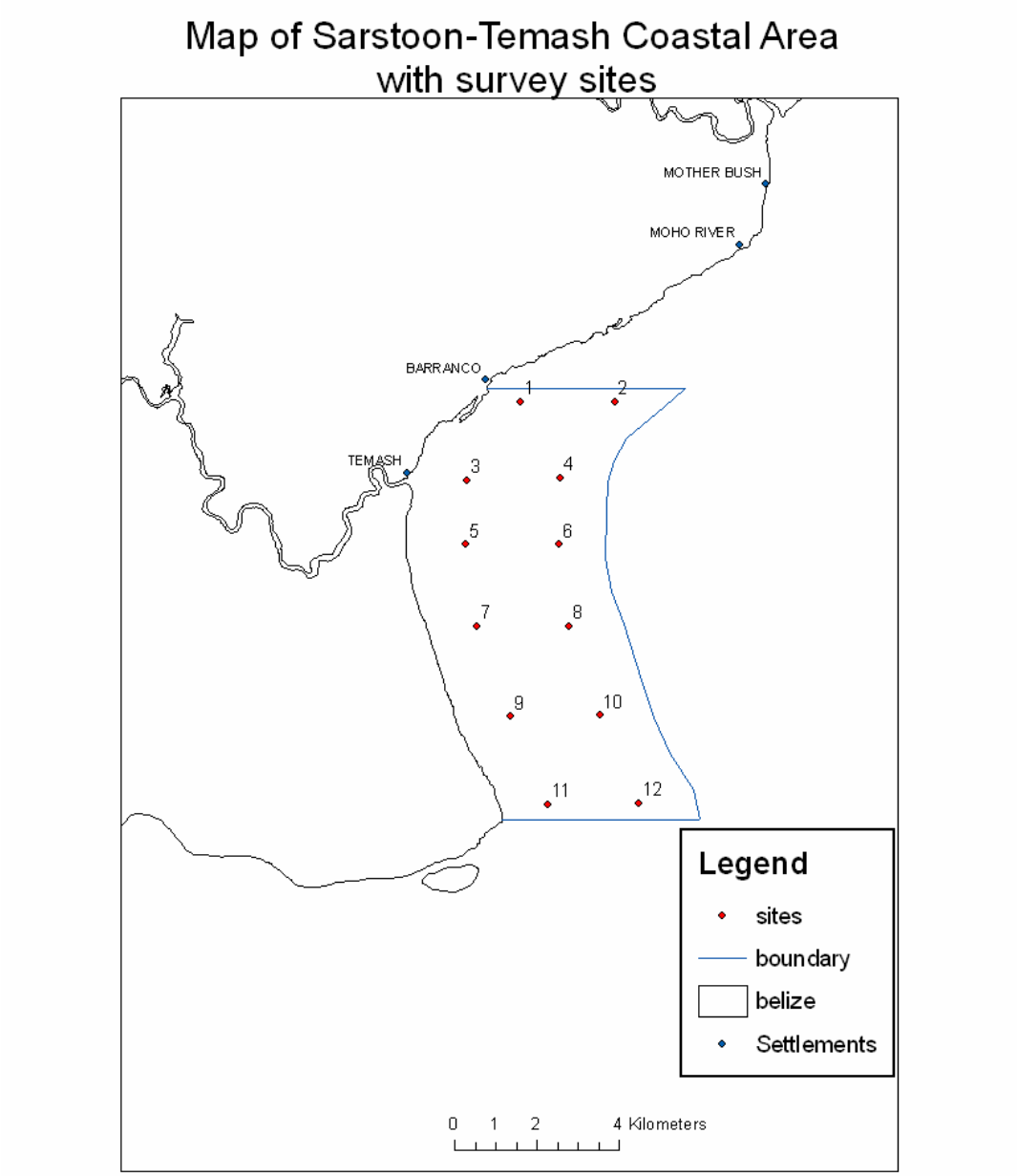
1. physical environment (oceanography)
2. seagrass community composition
3. fish diversity and abundance

Along this stretch of coastline at least six sampling sites will be surveyed, situated at equal intervals along the coast in line with key, freshwater influences (See Map 1). Each of the six sites will comprise of two sampling locations, A and B. Site A will be situated in the inner water nearer to shore. Site B will be situated further seaward near the 3 mile boundary. The coordinates for the sites will be provided based on key habitat information derived from the Marine Habitat Map. At each site, a minimum of eight and maximum of ten, 30 m transects will be sampled. Transects should be placed haphazardly at the site, with consecutive transects situated approximately 5m apart. Additionally, physical oceanographic parameters will be recorded and water samples taken at each site.

PHYSICAL OCEANOGRAPHY

For each site the location, site number, GPS coordinates, date, time, name of recorder and weather conditions (sea state, wind speed and direction and atmospheric conditions) will be recorded. Parameters to be measured are: depth, salinity, temperature, dissolved oxygen, turbidity, currents (?) and water samples taken for nutrient analysis. The physical parameters will be measured using a CTD probe, pre-calibrated. These physical parameters should be recorded for each site before commencement of the benthic surveys. The parameters should be recorded at every meter, starting just below the water surface. Water samples should be taken at each site approximately 0.5 m below the water surface and placed in a cool dark container, with at least two 1 liter samples collected per site. On return to the office, the samples should be frozen until analyzed.

Map 1 Study area for REA



SEAGRASS COMMUNITY SAMPLING

Seagrass density and community composition will be assessed using standard 0.5 x 0.5 m quadrats along each 30 m transect. Each transect will be placed randomly within the general site area, and extended in a straight line parallel to the depth contour. Consecutive transects should be placed randomly at least 5 m apart laterally. The quadrats are to be placed on the right of the transect line at 3 m intervals along the transect, starting at 0 m. A minimum of 8 and a maximum of 10 transects should be conducted at each site. The total percent cover of seagrass within the quadrat will be determined, using the marked grid area of the quadrat and percent cover photo standards (Appendix I) as a guide for percent cover estimation. Identify the species of seagrass within the quadrat and determine the percent contribution of each species to the total cover. Note that composition of all species must equal 100 %. Measure the average length of the seagrass blades using a plastic ruler, measuring in centimeters. The average length of the leaf blades is measured by randomly selecting 3 to 5 leaf blades from within each quadrat, ignoring the tallest 20% of leaves. Extend each leaf to its maximum length/height, without uprooting, and measure from the sediment to the leaf tip. Record each leaf length or the average length.

The type of sediment should be observed and recorded and an estimate of epiphyte cover recorded. To assess the sediment, dig into the top centimetre of the substrate and feel the texture of the sediment. Describe the sediment, by noting the grain size in order of dominance (e.g., Sand, Fine sand, Fine sand/Mud), see appendix II for descriptions of sediment type.

Next, determine the percent cover of epiphytes. The percentage cover of epiphytic algae is measured by estimating "the percentage of total surface area of leaves covered by algal growth". The percent cover of nonepiphytc algal species should be recorded. Nonepiphytic algae are those plants that are not attached to the seagrass but they may cover or overlie the seagrass blades. Also note the presence of any benthic species of interest such as corals, burrowing worms and other invertebrates, in each quadrat.

Record all data on the relevant data sheets provided.

Photograph the quadrats using underwater video camera, swimming at a constant pace with the video held approximately 0.5 m above the substrate. If necessary, collect samples of seagrass or algae for further identification in airtight, sealable plastic bags filled with sea water.

FISH DIVERSITY AND ABUNDANCE

Fish diversity and abundance will be assessed using the MBRS protocols of belt transects counts and roving diver surveys (MBRS 2003). The same 30 m transect line placed for the seagrass community assessment will be used to observe the type and numbers of fish of each species observed along the transect within a span of 2 m, 1 m on either side of the transect line. For the belt transect counts, the divers will swim in a straight line along the transect line within the 2m belt, along the depth contour. The 1 m T bar should be used as a guide for the divers. Count and record the fish observed only within the 2m belt. Note all species of fish observed and their numbers on a standard data sheet, which will be provided. Estimate the size of each fish and assign them to the following size categories (<5cm, 5-10cm, 10-20cm, 20-30cm, 30-40cm, >40cm). Use the bar to help estimate size (the bar can be marked at 5 cm intervals to aid in size

estimation). Some estimation of juvenile fish will also be determined. Swim at a constant rate to avoid spending uneven time in one section of transect in order to count every fish passing. Rather focus on the fish within transects at the point of swimming in that area. A speed that completes the 30 m transect in 6-8 minutes should be attempted. Continue placing transects haphazardly positioned at least 5 m laterally away from the previous position until eight to 10 transects have been completed.

The roving diver surveys will be conducted in the same general area within a 200 m diameter to record ALL FISH species noted in the area. Swim around the area for 30 minutes and record ALL SPECIES of fish observed. Do thorough searches in crevices, under overhangs or benthic structures. The objective is to find the maximum number of fish species within the area. Estimate the density of each species using the following categories: Single (1 fish), Few (2-10 fishes), Many (11-100 fishes) or Abundant (>100 fishes). Record the observations on the relevant data sheets provided.

SAMPLING SCHEDULE

Surveys will be conducted in October 2004 over a period of two weeks. Sampling will be attempted within 7 days for the six locations, based on time required for each site at the locations. The proposed timeframe for the REA surveys is from October 8-22, 2004. There should be de-briefing session on the methods before the start of the surveys, most likely around October 8-9th.

Surveys can be conducted throughout the day in two sessions, morning and afternoon. Survey trips can commence at 8:00 am and end by 4:00 pm. One location per day should be attempted, with 1 site in the morning and the other in the afternoon. For example, site 1 should be attempted within 8:00 and 11:00 am, while site 2 should be attempted within 1:00 and 4:00 pm, and so forth. With this schedule all 6 locations and 12 sites can be completed within 6-10 days.

LOGISTIC REQUIREMENTS

Certain key logistics will be required for the REA. These include the following and will be the responsibility of SATIIM:

Boat and fuel
Equipment for surveys (GPS, transects, quadrats, video camera, etc outlined below)
Accommodations for Fisheries Staff
Stipend for the data collectors (both Fisheries staff and community volunteers)
Dive tanks
Snorkeling equipment
First aid/safety equipment
Radios

EQUIPMENT LISTING

2 handheld GPS

1 CTD probe or Hydrolab (on loan from Fisheries)

3-4 Fibreglass measuring tapes - 30m (surveying tapes are suitable, such as Stanley brands)

3 0.5 m x 0.5 m quadrats (Quadrats can be prepared using ½" diameter pvc pipes of four 50 cm lengths joined with ½" elbows to create the 0.5x0.5 m square. A grid can be created inside the quadrat to aid in percent cover estimation. This can be achieved by drilling holes along each side of the quadrat at 5 cm intervals and strung with cord. To ensure sinking of the quadrat several small holes can be drilled at the corners on the elbows).

3 1 m graduated T-bars (this can be constructed from ½" diameter PVC pipe and a T connector glued together. The T connector should have a 60 cm long handle and two equal length arms (50 cm each) resulting in a total width of 1 m cross the top. Use permanent markers to create the scale along both arms with divisions at each 5 m. To ensure sinking of the bar a few small holes can be drilled along the length of the bar).

6 Underwater writing slates or paper

1 Video camera (on loan from Fisheries)

6 Clear plastic rulers

Snorkeling and dive gear for 6 persons

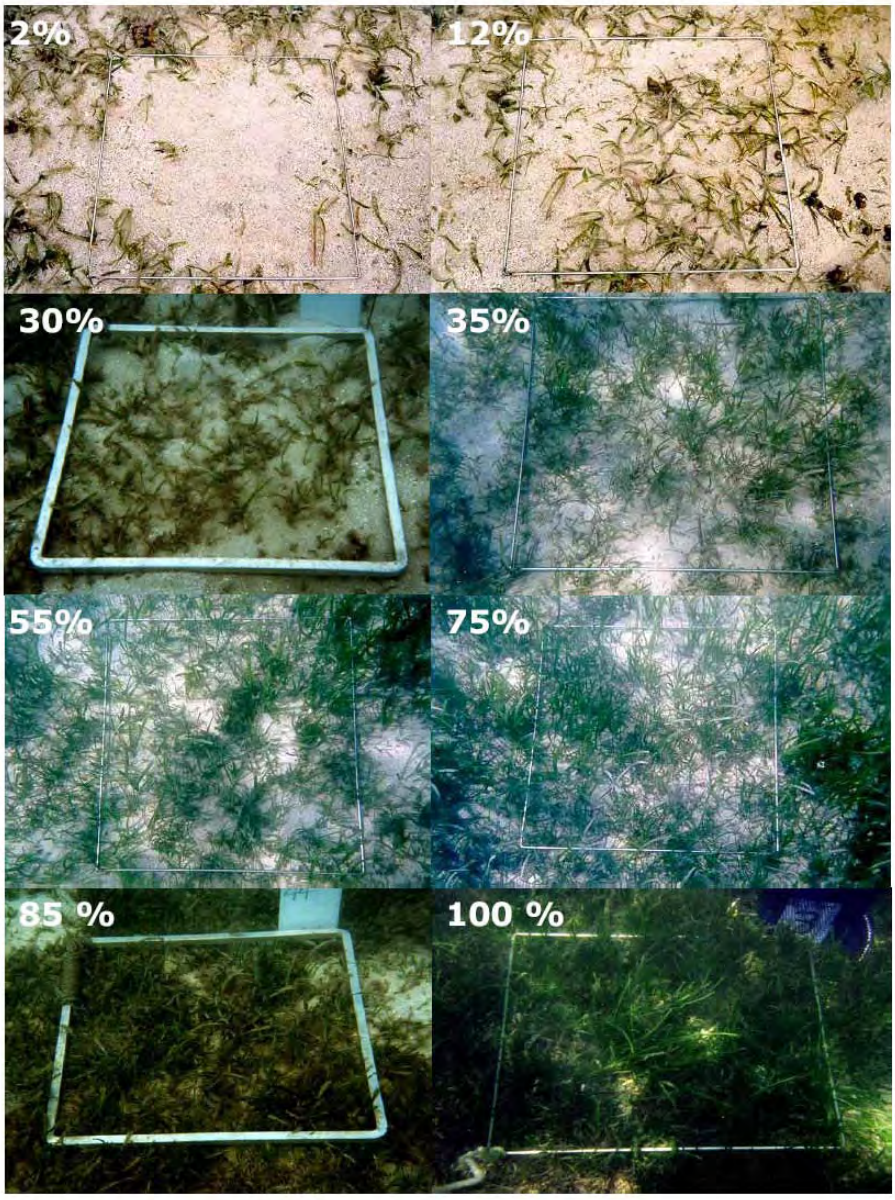
Lead weights for transect lines

Data sheets (these will be prepared and forwarded by next week)

Ziploc Plastic bags

Underwater species identification cards (if available) for fish and algae

Percent cover standards



(photo standards courtesy of the Seagrass-Watch Manual for Mapping & Monitoring Seagrass Resources by community (citizen) volunteers 2001)

Sediment classification and identification

• mud - has a smooth and sticky texture. Grain size is less than 63 µm
• fine sand - fairly smooth texture with some roughness just detectable. Not sticky in nature. Grain size greater than 63 µm and less than 0.25mm
• sand - rough grainy texture, particles clearly distinguishable. Grain size greater than 0.25mm and less than 0.5mm
• coarse sand - coarse texture, particles loose. Grain size greater than 0.5mm and less than 1mm
• gravel - very coarse texture, with some small stones. Grain size is greater than 1mm.

PHYSICAL OCEANOGRAPHY DATA SHEET

Complete 1 sheet per site

Location:	**Site #:**	**GPS Latitude:**
Data Collector:	**Sea State:**	**GPS Longitude:**
Date:	**Time:**	**Weather conditions:**

Depth	**Temperature**	**Salinity**	**Dissolved Oxygen**	**Light**	**Turbidity**	**Ph**	**Conductivity**	**Chlorophyll**
0 m								
1 m								
2 m								
3 m								
4 m								
5 m								
6 m								
7 m								
8 m								
9 m								
10 m								

Water sample #:

SEAGRASS COMMUNITY COMPOSITION DATA SHEETS

Location:	**Site #:**	**Latitude:**	**Date:**
Data Collector:	**Sea State:**	**Longitude:**	**Time:**

Transect #:

Sampling interval	**Total Seagrass % cover**	**Thalassia sp. % cover**	**Syringodium sp. % cover**	**Halophila sp. % cover**	**Leaf blade length (cm)**	**Sediment type**	**% epiphyte cover**	**% Algal cover**	**Other Inverts (corals, worms, mollusks, crustaceans, etc)**
0 m									
3 m									
6 m									
9 m									
12 m									
15 m									
18 m									
21 m									
24 m									
27 m									
30 m									

Transect #:

Sampling interval	**Total Seagrass % cover**	**Thalassia sp. % cover**	**Syringodium sp. % cover**	**Halophila sp. % cover**	**Leaf blade length (cm)**	**Sediment type**	**% epiphyte cover**	**% Algal cover**	**Other Inverts (corals, worms, mollusks, crustaceans, etc)**
0 m									
3 m									
6 m									
9 m									
12 m									
15 m									
18 m									
21 m									
24 m									
27 m									
30 m									

FISH DIVERSITY AND ABUNDANCE DATA SHEETS
Complete 1 sheet per transect

Location:	**Site #:**	**Latitude:**
Data Collector:	**Sea State:**	**Longitude:**
Date:	**Time:**	**Transect #:**

Families	**Scientific name**	**Common name**	**0-5 cm**	**6-10 cm**	**11-20 cm**	**21-30 cm**	**31-40 cm**	**>40 cm**
Surgeonfishes	*Acanthurus bahianus*	Ocean surgeonfish						
Acanthuridae	*A. chirurgus*	Doctorfish						
	A. coeruleus	Blue tang						
Grunts	*Haemulon plumieri*	White grunt						
	H. chrysargyreum	Smallmouth grunt						
Haemulidae	*H. flavolineatum*	French grunt						
Snappers	*Lutjanus apodus*	Schoolmaster						
	Lutjanus analis	Mutton snapper						
Lutjanidae	*L. synagris*	Lane snapper						
	Ocyurus chrysurus	Yellowtail snapper						
Parrotfish	*Scarus taeniopterus*	Princess parrotfish						
	S. iserti	Striped parrotfish						
Scaridae	*Sparisoma chrysopterum*	Redtail parrotfish						
	S. rubripinne	Yellowtail parrotfish						
	S. radians	Bucktooth parrotfish						
Jacks	*Caranx rubber*	Bar jack						
	C. latus	Horse-eye jack						
Carangidae	*Trachinotus goodie*	Palometa						
	Chloroscombrus chrysurus	Atlantic bumper						
Mojarras	*Gerres cinereus*	Yellowfin mojarra						
Gerridae	*Eucinostomus melanopterus*	Flagfin mojarra						
Miscellanous spp.	*Tylosurus crocodilus*	Houndfish						
	Sphyraena barracuda	Barracuda						
	Albula vulpes	Bonefish						
	Centropomus undecimalis	Snook						
	Mugil curema	White mullet						
	Bothus lunatus	Peacock flounder						
	Diodon holocanthus	Balloonfish						
Other spp.								

ROVING DIVER SURVEY SHEETS

Complete 1 sheet per site

Only record species if you are certain. Use a tick √ on the left side of the column **(√ S F M A) AND** circle the relevant code. Abundance codes: S = Single, F = Few (2-10), M = Many (11-100), A = Abundant (>100)

Surgeonfish	**Miscellanous spp.**
__ S F M A Ocean surgeonfish, *Acanthurus bahianus*	__ S F M A Houndfish, *Tylosurus crocodilus*
__ S F M A Doctorfish, *A. chirurgus*	__ S F M A Barracuda, *Sphyraena barracuda*
__ S F M A Blue tang, *A. coeruleus*	__ S F M A Bonefish, *Albula vulpes*
	__ S F M A Snook, *Centropomus undecimalis*
Grunts	__ S F M A White mullet, *Mugil curema*
__ S F M A White grunt, *Haemulon plumieri*	__ S F M A Peacock flounder, *Bothus lunatus*
__ S F M A Smallmouth grunt, *H. chrysargyreum*	__ S F M A Balloonfish, *Diodon holocanthus*
__ S F M A French grunt, *H. flavolineatum*	__ S F M A Sharpnose puffer, *Canthigaster rostrata*
	__ S F M A Bandtail puffer, *Sphoeroides spengleri*
Snappers	__ S F M A Lesser electric ray, *Narcine brasiliensis*
__ S F M A Schoolmaster, *Lutjanus apodus*	__ S F M A Southern stingray, *Dasyatis americana*
__ S F M A Mutton snapper, *Lutjanus analis*	
__ S F M A Lane snapper, *L. synagris*	
__ S F M A Yellowtail snapper, *Ocyurus chrysurus*	**Other spp.**
	__ S F M A
Parrotfish	__ S F M A
__ S F M A Princess parrotfish, *Scarus taeniopterus*	__ S F M A
__ S F M A Striped parrotfish, *S. iserti*	__ S F M A
__ S F M A Redtail parrotfish, *Sparisoma chrysopterum*	__ S F M A
__ S F M A Yellowtail parrotfish, *S. rubripinne*	__ S F M A
__ S F M A Bucktooth parrotfish, *S. radians*	
Jacks	
__ S F M A Bar jack, *Caranx rubber*	
__ S F M A Horse-eye jack, *C. latus*	
__ S F M A Palometa, *Trachinotus goodie*	
__ S F M A Atlantic bumper, *Chloroscombrus chrysurus*	
__ S F M A Permit, *Trachinotus falcatus*	
Mojarras	
__ S F M A Yellowfin mojarra, *Gerres cinereus*	
__ S F M A Flagfin mojarra, *Eucinostomus melanopterus*	
__ S F M A Irish Pompano, *Diapterus auratus*	

Appendix 3 Summarized data collected from the sampling of physical oceanography and seagrass communities

Physical oceanography data

Site	Depth	Temperature	Salinity	Dissolved Oxygen	Turbidity	Ph	Conductivity	Chlorophyll
Site F1	0	30.44	21.05	7.37	3.7	7.92	33.78	0.9
Site F1	1	30.32	25.31	7.22	4	7.98	39.89	1
Site F1	2	30.19	25.44	7.32	4.9	8	40.07	1.5
Site F1	3	30.18	25.45	7.39	15.3	8.01	40.07	7.1
AVE		**30.28**	**24.31**	**7.33**	**6.98**	**7.98**	**38.45**	**2.63**
STD		**0.12**	**2.18**	**0.08**	**5.57**	**0.04**	**3.12**	**2.99**
Site F2	0	31.01	23.85	7.69	2.5	8	37.84	3.4
Site F2	1	30.17	24.89	7.7	2.1	7.97	39.29	0.6
Site F2	2	29.98	25.27	7.66	3.4	7.96	39.82	0.3
Site F2	3	29.88	25.95	7.64	2.7	7.97	40.77	1
Site F2	4	29.89	26.25	8	1.9	8.01	41.2	0.7
AVE		**30.19**	**25.24**	**7.74**	**2.52**	**7.98**	**39.78**	**1.20**
STD		**0.48**	**0.95**	**0.15**	**0.58**	**0.02**	**1.32**	**1.25**
Site F3	0	29.91	20.43	7.72	7.4	7.35	32.86	-1.9
Site F3	1	30.57	24.46	7.17	2.4	7.95	38.69	0.4
Site F3	2	30.43	24.96	7.2	3.2	7.95	39.39	0.9
Site F3	3	30.4	25.28	7.17	2.5	7.94	39.85	0.6
Site F3	4	30.37	25.63	7.05	4.4	7.94	40.34	1.5
AVE		**30.34**	**24.15**	**7.26**	**3.98**	**7.83**	**38.23**	**0.30**
STD		**0.25**	**2.12**	**0.26**	**2.07**	**0.27**	**3.06**	**1.30**
Site F4	0	31.49	24.24	7.03	3.1	8.01	38.41	-1
Site F4	1	31.06	25.01	6.96	2.8	8	39.49	0.5
Site F4	2	30.59	29.03	6.85	3.3	7.99	45.11	0.8
Site F4	3	30.25	29.3	6.79	3.1	7.98	45.47	0.4
Site F4	4	30.18	29.34	6.74	7.2	7.98	45.53	2
AVE		**30.71**	**27.38**	**6.87**	**3.90**	**7.99**	**42.80**	**0.54**
STD		**0.56**	**2.54**	**0.12**	**1.85**	**0.01**	**3.54**	**1.07**

Site	Depth	Temperature	Salinity	Dissolved Oxygen	Turbidity	Ph	Conductivity	Chlorophyll
Site F5	0	30.61	22.48	7.7	2.3	7.97	35.85	0.2
Site F5	1	30.46	23.21	7.59	1.7	7.98	36.9	-0.3
Site F5	2	30.13	25.05	7.56	1.6	7.98	39.51	0.4
Site F5	3	30.03	25.71	7.49	2.1	7.97	40.45	0.7
Site F5	4	30.17	31.43	7.06	2.1	7.91	48.41	0.9
Site F5	5	30.28	32.76	6.27	2.9	7.85	50.24	1.1
Site F5	6	30.32	32.92	4.64	13	7.83	50.46	6
AVE		**30.29**	**27.65**	**6.90**	**3.67**	**7.93**	**43.12**	**1.29**
STD		**0.20**	**4.57**	**1.11**	**4.14**	**0.06**	**6.38**	**2.13**
site 1	0	29.48	21.85	6.19	9.2	7.98	34.9	3.9
site 1	1	29.95	24.23	6.12	3.7	7.94	38.34	1.2
site 1	2	30.05	24.48	5.97	2	7.94	38.69	0.8
site 1	3	30.07	24.55	5.23	2	7.93	38.79	0.8
AVE		**29.89**	**23.78**	**5.88**	**4.23**	**7.95**	**37.68**	**1.68**
STD		**0.28**	**1.29**	**0.44**	**3.41**	**0.02**	**1.86**	**1.50**
site 2	0	30.38	23.06	7.68	3.7	8.01	36.68	0.7
site 2	1	30.16	24.65	7.58	2.2	8.02	38.94	1
site 2	2	30	24.87	7.56	2.6	8.03	39.25	0.7
site 2	3	30.03	25.24	7.48	2.2	8.03	39.78	0.6
site 2	4	30.32	27.39	7.11	3.3	7.98	42.82	0.9
site 2	5	30.35	28.14	6.76	15.7	7.99	43.87	7.5
AVE		**30.21**	**25.56**	**7.36**	**4.95**	**8.01**	**40.22**	**1.90**
STD		**0.17**	**1.88**	**0.35**	**5.30**	**0.02**	**2.66**	**2.75**
site 3	0	29.99	24.25	7.22	1.2	7.95	38.37	0.2
site 3	1	30.2	25.16	6.99	3.1	8	39.67	0.1
site 3	2	30.04	25.41	6.95	3.2	8.01	40.02	0.8
site 3	3	30.03	25.53	6.87	2.7	8	40.19	1.2
site 3	4	30.19	25.94	6.71	10.6	7.9	40.77	5.2
AVE		**30.09**	**25.26**	**6.95**	**4.16**	**7.97**	**39.80**	**1.50**
STD		**0.10**	**0.63**	**0.19**	**3.69**	**0.05**	**0.89**	**2.12**

Site	Depth	Temperature	Salinity	Dissolved Oxygen	Turbidity	Ph	Conductivity	Chlorophyll
site 4	0	29.12	24.15	7.61	1.9	7.95	38.22	8.6
site 4	1	30	24.63	7.47	2.5	7.98	38.91	4.7
site 4	2	29.93	25.1	7.4	2.6	7.99	39.57	3.2
site 4	3	29.85	25.36	7.37	2.6	8	39.94	2.4
site 4	4	29.84	25.71	7.35	2.5	8.01	40.43	1.9
site 4	5	29.77	27.78	7.27	2.6	8	43.34	1.2
site 4	6	30.08	32.22	6.93	1.9	7.92	49.49	1.7
site 4	7	30.33	33.2	4.71	21.7	7.8	50.84	10.5
AVE		**29.87**	**27.27**	**7.01**	**4.79**	**7.96**	**42.59**	**4.28**
STD		**0.35**	**3.53**	**0.95**	**6.84**	**0.07**	**4.92**	**3.46**
site 5	0	29.77	21.72	7.61	5.9	7.6	34.72	-2.5
site 5	1	30.2	25.12	6.53	4.9	7.89	39.62	-0.2
site 5	2	30.11	25.24	6.75	3.7	7.96	39.78	0.4
site 5	3	29.99	25.4	6.88	3.3	7.97	40	0.4
site 5	4	30.06	25.54	6.9	19.9	7.95	40.2	8.9
site 5	5	30.17	23.44	6.23	41	7.6	37.22	17.7
AVE		**30.05**	**24.41**	**6.82**	**13.12**	**7.83**	**38.59**	**4.12**
STD		**0.16**	**1.52**	**0.46**	**15.02**	**0.18**	**2.19**	**7.71**
site 6	0	30.48	22.82	6.89	1.9	8.03	36.34	0.8
site 6	1	30.32	23.4	6.73	-0.1	8.04	37.17	-1.6
site 6	2	30.2	25.83	6.58	2.1	8.02	40.62	1.1
site 6	3	30.18	26.09	6.56	2.1	8.01	40.9	1.1
site 6	4	30.19	26.12	6.23	1.2	8	41.02	1.5
site 6	5	30.24	26.38	5.8	3.9	7.98	41.4	2.2
site 6	6	30.43	26.73	5.53	5.1	7.96	41.9	2.8
site 6	7	30.52	31.52	4.99	11.2	7.87	48.55	5
AVE		**30.32**	**26.11**	**6.16**	**3.43**	**7.99**	**40.99**	**1.61**
STD		**0.14**	**2.62**	**0.66**	**3.52**	**0.05**	**3.67**	**1.88**
site 7	0	31.27	23.92	7.41	1.2	8.05	37.95	-1.5
site 7	1	31.33	23.91	7.45	2.9	8.02	37.93	1.1
site 7	2	31.27	24.72	7.43	5.2	8.01	39.09	2
site 7	3	30.51	25.27	7.13	7.4	7.95	39.84	4.5
site 7	4	30.26	25.62	6.45	10.2	7.95	40.33	4.9
AVE		**30.93**	**24.69**	**7.17**	**5.38**	**8.00**	**39.03**	**2.20**
STD		**0.50**	**0.78**	**0.43**	**3.57**	**0.04**	**1.09**	**2.62**

Site	Depth	Temperature	Salinity	Dissolved Oxygen	Turbidity	Ph	Conductivity	Chlorophyll
site 8	0	30.58	20.79	7.57	5.2	8.01	33.4	2
site 8	1	30.38	22.62	6.77	2.5	8.01	36.04	1
site 8	2	30.15	25.17	6.54	2.7	8.03	39.68	0.7
site 8	3	30.19	25.85	6.38	2.8	8.07	40.65	1
site 8	4	30.25	26.24	6.17	3.1	8	41.19	1.1
site 8	5	30.26	26.39	6.14	4.2	7.99	41.41	1.2
site 8	6	30.3	26.72	5.77	7.4	7.96	41.87	3.5
site 8	7	30.46	28.91	5.44	2	7.71	44.95	5.3
AVE		**30.32**	**25.34**	**6.35**	**3.74**	**7.97**	**39.90**	**1.98**
STD		**0.14**	**2.53**	**0.65**	**1.80**	**0.11**	**3.61**	**1.62**
site 9	0	31.33	25.85	7.37	3.2	8.03	37.85	-0.2
site 9	1	31.34	23.89	7.33	3.4	8.02	37.91	1.1
site 9	2	31.06	25.24	7.32	4.6	8	39.81	2.3
site 9	3	30.4	25.84	6.89	8	7.97	40.64	2.7
site 9	4	30.21	26.05	6.25	13.9	7.96	40.93	6
AVE		**30.87**	**25.37**	**7.03**	**6.62**	**8.00**	**39.43**	**2.38**
STD		**0.53**	**0.88**	**0.48**	**4.50**	**0.03**	**1.47**	**2.32**
site 10	0	30.31	18.95	5.94	0.4	6.45	30.71	-0.8
site 10	1	30.38	24.99	6.72	3	8.02	39.43	-0.1
site 10	2	30.32	25.73	6.69	1.2	8.01	40.48	0.1
site 10	3	30.3	26.3	6.61	1.2	8.01	41.28	0.1
site 10	4	30.28	26.67	6.58	1.2	8.01	41.81	0.1
site 10	5	30.33	26.82	6.52	4.4	8	45.41	1.6
site 10	6	30.37	27.11	5.87	12.3	7.75	42.43	5.1
site 10	7	30.45	29.24	6.04	21.8	7.93	45.41	10
AVE		**30.34**	**25.73**	**6.37**	**5.69**	**7.77**	**40.87**	**2.01**
STD		**0.05**	**3.00**	**0.36**	**7.56**	**0.54**	**4.63**	**3.72**
site 11	0	31.09	19.91	7.7	2.5	7.94	32.15	1.5
site 11	1	31.19	23.63	7.75	6.3	8.04	37.53	1.7
site 11	2	30.74	25.64	7.21	14.8	7.97	40.36	7.1
AVE		**31.01**	**23.06**	**7.55**	**7.87**	**7.98**	**36.68**	**3.43**
STD		**0.24**	**2.91**	**0.30**	**6.30**	**0.05**	**4.17**	**3.18**
site 12	0	30.36	20.61	5.7	6.9	7.9	33.14	3
site 12	7	30.47	27.28	5.97	69.4	7.84	42.67	25.4
AVE		**30.42**	**23.95**	**5.84**	**38.15**	**7.87**	**37.91**	**14.20**
STD		**0.08**	**4.72**	**0.19**	**44.19**	**0.04**	**6.74**	**15.84**

Seagrass data summaries

Sites	seagrass cover	S.D.	S.E.
1	31.45	26.41	2.52
2	0.00	0.00	0.00
F1	13.62	15.68	1.49
F2	8.75	12.06	1.15
F3	13.63	14.55	1.46
F4	13.47	18.68	1.88
F5	2.59	6.56	0.66

Sites	turtle grass cover	S.D.	S.E.
1	31.45	26.41	2.52
2	0.00	0.00	0.00
F1	12.87	15.86	1.51
F2	8.75	12.06	1.15
F3	13.63	14.55	1.46
F4	13.47	18.68	1.88
F5	2.59	6.56	0.66

Sites	manatee grass cover	S.D.	S.E.
1	0.00	0.00	0.00
2	0.00	0.00	0.00
F1	0.75	2.69	0.26
F2	0.00	0.00	0.00
F3	0.00	0.00	0.00
F4	0.00	0.00	0.00
F5	0.00	0.00	0.00

Sites	algae cover	S.D.	S.E.
1	27.50	30.32	2.89
2	29.73	16.29	2.19
F1	40.92	31.77	3.03
F2	48.36	30.87	2.94
F3	45.53	27.35	2.75
F4	33.08	21.64	2.17
F5	61.67	27.38	2.75

Sites	epiphyte cover	S.D.	S.E.
1	17.58	25.48	2.43
2	0.00	0.00	0.00
F1	29.69	34.00	3.24
F2	31.87	39.45	3.76
F3	32.65	35.30	3.55
F4	29.63	28.01	2.82
F5	17.88	14.04	1.41

Sites	blade length	S.D.	S.E.
1	17.41	4.08	0.39
2	0.00	0.00	0.00
F1	16.27	4.02	0.38
F2	16.11	3.61	0.34
F3	17.33	5.14	0.52
F4	20.75	4.72	0.47
F5	18.41	4.09	0.41

Sites	total cover	S.D.	S.E.
1	58.95	31.93	3.04
2	29.73	16.29	2.19
F1	50.45	30.49	2.91
F2	57.12	29.53	2.82
F3	59.15	25.71	2.58
F4	46.56	24.48	2.46
F5	64.25	27.10	2.72

Appendix 4 List of Fish Species observed in the Rapid Ecological Assessment

Fish List	Latin name	Family	Common Name
atlantic bumper	*Chloroscombrus chrysurus*	Carangidae	jacks
bar jack	*Caranx ruber*	Carangidae	jacks
barracuda	*Sphyraena barracuda*	Sphyraenidae	barracudas
cero	*Scomberomorus regalis*	Scombridae	mackerels
checkered puffer	*Sphoeroides testudineus*	Tetraodontidae	pufferfishes
dusky damsel	*Stegastes adustus*	Pomacentridae	damsels
french grunt	*Haemulon flavolineatum*	Haemulidae	grunts
harlequin bass	*Serranus tigrinus*	Serranidae	seabasses
lane snapper	*Lutjanus synagris*	Lutjanidae	snappers
mutton snapper	*Lutjanus analis*	Lutjanidae	snappers
orangespotted goby	*Nes longus*	Gobiidae	Gobies
princess parrot	*Scarus taeniopterus*	Scaridae	parrotfishes
redtail parrot	*Sparisoma chrysopterum*	Scaridae	parrotfishes
remora	*Remora remora*		
sergeant major	*Abudefduf saxatilis*	Pomacentridae	damsels
slippery dick	*Halichoeres bivittatus*	Labridae	wrasses
southern stingray	*Dasyatis americana*		
striped parrot	*Scarus iserti*	Scaridae	parrotfishes
tomtate	*Haemulon aurolineatum*	Haemulidae	grunts
white grunt	*Haemulon plumierii*	Haemulidae	grunts
yellow stingray	*Urolophus jamaicensis*		
yellowfin mojarra	*Gerres cinereus*	Gerreidae	mojarras
yellowtail parrot	*Sparisoma rubripinne*	Scaridae	parrotfishes
yellowtail snapper	*Ocyurus chrysurus*	Lutjanidae	snappers

Appendix 5 Survey forms the socioeconomic survey of the stakeholders in the STMMA

STAKEHOLDER SURVEY OF SARSTOON-TEMASH COASTAL AREA

Date:	
Location:	
Population:	
Infrastructure (no of houses, building, etc):	
Type of housing:	
Access routes:	
Habitat condition:	
Transport:	
Waste management:	
Age, Gender of population:	

Demographics

Residence:	
Age:	
Family size:	
Years Fishing:	
Do you own a fishing vessel:	
What is the fishery:	
Length of boat:	
Boat type:	
Propulsion type:	
Engine size:	
Fishing area:	

Economics and Fishing efforts

IS fishing main livelihood?

Do you have other source of income?

If so what? Tourism, agriculture, labour, etc

Are you the main income earner?

How often do you fish (trips per month, days at sea, etc)?

How many persons fish with you?

What kind of target species do you fish?

What is the average size of the catch (lbs)?

How much do you earn on average from a fishing trip?

Do you fish year round or in seasons?

Are you familiar with the Belize fishing regulations?

Do you usually follow and observe these laws?

Status of Coastal Resources

Species	5 years ago	10 years ago	Cause of depletion
Lobster			
Conch			
Jewfish			
Tarpon			
Snook			
Bonefish			
Lane “silk” snapper			
Other snappers			
Grunts			
Jacks			
Mackerel			
Shrimp			
Green turtle			
Hawksbill			
Loggerhead			
Manatee			
Shark (sp)			
Other			

Excellent, Good, Moderate, Poor

What is the water quality of the area? Poor, Satisfactory, Good

What is the condition of nursery habitat such as mangroves and seagrass areas? Excellent, good, average, poor

Uses and Threats

What are major uses of the coastal resources?

Fishing	
Tourism (tour guiding, guest houses)	
Sport fishing	
Recreation	
Transportation	
Traditional use	
Other	

What are the major threats or issues regarding the coastal resources?

Piracy	
Stock depletion	
Over exploitation of marine resources	
Habitat destruction	
Shrimp trawling	
Illegal/improper fishing practices	
Poor enforcement of regulations	
Inadequate inter-agency coordination	
Up river/watershed influences	
Dual nationality, transboundary conflicts	
Other	

Issues of management and governance

What are the major management actions necessary to prevent threats and address issues?

What are the major governance issues?

Would you be interested and willing to work with SATIIM in managing the resources of the area?

Stakeholder Recommendations on key conservation and management options

What would you recommend as necessary actions to ensure conservation and sustainable use of resources?

Main questions for key informants

What are the key uses of the coastal resources adjacent to the Sarstoon-Temash national park?

Who are the major users of the resources?

What do you think is the level of human impact to the coastal resources of the area?

What are critical issues or threats to the resources of the area?

What management and/or development strategies should be implemented to conserve the resources and ensure sustainable use of the area?