

HOL CHAN MARINE RESERVE MANAGEMENT PLAN

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Published by:
UICN
Ministry of Agriculture, Fisheries and Cooperatives
BMZ

333.918

l-34c

Hol Chan Marine Reserve Management Plan / Prepared by Earl Yong, Barbara Bilgre; edited by Francisco Pizarro. - 1. ed. - San José, C.R. : UICN. Oficina Regional para Mesoamérica, 2002.

128 p.; 15.5 x22.5 cm

ISBN 9968-743-63-1

1. Planes de manejo. 2. Reservas marinas. 3. Arrecifes de Coral.
4. Reserva Marina Hol Chan. 5. Belice. 6. América Central I.
Título.

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Table of Contents

	Page No.
List of Tables	IV
List of Figures	IV
List of Acronyms	V
Acknowledgements	VI
1. BACKGROUND	1
1.1. Introduction	1
1.2. History and Development	3
1.3. Purpose and Scope of Plan	6
1.4. Legislative Authority	8
2. GENERAL INFORMATION	11
2.1. Location	11
2.2. Access	11
2.3. Land and Sea Tenure	12
2.4. Maps, Photographs, Satellite Imagery	13
3. PHYSICAL INFORMATION	14
3.1. Geology and Substrates Types	14
3.2. Bathymetry and Turbidity	15
3.3. Tides and Water Movement	15
3.4. Temperature, pH and Salinity	15
3.5. Climate	15
3.5.1. Wind and Waves	15
3.5.2. Hurricanes	15
3.5.3. Rainfall	16
4. BIOLOGICAL INFORMATION	17
4.1. The Coral Reef Habitat	17
4.1.1. The Fore Reef	17

4.1.2.	The Reef Crest	17
4.1.3.	The Back Reef	18
4.1.4.	Hol Chan Channel	18
4.1.5.	Shark and Ray Alley	19
4.2.	The Lagoon Habitat	19
4.3.	The Mangrove Habitat	20
5.	EXISTING USES	22
5.1.	Tourism	22
5.1.1.	Scuba Diving (Zone A & D)	25
5.1.2.	Snorkeling (Zone A & D)	25
5.1.3.	Sportfishing (Zone C & D)	26
5.2.	Commercial Fishing	26
5.3.	Research and Environmental Monitoring	27
5.4.	Education	33
6.	CONSTRAINTS AND POTENTIAL MANAGEMENT PROBLEM	35
7.	ZONING PLAN	37
7.1.	Goals and Objectives	37
7.2.	Boundaries	39
7.3.	Zoning Plan and Objectives	39
7.4.	Admission Fees	48
8.	ENFORCEMENT AND SURVEILLANCE	50
9.	RESEARCH AND MONITORING	52
9.1.	Physical and Chemical Studies	52
9.2.	Biological Studies	53
9.3.	Socio-economic studies	55
9.4.	Climate Studies	56
10.	INTERPRETATION AND EDUCATION	57
10.1.	Museum and Resource Center	57

10.2.	Interpretive Materials	57
10.3.	Education and Community Outreach	59
11.	ENVIRONMENTAL MANAGEMENT	61
12.	RECREATION AND TOURISM MANAGEMENT	64
12.1.	Habitat Expansion	65
12.2.	Habitat Enhancement	66
12.3.	Alternative Sites	67
13.	ADMINISTRATION AND MAINTENANCE	68
13.1.	Organizational Structure	68
13.2.	Staffing	70
13.3.	Training	74
13.4.	Infrastructure	75
13.5.	Financial Statement	76
13.6.	Budget	79
13.7.	Other Management Considerations	81
14.	FINANCIAL SUSTAINABILITY PLAN	83
15.	REFERENCES	86
Appendix 1:	Hol Chan Marine Reserve Legislation	90
Appendix 2:	Board of Trustees Regulations	106
Appendix 3:	Common Fishes of the HCMR	113
Appendix 4:	Common Corals, Sponges, Plants and other Invertebrates of the HCMR	118

List of Tables

		Page No.
Table 1:	Income and Expenditure (1998 & 1999)	50
Table 2:	Balance Sheet (1998 & 1999)	51
Table 3:	Projected Expenditure (FY 2000)	51

List of Figures

		Page No.
Figure 1:	Map of Hol Chan Marine Reserve	7
Figure 2:	Map of Marine Habitats	15
Figure 3:	Graph of annual Tourists Visitation (1994 – 1999)	16
Figure 4:	Pir Chart of Tourists Activities (1999)	16
Figure 5:	Zoning Map	26
Figure 6:	Institutional Structure of Fisheries Department	44
Figure 7:	Proposed Administrative Structure for HCMR	45
Figure 8:	Graph of Annual Income and Expenditure (1995-1998)	50

List of Acronyms

CARICOMP	Caribbean Coastal and Marine Productivity Program
CZMA&I	Coastal Zone Management Authority and Institute
GOB	Government of Belize
HCMR	Hol Chan Marine Reserve
IUCN	World Conservation Union
NGO	Non-Government Organization
NPSA	National Parks Systems Act
PCV	Peace Corps Volunteer
USAID	United States Agency for International Development
WPA	Wildlife Protection Act
WCS	Wildlife Conservation Society

Acknowledgements

The update of the HCMR Management Plan was made possible through the financial support of BMZ and IUCN. Also could not have been successfully undertaken without the guidance and information given, and the experiences and perspectives shared by a number of persons. On behalf of the authors, we take this opportunity to thank the many persons and organizations for their kind assistance.

We are grateful to the following persons and institutions for providing background information on the reserve, namely Ms. Janet Gibson (CZMA&I), Mr. James Azueta (FD), Mr. Miguel Alamilla (HCMR), Mr. Brandon Kitagawa (PCV), Mr. Billy Leslie (SPTGA) and Mr. Changa Paz (Amigos Dive Shop).

For providing logistical support during the various site visits, we extend special gratitude to Mr. Miguel Alamilla and the staff of the HCMR.

Finally, we wish to say thanks to the many persons who took time from their busy schedule to meet with the authors during the initial stages of the study.

1. BACKGROUND

1.1. INTRODUCTION

Coral reefs are one of the oldest and most biologically diverse ecosystems on Earth. Their life processes are extremely complex, with a high degree of interdependence between the organisms. The specialization of the organisms reduces the elasticity of the ecosystem making it fragile and more susceptible to stress and changes in the environment.

The need for the establishment of protected areas along the Belize barrier reef has been recognized as a means of preserving this valuable national heritage, which not only supports a variety of reef types unparalleled elsewhere in the Caribbean but which also remains in a nearly pristine condition (Dahl et al., 1974). The need to protect the reef is particularly urgent for areas near San Pedro, Ambergris Caye, where further tourist development on a large scale appears imminent. The reefs near San Pedro have already been exposed to heavy use and show signs of stress caused by over collecting, over fishing, and damage by anchors. With increased development, greater stress on the reefs and their life processes is anticipated, including the effects of dredge and fill operations which lead to increased sediment load in the water column and reduced light, both of which are highly detrimental to corals and sea grasses. Increased sewage output may also result, which can lead to depressed oxygen levels and altered nutrient cycles, which in turn disrupt the ecological balance of coral reefs.

The protection of coral reefs serves many purposes. By establishing protected areas, genetic diversity is preserved, which in turn may lead to important discoveries for future uses, such as resources for mariculture and medicinal purposes. For example, several marine plant and animal species are currently being investigated as a source of antibiotics and anti-cancer drugs.

Conserving ecosystems, which are rich in species, represents good investment and guarantees the continuity of native stock available to restore depleted areas.

A coral reef reserve would also protect commercially valuable species, such as the queen conch, the spiny lobster and several reef fish species such as the groupers. A reserve provides breeding, sanctuaries and nursery areas for juveniles. They also serve as replenishment areas for nearby depleted habitats. The preservation of fisheries that are related to the coral reef should be of vital economic concern.

Reserves or protected areas are a major tourist attraction for diving, snorkeling and underwater photography. Marine reserves established in other Caribbean countries have been shown to contribute substantially to the tourist trade. Marine reserves established in Belize would also serve as important recreational areas for Belizeans. Reserves also provide areas for education and research.

The establishment of marine reserves would lead to economic benefits from the increase in the tourist trade and the increased catches in fisheries.

The protection of reefs in particular is also of vital concern with regard to the physical protection they provide to the coastline. They serve to minimize the impact of storms, wave action and other physical stresses. Without the buffer of coral reefs, the more physically vulnerable seagrass beds and mangroves would be exposed to destructive climatic forces. At the same time, the coral reef is dependent on the mangroves and grass beds which filter sediments which would otherwise smother and kill the corals. (Gulf of Mexico and South Atlantic Fishery Management Councils, 1982).

Of the 1,359 sites designated as marine protected areas in the Wider

Caribbean Region in 1996, only 15% were completed protected, 51% had partial protection, and 32% were unprotected (CTO, 2000). Located just four miles south of San Pedro Town, the Hol Chan Marine Reserve is one of the few protected areas in which the objectives of resource management and sustainability through zoning have been met with some degree of success (Carter *et al.*, 1994). Prior to its designation in July 1987, the Hol Chan channel and its adjacent seagrass and mangrove habitats were subjected to heavy pressures from uncontrolled fishing practices, which had led to the removal of the large predatory fishes from the reef and the depletion of commercially valuable conch and lobster populations (Carter *et al.*, 1994). On the island, developers were clearing mangroves and dredging seagrass adjacent to the proposed reserve boundaries for housing and hotel projects and boat marinas (Carter *et al.* 1994). It seemed as if development was as relentless and unstoppable as a glacier.

Today, the staff of the Hol Chan Marine Reserve has addressed many of these issues through enforcement and surveillance, education and community outreach, scientific research and monitoring and environmental management programs. Mangrove clearance has stopped in areas near the reserve boundaries; the use of spear guns, nets and trawls by fishers are banned and only the traditional fishers of the area are allowed to fish in certain zones; and safe diving and snorkeling conduct is now in place.

1.2. History and Development

Since the early 1960s the Hol Chan channel -a break in the barrier reef located between San Pedro and Caye Caulker- has been on the government's recommended list of protected areas (Carter *et al.*, 1994). In 1972, a United Nations expert again recommended protected status for Hol Chan, but this recommendation also appears to have been ignored by the government (Mascia, 2000). A few years later, the local tour guides recommended

protected status for a large tract of reef in front of San Pedro Town; this plan was rejected because it favored the interest of fishing guides at the expense of commercial fishermen. (Carter *et al.*, 1994). In the meantime, the local fishers continued to deplete the conch, lobster and finfish populations while the tour guides continued to take tourists to snorkel and scuba dive at Hol Chan, resulting in resource-use conflicts between the fishers and guides.

A decade later, a foreign researcher of the Wildlife Conservation Society (WCS) spearheaded a series of consultations with the community of San Pedro in order to resolve these conflicts through the establishment of a marine reserve at Hol Chan (Carter *et al.*, 1994). Whether the concept of a marine reserve was conceived locally or externally is still unclear, but the consultative process relied heavily upon external actors: the foreign researcher solicited financial support, a foreign conservation NGO provided that support, and a combination of foreigners and non-resident Belizeans facilitated the consultative process (Mascia, 2000). An informal advisory committee of the various user-groups and other stakeholders was established to advise the community and the Government on the development of the proposed marine reserve (Carter *et al.*, 1994). Based on a series of socio-economic and biological surveys, a draft management plan was developed by a Belizean consultant for review by the advisory committee and the Government (Carter *et al.*, 1994). Following the distribution of the draft management plan, several public meetings were held to discuss the impact of this proposed marine reserve to the overall development of the island (Carter *et al.*, 1994).

Since the plan called for restrictions on use by commercial fishers and sport-fishing guides, there was some resistance from the community to adopt the plan (Carter *et al.*, 1994). After several months of debate and discussion over the boundaries and restrictions defined in the plan, a compromise was reached with the commercial fishermen who succeeded in securing certain

productive sections south of the Hol Chan channel open to fishing (Carter *et al.*, 1994). The revised plan with its boundaries shifted a quarter of a mile to the north was submitted to the Minister responsible for fisheries, the Fisheries Administrator, and the Fisheries Advisory Board for final review and approval (Carter *et al.*, 1994). In July 1987, the Hol Chan Marine Reserve (HCMR) was legally established by order of the Minister responsible for fisheries (Mascia, 2000).

Five months prior to its designation, the planner for the Hol Chan Advisory Committee submitted a funding proposal to World Wide Fund for initial funding. In November of 1987, Hol Chan received about \$BZ300, 000.00 for its first three years of operations. Another \$Bz200,000.00 became available for another two years of operation. Hol Chan also received \$US40,000.00 from USAID during this time.

In March 1990, a visitor fee system was introduced to generate revenues and ensure long-term financial capability to manage the reserve. Since the regulations had to be amended before the money could be spent, a Trust Fund to hold the money and a Board of Trustees to direct and manage the affairs of the reserve was established in 1994. This savings became the “seed” money for the operational expenses of the reserve after funding support from WWF ceased in 1994.

In 1998, PACT instituted a mandatory 20% levy on all revenues generated by each of the protected areas in Belize. This translates to \$BZ1.00 lost to PACT for every \$Bz5.00 collected from the sale of tickets. For most of the protected areas, this levy is irrelevant because self-generated revenues represent but a tiny percentage of their total operating budget. The HCMR, by contrast, is self-sufficient; its entire operating budget is derived from access fees. The long-term implications of this levy on the HCMR are unclear, though it may diminish the capacity of HCMR personnel to monitor and

enforce HCMR institutions (Mascia, 2000).

In September 1999, Shark Ray Alley became the new “added attraction” to the reserve. Encompassing about 1.5 square miles of reef and seagrass, Shark Ray Alley has become as popular as Hol Chan where tourists are guaranteed a snorkel with sharks and stingrays.

Today, the Hol Chan Marine Reserve is the most visited protected area in all of Belize, with over 37,000 visitations to the reserve each year. It has generated more money than all of the other protected areas, which it uses to cover most of the operational expenses. On the other hand, little research, monitoring and environmental education are taking place within the reserve, simply because there is not sufficient money to replace damaged or broken field equipment and other materials.

1.3. Purpose and Scope of Plan

The Hol Chan Marine Reserve Management Plan serves as a working document for the sustainable use and management of the marine resources in the area. This plan prescribes a zoning scheme that provides opportunities for the protection of specific natural features; for the maintenance of environmental services; and for tourism and fishing. It also prescribes a financial sustainability plan that could support the capital and operational expenses of the reserve.

Section 1 of the plan describes the need for protecting the Hol Chan area as a marine reserve, a historical overview of its early beginnings to reserve status, and the current legislative authority under which it is governed.

Section 2 describes the regional setting, site accessibility and other general information of the area, while Section 3 and 4 looks at physical environmental and biological information respectively.

Section 5 includes socio-economic information on the types of fishing and tourism activities carried out at the reserve and any existing educational and research and monitoring programs.

Section 6 describes the major constraints and potential management problems affecting the efficient management of the reserve.

Section 7 describes the actual boundaries and zoning plan together with the rules and regulations that govern each zone.

Section 8 looks at the existing enforcement and surveillance program and make recommendations for increasing the efficiency of the reserve in reducing illegal and unnecessary infractions to the reef.

Section 9 and 10 look at the reserve's existing resource management programs and make recommendations for further research and monitoring, and education and community outreach programs.

Section 11 includes a management strategy for reducing environmental damage to the reef and makes recommendations for the recovery of damaged or dead resources.

Section 12 looks at the current recreational and tourism activities conducted at the reserve and makes recommendations for reducing user-conflicts in heavily used areas. This section also proposes alternative sites for tourism development and the potential for integrating the appropriators and stakeholders in the protection and management of the reserve.

Section 13 looks at the existing administration and maintenance of the reserve and makes recommendations for improving integrated management at the community and grass roots level.

Section 14 is the last section and proposes a financial sustainability plan.

1.4. Legislative Authority

In July 1987, the Hol Chan Marine Reserve was granted reserve status under section 7 of the Fisheries (Amendment Act) of 1983. Section 9A-(1) of this Act states that “the Minister may, where he considers that the extraordinary measures are necessary, by order published in the Gazette, declare any area within the fishing limits of Belize and as appropriate any adjacent surrounding land, to be a marine reserve”. Subsection 9A-1(a) provides for special protection to the aquatic flora and fauna and to protect and preserve the natural breeding grounds and habitats of aquatic life. Subsection 9A-3(a) further states that “no person shall, in a marine reserve, engage in fishing without a license issued by the Fisheries Administrator”. (Appendix 1: HCMR Legislation)

In December 1988, the Hol Chan Marine Reserve Regulations was gazetted into law creating three zones and the rules and regulations governing each zone. They are Zone A, Zone B and Zone C. Recreational (non-extractive) activities such as diving and snorkeling can be carried out within Zone A. However, no person shall engage in fishing or remove or disturb any species of flora or fauna including rocks, dead coral shells, or sand within this zone. Sports and commercial fishing can be done within zone B and C under a special license from the Fisheries Administrator.

In September 1999, the HCMR regulations were amended to include another section of reef adjoining Zone A. It now features four zones and several sub-zones for special uses. Section 8A of the Hol Chan Marine Reserve (Amendment) Regulations of 1999 was used to designate Zone D as a multi-purpose use zone consisting of a General Use Area and two Exclusive Recreation Areas. Within the General Use Area commercial

fishing is allowed in all of Zone D except for the exclusive recreational areas of “Shark Ray Alley” and “Amigos del Mar Dive Wreck”. Scuba diving and feeding of fish by tourists is prohibited at Shark Ray Alley. Hol Chan Marine Reserve (Amendment) Regulations of 1999 has replaced the former as the principal regulations.

The Hol Chan Marine Reserve (Amendment) Regulations of 1994 also provides for the management of the HCMR through the establishment of a Board of Trustees. Section 13(1) states that “there is hereby established: a Board of Trustees for the purpose of directing and managing the affairs of the reserve”. Section 14(1)(e) further states that “the function of the Board shall be to: manage the affairs of the reserve and disburse moneys from the same (i.e. The Trust Fund) for the purpose of maintaining the integrity of the ecosystems within the reserve. The Board comprises nine members from the private and public sectors and meets at least once every quarter for the transaction of business. (Appendix 2: Board of Trustees Regulations)

The Fisheries Regulations of 1977 also apply within Hol Chan. Section 8(2) of the Fisheries (Amendment) Regulations of 1982 states that “no person shall with intent to take fish, use any trap or other device constructed of net or wire in any area within a distance of one hundred yards of the Barrier Reef. Section 26 of this regulation also prohibits anyone from setting nets across channels to restrict the free passage of boats or to wholly prevent the passage of fish.

The Wildlife Protection Act (WPA) of 1981 and the National Parks System Act (NPSA) of 1981 also provides for the governance of coastal and marine resources, though those portions of the Acts largely overlap with the Fisheries Act. The WPA states that “no person shall hunt, kill, or take any species of whale, any species of dolphin, manatee, Caribbean monk seal, salt-water crocodile and Morelet’s crocodile. Under the NPSA, the minister can

declare crown lands, including submerged lands and associated waters a national park, nature reserve, wildlife sanctuary or natural monument.

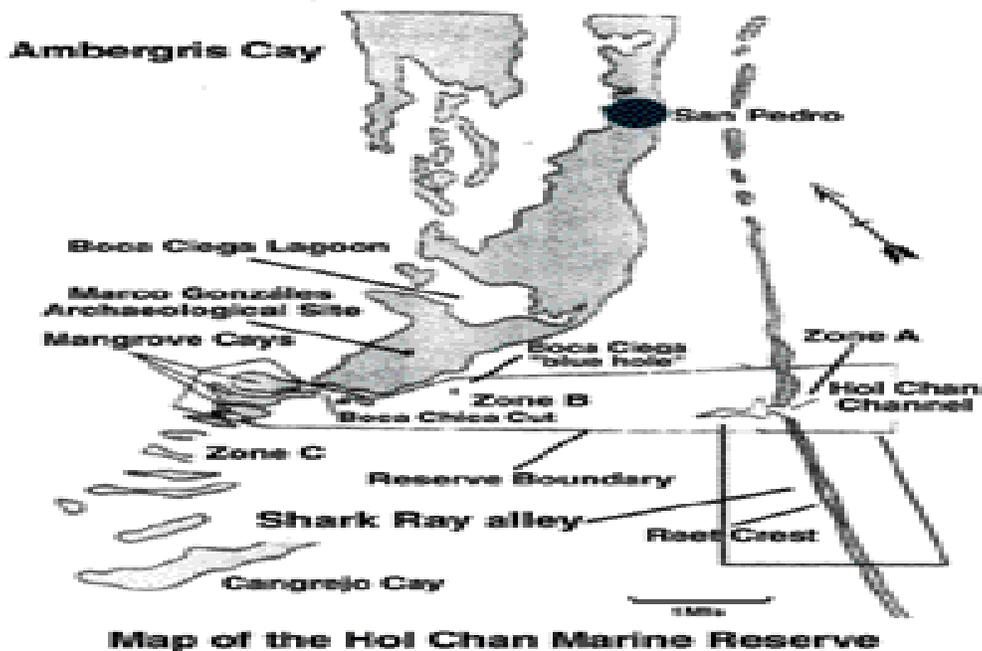
Other legislation with limited governance over the management of marine resources includes the Mangrove Regulations of 1989, the Environmental Protection Act of 1992, the Protected Areas Conservation Trust Act of 1995, and the Coastal Zone Management Act of 1998, the latter two lacking any authority for marine resources governance.

2. GENERAL INFORMATION

2.1. Location

The Belize barrier reef, which stretches for approximately 220 km, lies just 1 km offshore from the town of San Pedro, Ambergris Caye. The barrier reef is the tourist industry's most valuable asset and San Pedro has developed as the main center. The Hol Chan channel, the major focus of the reserve, is located approximately four miles southeast of San Pedro, Ambergris Caye. It encompasses 18.13 km² of coral reefs, seagrass beds and mangrove swamps.

Figure 1: Map of Hol Chan Marine Reserve



2.2. Access

The Hol Chan channel or 'cut' is easily accessible by boat from San Pedro and Caye Caulker and is regularly visited by local tour boats from these two northern cayes. Local tour boats from Belize City are also making more regular trips to the reserve making several other stops on the way back to the

City. “Zone A”, “Zone B”, “Zone C” and “Zone D”, encompass three distinct habitat types: in the easternmost portion of the HCMR, Zone A (2.59km²) and D encompass 7.77 km² of barrier reef; moving westwards, Zone B is the largest zone and encompasses 7.77 km² of seagrass beds; adjacent to this zone is Zone C which encompasses 2.59 km² of mangroves and seagrass at the southern tip of Ambergris Caye.

Admission to the reserve is based on a relatively simple tiered system of access rights based on time of day, nationality, and age (Mascia, 2000). The reserve is “open to the public” from Mondays to Fridays at 8:00am to 4:00pm, on Saturdays from 12:00pm to 4:00pm and on Sundays from 8:00am to 12:00pm. During these hours, tourists pay \$Bz5.00/day for admission to Zone A, B and C only. Belizeans pay half as much, and are admitted to the area free of charge on Sundays. All children under twelve are exempt from payment. Admission to Zone D (Shark Ray Alley) is \$Bz7.00/day for tourists and \$Bz1.00/day for Belizeans. All guide boats pay an annual fee of \$Bz10.00 per vessel to enter Zone A, B, C and D.

2.3. Land And Sea Tenure

Hol Chan Marine Reserve is made up of 18.13 km² of nationally owned land and seabed, the latter comprising over 90% of the total area. It includes the seabed, seven small mangrove islands, and a narrow strip of mangrove forest on the southern tip of Ambergris Caye.

Prior to receiving reserve status in 1987, the only titled land within the proposed boundaries consisted of a narrow strip of mangrove forest along the southern tip of Ambergris Caye. At the time, Caribbean Cove Ltd. owned the land and had plans to subdivide the land and construct a marina. Recognizing the environmental implications such a project would have on the fragile ecosystems, the GOB initiated discussions with the developers.

Seven years later the GOB agreed to “swap” the titled land in exchange for land elsewhere.

2.4. Maps, Photographs, Satellite Imagery Coverage

A digitized base map demarcating the boundaries and zones of the reserve is available for the HCMR. Black and white and color aerial photographs and several satellite images are also available but still need to be geo-referenced and digitized. A 1:50,000 marine habitat map of the country is also available in Hol Chan Marine Office, Fisheries Department and other institutions.

3. PHYSICAL INFORMATION

3.1. Geology and Substrates Types

The Belize submarine shelf is 240 km long and its reefs represent the largest reef complex in the Atlantic-Caribbean area. With its three different offshore atolls, it also rivals the Great Barrier Reef in the complexity of coral reefs and variety of sediment types (James and Ginsburg, 1979).

The Belize shelf is divided into distinct northern and southern halves. Its edge is characterized by a series of five discontinuous ridges that trend northeast and which are thought to be fault-controlled. The least defined ridge lies along the northern edge of the barrier reef and Ambergris Caye, (James and Ginsburg, 1979), encompassing the Hol Chan reef area. In this area the lagoon depths average three meters and are not greater than 5.5 meters. The reef facies occupy a narrow strip on the seaward edge of the shelf. Leeward of this zone, debris accumulates in the reef lagoon as coarse, slightly muddy skeletal sand which is stabilized by beds of *Thalassia* seagrass and the algae *Halimeda* (Miller and Macintyre, 1977).

Ambergris Caye itself is the northernmost and largest of the chain of carbonate islands on the Belize shelf edge. It has a narrow, windward sand and coral rubble beach ridge, with a broad expanse of supratidal flats and intra-island lagoons, which are interspersed with outcrops of Pleistocene limestone that form the core of the island (Miller and Macintyre, 1977).

The Belize shelf is the drowned expression of a low-relief karst surface, on which are locally developed sinkholes and incised river channels (Mazzullo and Reid, 1985). Examples of these can be seen in the channels of the Boca Chica area, which probably represent drowned river channels or solution beds, and the Boca Ciega “blue hole” which is a collapsed sinkhole. This

sinkhole opens into a large cavern, the extent of which has not been fully explored.

The Boca Chica area is part of the Cangrejo shoals area. Its channels are comprised of organic-rich lime mud. The southern tip of Ambergris Caye is in the process of extending southward, assisted by the growth of mangroves. (Wantland and Pusey, 1975). Removal of the fringing mangroves on the north side of the Boca Chica channel undoubtedly will result in erosion and removal of the thick mud section there.

3.2. Bathymetry and Turbidity

The waters are well circulated and clear.

3.3. Tides and Water Movement

The average tidal difference is 0.5 m.

The prevailing current inside the barrier reef is southerly; currents at reef entrances show a westerly flow.

3.4 Temperature, pH and Salinity

The surface water temperature near the barrier reef in July and August is 29 °C. The water is well mixed with normal seawater salinities of 35-37ppt.

3.5. Climate

3.5.1. Wind and Waves

Off Ambergris Caye, NE winds predominate at 5-15 knots. Seasonal “northers” between November-March, which are characterized by squall lines and high gusts, affect movement of spiny lobsters.

3.5.2. Hurricanes

Hurricane frequency is every 3 to 6 years on average. These storms are characterized by winds greater than 65 knots, high tides, storm surges and heavy rain. They have a great impact on reefs.

3.5.3. Rainfall

The average for the Ambergris Caye area is 133cm/year; the rainy season is from June to October.

4. BIOLOGICAL INFORMATION

4.1. The Coral Reef Habitat

4.1.1. The Fore Reef

Immediately outside the reef crest exists a flat rocky area of 5m depth with numerous soft corals, including *Gorgonia ventalina*, *Plexurella sp.* and *Pseudopterogorgia sp.* Moving seaward the water depth increases gradually and at 9m evident East-West ridges are apparent. Relief at these initial ridges is slight, approximately 0.5m and gorgonian cover persists.

As depth increases familiar corals take on different configurations to adjust to light attenuation. Platey formations of *Montastrea sp.* and *Porites astreoides* are evident at 14m along with large specimens of *Verongia* and *Xestospongia*. At this depth the spur and grooves are more evenly separated and mostly continuous. The reef wall of ‘drop-off’ occurs approximately 3/4 miles seaward of the reef crest.

4.1.2. The Reef Crest

A foundation of dead *A. palmata* and *M. annularis* underlie the reef crest and provide support for the live corals, *A. palmata*, *P. porites* and *A. agaricites*. The dead corals are often extensively bored and covered by an algal turf.

At various locations, small channels run perpendicular to the reef crest thus allowing water exchange between the open sea and the lagoon. These channels are often extremely shallow and lined with outcrops of the hydrocoral *Millepora complanata*.

The outer reef crest is subject to nearly constant wave swell and *A.*

palmata can be found in great abundance. The faces of the coral branches most often form perpendicular to the angle of wave direction to prevent excessive breakage.

4.1.3. The Back Reef

The area extending to 40m west of the reef crest contains many patch reefs situated in the midst of coral rubble often covered with an algal turf. Coarse sand and gravel underlie the rubble in this shallow wave swept region. Depth varies from 1.0 to 1.75m.

Patch reefs occur in this area due to displacement of coral fragments during periods of intense wave action. Encrusting corals such as *Porites asteroides* and *Diploria sp.*, often grow on dead coral formations, building patch reefs closer to the surface of the water, the corals *Agaricia agaricites* and *Siderastrea siderea* also appear consistently on patch reefs in the back reef. Many of the smaller reef fish can be found living amongst the patch reefs, especially the many herbivores. Overturned coral formations are often partially exposed at low tide just north and south of Hol Chan channel.

4.1.4. Hol Chan Channel

The channel walls are formed of dead *Acropora palmata* leaving small caves and ledges on both the north and south sides of the cut. Walls are sporadically covered with the live corals *Siderastrea*, *Agaricia*, *Diploria* and *Gorgonia*. Thick coral growth, specifically *Acropora palmata*, occurs in the upper two meters of the walls.

The channel curves southward in a slight U-shape as one travels seaward, the width of the channel ranging from 20m to 30m. The

sandy bottom of the channel is mostly barren of life and approximately 10m deep throughout. Scouring due to wave action displaces coral fragments outside the channel and leaves only coarse sand. Moving seaward, the coral walls discontinue and water depth decreases to 6m. More growth appears on the bottom with abundant algal cover.

4.1.5. Shark and Ray Alley

Located in the calm protected waters of the back reef, Shark and Ray Alley is named for its resident nurse shark and southern stingrays that gather together for an effortless meal from the fishermen or tourist guides that visit the area. This feeding activity has also attracted large schools of gray snappers and other species of reef fish.

The bottom type is composed of coarse to fine sand dominated by the seagrass *Thalassia*. The hard bottom supports a thriving community of marine life including sponges, corals, and various coralline algae. Encrusting corals such as *Porites*, *Asteroides* and *Diplora spp.* can be found growing on dead coral rubble. The rose coral, *Manicina aequalata*, is also common among the grass beds.

4.2. The Lagoon Habitat

Considering the lagoon to be the area from just outside the Boca Chica Channel to within 40m of the reef crest, it consists chiefly of coarse to fine sand and the seagrasses *Thalassia* and *Syringodium*. In lesser amounts occur sand and rubble zones, which support a high diversity of marine life including sponges, small coral formations and various coralline algae. There appears to be no distinct pattern as to where grass patches in sand flats or sand patches in grass flats will occur. A rough approximation of 50% grass patch

cover from just outside the Boca Chica Channel to within 40m of the reef crest, it consists chiefly of coarse to fine sand and the seagrasses *Thalassia* and *Syringodium*. In lesser amounts occur sand and rubble zones, which support a high diversity of marine life including sponges, small coral formations and various coralline algae. There appears to be no distinct pattern as to where grass patches in sand flats or sand patches in grass flats will occur. A rough approximation of 50% grass patch covers the phytoplankton and algae for photosynthesis. Fish such as Surgeonfish and Parrotfish graze on the algae and seagrasses and return to the reefs, depositing the nutrient there in their faeces, such as turtles, manatees, conch and lobster. *Thalassia* roots and leaves provide shelter and attachment sites for a microcosm of marine life.

4.3. The Mangrove Habitat

This area of the reserve is comprised of seven mangrove cayes lying just off the southern tip of Ambergris Caye, separated from the cayes by the Boca Chica “cut”. This series of channels are used by sportfishermen for harpoon fishing. The nearby sand flats are fished for bonefish.

The most common plants existing in these highly saline conditions are *Conocarpus erectus* (buttonwood), *Laguncularia racemosa* (white mangrove), *Avicennia Germinans* (black mangrove) and *Rhizophora mangle* (red mangrove). The roots of the latter, the red mangrove, provide abundant surface area for epiphytic growth thus providing food and shelter for various fauna. These mangrove areas provide nurseries for juveniles of many reef fishes; they also provide feeding grounds and introduce fixed nitrogen and organic detritus into the trophic system of the reef.

The bottoms of the mangrove channels are composed of fine silt and sand mixture, often heavily covered with the seagrasses *Thalassia* and

Syringodium. Calcareous algae, mainly *Halimeda* and *Penicillus*, are interspersed randomly throughout the seagrass beds. A gentle gradient from 1.5m to 3.0m occurs from mangrove thicket to the center of the channels. The depth of the Boca Chica channel remains fairly constant at 3.0m.

Besides the flora mentioned above, the following fish are found in great numbers within the mangrove habitat: *Haemulon sciurus* (blue striped grunt), *H. flavolineatum* (French grunt), *H. plumieri* (white grunt), *Lutjanus apodus* (schoolmaster), *L. griseus* (grey snapper), *Urolophus jamaicensis*, *Pomacanthus paru* (French angelfish), *P. arcuatus* (grey angelfish), *Chaetodon striatus* (banded butterflyfish), *C. capistratus* (four-eye butterflyfish). The invertebrate *Ecteinascidia turbinata* is also very abundant. Additional lists of the common fishes and the corals, sponges and plants of the reserve can be found in Appendix 3 and 4.

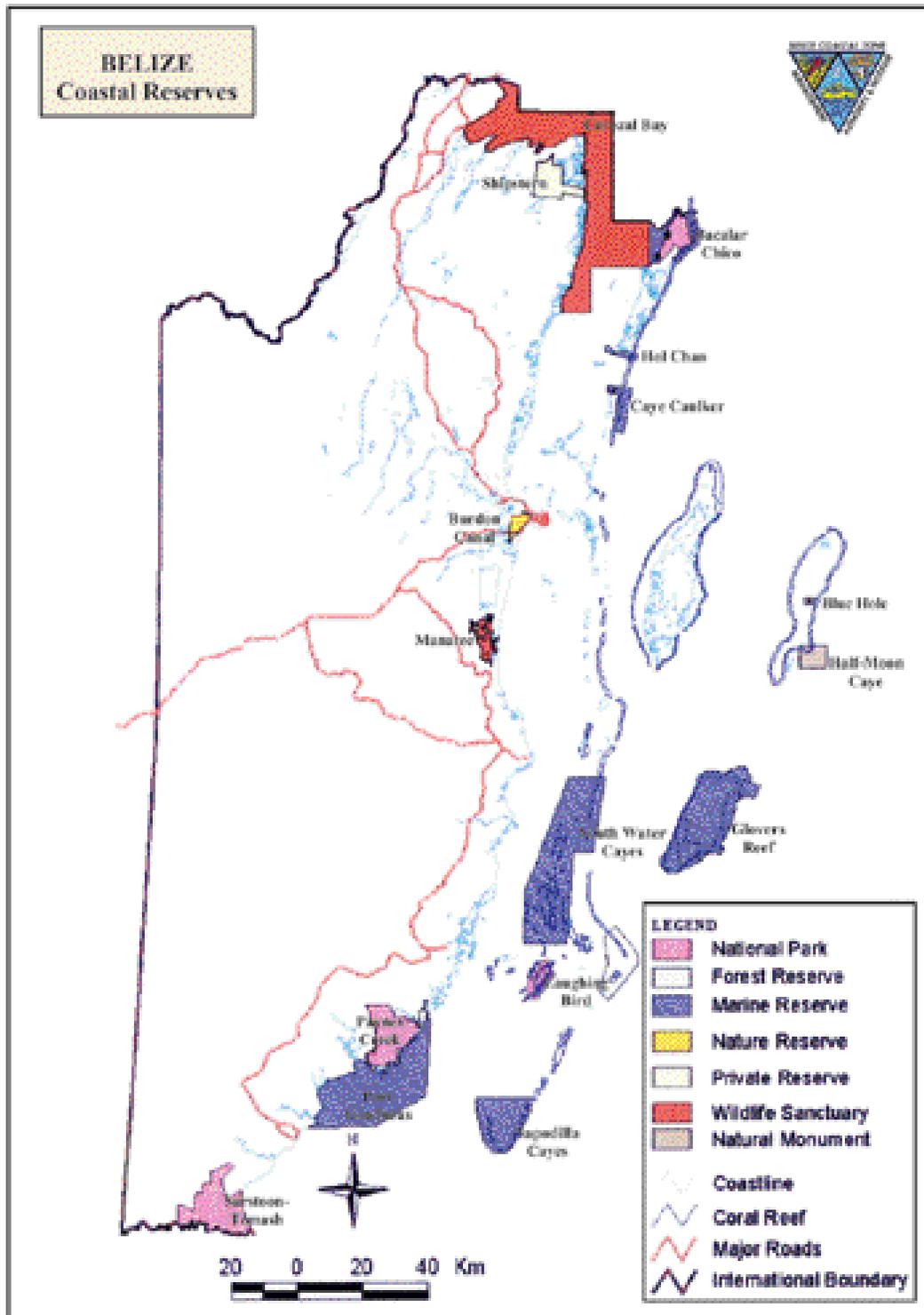
5. EXISTING USES

5.1. Tourism

The tourism industry began in the mid-1960's when Belize became known for its diving (CTO, 2000). The first hotel opened its door to the public in 1965 followed by a dive shop and a restaurant (Mascia, 2000). Since then, San Pedro has become the center of the tourism industry in Belize, offering a wide variety of recreational activities ranging from sportsfishing, diving, snorkeling, birding, and manatee watching. Today, sportfishing, dive and snorkel shops, hotels, restaurants, and bars line the oceanfront at the center of town, while local residents live inland or on the lagoon side of the island (Mascia, 2000).

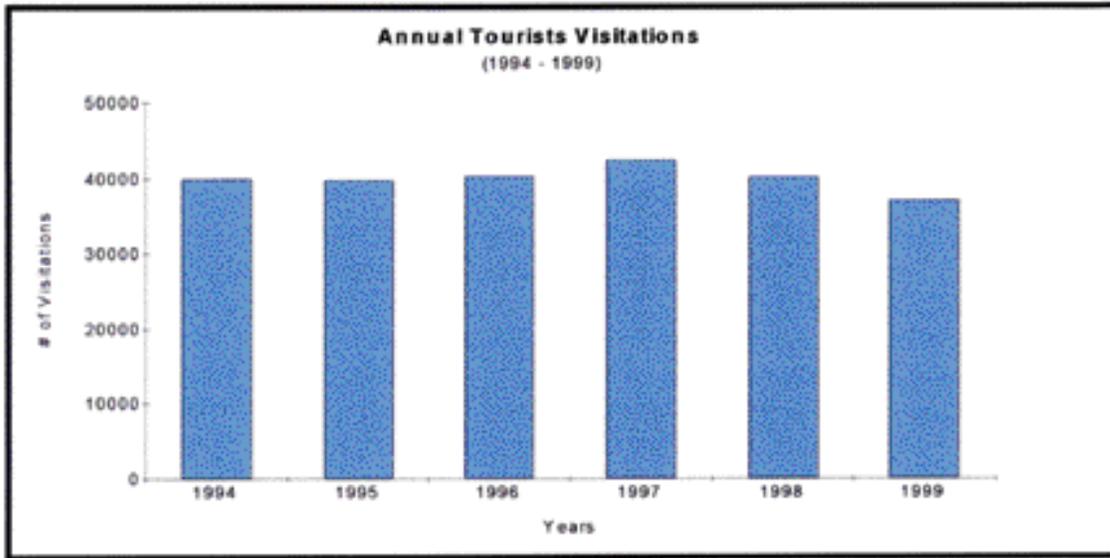
The Hol Chan channel has always been known for its high diversity and beauty of marine life, making it a popular spot for divers and snorkellers. Visitation records for 1991-1992 showed a total of 33,630 tourists visited Zone A of the reserve. Tourist visitation to the reserve grew steadily over the years reaching its peak in 1996-1997 with 42,460 visitations to Zone A. The following year (1997-1998), the reserve received 40,048 visitors, a decrease of 5.7%. This significant drop in visitation has been attributed to Hurricane Mitch is "near miss" in late October. The 1998-1999 visitation records continues to show a decrease in visitation with a total of 37,059 visits to Zone A, a decrease of 7.5%. This further decrease in visitation has also been attributed to the Mitch scare in late October.

Figure2: Belize Coastal Reserves



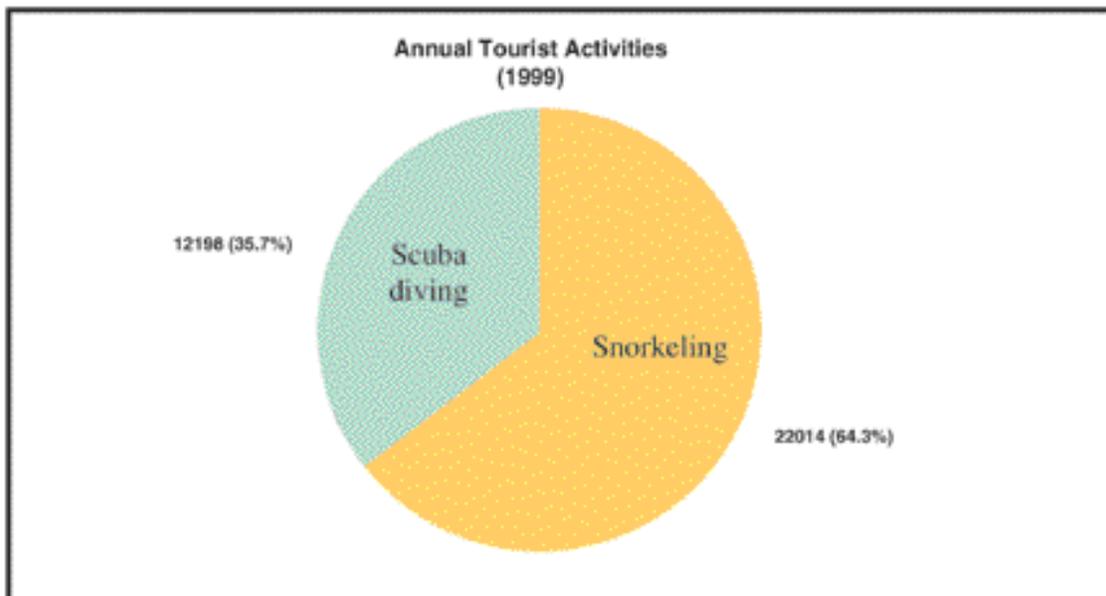
Source: Coastal Zone Management Authority & Institute

Figure 3: Annual Tourists Visitations (1994 -1999)



Tourists entering Zone A and D of the reserve engaged in at least one of two recreational activities: diving and snorkeling. The 1999 visitation records estimated that 22,014 of all tourists in Zone A engaged in snorkeling while 12,198 engaged in scuba diving. This three- to- one ratio of snorkellers versus divers has remained the same for the last six years.

Figure 4: Annual Tourists Activities (1999)



Records on sportfishing activities within Zone C of the reserve are based solely on anecdotal information. Zone C lacks good bonefish “flats” and this is probably the reason it is rarely used by sportfishing guides (Miguel Alamilla, pers.com.).

5.1.1. Scuba Diving (Zone A & D)

As mentioned earlier, the Hol Chan channel is probably the most heavily visited dive spot within the reserve. Apart from this channel, diving also occurs at six other locations along the three mile stretch of fore-reef. These sites include: pillar coral dive site; eagle ray canyon; a site in front of the Hol Chan channel; sandbore dive site; amigos wreck; and another site between the sandbore and amigos wreck. Divers are required to have a trained dive guide on every dive. Dive guides are required to explain the rules and regulations of the reserve, thus reducing the risk of damage to the corals and fish life. The relatively few number of dive sites in relation to the large numbers of diver has sometimes led to over-crowding, user conflicts between operators, and environmental degradation. Conflicts also occur between commercial fishermen in Zone D who sometimes have difficulty determining the boundaries of the Exclusive Recreational Zone from the General Use Zone.

5.1.2. Snorkeling (Zone A & D)

Snorkeling is the most popular recreational activity among tourists visiting the reserve. Over 20,000 visitors snorkel the Hol Chan channel and Shark Ray Alley each year. Due to the limited numbers of snorkeling sites, the number of operators and tourists sometimes leads to over-crowding at these sites, resulting in environmental degradation and sometimes causing conflicts among operators. User

conflicts within Zone D is especially difficult to control because the “exclusive recreational area” of Shark Ray Alley is not clearly defined or demarcated, making it difficult for commercial fishermen to determine where fishing is not allowed. Since a snorkeling guide is not required to accompany the snorkellers, visitors usually end up snorkeling on their own. Boat operators usually make several other stops along the reef after leaving the reserve.

5.1.3. Sportfishing (Zone C & D)

Bonefish in the sandy flats south of Ambergris Caye were the target of the earliest tourists in search of sport-fishing thrills, but today reef fishing (for snappers and groupers) and offshore fishing (for pelagic billfish, etc.) are increasingly popular (Mascia, 2000).

Most sport fishing occurs in Zone D for snappers, groupers and barracuda. Reef fish (i.e., food fish) are usually kept following capture, with most (if not all) of the fish going to the guide for personal consumption or sale; other fish are usually released following capture.

Since Zone C has no bonefish “flats”, sportfishing rarely, if ever, occurs within this zone. Sport fishermen prefer to fish the extensive sandy flats near Cayo Congrejo, just south of the Reserve.

5.2. Commercial Fishing (Zone B & D)

Sanpedranos started fishing commercially for conch, lobster and finfish in the mid 1950’s, but have now largely abandoned it in favor of the tourism industry. Today, San Pedranos only dive the barrier reef near Ambergris Caye and, with the exception of a few full-time fishermen, fish only as part

of an intense pulse of fishing effort during the first few weeks of the season, when catches are the highest (Mascia, 2000).

In the planning phase of the reserve, a usage survey was conducted among 11 fishermen. From the responses, six said they set lobster traps in Zone B and 14 said they also do conch diving within this zone. Only one fisherman claimed he received more than 50% of his catch from this zone. Thirteen said they do hook-and-line fishing within the reserve for snapper, barracuda, jack, grouper, parrotfish, hogfish, and porgy.

Two years after Hol Chan received reserve status the six fishermen who fished the Hol Chan area before it was a reserve were asked to complete a questionnaire. Based on the results of this survey and landing records from the Caribena Cooperatives, all indicated an increase in catch for lobster and conch. Mr. Genaro Nunez, the biggest investor, reported that his annual lobster catch increased from 1475 lbs. in 1988 to 2400 lbs. in 1989. Another full time conch fisherman reported a catch increase adjacent to Zone A (HCMR progress report, April 1989).

The results of this survey can be substantiated somewhat by a conch population census conducted in Zone A and adjacent areas (including Zone B). Conch studies in Zone A and adjacent areas (including Zone B) show a “spill over” effect from Zone A. Conch populations are at 0.18 conch/m² in a radius of 600 ft. from Zone A behind the barrier reef (HCMR progress report, April 1989). No other similar studies have been done since, even though these fishermen continue to fish within the reserve boundaries.

5.3. Research & Environmental Monitoring

The main focus of research conducted in Hol Chan is monitoring. The monitoring projects have focused on lobster surveys, conch transects, finfish

counts and coral diversity surveys. Coral surveys have also focused on diseases such as the Black Band disease and the coral-bleaching phenomenon.

Lobster Surveys

Lobster surveys were conducted in 1990-1992 to determine the population density inside the reserve and to compare the population density with other areas outside the reserve, particularly at Mexico Rocks and Robles Pt. This study showed a population density of 38.4 lobster/hr inside the reserve which was comparable to that recorded in August 1991 (39.7 lobster/hr.). Approximately 73% of the lobsters were legally mature and 19% had eggs (berried) (HCMR progress report, March 1992). The comparative study showed Hol Chan's lobster population to be nineteen times higher than Mexico Rocks and thirteen times higher than Robles Pt (HCMR progress report, October 1992).

Lobster surveys have clearly demonstrated that there are more lobsters present within the boundaries of the reserve than there are in other areas. Unfortunately, no comparative analysis of lobster populations over time has been conducted. The lobster numbers taken from the bi-annual reports produced by the reserve personnel were compared to the number of lobsters per survey hour for 1999/2000 which was analyzed by the authors. The lobster counts in 1999/2000 initially appear to be lower than counts during the early 1990s (HCMR, data set).

Post larval studies using the "Witham" surface collectors show a very healthy population of lobsters in Zone C of the reserve (HCMR progress report, April 1989).

A lobster habitat tagging study was conducted inside the reserve to determine the degree of mobility of the lobsters during the important breeding

season. This study showed a consistent movement of lobster population from the tagged habitat to other areas (HCMR progress report, September 1991).

Conch Surveys

Conch studies in Zone A and adjacent areas (including Zone B) showed a “spill over” effect from Zone A. Conch populations are at 0.18 conch/m² on a radius of 600 ft. from Zone A behind the barrier reef (HCMR progress report, April 1989). A usage survey among the 6 fishermen who used the reserve and landing records from the Caribena Cooperative showed an increase in catches for lobster and conch (HCMR progress report, April 1989).

Another study on the landing records for 1981-1988 showed that the six fishermen did not suffer a disproportionate decline in revenues as compared to the cooperative as a whole. In fact, this study showed a slight increase in conch and lobster revenues for these six fishermen after 1987. Their lobster catches have also increased slightly since 1987. The report concluded that there is insufficient evidence to assert that the reserve has increased the catch for the fishermen using the peripheral areas around the reserve (Schmidt, 1990).

Additional conch surveys carried out from 1990– 1992 showed a higher concentration of all size classes in Zone A versus Zone B. Size classes include juvenile (1- 17 cm), juvenile (legally harvestable but still immature) and sexually mature and legal size conch. The highest density of conch was found to be in the “sand row” habitat – a sandy area running parallel to the reef in the reef flat area. These surveys also showed that 40.2% of the 435 legally harvestable conchs measured were sexually immature. Similar studies conducted at Mexico Rocks showed both juveniles and adults were found in

lesser densities than at the reserve (HCMR progress report, October 1992).

A study was conducted to evaluate the extent of a conch “die-off” in the reserve and to explore its possible causes. The main cause of the die-off was not determined but many causative factors were suggested. The “die-off” was restricted to the reserve and the southern boundary. The backreef was most affected showing 65% dead, while the reef crest was less affected with only 9.8% dead (Azueta *et al.*, 1991).

Fish Surveys

Sedberry *et al.*, (1992) conducted a fish survey in an attempt to quantify the effects of protected status on fish populations inside and outside the HCMR. The results of this study showed that the larger species of fish – such as Nassau grouper, graysby and black grouper were more abundant within the reserve than at Tres Cocos. This study also showed a higher number of commercially important finfish species (for yellowtail snapper, mahogany snapper and schoolmaster) inside the reserve than at Tres Cocos.

Barrick (1992), also conducted a similar study in fish community structure over time in the HCMR and between protected and non-protected sites. The results of this study showed that the abundance, mean length, biomass, and species richness of commercially important species were generally greater in the HCMR in 1991 than in 1998 and greater in the HCMR than in the non-protected site at Tres Cocos.

The reserve biologists also conducted similar fish surveys around the same time the other two studies were conducted. The results of this study show that:

- (i) The reserve has a higher number of species as well as commercial species than the non-protected area at Tres Cocos;
- (ii) The number of individuals and commercial individuals are

higher in the reserve than at Tres Cocos;

- (iii) The average sizes (especially for commercial species) are greater in the reserve than at Tres Cocos (HCMR progress report, March 1992).

The study conducted by the reserve biologists also included Mexico Rocks. The results of this study show that:

- (i) The reserve has larger fish than at Mexico Rocks;
- (ii) The reserve has twice the number of species surveyed and three times the number of commercial species;
- (iii) The reserve has 66% more biomass than Mexico Rocks (HCMR progress report, October 1992)

Coral Surveys

Coral surveys for quantitatively assessing the general health and status of the reef includes a number of methods – from the low-tech linear chain method (CARICOMP) to the high- tech digital video method (AGRA/CPAAC). The HCMR progress reports suggests that a considerable amount of time was spent experimenting with and trying to refine the various monitoring techniques, leaving very little usable data for comparisons. In addition, several years were spent combating the occurrence of Black Band Disease (BBD) in the early 1990s. A considerable amount of time was also spent monitoring the recovery of corals from two separate “bleaching” events in 1996 and 1998.

Treatment of BBD involved the use of an aspirator device for removing the cyanophyte’s filaments from the coral’s surface. A clay barrier was then applied and the affected area measured to determine the success rate of recovery. The overall success rate of individual treatments was low (41%). The brain coral *D. strigosa* showed significant levels of black-band disease. The study also showed that the disease disappeared naturally from a number

of untreated corals.

Permanent stations were established in Zone A and C of the reserve using the CARICOMP method, however the authors could not locate any usable data for comparison.

Another significant coral analysis focused on bleaching events that have been increasing in Belize over the last decade. In 1996, a study was conducted to assess the level of bleaching within the reserve. Forty-nine coral colonies (composed of single stands of *Acropora palmata*, *Porites porites*, *Millipora alcicornis*, *Montastrea annularis*, and *Diplora strigosa*) were assessed. *P. porites* was the worst affected with up to 90% of the colony bleached, while *M. alcicornis* was the least affected (10% bleached). The other three species had varying amounts of bleaching, but nothing as significant to the previous year and affectation seems to be limited.

Sedimentation study was also conducted at different locations inside Zone A of the reserve, including the heavily used Hol Chan cut. Rates above 10 grams/cm²/day are considered detrimental to coral health and were present in Hol Chan cut on a number of occasions (HCMR progress report, March 1992).

Monitoring efforts in all areas of the marine habitat of the reserve have been very basic. No long-term comparisons have been made to assess the success of the reserve. Not only do data methods need to be standardized and consistent to allow for comparisons, but also other causative factors need to be eliminated from the data to truly understand the success of the reserve. Collecting simple data on currents, turbidity level, salinity level, and surface and sub-surface water temperatures can easily assess fluctuations in environmental variables.

Other research within the reserve has been for student projects for several

undergraduates and a few graduates who have produced theses and dissertations. Of note are the economic study on tourism and conservation at the HCMR conducted by Paul Schmidt in 1990, and a similar economic study carried out by Jaime Bonilla in 2000. Dr. Mike Mascia also completed a case study on the governance of the reserve and an undergraduate student conducted an impact study on human interactions with the sharks at Shark and Ray Alley. In her paper, she made recommendations for human behavior during shark and ray encounters, most of which have been adopted by the GOB in its legislation regarding this area.

5.4. Education

The reserve has also significantly served as an education center, both within the reserve and at the office in San Pedro. Locals, tourists, Belizean and foreign students have all benefited from the interpretive materials and educational programs offered by the reserve. The reserve continues to maintain a visitor's information center with displays of corals, shells, posters, and conservation information.

A number of educational materials have been developed including a color brochure, leaflets on reef etiquette and water safety, a poster and guidebook, and a number of poster presentations for display at the visitor center and at workshops and conservation exhibitions. The reserve staff has also assisted the Education Department's Curriculum Development Unit by writing the "Coral Reef" chapter for the Marine Conservation Manual. This manual has been distributed to all the primary school teachers for integration into their curriculum. The staff also produced a "Marine Life" booklet from the "Conservation Corner" articles in the San Pedro Sun newspaper. This booklet has been distributed to all high school teachers for integration into their English classes.

A questionnaire was designed to determine if the guides are adequately informing tourists visiting the reserve about the required conservation measures. The results of this survey indicate that 76.6% of the guides are doing a good job at informing their tourists about the conservation measures (HCMR progress report, September 1991).

Weekly conservation articles have been written in the local newspaper. These articles have been quite a success and have generated numerous discussions about environmental concerns from all segments of the population.

Three of the four high school classes are receiving weekly lectures about marine biology and environmental conservation from the reserve staff. This program has been quite successful in fact, the current manager of the reserve was a past student of these weekly lectures.

A series of slide presentations have been put together on marine ecology, coral and fish identification and on sea turtles and trade in endangered wildlife. These slide shows have been offered to locals, tourists, tour guides and to the schools.

“Diving into Conservation” workshops were held with the major dive and snorkel shops on the island to discuss environmental issues at the reserve. The reserve also sponsored displays at the Earth Day celebrations in San Pedro, at the Agriculture and Trade Show in Belmopan, and at the Cultural Fair at Belize Technical College (University of Belize).

Currently, students from Smith College in Massachusetts are assisting with the education program.

6. CONSTRAINTS AND POTENTIAL MANAGEMENT PROBLEMS

- Attaining self-sufficiency from the funds generated from the sale of tickets is currently the biggest issue facing the reserve. Such financial constraints have decreased the staff's capacity to manage the reserve in an efficient manner. External funding from PACT should be sought to upgrade the visitor center into a marine museum and resource center. Additional funding to purchase new field and lab equipment and mooring buoys should be sought through GEF and UNDP.
- A loss of 20% in revenues generated by the reserve. This mandatory contribution to PACT will affect the reserve's financial capability to purchase much needed equipment. For most of the protected areas, this levy is irrelevant because self-generated revenues represent but a tiny percentage of their total operating budget. The HCMR, by contrast, is self-sufficient; its entire operating budget is derived from access fees. The long-term implications of this levy on the HCMR are unclear, though it may diminish the capacity of HCMR personnel to monitor and enforce HCMR institutions (Mascia, 2000).
- The lack of adequate community participation in the management of the reserve. This grass-roots approach for managing the reserve was lost when the Board of Trustees replaced the Advisory Committee in 1992.
- Securing a local biologist and environmental educator suitable for their respective jobs has posed some management problems in the past. The reserve has changed biologists four times over the last 12 years, creating discontinuity in the research and monitoring programs. It is important that these jobs positions be carefully investigated as the success of the reserve depends to a great extent on their abilities to implement the

research and educational programs.

- Resource-use conflicts at Hol Chan cut and Shark and Ray Alley are high, sometimes leading to clashes among the various user groups. This concentration of visitors in two small areas has already lead to the degradation of the reef and seagrass habitat. It is hoped that this problem will be alleviated by the formation of an advisory committee comprised of representatives from these groups.
- Land-based sources of pollution from all the development projects occurring on the island pose a serious threat to the integrity of the reserve. Development projects adjacent to the reserve should be carefully monitored.

7. ZONING PLAN

7.1. Goals and Objectives

Goal I

To maintain a sample coral reef ecosystem in its natural state.

Specific Objectives:

- (a) To restore the earlier beauty of the Hol Chan area; e.g., by restricting fishing it is hoped that the ecological balance will be restored. For example, the return of more herbivorous fishes may in turn assist with control of the apparent algal bloom which has occurred in the shallower areas; top level predators, such as barracuda, snapper and grouper, have also been seriously depleted in the Hol Chan area as a result of overfishing, and may also have caused an ecological imbalance between predator and prey in the tightly-knit coral reef fish community.
- (b) To preserve areas of critical habitat for several endangered species such as the reef and turtle grass beds for turtles and the mangrove areas for manatees.
- (c) To regulate the use of the area by tourists and fishermen to prevent its overexploitation.

Goal II

To provide recreation and tourism services and preserve the value of the area for fisheries.

Specific Objectives:

- (a) To provide an undisturbed area for tourism and recreation, but in a controlled and well-informed manner.
- (b) To promote uses compatible with conservation and sustainable development objectives, primarily through zoning.
- (c) To provide protected habitats for commercially important species i.e., the coral reef for reef fish and lobster, the turtle grass beds for lobster and conch, and the mangrove areas for nurseries of many different finfish species and invertebrates.
- (d) To enhance the social and economic benefits of the area.

Goal III

To provide an area for education and research.

Specific Objectives:

- (a) To foster general interest in and knowledge of the coastal environment through education and interpretative programs.
- (b) To encourage scientific research in all sections of the reserve.

Goal IV

To conserve genetic resources.

Specific Objectives:

- (a) To provide an undisturbed area which will result in increased recruitment to the fisheries of the adjacent areas.
- (b) To conserve an ecosystem i.e., mangroves, turtle grass beds and coral reef, which is representative of the reef complex and which functions as an ecological entity.

7.2. Boundaries

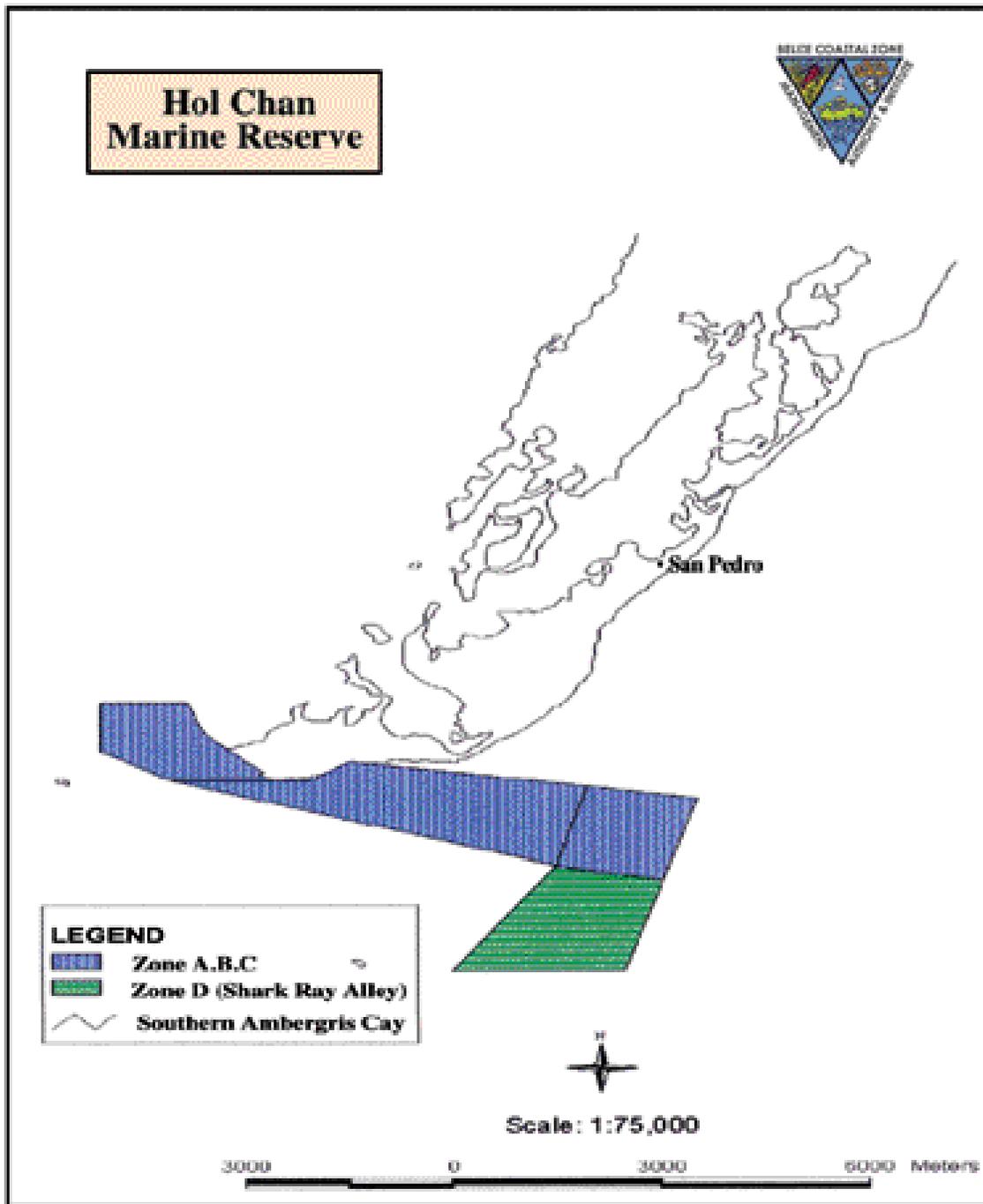
In November 1987, a set of twenty-two orange buoys was installed to demarcate the boundaries of zones A, B, and C. After most of these buoys were lost due to vandalism by fishermen and accidental damage, a new system demarcating Zone A with flagged poles was installed in August 1988. There were no problems with vandalism under the latter system, which survived well. In October 1998, Mitch removed the remaining buoys from the reserve.

Several marker buoys have been deployed at Zone A; however, the rest of the reserve is not properly demarcated. It is important that the boundaries of the reserve and the various zones are well marked by buoys. The Exclusive Recreational Use Zone in Zone D needs to be defined and marked by buoys.

7.3. Zoning Plan and Regulations

For the purpose of proper control and management of the HCMR, four zones have been created within the boundaries of the reserve - Zone A, Zone B, Zone C and Zone D.

Figure 5: Zoning Map of HCMR



Source: Coastal Zone Management Authority & Institute

General Rules of the Reserve

- (a)** No person shall have in his possession within the boundaries of the reserve any flora and fauna, without special license from the Fisheries Administrator.
- (b)** No person shall deposit any material in or on the waters of the reserve, except in cases allowed by special license from the Fisheries Administrator.
- (c)** No person shall construct any structure, whether permanent or temporary, in the reserve.
- (d)** No person shall discharge or deposit any waste material into the water or land areas of the reserve.
- (e)** No person shall mark or tamper with any sign, buoy or notice installed in the reserve by the Fisheries Administrator.
- (f)** Visitors shall first obtain a ticket, on payment of the prescribed fee, from the reserve headquarters before entry to any of the zones.
- (g)** Scientific research will be permitted under license granted by the Fisheries Administrator.
- (h)** All boats shall obtain registration from the Administrator and apply the mark/sticker provided in a prominent position on the registered boat;
- (i)** Permits/licenses issued are not transferable and will only be renewed upon application to the Administrator;

- (j) Any accident involving personal injury or damage to property shall be reported to the Reserve Manager as soon as possible, but the Reserve Management/Fisheries Department/Government of Belize accepts no liability in this regard.
- (k) All other Fisheries Laws will be enforced.

Zone A

Objectives

The specific objectives of this zone are:

- (a) To provide an area for recreational diving and viewing of the reef at Hol Chan.
- (b) To preserve a representative sample of the coral reef ecosystem.
- (c) To enable areas to recuperate from over-use and to return to their former natural state.
- (d) To provide an undisturbed area which will in turn provide recruitment of species to adjacent areas.

Use and Entry

The following additional rules shall apply to Zone A:

- (a) No person shall engage in fishing;
- (b) All boats shall anchor at the mooring provided, except in cases of

emergency where life and property may be endangered;

- (c) No person shall remove from its place or disturb any species of flora or fauna, including rocks, dead coral, shells or sand;
- (d) No person shall cast or drag any anchor in such a way as to damage coral reef formations;
- (e) All boats operating in this zone shall obtain registration from the Administrator in the prescribed form set out in Schedule 1.
- (f) Diving guides in this zone will abide by the following rules:
 - (i) to acquaint passengers with the rules of the reserve;
 - (ii) to anchor at the mooring provided;
 - (iii) to fly the “divers down” flag during all dives;
 - (iv) only certified SCUBA divers or those undergoing an approved training course will be allowed to use scuba tanks;

Zone B

Objectives

The specific objectives of this zone are:

- (a) To provide opportunities for established uses and activities to continue; these include mainly commercial fishing for conch and lobster.

- (b) To provide an area for water sports such as water-skiing and sailing.
- (c) To provide a protected area of seagrass beds and associated back reef habitats, which are vital to the health of the coral reef.

Use and Entry

The following rules shall apply to Zone B:

- (a) No person shall engage in trawling;
- (b) No person shall engage in fishing except under a special license from the Administrator in the prescribed form set out in Schedule 2;
- (c) No fishing will be permitted in the Boca Ciega “blue hole” with the use of nets or spears.
- (d) Fishermen using this zone shall submit details of catch from the reserve area as requested under Schedule 2 Form E1 of the Fisheries Regulations;

Zone C

Objectives

The specific objectives of this Zone are:

- (a) To provide opportunities for established uses and activities to continue.
- (b) To promote sportfishing.

- (c) To preserve a representative sample of a mangrove ecosystem.
- (d) To preserve a highly productive area which is a nursery for many species and which is intimately linked with, and provides a nutrient flow to, the coral reef.

Use and Entry

The following additional rules shall apply to Zone C:

- (a) No person shall engage in fishing except under a special license from the Administrator in the prescribed form set out in Schedule 2;
- (b) All boats used for sportfishing shall obtain registration from the Administrator in the form set out in Schedule 1;
- (c) Sportfishing guides will be required to:
 - (i) submit details of catch and area fished to the park manager when requested;
 - (ii) release fish wherever possible.
- (d) Fishermen using this zone will be required to submit details of catch from the reserve area as requested under Schedule 2 Form E1 of the Fisheries Regulations;

Zone D

Objectives

The specific objectives of this zone are:

- (a) To provide an area for recreational diving on the reef, such as Amigos del Mar Wreck; and snorkeling with sharks and ray at the now famous Shark and Ray Alley.
- b) To provide opportunities for established uses and activities to continue; these include mainly commercial fishing for lobster and finfish.
- (c) To provide a protected area of seagrass beds and associated back reef habitats, which are vital to the health of the coral reef.

Use and Entry

The following rules shall apply to Zone D:

- (a) There shall be within this zone a “General Use Area” which shall be protected as follows:
 - (i) commercial fishing shall be allowed in all of Zone D except in the exclusive recreational areas of “Shark Ray Alley” and “Amigos Del Mar Dive Wreck”;
 - (ii) fishermen shall submit catch data upon request by the staff of the Reserve;
 - (iii) fishermen shall obtain the Hol Chan Marine Reserve stamp on their fishing licenses;
 - (iv) no gloves shall be allowed; and
 - (v) the down-under diver’s flag shall be displayed at all times by tour guiding vessels;

- (b)** There shall be within this zone “Exclusive Recreation Areas” which shall be protected as follows:
- (i)** special marker buoys shall demarcate the boundaries of the exclusive recreation areas, and these areas shall be comprised of the area at “Shark Ray Alley” and the other area outside the reef at the “Amigos Del Mar Dive Wreck”;
 - (ii)** no fishing;
 - (iii)** no feeding of fish by tourists;
 - (iv)** no touching of flora or fauna;
 - (v)** no scuba diving shall be allowed in Shark Ray Alley except for research purposes under a special license issued by the Fisheries Administrator;
 - (vi)** commercial, recreational vessels shall be allowed to stay in the exclusive recreation areas for periods of not more than one hour at any one time, and only if there are in that area mooring buoys available;
 - (vii)** commercial recreational vessels within the exclusive recreation areas shall first report to the Ranger on duty before engaging in any water-related activities;
 - (viii)** down-under divers flags shall be displayed at all times; and
 - (ix)** no fishing gear shall be allowed on board any commercial recreational vessel except fins and masks.

7.4. Admission Fees

Admission to the Reserve shall be on payment of the following fees for tourists, Belizeans and commercial recreational vessels:

(a) Zone <u>A, B, C</u>	<u>Fee</u>
1. Tourist	\$Bz5.00/person/day
2. Belizean	\$Bz2.00/person/day
3. Commercial/Recreational Vessels	\$Bz10.00/vessel/annum
(b) Zone <u>D</u>	<u>Fee</u>
1. Tourists	\$Bz7.00/person/day
2. Belizeans	\$Bz1.00/person/day
3. Commercial/Recreational Vessels	\$Bz10.00/vessel/annum
(c) Zones <u>B & C (for sportfishing)</u>	<u>Fee</u>
1. Tourists	\$Bz5.00/person/day
2. Belizeans	\$Bz2.50/person/day
3. Commercial/Recreational Vessels	\$Bz10.00/vessel/annum

No fees shall be charged:

- (a) To any child below the age of twelve years;
- (b) To Belizeans who enter the Reserve on Sundays, unless that day falls on a Public or Bank holiday, in which case the normal fees shall be charged.

8. ENFORCEMENT AND SURVEILLANCE

The surveillance of the reserve and the enforcement of its regulations is chiefly the responsibility of the reserve rangers and manager. It is extremely important that the reserve regulations be strictly enforced at all times. At the same time it is also equally important that the users of the resource are well informed about the rules and regulations of the reserve. This program should include the following:

- Regular patrols in Zone B and C to deter any illegal fishing activities. Patrols to these areas could be done in the mornings just before the reserve opens and in the evenings after the reserve closes. “Spot” checks at night to Hol Chan cut and Shark and Ray Alley could be carried out jointly with the San Pedro Police patrols. It is extremely important that the reserve regulations be strictly enforced at the outset.
- Since Zone A and D are the most heavily used areas, it is important that the patrol boat remain between these two zones, collecting tickets and making sure that the rules governing these two zones are enforced. Underwater “spot” checks could be conducted to ensure that tour guides and tourists alike are not trampling on the corals or removing any flora or fauna from the reserve.
- It is also important that education or explaining the rules of the reserve to the various users should accompany any enforcement action. For example, the rangers could spend time explaining the rules of the reserve to the tourists during the purchase of tickets and issue handouts and brochures that further explains the rules of the reserve.
- The tourist guides can also do their part by being vigilant and explaining the rules to their clients. To enhance this aspect, the rangers and the

environmental educator could organize a “patrol” week where the dive shops are visited and the rules and rationale of the reserve are explained to the guides. This program could be organized through the San Pedro Tour Guide Association and the Hotel Association.

9. RESEARCH AND MONITORING

The staff biologist will be chiefly responsible for implementing the research and monitoring program. The major goal of the program is to provide information necessary for the management and sustainable use of the resource. As described in Section 5, a substantial amount of monitoring and research work has been carried out at the reserve, as well as comparative studies at Mexico Rocks and Rocky Pt. However, no long-term studies have been done to assess the true success of the reserve. These studies need to be carried out over longer periods and the data monitoring techniques need to be standardized and consistent to allow for comparisons.

As mention in Section 13, the reserve needs a small laboratory to increase its capacity to conduct research and monitoring over a long-term basis. It is also important that the reserve formalize partnerships with academia and other research institutions to help implement the monitoring and research programs. Interns from the San Pedro High School could assist the biologists in the collection of data. Visiting scientists could conduct research that is pertinent to the basic needs of the reserve.

Research projects should be ranked in order of priority in order to encourage and facilitate research within the reserve. The findings from such research should be disseminated to the public through slide shows, booklets, or talks to the local high school.

The research and monitoring program should focus on the following studies:

9.1. Physical and Chemical Studies

- (a) Water quality monitoring of temperature, salinity, pH, turbidity and nutrients (N, P) should continue to be monitored on a daily basis at

permanent stations inside the reserve and along the coast of San Pedro Town.

Measurements on turbidity and nutrients should be closely monitored to determine any point sources of pollution caused by land-use activities on the caye.

This program could also address some of basic public health issues such as the swimming area in front of the Town. Such a program had already been proposed to the Town Board for funding. The San Pedro Environmental Committee (SPEC) could continue to pursue this avenue with the Town Board, HCMR and the Public Health Office.

- (b) Sedimentation rate should continue to be measured to evaluate the long-term effects of snorkellers and divers on the amount of sediment settling on the corals. Sediment traps should be re-deployed in areas of high visitor use such as the Hol Chan cut.

9.2. Biological Studies

- (a) Primary productivity in mangroves, seagrass and coral reefs are essential in determining the overall health of the ecosystem. The regional CARICOMP program should continue to be used to evaluate the productivity of the reserve. Mangrove stations should also be established at Cayo Congrego, just south of the reserve.
- (b) An inventory of the biodiversity of the reserve should be conducted to update the existing species list for the reserve.
- (c) Stationary visual census for quantitatively assessing community structure of coral reef fishes should continue to evaluate the effects of protected status on fish populations inside and outside the reserve. Comparative studies should continue at Mexico's Rocks, Tres Cocos and Rocky Pt.

- (d) Benthic coral transects to quantitatively assess the community structure of coral reefs should continue using the regional AGRA CPAAC program. Such studies could continue to provide the basic quantitative measures for assessing any changes in coral cover over time or differences in coral cover between and among reef communities. Comparative studies should continue to be done at Mexico's Rocks and Rocky Pt.
- (e) Swimming strip-transects for estimating conch and lobster densities and population structure should continue to evaluate the effects of protected status on conch and lobster populations inside and outside the reserve. Comparative studies should continue at Mexico's Rock and Rocky Pt.
- (f) Tagging of lobster and conch to determine population distribution, migration patterns, and breeding and feeding behaviors should continue to help identify critical breeding and feeding grounds within and without the reserve.
- (g) Post-larval recruit studies using the "Witham" surface collectors should continue to be used to evaluate the importance of the area as a nursery ground for commercially important species such as lobster, conch, snappers and groupers.
- (h) Coral recruitment studies could provide insight into the success of the reef in recruiting new corals to the reef.
- (i) Keystone species such as the black sea urchin (*Diadema*) should continue to be monitored using the swimming strip transect. Populations are reportedly beginning to recover from the mass mortality of the early 1980s.

- (j) Diseases such as Black Band Disease that attack and kill corals should continue to be closely monitored, particularly in the heavily used areas around Hol Chan cut. A remedial plan should also be in place to treat this disease before it spreads to other pristine areas of the reef.
- (k) The conch population at the reserve mysteriously “died” off in the early 1990s. This should be investigated further.
- (l) The bleaching of corals should continue to be closely monitored, as this phenomenon is an indication that the reef is under some form of stress. Bleached corals could be marked and monitored over time to determine the rate of recovery.

9.3. Socio-economic Studies

- (a) Similar surveys to evaluate the attitudes and behavior of tourists and residents towards the reserve should continue. Such studies could help determine the effectiveness of the reserve in managing the resource.
- (b) Studies to monitor the effects of visitor use by recording the number of corals with fin marks should continue to help quantify the negative impacts of visitors on the reef. Comparative study could be done between the highly used Hol Chan cut and another less heavily used area such as Mexico Rocks. Based on the Limits of Acceptable Change, fin marks could be used to quantify the negative impacts of visitors on the resource.
- (c) The collection of data on fish, conch and lobster catch from fishermen using Zone B and D of the reserve and other areas adjacent to

the reserve should continue. The catch and effort data could be used to determine the amount of revenue generated from fishing inside and adjacent to the reserve.

9.4. Climatic Studies

- (a)** Monitor sea level rise using the Caribbean Planning Adaptation for Climatic Change Methodologies.
- (b)** Collect meteorological data on rainfall, temperature, wind speed and wind direction, relative humidity, and barometric pressure.

10. INTERPRETATION AND EDUCATION

The environmental educator will be chiefly responsible for implementing the interpretation and educational program. The major goal of the program is to increase environmental awareness and strengthen local capacity to assist in the long-term protection of the reserve. As mentioned in Section 5, the reserve have conducted numerous educational programs and created a number of interpretive materials for dissemination to the public. However, more emphasis needs to be placed on education.

This program should include the following aspects:

10.1. Museum and Resource Center

The visitor center needs upgrading into a marine museum and resource center for visitors and students alike. A large mural depicting the various zones of the barrier reef can be mounted for display. Several large 55-gallon aquariums could also be mounted for display. The library needs more resource material and better displays on corals. A concerted effort must be made to collate all studies done on the reserve for display on the library.

A GIS-produced habitat map of the reserve could be mounted on the wall together with a brief description of each habitat and its importance. Such a map is available at the CZMP Office in Belize City. Poster presentations on visitation and findings from the research and monitoring program could be mounted.

10.2. Interpretive Materials

- (a) Several large signs depicting the zones of the reserve and the rules and regulations that govern each could be mounted at the park in San

Pedro Town and in Caye Caulker Village. The San Pedro Town Board had express interest in permitting such a sign at the town's park. The sign at Caye Caulker could be done jointly with the CCVC and Siwa-ban Foundation.

- (b) A color brochure on the HCMR has been completed. IUCN/Mesoamerica funded this. However, additional leaflets on the “Do’s and Don’ts” of the reserve, “reef etiquette” and “water safety” could complement the information given in the brochure. Such leaflets have already been developed and just need to be photocopied.
- (c) A laminated zoning map of the reserve could be made and distributed to the tourist guides for their use when giving orientation to the guests. The regulations could be printed at the back of the map. This could be carry out jointly with the SPTGA and HCMR.
- (d) Murals depicting the various zones and habitats found at Hol Chan could be mounted at the San Pedro Airport and at the Tourism Center in Caye Caulker. One San Pedro airline has expressed interest in placing a mural at the airport. The mural could have a general description of each habitat type and the importance or environmental service it provides to us.
- (e) The Hol Chan poster and field guide to the corals and common fish of the reserve should be re-printed for sale.
- (f) Prepare poster presentations on visitation and findings from the research and monitoring programs for display in the museum and local and national events.

- (g) A guidebook to this and other marine reserve areas in Belize could be planned for the future. There are currently 11 marine protected areas along the reefs of Belize.
- (h) Reprint the OTAPS/Peace Corps funded booklet “Welcome to the Underworld: An Introduction to the Marine Life of Belize” for distribution to the secondary schools. This booklet is a collection of “Conservation Corner” articles with illustrations and study questions.
- (i) Reprint the CDU’s Marine Conservation Manual for distribution to the primary schools.

10.3. Education and Community Outreach

- (a) Hold an annual conservation seminar for tour guides from San Pedro and Caye Caulker to familiarize them with the marine reserve and in particular with its rules and regulations. This seminar could take place in late September just before the tourist season starts. These seminars could also serve as a forum for discussing potential conflicts among the various users of Hol Chan cut and Shark and Ray Alley and ways to resolve these conflicts.
- (b) Hold marine ecology lectures/slide shows for tour guides who are interested in learning more about marine ecology, coral and fish identification, natural history, and mangrove ecology. This could be organized through the SPTGA.
- (c) Hold special workshops for sportfishing guides and fishermen who are interested in becoming fishing guides. These workshops could serve as a forum for developing guidelines on catch and release. This could be organized through the Caribeña Cooperatives.

- (d) Continue the weekly marine biology classes at the San Pedro High School. The existing syllabus should continue to be used as well. Field trips should also be encouraged.
- (e) Hold summer teacher workshops for primary and high school teachers in San Pedro and Caye Caulker. This could be organized through the Ministry of Education's CDU.
- (f) Continue to organize educational field trips for the primary schools in San Pedro.
- (g) Continue the weekly article in the Conservation Corner of the local newspaper (San Pedro Sun). This could generate healthy discussions about environmental issues facing the island.
- (h) Continue to mount displays at international and national events such as International Year of the Reef, Earth Day, and the National Agriculture and Trade Show.
- (i) Continue to organize beach patrols to protect the sea turtle beach on Ambergris Caye. This should continue with BAS.
- (j) Continue to organize annual beach clean-ups with the schools, Natural Guard, Green Reef and the SPTGA.
- (k) Produce a quarterly newsletter. This could be done jointly with the SPTGA.

11. ENVIRONMENTAL MANAGEMENT

The reserve manager will be chiefly responsible for implementing the environmental management plan. The major goal of the plan is to identify and address any environmental issues that may jeopardize the integrity of the reserve. The Hol Chan Advisory Committee should continue to serve as a forum for addressing these issues. From past experiences, it is usually helpful to solicit the aid of the local community, as this is fundamental to the success of the program. Decisions should continue to rest with the Fisheries Department.

The reserve has made great strides in restoring the natural beauty of its marine life. By prohibiting fishing in Zone A, the larger herbivores, such as parrotfish, have return to the reef. Larger predators, such as groupers and snappers, abound in Zone A. Preliminary studies have shown a “spill-over” effect of catch in areas adjacent to Zone A. Fishermen have also reported increases in catch in areas adjacent to the reserve (see Section 5). The reserve’s success in preserving a representative sample of the coral reef has been well demonstrated; however, the very people who go there to view and enjoy the marine life are now threatening this very beauty and complexity.

Studies done at the Hol Chan cut showed a high number of fins marks on living corals. Other studies have also shown an increase in the occurrence of diseases such as Black Band Disease, in areas of high visitor use. The Hol Chan cut alone receives over 22,000 snorkellers each year and these figures are expected to increase with the rise in tourist arrivals to San Pedro and Caye Caulker in the near future. In order to minimize the environmental impact to the coral reef environment, visitor use at the reserve needs to be carefully regulated and measures taken for the recovery of damaged resources.

This program should focus on the following aspects:

- Limit the number of snorkellers to the Hol Chan cut by using Shark and Ray Alley as a “spill-over” area for snorkellers. The carrying capacity for snorkellers at the Hol Chan cut needs to be determined before any limits are put into place. The HCMR Advisory Committee should participate in this process.
- Conduct more vigilant “underwater” patrols to deter visitors from damaging the reef. Often snorkellers are not well informed about the sensitivity of the coral reef environment and the rationale for not touching or breaking the reef. Fines should be levied upon the guides whose guests are found touching or breaking the reef.
- Limit scuba diving in the Hol Chan cut, especially when there is a strong current flowing through the channel. Both guides and divers have the tendency to cling to the corals to help slow them down. This practice should be banned in the reserve. Similar fines should be levied on the guides who are caught holding on to the reef.
- Even though Shark and Ray Alley should serve as a “spill-over” to the Hol Chan cut, carrying capacity should also be determined at this site to regulate visitor interactions with the nurse sharks and stingrays.
- Create an artificial reef for snorkellers at Zone D by deploying several “reef balls” in the Exclusive Recreational Zone. This new site could eventually serve as another “spill-over” area for the Hol Chan cut. This project could be organized jointly with the SPTGA “Reef Ball” Project.
- Continue the reef-mooring program by installing moorings where necessary. Several of the dive sites inside the reserve currently need moorings.

- Close Zone A and D (excluding Shark and Ray Alley) to visitors during a bleaching event or an outbreak of Black Band Disease. These usually indicate that the reef is under severe stress and therefore needs time to recover.

12. RECREATION & TOURISM MANAGEMENT

As detailed in Section 5, the principal tourism products offered by the HCMR include snorkeling, diving and swimming with nurse sharks and stingrays. Snorkeling is the most popular recreational activities among tourists, accounting for over 60% of all visitors to the reserve. Snorkeling occurs at the Hol Chan cut, a small break in the reef and since this is the only available site for “good” snorkeling, this have sometimes lead to over-crowding and conflicts between tourists and tour guides. The Hol Chan channel is also heavily visited by divers and is probably the most popular dive spot in the reserve.

Apart from this channel, diving also occur at 6 other locations along the 2 mile stretch of fore-reef. These sites includes: pillar coral dive site; eagle ray canyon; a site in front of the Hol Chan channel; sandbore dive site; amigos wreck; and another site between the sandbore and amigos wreck. The relatively few number of dives sites in relation to the large numbers of divers, have sometimes led to over-crowding, user conflicts between operators, and environmental degradation.

Conflicts also occur between commercial fishermen in Zone D who sometimes have difficulty determining the boundaries of the Exclusive Recreational Zone from the General Use Zone. User conflicts within Zone D are especially difficult to control because the “exclusive recreational area” of Shark Ray Alley is not clearly defined or demarcated, making it difficult for commercial fishermen to determine where fishing is not allowed.

As the tourism industry continues to grow, these sites will continue to attract more visitors to the reserve, leading to over-crowding and environmental degradation. Management measures that may help to reduce user conflicts at these sites may include:

12.1. Habitat Expansion

Zone A

The first would be to increase the size of zone A by extending its northern boundary along the reef to the San Pedro cut, thus incorporating an additional 15 dive sites. Since these sites are not protected, fish attracted to the moorings are continuously being removed by the commercial and sportfishermen. It is for this reason that the majority of dive guides prefer to take their guests to the reserve.

This site has been in consideration for protection since the early 1980s and again in 2000. By protecting this area against commercial fishing, the following two-prong effect will result:

- (i) the larger herbivore and predatory fishes will return to the reef, thus restoring the natural ecological balance of the area.
- (ii) there would be more sites for divers to choose from, thus reducing the over-crowding of divers to the reserve.

Zone C

The second would be to increase the size of Zone C by extending the southern boundary to include a series of mangrove cayes and “flats”. This area supports a thriving population of sportfishes, including bonefish, tarpon and Crevalle Jack. According to the fishing guides, the major threat to this resource includes unregulated fishing practices and the destruction of the mangrove habitat for tourism development.

Although this area was never considered for protection, the SPTGA feels

that it is time for this area to be incorporated into the boundaries of the reserve. By regulating fishing and protecting the mangroves in this area, the following three-prong effect will result:

- (i) larval recruitment of all species, including those of economic importance, will be enhanced in areas adjacent to the reserve;
- (ii) a nursery area for the reef organisms in Zone D will be provided
- (iii) revenues from sport fishing activities will increase
- (iv) an alternative site will be provided for sport fishermen currently using the reef in front of San Pedro.

12.2. Habitat Enhancement

FAD

Fish attracting devices (FAD) have been known to attract fish and other marine life in areas where fish would not normally congregate. In Hawaii, for example, FADs placed in very deep waters off the reef have attracted large numbers of jacks, snappers, mackerel, dolphin fish, marlins, and sharks. Commercial fishermen and fishing guides have reported increases in catches in areas where FADs are found.

The San Pedro Tour Guide Association (SPTGA) has embarked on a similar program to deploy several FADs in about 3,000 feet of water off the island. Once deployed, the SPTGA plans to encourage fishermen and fishing guides to use these areas so as to relieve fishing pressure off the main reef. The reserve should encourage the SPTGA to deploy these devices in the General Use Area of Zone D.

Artificial Reefs

Like FADs, artificial reefs are known to attract fish, coral, plants and other marine creatures. Everything from old tires, vehicles, and ships have been used to create artificial reefs; however, they all have their drawbacks - tires break loose and metal rusts. A promising new way of creating reefs involves the use of concrete dome structures called “reef balls”. These concrete structures are now being used in Florida and parts of the Caribbean to help damaged or dead reefs recover.

The SPTGA has embarked on a Reef Enhancement Project using the 40 concrete “reef balls” to create an artificial reef on western Ambergris at Slackchwe. Once deployed, the SPTGA plans to use this site during unfavorable weather conditions on the east side of the island.

Since the molding for the “reef balls” are available in San Pedro, the reserve should embark on a similar program to create an artificial reef in the Exclusive Recreational Area in Zone D.

12.3. Alternative Sites

Mexico Rocks, Dos Cocos, Tuffy & Coral Forest

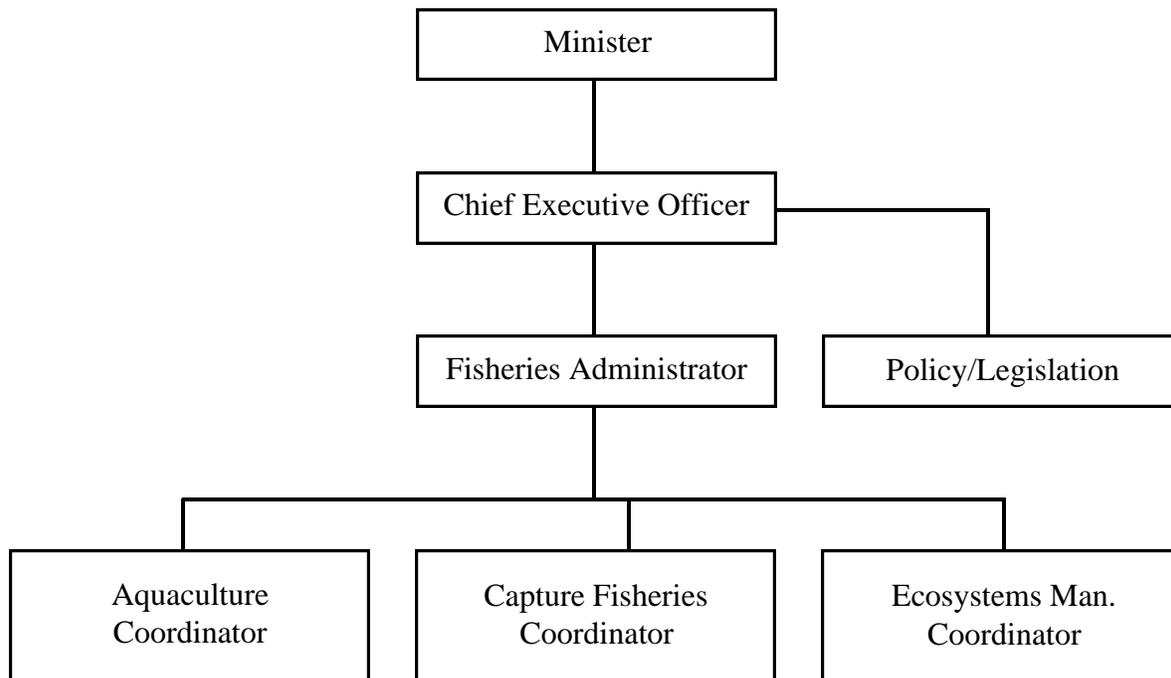
Mexico Rocks has been considered for protection since the early 1990s. In fact, the HCMR was very instrumental in conducting several studies and drafting a management plan for this area. This unique patch reef is said to have a higher coral diversity than Hol Chan. Mexico Rocks, together with Dos Cocos, Tuffy and Coral Forest should all be declared as marine reserves. Management of these sites should be carried out by the SPTGA and the HCMR. The Hol Chan Advisory Committee for implementation by the SPTGA and HCMR could develop a Voluntary Protection and Enforcement Program.

13. ADMINISTRATION AND MAINTENANCE

13.1. Organizational Structure

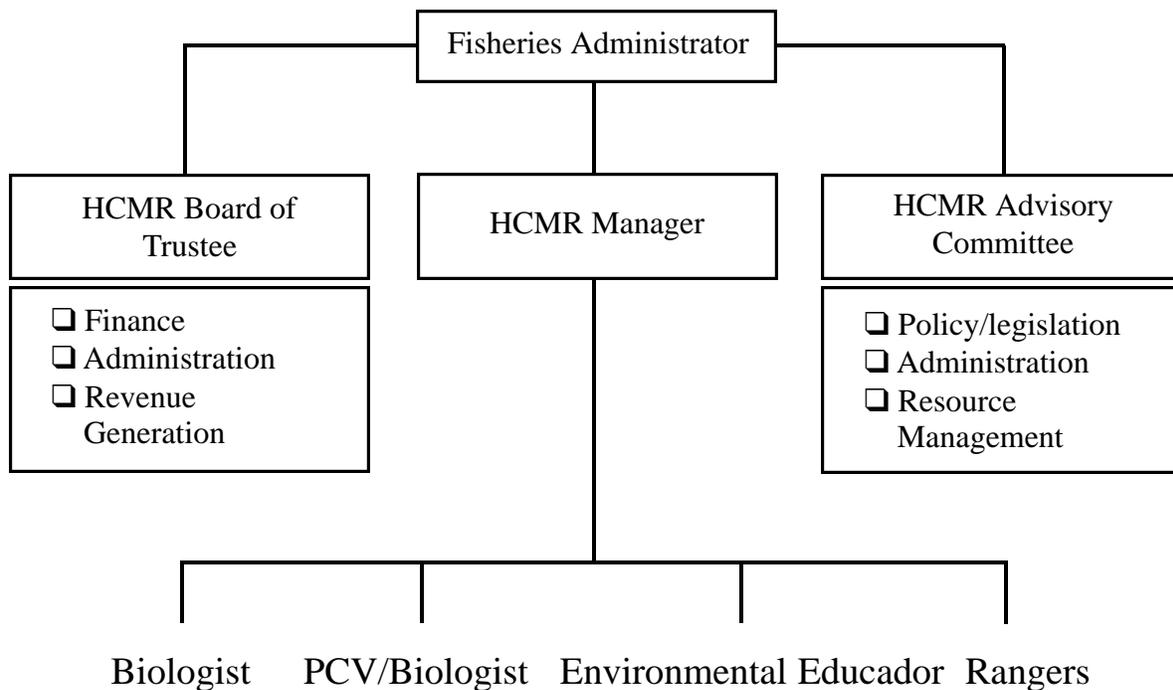
The administration of the HCMR is carried out by the Fisheries Department, under the Ministry of Agriculture, Fisheries and Cooperatives. Policies and laws governing the reserve are concentrated at the Ministerial level while the implementation of the management plan is concentrated at the departmental level. A Board of Trustees comprising of 9 members from the private and public sectors manages the financial affairs of the reserve. On-site a reserve staff that is responsible for the day-to-day management of the reserve carries out further management.

Figure 6: Institutional Structure for the Fisheries Department



A major constraint to the existing administrative structure is the lack of community participation at the local level. The appointment of an Advisory Committee could serve as an effective management strategy for incorporating the local community in the integrated management and protection of the reserve. The Minister responsible Fisheries shall appoint members from the community to advise the Fisheries Administrator in the administration of the reserve. The Committee will be responsible for ensuring that the management plan is implemented.

Figure 7: Proposed Structure for the Administrator of HCMR



Committee Members

The Board shall consist of the following representatives from the community and the GOB.

1. Green Reef
2. San Pedro Tour Guide Association

3. Caribena Cooperatives
4. San Pedro High School
5. Hotel Association
6. San Pedro Environmental Committee
7. Primary School
8. Town Board
9. HCMR
10. Fisheries Department
11. HCMR Board of Trustees

General Terms of Reference

1. Evaluate the management programs as described in the Management Plan and make recommendations for improvements. Where necessary, assist the reserve staff with administrative matters, publicity campaigns, enforcement, education and community outreach and research and monitoring.
2. Assist the HCMR Board in the development of sustainable financing mechanisms.
3. Report on environmental matters affecting the integrity of the reserve and make recommendations for actions to be taken for the recovery of the resources.
4. Ensure that the community has continued input in the running of the reserve.

13.2. Staffing

The reserve staff comprises of one manager, one Peace Corps Volunteer

biologist, two rangers, and one technician. There are currently two vacant positions, one for a local biologist and the other a secretary. The overall staff turnover is high, particularly for the biologist post and PCV counterparts. The reserve has changed 4 local biologists and 3 PCV in 12 years, creating discontinuity with the research and monitoring programs.

Below is recommended staffing for the reserve.

(a) Reserve Manager (1)

(i) Requirements

The minimum requirements for this position are an Associate Degree in Business Administration. and a minor in Computer Science.

(ii) Roles and Responsibilities

1. To implement and update the management plan.
2. To update and implement the recreation and tourism program.
3. To undertake field operations including enforcement and maintenance.
4. To guide the other staff in their duties.
6. To handle all monies and keep accounts for the reserve.
7. To write grants
8. Submit quarterly financial reports to the Fisheries Administrator and Board of Trustees.
9. Submit bi-annual technical reports to the Fisheries Department and the Advisory Committee.

(b) Reserve Biologist (1)

(i) Requirements

The minimum requirements for this position are 2 advanced levels, one in biology and one other subject, preferably chemistry or an Associate Degree in Natural Resource Management from the University of Belize.

(ii) Duties and Responsibilities

1. To carry out research and monitoring.
2. To update and implement the resource management program.
3. To update and implement the environmental management program
4. To synthesize data and generate reports on a bi-annual basis.
5. To work as counterpart to Peace Corps Volunteer.
6. To maintain and service the lab and its research equipment.

(c) Reserve Rangers (2)

(i) Requirements

The minimum requirements for this position are 2 “0” levels or CXE’s in English and Math; or 10 years working experience as a fisherman or SCUBA diver. One of the reserve rangers shall be recruited from San Pedro. They shall be appointed as Fisheries Officers under section 4 of the Fisheries Ordinance.

(ii) Duties and Responsibilities

1. To enforce the rules of the reserve and make arrests when necessary.
2. To conduct daily patrols and monitor all activities within the reserve.

3. To maintain and service field equipment.
4. To keep daily records of visitors and fishermen using the reserve.
5. To keep daily account of ticket sales at the reserve.

(d) Environmental Educator (1)

(i) Requirements

The minimum requirements for this position are an Associate Degree in Natural Resource Management from the University of Belize or a Trained Teacher's Certificate.

(ii) Duties and Responsibilities

1. To conduct educational and training workshops for the various users of the reserve.
2. To update and implement the educational and community outreach program.
3. To maintain the visitor center
4. To produce a newsletter and other interpretive materials.
5. To disseminate information to visitors and students
6. To liaise between the HCMR and the public on matters relating to the reserve.

(f) Peace Corps Volunteers (1)

(i) Requirements

The minimum requirement for this position is a B.Sc. in biology/marine science.

(ii) Roles and Responsibilities

1. To conduct research and monitoring.
2. To conduct environmental education and outreach programs.
3. Serve as counterpart to the local biologist and environmental educator.
4. Assist in grant writing.

13.3. Training

The majority of the staff has been on a number of training programs both in Belize and abroad. All are certified scuba divers, with one diving instructor. The rangers have undergone police training as well. The senior ranger recently attended an Environmental Enforcement workshop in Costa Rica. The manager has attended a number of conferences on coral reefs and protected areas management. It is important that the staff continues to take advantage of these training programs to continue to enhance their capacity to efficiently manage the reserve.

Since the manager will spend more time managing the affairs of the reserve, he/she should take advantage of courses on grant writing and administration. The manager also should become a certified diving instructor. Other staff members could then receive advanced courses up to dive master level. The manager should also continue to take advantage of other workshops and training seminars on coral reefs.

The biologist will require training in the methodologies used to quantitatively assess the general health and status of the coral reef environment. The biologist should learn the AGRA method for monitoring coral reefs, the visual census method for assessing reefs fish populations and the belt transects for assessing conch and lobster populations. The biologist should also undergo training in other regional monitoring programs such as the

CARICOMP method. The biologist should also undergo training in environmental management and other regional workshops on coral reefs.

The environmental educator should undergo training in interpretive techniques for relating information to the visitors and community. The educator should also take advantage of public relations courses and any regional workshops on environmental education.

13.4. Infrastructure

In January 1998, the Trust Fund Committee secured a loan from the Belize Bank and purchased the Caribena Cooperative's building to house the HCMR office. The lower flat of the building serves as the office and visitor's center, while the upper flat has several apartments for rent or lease. The storeroom is located behind the visitor center. There is a small dock next to the Texaco gas station where the boats are moored.

The dock should be extended a couple of feet to build a small shed at the end of the dock. This shed could serve as the storeroom to house the fuel and other field equipment. The existing storeroom could then be used to house a small dry lab/office for the biologists.

The visitor center should be developed into a marine museum and resource center for visitors and students alike. A large mural depicting the various zones of the barrier reef could be constructed for display. Several large 55-gallon aquariums could also be on display. The library needs more resource material and the coral display needs more corals.

A large wooden sign facing Caribena Street should be erected above the office. In addition, directional signs can be placed at the junction of Barrier Reef Drive and Caribena Street encouraging tourists and Belizeans to visit the office.

13.5. Financial Statement (ending Dec, 1999)

(a) Income and Expenditure

Revenues generated for the HCMR comes primarily from the sale of tickets, though a small portion also come from boat registration, apartment rental and from grants and donations. Revenues generated over the last 5 years of the reserve's operations have amounted to \$BZ984, 672 (Zelaya, 1999). For the first four years the monies collected from the sale of tickets were placed in a bank savings account. Since then the reserve has been covering its operational or overhead expenses but not many funds remain for large purchases such as field and lab equipment, engine replacement and other capital expenses. The lack of sufficient funds to make large purchases has decreased the capacity of the reserve staff to manage the resources.

Figure 8: Annual Income & Expenditure (1995 - 1999)

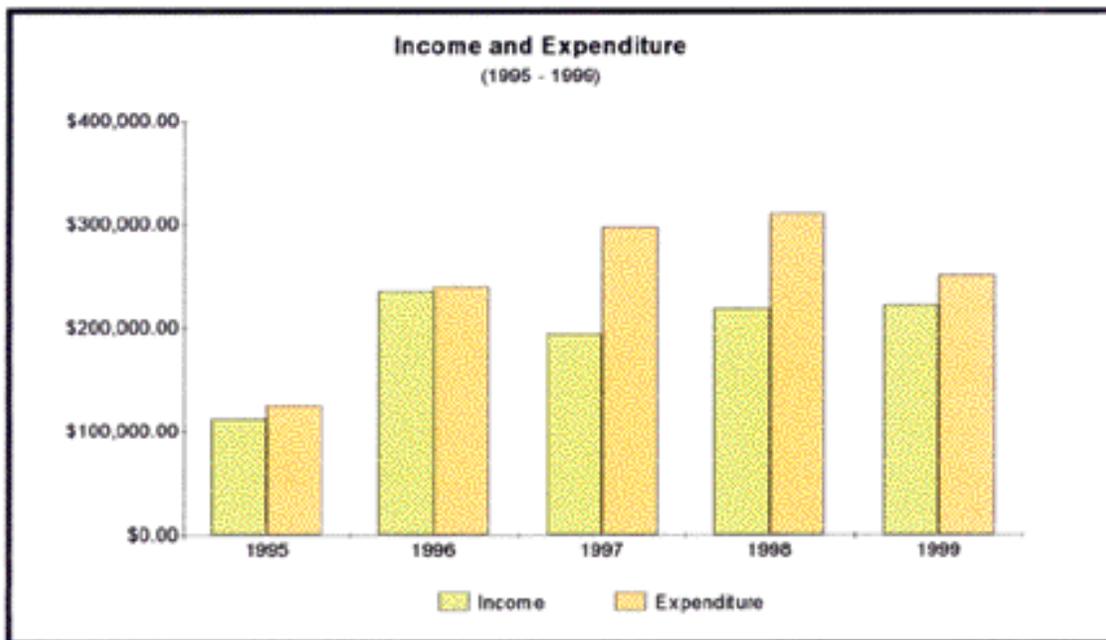


Table 2: Balance Sheet (1998 & 1999) (\$Bz)

(b) Balance Sheet

	1999	1998
Fixed Assets	346,510	365,986
Current Assets		
Cash and Bank Balance	145,945	132,788
Accounts receivable and prepayments	7,229	7,229
Total	153,174	140,017
Total Assets	499,684	506,003
Current Liabilities		
Accounts Payable and Accruals	71,864	49,208
Bank Overdraft	9,839	8,779
Total	81,703	57,987
Long Term Liabilities		
Loan	184,187	185,000
Total Liabilities	265,890	242,987
Net Assets	233,794	263,016
Accumulated Fund	233,794	263,016

13.6. Budget

Table 3: Projected Expenditure (FY 2000)

(a) Salaries

1 Park Manager	\$ 21,744.00	
1 Park Biologist	16,368.00	
2 Park Rangers	30,624.00	
1 Technician	15,924.00	
1 Secretary	10,464.00	
Subtotal		\$95,142.00

(b) Social Security

\$6.50/mth x 6	\$ 2,808.00	
Subtotal		\$2,808.00

(c) Living Allowance 20% of salary

1 Park Biologist	\$ 3,396.00	
2 Park Ranger	4,680.00	
Subtotal		\$8,076.00

(d) Rental & Utilities

Mortgage payment \$2526.18/mth/12mth	\$ 30,314.16	
Telephone \$700/mth/12mth	8,400.00	
Electricity \$550/mth/12mth	6,600.00	
Subtotal		\$40,514.16

(e) **Office Equipment**

Paper/manila envelope/folder \$200/mth/12mth	\$	2,400.00
Computer upgrade		3,000.00
Printer ink 6 * \$150		900.00
Journals/magazines 12 mths * \$50.00		600.00
Subtotal		\$6,900.00

(f) **Fuel**

Gasoline 30gals/day/365 * \$2.50/gal	\$	27,375.00
Lube 6qrts/day/365 * \$5.00 qrt		10,950.00
Subtotal		\$38,325.00

(g) **Maintenance & Equipment**

Replacement of buoys 600ft rope * \$1.25/ft	\$	750.00
Lanchoncito boat repair		755.00
19 footer boat repair		800.00
Engine repair		500.00
Uniforms 20prs * \$70.00		1,400.00
1 200Hp Yamaha outboard		14,000.00
Subtotal		\$16,805.00

(h) **Education & Travel**

Brochures	\$	2,000.00
Films 20rls * \$15/\$30 developing		900.00
Extensions/workshops 7schools/2 persons/ airfare 4 trips * \$77.00		208.00
Accommodations 6 days * \$100		600.00

im 12 days * \$60.00	720.00
Training 3 trips on coral reefs	9,000.00
6 workshops * \$200.00	1,200.00
Travel (local) 20trips airfare * \$77	1,540.00
per diems (60) * \$30.00	1,800.00
Accommodations 20 * \$50.00	1,000.00
Committee meetings 4/3 airfare	
12 * \$77	924.00
hotel 12 * \$90	1,080.00
catering 4 * \$200	800.00
Subtotal	\$ 21,772.00
Grand Total	\$230,324.16

13.7. Other Management Considerations

The reserve should forge closer relationships with local NGOs through the establishment of co-management agreements. These agreements could create a vehicle to channel financial support to existing marine conservation efforts and needs at the reserve and other areas. The SPTGA and Green Reef are two local NGOs that have been actively involved in marine conservation and management in San Pedro through a number of community projects.

San Pedro Tour Guide Association

The San Pedro Tour Guide Association is the oldest, largest, and most powerful professional guide association in Belize. Established in 1986, when there were only a few dozen full-time guides in San Pedro, the San Pedro Tour Guide Association now has a membership that includes almost 200 of the 250 licensed guides on the island (Mascia, 2000). The power lost by the fisheries cooperatives has largely been transferred to the association.

This association actively promotes the interests of its members in discussions with government, especially with respect to issues concerning marine resource governance (i.e., conservation) and licensing standards for individuals whose occupation is marine tourism.

Green Reef

San Pedro became home to its first conservation NGO in 1997. Unlike other NGO efforts in Belize, Green Reef is the product of the local community. Green Reef's primary interest is conservation of the marine environment, though it has interpreted this mandate broadly and has recently been delgated responsibility for the management of two small bird sanctuaries from the BAS. It has recently been given financial support from PACT and international (CZMP) donors and technical support/human resources assistance from the United States (Peace Corps Volunteer).

14. FINANCIAL SUSTAINABILITY PLAN

Recreational visits to the HCMR are an important and valuable component of the tourism industry in San Pedro. The reef at the Hol Chan cut attracts over 30,000 visitors each year, demanding services such as hotels, restaurants, dive shops, boat rentals, tours, and laundry. The demand for these services are fueled by the natural attraction of the reef; however, if proper conservation measures are not put into place, the reef and its adjacent habitats may continue to deteriorate (Bonilla & Córdoba, 2000).

As the number of visitors to the reserve increase, the level of deterioration will also increase if the level of protection and regulation remains the same. It is therefore very important for the reserve to increase its enforcement and surveillance activities, increase the size of the reserve boundaries and staffing, and expand the education and research programs (as described in the previous sections).

Increasing the level of protection will also increase the cost for managing the reserve. The cost of managing the reserve over the last 5 years exceeded the income generated from the sale of tickets (see section 13). One way of generating more revenues for the reserve is to increase the entrance fees. A study conducted by Bonilla show that by raising the entrance fee to a level between \$US7.50 to \$US10.00 should not deter any significant amount of visitors from going to the reserve while dramatically increasing revenues (Bonilla & Córdoba, 2000).

A new fee structure for the reserve was implemented in September 1999; however, it has not come into effect as yet. It includes an additional \$BZ7.00 to enter Zone D (Shark and Ray Alley). The transaction costs of charging separately could be large, vis-a-vis the willingness to pay to visit both zones. Thus, a single-payment for both areas could be the best way to

proceed, simplifying things for tourists, guides and the reserve administration (Bonilla & Cordoba, 2000).

Another way of increasing revenues for the reserve is to increase the size of the reserve to include the reef in front of San Pedro Town and the bonefish “flats” next to Zone C. This size increase would also reduce user-conflicts at the other heavily used sites as well as decreasing the environmental damage caused by overcrowding.

Alternative source of revenues could also come from the following sources:

(a) Central Government

Since the GOB is benefiting from the foreign exchange generated from tourism that is fueled mainly by the natural beauty of the reef, the reserve administrative and operational costs should be subsidized by central government.

(b) San Pedro Town Board

The San Pedro Town Board also has a stake in maintaining the reef in a pristine state and therefore should subsidize the management of the reserve.

(c) Local Businesses

The reserve should embark on a massive membership drive to raise funds from the local businesses to help manage the reserve. This could possibly be done through an association such as the “Friends of HCMR”.

(d) Local NGOs

The reserve should forge closer relationships with local NGOs through the establishment of co-management agreements. These agreements could create a vehicle to channel financial support to existing marine conservation efforts and needs at the reserve and other areas. The SPTGA and Green Reef are two local NGOs that have been actively involved in marine conservation and management in San Pedro through a number of community projects.

(e) Foreign Donor Agencies

The reserve should continue to seek funding from foreign donors and corporations to support the various resource and environmental programs.

15. REFERENCES

Azueta, James, et. al. December 12, 1991. Conch Die-off in the Hol Chan Marine Reserve. Draft Report. Presented to the Fisheries Department.

Baker, Pamela Barrick. 1992. Effects of the Hol Chan Marine Reserve (Belize) on Associated Coral Reef Finfish Populations. A Thesis in Partial Fulfillment of the Requirements for the Degree of Masters of Arts in Marine Affairs. University of Rhode Island.

Beardsley, Kate. Spring, 1996. Feeding Frenzy. An Impact Analysis of Recreational activities on Shark Ray Alley. School for International Training. College Semester Abroad.

Bonilla, Jaime and, Cynthia Córdoba. 2000. Assessment of Tourism's Sustainability at the Hol Chan Marine Reserve and Rapid Economic Valuation of Environmental Services. Sustainable Marine Biodiversity Conservation: Linking Tourism to Marine and Coastal Protected Areas.

Borowitzka, M.A. 1981. Algae and grazing in coral reef ecosystems. *Endeavor*, 5:99-106.

Brock, R.E. 1979. An experimental study on the effects of grazing by parrotfishes and role of refuges in benthic community structure. *Marine Biology* 51, 381-388.

Carter, Jacque, Janet Gibson and James Azueta. 1994. Creation of the Hol Chan Marine Reserve in Belize: A Grass-Roots Approach to Barrier Reef Conservation.

Coastal Zone Management Act, 1998. S.I. No. 5 of 1998.

Dahl et al, 1974. A comparative study of coral reef research sites. *Atoll Res. Bull.* 172, 37-120.

Davis, Regina Marcel. Fall 1997. Fish Species Composition and Biological Diversity. A Comparative Analysis at Hol Chan Marine Reserve. 1988 - 1997. School for International Training. College Semester Abroad.

Ecotech Inc. Limited. Framework for a National Parks Commission. Final Report. Commissioned by the Caribbean Tourism Organization.

Fisheries (Hol Chan Marine Reserve) Order, 1987. Declaration of HCMR.

Fisheries (Hol Chan Marine Reserve) (Amendment) Order, 1999. S.I. No. 100 of 1999. Declaration of Zone D.

Fisheries (Hol Chan Marine Reserve) (Amendment) Regulations, 1999. S.I. No. 101 of 1999.

Gibson, Janet. Hol Chan Marine Reserve. Management Plan. April 1986.

Gulf of Mexico and South Atlantic Fishery Management Councils, April 1982. Fishery Management Plan Final Environmental Impact Statement For Coral and Coral Reefs.

Hol Chan Marine Reserve Regulations, 1988. S.I. No. 107 of 1988.

Hol Chan Marine Reserve (Amendment) Regulations, 1994. S.I. No. 170 of 1994. Establishment of Board of Trustees.

HCMR Six-month Progress Report. April 1989

HCMR Six-month Progress Report. October 1989.

HCMR Six-month Progress Report. April 1990

HCMR Six-month Progress Report. September 1991

HCMR Six-month Progress Report. March 1992.

HCMR Six-month Progress Report. October 1992

HCMR Six-month Progress Report. September 1993.

HCMR Annual Report. Jan-Dec, 1998.

James, N.P. and Ginsburg, R.N., 1979. *The Seaward Margin of Belize Barrier and Atoll Reefs*. Blackwell Scientific Publications

Lugo, A.E. and Snedaker, S.C., 1974. *The Ecology of Mangroves*. *Annual Review of Ecology and Systematics*, 5:39-64.

Mascia, Mike. 2000.

Mazzullo, S.J. and Reid II, A.M. 1985. *Field Trip Guidebook - Modern and Pleistocene Shelf Carbonates of Belize*. Permian Basin, Graduate Center, Midland, Texas.

Mcfield, M. 2000. *Evaluation of Management Effectiveness: Belize Marine Protected Areas System*. CZMA/I.

Miller, J.A. and Macintyre, I.G., 1977. *Field Guidebook to the Reefs of Belize*. 3rd International Symposium on Coral Reefs

Miller, Kenton R., 1978. *Planning National Parks for Ecodevelopment — Methods and Cases from Latin America*.

Peck, Alison. Spring, 1996. *A Survey of Caribbean Marine Flora*. School for International Training. College Semester Abroad.

Peckol, Paulette, et. al. July 14, 2000. *Assessment of the Condition of Forereef and Backreef Sites of Northern and South-Central Belize, Including Recovery from Bleaching and Hurricane Disturbances*. For AGRA Reports Volume. Atoll Research Bulletin.

Perkins, J.S., 1983. *The Belize Barrier Reef Ecosystem: An Assessment of its Resources, Conservation Status and Management*. New York Zoological Society

Polunin, Nicholas V.C., and Ivor D. Williams. 1999. *Ecological Impacts of Caribbean Marine Reserves*. Newcastle upon Tyne, Uk. Department of Marine Science and Coastal Management, University of Newcastle.

Polunin, M. 2000. Ecological and Social Impacts in Planning Caribbean Marine Reserves. Natural Resources Systems Programme Final Technical Report. London Department of International Development.

Roberts, CM (1995). Rapid Build-up of Fish Biomass in a Caribbean Marine Reserve. *Cons Biol*, 9: 815-826.

Robinson, Alan H. 1976. Recreation, Interpretation and Environmental Education in Marine Parks: Concepts, Planning, Techniques and Future Directions. IUCN Publication (n.s.) 37.

Salm, Rodney V. and Clark, John R., 1984 Marine and Coastal Protected Areas: A Guide for Planners and Managers. IUCN

San Pedro Tour Guide Association. Reef Enhancement Project - Slackchwe. Reef Ball.

Schmidt, Paul Joseph. May 1990. An Economic Evaluation of Tourism and Conservation: A Case Study of the Hol Chan Marine Reserve; San Pedro, Belize. A Thesis Presented to the Faculty of the Department of Economic and Business, the Colorado College, in partial fulfillment of the requirements for the Degree of Bachelor of Arts.

Sedberry, G, Carter J, Barrick, P (1992). The Effects of Fishing and Protective Management on Coral Reefs of Belize. In: Proceedings of the Gulf and Caribbean Fisheries Institute, No. 11. Merida, Mexico, pp. 1-25.

Wantland, K.F. and Pusey III, W.C. (eds.) 1975. Belize Shelf - Carbonate Sediments, Clastic Sediments, and Ecology. Amer. Assn. of Petrol. Geol, Studies in Geology No. 2.

Zelaya, 1999. Financial Report for the Hol Chan Marine Reserve, 1990-1999.

Appendix 1
HCMR Legislation

BELIZE:

**STATUTORY INSTRUMENT
N°. 57 of 1987**

*ORDER made by the Minister of Agriculture in Exercise of the powers conferred upon him by section 13A of the Fisheries Ordinance Chapter 174 of the Laws of the Belize 1980 (corresponding to Section 9A of the Chapter 133 of the Laws of the Belize 1958 edition) and all other powers thereunto him enabling.
(Gazetted 25th, July, 1987)*

- | | |
|--|---------------------------------|
| 1. This order may be cited as the
FISHERIES (HOL CHAN AREA MARINE RESERVE)
ORDER, 1987 | Short Title |
| 2. The area known as "Hol Chan Area", as more fully described in the Schedule hereto, is hereby declared to be a marine reserve for the Purposes of the Fisheries Ordinance. | Hol Chan Area
Marine Reserve |

MADE by the Minister of Agriculture this 20th day of July, 1987.

(DEAN R. LINDO)
Minister of Agriculture

SCHEDULE

Zone A

All that area comprising sea and reef on the South of Ambergris Caye containing about 2.73 sq. Kilometres and also described as the area enclosed by the lines joining the four points having grid coordinates N (1976 253.3 N, 396 509.6 E); K(1976 010 N, 398 100 E); L(1974 320 N, 397 610 E); M (1974 616.8 N, 396 064.4 E); L (1974 320 N, 397 610 E); M (1974 616.8 N, 396 064.4 E) Respectively.

Zone B

All that area comprising sea and reef on the South of Ambergris Caye containing 5.9 sq. Kilometres and also described as the area enclosed by the lines joining the 5 points having grid coordinates I (1976 375 N, 392 500 E), J (1976 775 N, 393 100 E); N (1976 253.3 N, 396 509.6 E); M (1974 616,8 N, 396 064.4 E); H (1976 375 N, 390 500 E) Respectively.

Zone C

All that area comprising land and sea containing 2.53 sq. Kilometres situate at the Southend of Ambergris Caye bounded on the North, South, and West by sea on the East by land known as Boca Chica and also described as all that area enclosed by the lines joining the eight points having grid coordinates A(1976 375 N, 392 000 E); P (1976 517.8 N, 391 781.1 E); Q (1976 534.1 N, 391 848.1E); R(1977 343.2 N, 391000 E); D (1978 000 N, 390 750 E); E (1978 000 N, 389 500 E); G (1977 000 N, 389 500 E), H (1976 375 N, 390 500 E); respectively.

STATUTORY INSTRUMENT
Nº. 107 of 1988

REGULATIONS made by the Minister of Agriculture in exercise of the powers conferred on him by Section 13 of the Fisheries Act, Chapter 174 of the Laws of Belize, 1980 and all other Powers thereunto him enabling

(Gazetted 31st December 1988)

1. These Regulations may be cited as the HOL CHAN MARINE RESERVE REGULATIONS, 1988. Short Title

2. In these Regulations- Definitions
 - “Administrator” means any fishery officer appointed as Administrator for the purpose of these Regulations;
 - “Fish” has to meaning assigned to it in Fisheries Act; Cap. 174.
 - “Fishing” means the taking of fish;
 - “Reserve” means the Hol Chan Marine Reserve, as declared by the Fisheries (Hol Chan Area Marine Reserve) Order 1987; S.I. 57/87
 - “Zone” means any of the areas demarcated as restricted areas in the Reserve.

3. (1) For the purpose of proper control and regulation of the Zones Reserve there are created three zones within the Reserve to be called:
 - (a) Zone A
 - (b) Zone B
 - (c) Zone C

- (2) The above Zones shall be clearly demarcated as restricted areas by buoys and other suitable signs.
4. No person within the boundaries of the Reserve- Restrictions
- (a) Shall have in his possession any flora or fauna without special license from the Administrator;
 - (b) Shall deposit any materials in or on the waters of the Reserve except by special license from the Administrator;
 - (c) Shall erect any structure, whether temporary or permanent;
 - (d) Shall discharge or deposit any waste material into the water or land areas;
 - (e) Shall mark or tamper with any sign, buoy or notice installed by the Administrator;
5. Any accident involving personal injury or damage to property shall be reported to the Reserve Manager as soon as possible, but neither the Administrator nor the Government of Belize shall be liable for such injury or damage. Report of accident, etc.
6. The following additional rules shall apply to the Zone A; Additional Rules for Zone A.
- (a) no person shall engage in finishing;
 - (b) visitors shall first obtain a ticket, on payment of the prescribed fee, from the Reserve headquarters before entry to this Zone;
 - (c) all boats shall anchor at the mooring provided in this Zone except in cases of emergency where life and property may be in danger;
 - (d) no person shall remove from its place or disturb

any species of flora or fauna, including rocks, dead coral shells or sand;

(e) no person shall cast or drag any anchor in such a way as to damage coral reef formations;

(f) all boats operating in this Zone shall obtain registration from the Administrator in the prescribed form set out in Schedule 1.

7. The following additional rules shall apply to Zone B: Additional Rules for Zone B.
- (a) no person shall engage in trawling
- (b) no person shall engage in fishing except under a special licence from the Administrator in the prescribed form set out in Schedule 2.
8. The following additional rules shall apply to Zone C: Additional Rules for Zone C.
- (a) no person shall engage fishing except under a special licence from the Administrator in the prescribed form set out in Schedule 2.
- (b) all boats used for sport fishing shall obtain registration from the Administrator in the form set out in Schedule 1.
9. Permits issued under these Regulations are: Permits not transferable etc.
- (a) not transferable:
- (b) renewable upon application to the Administrator ;
- (c) subject to cancellation if any of the conditions of the permit or any of these regulations is contravened.
10. The Fisheries Regulations 1977 shall apply within the Reserve. Application of Fisheries Regulations.

11. (1) The Reserve shall remain open to the public on all days of the week as follows: Fees.

1. Mondays to Fridays.....8:00 a.m. to 4:00 p.m.
2. Saturdays.....12:00 p.m. to 4:00 p.m.
3. Sundays8:00 a.m. to 12:00 p.m.

(2) Admission to the Reserve shall be on payment of the following fees for tourists, Belizeans and guide boats:

(a) Zone A:

1. Tourists\$ 3.00 per person per day
2. Belizeans\$ 1.50 per person per day
3. Guide Boats\$ 15.00 per boat per annum

(b) Zone B and Zone C (for sport fishing)

1. Tourists..... \$ 3.00 per person per day
2. Belizeans\$ 1.50 per person per day
3. Guide Boats\$ 15.00 per boat per annum

Provided that no fees shall be charged-

(a) in the case of children below twelve years of age; and

(b) in the case of Belizeans who enter the Reserve on Sundays but not on any other public or bank holiday.

12. Any person who contravenes these Regulations is guilty of an offence and is liable on summary conviction to a fine not exceeding one thousand dollars or to imprisonment for a period not exceeding six months or to both such fine and imprisonment. Penalty

13. These Regulations shall come into operation on theday of.....1988. Commencement
MADE 13 day of December 1988.

(DEAN R. LINDO)
Minister of Agriculture

SCHEDULE 1

Application for boat registration for operation in Hol Chan Marine Reserve (in duplicate)

- 1) Name of boat owner.
- 2) Name of captain.
- 3) Name of boat, if any
- 4) Length of boat.
- 5) Width of boat.
- 6) Engine type and H.P
- 7) Passenger capacity.
- 8) Type of activity:
 - (a) Glass-bottom viewing;
 - (b) Snorkeling;
 - (c) Scuba diving;
 - (d) Sportfishing.

Date_____ Signature_____

Registration Form
Name of boat, owner.
Name of Captain.
Name of boat.

This boat is registered to carry up to_____passengers and to conduct the folowing activities in the Hol Chan Marine Reserve i.e.....

Conditions of registration:

- 1 - If carrying passengers to dive in the reserve, the captain/guide is responsible for the following:
 - (i) to acquaint passengers with rules of the Reserve.
 - (ii) to anchor at the mooring provided when in Zona A.
 - (iii) to fly the “divers down” flag during all dives.
 - (iv) only certified scuba divers or those undergoing an approved training course will be allowed to use scuba tanks.

2. If carrying passengers to carry out sportfishing, the captain/guide is responsible for the following:
 - (i) to submit details of catch and area fished to the park manager when requested;
 - (ii) to release fish wherever possible.

3. To apply the mark/sticker provided in a prominent position on the registered boat.

Date _____

Fisheries Administrator

SCHEDULE 2

Fishing Licence for the Hol Chan Reserve

1. Fisherman will be required to fill in a special application form for fishing in the Reserve.
This will be the same as the currently used fishing licence application form and boat licence application form, but with the following 3 conditions:

(a) I hereby will submit details of catch from the reserve area as requested under Schedule 2 Form E1 of the Fisheries Regulations.

(b) Fishing will not be conducted in the Boca Ciega blue hole in Zona B with the use of nets or spears.

(c) Fishing will not be conducted in Zona A of the reserve.

2. Licences for general fishing will then be stamped with a special stamp allowing the holder to fish in Zona B and C of the Hol Chan Reserve.
3. Boats licenced to operate in the reserve for commercial fishing will be provided with a special mark/sticker.

Date _____
_____ Fisheries Administrator

STATUTORY INSTRUMENT
No. 112 of 1989

APPOINTMENT made by the Minister of Agriculture and Fisheries in exercise of the powers conferred upon him by section 4 of the Fisheries Act, Chapter 174 of the laws of Belize, 1980.

(Gazetted 28th October, 1989)

1. These Order may be cited as the: Short Title.

FISHERY OFFICERS (APPOINTMENT) ORDER, 1989.

2. I, MICHAEL ESPAT, Minister of Agriculture and Fisheries, in exercise of the power conferred upon me by Section 4 of the Fisheries Act, do hereby appoint the persons for the time being holding the following Officers

offices to be “FISHERY OFFICERS” for the purpose of carrying into effect the provisions of the said Act and the regulations made thereunder:-

Fisheries Administrator

Fisheries Officer

Assistant Fisheries Officer

Fisheries Inspector

3. The Fishery Officers (Appointment) order dated 22nd March, 1973 (S.I. 25 of 1973) is hereby repealed. Repeal of
S.I. 25/1973

(MICHAEL ESPAT)
Minister of Agriculture and Fisheries

STATUTORY INSTRUMENT
No. 113 of 1989

REGULATIONS made by the Minister of Agriculture and Fisheries in exercise of the powers conferred upon him by Section 13 of the Fisheries Act, Chapter 174 of the laws of Belize, 1980 and all other powers thereunto him enabling.

(Gazetted 28th October, 1989)

1. These Regulations may be cited as the Short Title
HOL CHAN MARINE RESERVE (AMENDMENT)
REGULATIONS, 1989

and shall be read and construed as one with the Hol

- Chan Marine Reserve Regulations which are hereinafter referred to as the principal Regulations
2. Regulation 2 of the principal Regulations is hereby amended by adding the following new definition immediately after the definition of “Zone”:-
- S.I. 107/88
Amendment
of
Regulation 2

“Zone A”, “Zone B” and “Zone C” shall have the descriptions respectively assigned to them in the Schedule to Fisheries (Hol Chan Area Marine Reserve) order, 1987

S.I. 57/87

3. Regulation 13 of the principal Regulations is hereby repealed and replaced by the following:-
- Amendment
Regulation
13.

“13. These Regulations shall come into operation on the thirteenth day of December 1988.”

Made by the Minister of Agriculture and Fisheries this 16th day of October, 1989.

(MICHAEL ESPAT)
Minister of Agriculture and Fisheries

STATUTORY INSTRUMENT
No. 100 of 1999

ORDER made by the Minister of Agriculture, Fisheries and Cooperatives in exercise of the powers conferred upon him by section 13 of the Fisheries Act, Chapter 174 of the Laws of Belize, Revised Editions 1980-90, and all other powers thereunto him enabling.

(Gazetted 18th September, 1999)

1. This Order may be cited as the

FISHERIES HOL CHAN AREAS MARINE

Short Title

RESERVE) (AMENDMENT) ORDER, 1999

and shall be read and construed as one with the Fisheries (Hol Chan Marine Reserve) Order, which is hereinafter referred to as the principal Order.

Sub. Leg.
1991 Edn.
Vol. IV.
CAP. 174
P.5.
Amendment
of Schedule

2. The Schedule to the principal Order is hereby amended by the addition there to of a new Zone D immediately after Zone C as follows:-

“Zone D”

ALL THAT AREA comprising the sea and reef on the south of Ambergris Caye containing about 2sq miles and also described as the area enclosed by the lines joining the 4 points having grid coordinates NW (395312.500E, 197485.00 N), NE (397610.00E, 1974320.00N), SE (397018.200E, 19972129.00N), SW (394768.300 E, 1972659.00N) respectively.”

3. This Order shall come into force on the 31st day of August, 1999.

Commencement

MADE by the Minister of Agriculture, Fisheries and Cooperatives this 31st day of August, 1999.

(DANIEL SILVA)
*Minister of Agriculture,
Fisheries and Cooperatives*

**STATUTORY INSTRUMENT
No. 101 of 1999**

REGULATIONS made by the Minister of Agriculture, Fisheries and Cooperatives in exercise of the powers conferred upon him by section 13 of the Fisheries Act, Chapter 174 of the Laws of Belize, Revised Edition 1980-90, and all other powers thereunto him enabling.

(Gazetted 18th September, 1999.)

- | | | |
|----|---|---|
| 1. | These Regulations may be cited as the

FISHERIES (HOL CHAN MARINE RESERVE)
(AMENDMENT) REGULATIONS, 1999.

and shall be read and construed as one with the Fisheries
(Hol Chan Marine Reserve) Regulations which, as
amended are hereinafter referred to as the principal
Regulations | Short Title

Sub Leg.
1991 Edn.
Vol. I.V.
CAP. 174
S.I. 170/1994
S.I. 35/1996. |
| 2. | Regulation 2 of the principal Regulations is hereby
amended deleting the definition of “ Zone A”, “ Zone B”,
“ Zone C”, and replacing it by the following:-

““ Zone A”, “ Zone B”, “ Zone C”, and “ Zone D”, shall
have the descriptions respectively assigned to them in the
Schedule to the Fisheries (Hol Chan Marine Reserve)
Order.” | Amendment
of Regulation
2.

Sub. Leg.
1991 Edn.
Vol. I.V
CAP. 174
P.5. |
| 3. | Regulation 3 of the principal Regulations is hereby amended
repealing subregulation (1) and replacing it with the
following

“ (1) For the purpose of proper control and regulation of
the Reserve there are hereby created four zones within the
Reserve to be called:-
(a) Zone A;

(b) Zone B;

(c) Zone C, and

(d) Zone D.” | Amendment
of
Regulation 3 |
| 4. | The principal Regulations are hereby amended by the
addition of a new Regulation 8 A immediately after
Regulation 8 as follows.- | Addition of
new
Regulation
8A. |

- 8A. This area shall be protected as a multi-purpose use zone and the following additional rules shall apply to Zone D:-
- Additional
Rules
for Zone D.
- (a) There shall be within this zone a “General Use Area” which shall be protected as follows:-
- (i) commercial fishing shall be allowed in all of Zone D except in the exclusive recreational areas of “ Shark Ray Alley” and “Amigos Del Mar Dive Wreck”;
 - (ii) fishermen who use Zone D shall submit catch data upon request by the staff of the Reserve;
 - (iii) fishermen who use Zone D shall obtain the Hol CHan Marine Reserve stamp on their fishing licences;
 - (iv) no gloves shall be allowed in Zone D; and
 - (v) the down-under diver’s flag shall be displayed at all times by tour guiding vessels;
- (b) there shall be within this zone “Exclusive Recreation Areas” which shall be protected as follows”-
- (i) special marker buoys shall demarcate the boundaries of the exclusive recreation areas and these areas shall be comprised of the area at “Shark Ray Alley” and the other area outside the reef at the “Amigos Del Mar Dive Wreck”;
 - (ii) no fishing shall be allowed in the exclusive recreation areas;
 - (iii) no feeding of fish by tourists shall be

allowed in the exclusive recreation areas;

- (iv) no touching of flora or fauna shall be allowed in the exclusive recreation areas;
- (v) no scuba diving shall be allowed in Shark Ray Alley except for research purposes under a special licence issued by the Fisheries Administrator in that behalf;
- (vi) commercial, recreational vessels shall be allowed to stay in the exclusive recreation areas for periods of not more than one hour at any one time, and only if there are in that area mooring buoys available;
- (vii) commercial recreational vessels within the exclusive recreation areas shall first report to the Ranger on duty before engaging in any water-related activities;
- (viii) down-under divers flags shall be displayed at all times; and
- (ix) no fishing gear shall be allowed on board any commercial recreational vessel except fins and masks.”

5. Regulation 11 of the principal Regulations is hereby amended by repealing subregulation (2) and replacing it with the following:

Amendment
of Regulation
11.

“(2) Admission to the Reserve shall be on payment of the following fees for tourists, Belizeans and commercial recreational vessels:

<i>(a)</i>	<u>Zones A,B,C</u>	<u>Fee</u>
	1. Tourist.....	\$ 5.00 per person per day
	2. Belizeans.....	\$ 2.00 per person per day
	3. Commercial	

Recreational
Vessels..... \$ 10.00 per vessel per annum

- (b) **Zone D** **Fee**
1. Tourist.....\$ 7.00 per person per day
2. Belizeans.....\$ 1.00 per person per day
3. Commercial
Recreational
Vessels..... \$ 10.00 per vessel per annum

- (c) **Zones B & C** **Fees**
(for sport fishing)
1. Tourist.....\$ 5.00 per person per day
2. Belizeans.....\$ 2.50 per person per day
3. Commercial
Recreational
Vessels..... \$ 10.00 per vessel per annum

Provided that no fees shall be charged:

- (a) to any child below the age of twelve years;
(b) to Belizeans who enter the Reserve on Sundays, unless that day falls on a Public or Bank holiday, in which case the normal fees shall be charged.”

6. The Fisheries (Hol Chan Marine Reserve) (Amendment) Regulations, 1999, are hereby repealed. Repeals S.I. No. 35/1996.
7. These Regulations shall come into force on the 31st day of August, 1999. Commencement

(DANIEL SILVA)
*Minister of Agriculture,
Fisheries and Cooperatives*

Appendix 2
Board of Trustee Regulations

BELIZE:

**STATUTORY INSTRUMENT
No. 170 of 1994**

REGULATIONS made by the Minister of fisheries in exercise of the powers conferred upon him by section 13 of the Fisheries Act, Chapter 174 of the Laws of Belize, Revised Edition; 1980-1990, and all other powers thereunto him enabling.

(Gazetted 18th November, 1994)

1. These Regulations may be cited as the Short Title.

HOL CHAN MARINE RESERVE (AMENDMENT)
REGULATIONS, 1994.

and shall be read and construed as one with the Hol Chan Marine Reserve Regulations which are hereinafter referred to as the principal Regulations. Sub. Leg.
Vol. IV
CAP.174
Pg. 40.

2. Regulation 2 of the principal Regulations is hereby amended by inserting. the following definition immediately after the definition “ Administrator”.

“Board” means the Board of Trustees established under regulation 13 of these Regulations.”

3. The principal Regulation are hereby amended by the additon of the following new regulation 13 to 17 immediately after regulation 12: Addition of
new
regulation
to 17.

13. (1) There is hereby established; Board of Trustees for the purpose of directing and managing the affairs of the Reserve affairs to the Reserve. Establish
of Board
of Trustees

- (2) The constitution and procedure of the Board shall be as set out in the Third Schedule to these Regulations. Third
Schedule
14. (1) The function of the Board shall be to: Function
of the Board
- (a) be responsible for the efficient administration of the affairs of the Reserve.
 - b) make recommendations regarding admission fees and other charges to be levied in relation to the Reserve;
 - (c) solicit and accept donations, subscriptions and benefactions for the maintenance of the Reserve;
 - (d) hold on trust all funds and revenues of the Reserve including subscriptions, covenants, sponsorships and legacies;
 - (e) manage the affairs of the Reserve and disburse moneys from the same for the purpose of maintaining the integrity of the ecosystems within the Reserve;
 - (f) borrow money, with the consent of the Minister of Finance, for any purpose connected with the administration of the Reserve;
 - (g) invest money of the Reserve but only after consultation with the Minister of Finance and upon the recommendation of a reputable financial institution; and
 - (h) carry out any other function as may be assigned by the Minister for the efficient functioning of the Reserve;
15. (1) The Board shall, with the approval of the Minister of Finance open and maintain at reputable bank, an account for the funds Reserve Fund Account to known as the Reserve Fund Account. Reserve
Fund
Account.

- (2) The Reserve Fund Account may only be operated on by cheque or other negotiable instrument assigned by the Chairman or other member of the Board authorised to sign, and counter-signed by any other member of the Board authorised to counter-sign.
- (3) No money shall be paid out of the Reserve Fund Account except with the authority and in accordance with any general or special directions of the Board.
- (4) All money forming part of the fund of the Reserve shall, as soon as practicable after it is received by any member of the Board, be paid into the Reserve Fund Account.

16.(1) The Revenues of the Reserve shall consist of the Following money:

Revenues of
the reserve

- (a) fees and other charges collected from the use of the Reserve.
- (b) donations solicited by the Board
- (c) contributions from the Government.
- (d) Donations or contributions from organizations
- (e) all income derived from the investment of money by or on behalf of the Reserve.
- (f) any other money lawfully contributed ,donated or bequethed to Reserve.

(2) The Funds of the Reserve shall be kept separate from the Consolidated Revenue Fund and any general funds of the Government.

(3) The revenues of the Reserve shall be used exclusively for the proper and efficient

administration, management and conservation of the Reserve.

17. (1) The Board shall keep full and correct accounts of all moneys received and expended on behalf of the Reserve. Duty to keep proper accounts.
- (2) An annual audit of accounts shall be carried out by the Auditor General or an independent auditor to be appointed by the Minister of Finance.
- (3) The Board shall at be prepare a statement of the assets and liabilities of the Reserve as at the end of each financial year and forward the same through the Minister responsible for fisheries to the Minister of Finance who shall present the said statement to the National Assembly as soon as practicable”.
- (4) The principal Regulations are hereby amended by the addition of the following new third Schedule after the Second Schedule: Addition of Third Schedule

THIRD SCHEDULE (Reg 13)

1. The Board shall be comprised of nine members as follows:
- (a) the Manager of the Hol Chan Marine Reserve;
 - (b) the Chairman of Hol Chan Advisory Committee;
 - (c) the Chairman of the Fisheries Advisory Board.
 - (d) the Fisheries Administrator;
 - (e) the Financial Secretary or his representative from Ministry of Finance;
 - (f) the National Coordinator and Science Advisor of the Global Environmental Facility (GEF) Project;

(g) The Chairman of Caribeña Fisherman Cooperative;

(h) the President of the San Pedro Belize
Tourism Industry Association; and

(i) the President of the San Pedro Chamber of
Commerce

2. The members of the Board shall elect one of the members thereof to be its Chairman
3. The Chairman may at any time resign his office by instrument in writing addressed to the Minister and as from the date of the receipt of the instrument by the Minister, unless some other date is mentioned in their instrument, the Chairman shall cease to be a Chairman but shall continue to be a member of the Board.
4. The Board shall meet at least once every quarter or at such shorter intervals as may be necessary for the transaction of business.
5. Meetings of the Board shall be in such places and times as the Board may determine.
6. The Chairman may at any time call a special meeting and shall do so within seven days of his being requested to do so in writing by not less than four members of the Board.
7. The Chairman shall preside at all the meetings of the Board but where any meeting the chairman is absent, the members present and constituting a quorum may elect a person from among themselves to be a Chairman for that meeting.
8. Five members of the board shall constitute a quorum.
9. Decisions of the Board shall be a majority of votes.

10. Every member of the Board shall have one vote but in cases where voting is equal the Chairman shall have a casting vote in addition to his original vote.
11. The constitution of the Board and any Changes occurring there in from time shall be published in the Gazette
12. Subject to existence of a quorum, the powers of the Board shall not to be affected by any vacancy ion the membership there of.
13. All documents made by ,and decision of the Board shall be signed by the Chairman or by any member of the Board authorised to act in that behalf by Board.
14. Subject to this Schedule the Board may regulate its own procedure”.

Made by the Minister of Agriculture this 15th day of November 1994

(RUSSEL GARCIA)
Minister of Agriculture
Minister responsible for Fisheries”

Appendix 3
Common Fishes of HCMR

List of common fish of HCMR

Scientific name

Common name

Abudefduf saxatilis	sergeant major
Abudefduf Taurus	night sergeant
Acanthurus chirurgus	doctorfish
Acanthurus bahianus	ocean surgeonfish
Acanthurus coeruleus	blue tang
Adioryx coruscus	reef squirrelfish
Aetoboatus narinari	spotted eagle ray
Albula vulpes	bonefish
Aluterus scriptus	scrawled filefish
Amblycirrhitis pinos	hawkfish
Anisotremus surinamensis	black margate
Anisotremus virginicus	porkfish
Apogon aurolineatus	bridled cardinalfish
Apogon maculatus	flamefish
Archosargus rhomboidalis	sea bream
Astrapogon stellatus	conchfish
Astropogon alutus	bronze cardinalfish
Atherinomorus stipes	hard head silverside
Aulostomus maculatus	trumpetfish
Balistes vetula	queen trigger
Balistes capriscus	gray trigger
Bodianus rufus	spanish hogfish
Bothus lunatus	peacock flounder
Calamus calamus	saucereye porgy
Canthidermis sufflamen	ocean trigger
Caranx bartholomaei	yellow jack
Caranx ruber	bar jack
Caranx hippos	crevalle jack
Caranx latux	horse-eyed jack
Canthigaster rostrata	sharpnose puffer
Cantherhinus pullus	orangespotted filefish
Carcharhinus leucas	bull shark
Carcharhinus limbatus	black tip shark
Centropomus undecimalis	snook
Chaetodon ocellatus	spotfin butterflyfish
Chaetodon Striatus	banded butterflyfish

Chaetodon capistratus	four-eye butterflyfish
Chaetodipterus faber	spadefish
Chilomycterus schoepfi	striped burrfish
Chromis cyaneus	blue chromis
Chromis multilineata	brown chromis
Coryphaena hippurus	dolphin
Coryphopterus glaucofraenum	bridled goby
Cotyphopterus personatus	masked goby
Cyprinodon variegatus	sheepshead minnow
Cypselurus heterurus	atlantic flyingfish
Dasyatis americana	southern stingray
Diodon holocanthus	balloonfish
Diodon hystrix	porcupinefish
Diplodus argenteus	silver porgy
Echeneis naucrates	shark sucker
Epinephalus adscensionis	rock hind
Epinephalus morio	red grouper
Epinephalus gattatus	red hind grouper
Epinephalus striatus	Nassau grouper
Epinephalus fulvus	coney
Epinephalus Cruentatus	graysby
Epinephalus itajara	jewfish
Equetus lanceolatus	jackknife fish
Eucinostomus sp.	mojarra
Eupomacentrus leucostictus	beaugregory
Eupomacentrus dorsopunicans	dusky damselfish
Fistularia tabacaria	cornetfish
Flammeo marianus	longspine squirrelfish
Galeocerda cuvieri	tiger shark
Gerres anereus	yellowfin mojarra
Ginglymostoma cirratum	nurse shark
Gnatholepsis thompsoni	goldspot goby
Gobionellus saepepallens	dash goby
Gobiosoma oceanops	neon goby
Gramma loreto	fairy basslet
Gymnothorax funebris	green moray
Gymnothorax moringa	spotted moray
Gymnothorax vicinus	purple mouth moray
Haemulon album	margate

Haemulon chrysargyreum	smallmouth grunt
Haemulon scriurus	blue-striped grunt
Haemulon plumieri	white grunt
Haemulum parra	sailor's choice
Haemulon flavolineatum	French grunt
Haemulon aurolineatum	tomtate
Haemulon melanurum	cottonwick
Halichoeres garnoti	yellowhead wrasse
Halichoeres bivittatus	slippery dick
Halichoeres maculipinna	clown wrasse
Halichoeres radiatus	puddingwife
Harengula jaguana	scaled sardine
Hemiramphus brasiliensis	ballyhoo
Hippocampus sp.	seahorse
Holocentrus ascensionis	long jaw squirrelfish
Holocentrus coruscum	reef squirrelfish
Holacanthus tricolor	rock beauty
Holacanthus ciliaris	queen angelfish
Hyporamphus unifasciatus	halfbeak
Hypoplectrus sp.	hamlet
Jenkensia lamprotaenia	dwarf herring
Kyphosus sectatrix	Bermuda chub
Lachnolaimus maximus	hogfish
Lactophrys polygona	honeycomb cowfish
Lactophrys quadricornis	scrawled cowfish
Lactophrys trigonus	trunkfish
Liopropoma rubre	peppermint bass
Liopropoma carmabi	candy bass
Loliot es surinamensis	triple-tail
Lophogobius eyprinoides	crested goby
Lutjanus apodus	schoolmaster
Lutjanus griseus	grey snapper
Lutjanus synagris	lane snapper
Lutjanus jocu	dog snapper
Lutjanus cyanopterus	cupera snapper
Lutjanus mahogoni	mahogany snapper
Lutjanus analis	mutton snapper
Malacanthus plumieri	sand tilefish
Microspathodon chrysurus	yellowtail damselfish

Mulloidichthys martinicus	yellow goatfish
Mycteroperca bonaci	black grouper
Ocyurus chrysurus	yellowtail snapper
Playbelone argalus	keeltail needlefish
Pomacanthus arcuatus	gray angelfish
Pomacanthus paru	French angelfish
Pseudupeneus maculatus	spotted goatfish
Scarus guacamaia	rainbow parrotfish
Scarus taeniopterus	princess parrotfish
Scarus vetula	queen parrotfish
Serranus tabacarius	tobacco fish
Serranus tigrinus	harlequin bass
Sparisoma aurofrenatum	redband parrotfish
Sparisoma chrysopterygum	reftail parrotfish
Sparisoma rubripinne	redfin parrotfish
Sparisoma viride	stoplight parrotfish
Sphyraena barracuda	great barracuda
Stegastes diencaeus	longfin damselfish
Stegastes partitus	bicolor damselfish
Stegastes planifrons	threespot damselfish
Stegastis variabilis	cocoa damselfish
Synodus sp.	Lizardfish
Thalassoma bifasciatum	bluehead wrasse
Trachinotus falcatus	permit
Tylosurus crocodiles	houndfish

Appendix 4
Common Corals, Sponges, Plants & other
Invertebrates of HCMR

List of common corals, sponges, plants and other invertebrates found in HCMR

Scientific Name

Common Name

Hard Corals

Acropora cervicornis	staghorn coral
Acropora palmata	elkhorn cora
Agaricia agaricites	leaf coral
Agaricia lamarcki	sheet coral
Agaricia tenuifolia	ribbon coral
Colpophyllia natans	giant brain coral
Dichocoenia stokesii	elliptical star coral
Diploria strigosa	smooth brain coral
Diploria labyrinthiformis	grooved brain coral
Madracis sp.	pencil coral
Manicina areolata	rose coral
Montastrea annularis	mountainous star coral
Montastrea cavernosa	cavernous star coral
Porites	club finger coral
Porites asteroides	mustard hill coral
Siderastrea radians	rough starlet coral
Siderastrea siderea	smooth starlet coral

Gorgonians

Briareum asbestinum	corky sea fingers
Eunicea sp.	knobby condelabra
Gorgonia Ventalina	common sea fan
Gorgonia flabellum	Venus sea fan
Muricea muricata	spiny muricea
Plexaurella sp.	sea rod
Pseudopterogorgia sp.	sea plume
Pterogorgia sp.	sea whip

Sponges

Cliona sp.	red boring sponge
Ircinia strobilina	cake sponge
Neopetrosia longleyi	sprawling sponge
Verongia sp.	candle sponge
Xestospongia sp.	basket sponge

Algae

Codium decorticatum	
Dictosphaeria cavernosa	green bubble algae
Halimeda opuntia	
Halimeda incrassata	
Penicillus capitatus	shaving brush
Rhipocephalus phoenix	
Turbinaria turbinata	
Udotea flabellum	mermaid's fan

Sea grasses

Syringodium filiforme	manatee grass
Thalassia testudinum	turtle grass

Miscellaneous

Bartholomea annulata	common anemone
Diadema antillarum	long-spined sea urchin
Ecteinascidia turbinata	mangrove tunicate
Millepora complanata	leafy stinging coral
Millepora alicornis	encrusting stinging coral
Tripneustes esculentus	West Indian sea egg