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**COASTAL AND MARINE SECTOR ANALYSIS
OF BELIZE**

A Background Paper for the Belize
Country Environmental Profile

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BELIZE COUNTRY ENVIRONMENTAL PROFILE**Coastal and Marine Sector Analysis****Physical Characterization****Areas of Special Interest****Control and Ownership of Belize's Coastal and Marine Land and Waters****Coastal Demographics and Issues****Coastal Agriculture****The Fishing Industry****Mineral Resources****Tourism****Ports****Natural Disaster Preparedness****Physical Characterization: Introduction**

Belize is fortunate to possess both a diverse and abundant coastal and marine natural resource base. The country's mainland coastline extends 280 km from the Rio Hondo in the north to the Sarstoon River on the Guatemala border in the south. The country's outer continental shelf measures approximately 7320 km² in area and averages 30 km in width.

There are five prominent physiographic features that characterize Belize's coastal and nearshore marine areas. These are: a broad flat coastal plain in the north which narrows in the south; an offshore lagoon enclosed by a seaward barrier reef; numerous sand cays largely confined inside of the reef; a barrier reef which extends the length of the country; and three atolls situated seaward to the reef.

The northern coastal plain of Belize is thought to have originally been a bay which has gradually filled in over time by sedimentary processes. The present day plain is underlain by a flat karst formation which partially explains the occurrence of the numerous coastal lagoons, embayments and wetland areas that characterize the region. There are few rivers in the area, the major ones being Rio Hondo and New River, and drainage is poor.

The southern coastal plain reaches its narrowest point near Dangriga before broadening out again to the base of the Maya Mountains. In contrast to northern Belize, there are few coastal lagoons, numerous fast-flowing rivers, and the soils are primarily alluvial in nature.

Offshore, the lagoon's northern shelf is an extension of the coastal plain and is characterized by a shallow flat featureless bottom ranging in width from 20 to 25 km. Depths in this area average between 2 to 3 meters with a 6 meter maximum. (Fig. 1) The shelf south of Belize City begins to deepen forming a channel between the mainland and the outer shelf platform before reaching a depth of 65 meters in the Gulf of Honduras.

There are approximately 180 cays in Belizean waters totaling an estimated 320 km² in area. (Wright et al 1959) These range from small ephemeral sand spits to large-scale permanent features capable of sustaining human populations. Stoddart et al (1982) identified eleven cay types in Belizean waters based on substrate composition, vegetation type and extent of cover, and physical location. (Table 1) The cayes typically develop at gaps between stretches of linear reef on small arcuate reef segments or at prominent disfigurations on bends in the reefs. Another shelf feature occurring seaward to Placencia Peninsula are numerous submerged rhomboid shoals or *facies* primarily composed of coral and algal rubble.

Belize's barrier reef is ^anearly continuous formation extending from the Sapodilla Cayes to the Mexican border, a distance of approximately 220 km. The reef, which is part of a larger structure reaching 450 km into the upper Yucatan Peninsula, is considered to be the second largest barrier reef in the world. The reef ranges in distance from the mainland from only a few hundred meters near Mexican Rocks on Ambergris Caye to over 40 km near Placencia.

The physical and biotic zonation patterns of the barrier reef appear to be similar to those previously described from other reefs in the region. (Fig. 2) The fore-reef, or the windward portion of the reef, extends from the reef crest to a depth of 40 meters. Within the fore-reef several sub-zones can be distinguished. These are: a relatively deep outer ridge characterized by deep-water corals, sponges and soft corals which grades into a series of coral ridges and sand channels (spur and groove sub-zone) where more high-energy tolerant coral species predominate together with milliporans (fire coral). Leeward to this sub-zone, there exists a buttress zone composed of palmate and ^{finger} ~~ring~~ corals. The reef crest is the area of maximum wave energy where only the hardest corals survive. Behind it, in the back of the reef zone, a rubble and pavement sub-zone characterized by broken coral and shell fragments separates labyrinthiform patch reefs from the inner lagoon.

Seaward of the barrier reef, the continental margin is characterized by a series of discontinuous ridges that run southwest to northeast.

On two of these ridge lines three coral atolls have developed separated by waters ranging from 360 to 1100 meters deep. The three atolls are aligned on a north-northeast to south-southwest axis and range in size from 218 km² (Lighthouse) to 566 km² (Turneffe). Generally, Lighthouse and Glover's Reefs share many similarities not found in Turneffe which include windward and leeward coral zonation patterns and the presence of patch reefs in the central lagoons. (Fig. 3a,b) Turneffe, which is protected from a westerly swell by Lighthouse Reef, has a different coral composition on its windward side and generally lacks a well defined reef crest and flat on its leeward side. There are no living patch reefs in Turneffe lagoon.

Seaward to the ridge line supporting Glovers and Lighthouse Reefs there is a rapid drop culminating in the Cayan Trough extending below 4000 meters.

On the shallow shelf area north of Belize City, bottom sediments are characterized by a terrigenous band occurring in the nearshore zone and an offshore mud dominated by foraminiferous tests (James and Ginsburg 1979). On the southern shelf Pundz et al (1975) identified three distinct facies: a nearshore terrigenous facie; a mixed facie or mud varying in percentage composition of terrigenous and carbonate content; and a sediment facie near the barrier reef platform which reflects the biogenic carbonate compounds of the reef.

Climatic Regime

The Belize coastal area is openly exposed to the southeast trade belt with winds which blow intermittently from the east and southeast averaging 10 to 13 knots and reaching their greatest constancy in July. Rainfall patterns demonstrate a distinct gradation along the coast with accumulations varying from less than ²⁰³ 25 cm/year in the north to amounts greater than ⁴⁵⁵ 70 cm in the south. Similarly, the distinction between wet

(June to January) and dry seasons (February to May) becomes increasingly blurred the further south one travels in Belize. Two meteorological disturbances can significantly alter these patterns; The arrival of cold northeast air masses or "northerners", which occur for short periods during October to January, bring in strong northerly winds and heavy rains with choppy seas which ^{make} navigation dangerous. The second and potentially more threatening disturbance is the occurrence of tropical cyclones.

These systems are commonly described as non-frontal, low pressure, large-scale phenomena which develop over tropical waters with a definite organized circulation (Neuman et al 1978). Dependent on the speed of the wind and its sustainability, cyclones are classified as tropical depressions, storms or hurricanes. By definition hurricanes are cyclones which reach a minimum sustained wind of 64 knots per minute or more.

While Belize is situated somewhat out of the major hurricane belt (from the period 1886 to 1978 Belize only accounted for five per cent of all recorded activity) the country has a long history of encounters with tropical cyclones (Fig. 4). Gibson (draft) has suggested that hurricanes affecting Belize share the following characteristics; a peak occurrence in September (43%) with significant frequencies in August and October; most hurricanes which affect Belize originate East of 60° W; and most maintain strong westerly tracks.

Hydrography

The offshore current regime is dominated by the northwesterly Caribbean Current. Off the coast of Belize the current becomes northerly varying in velocity from one to three knots. In the

southern portion of Belize near the Gulf of Honduras a component of the offshore current appears to verge to the south and west forming a counter-clockwise gyre in the gulf area. Inshore from the barrier there exists a narrow counter-current which flows to the south (Fig. 1). The nearshore waters of northern Belize are poorly circulated resulting from the protective line of cays inside of the reef. This results in greater variations in surface temperatures and salinities dependent on the season than those found in southern waters. Annual surface water temperature values range from 25° to 29° C. Deeper waters are stratified with a well developed thermocline occurring at 50 meters (James and Ginsburg 1979). Offshore salinities are typically oceanic (35 ppt) with significant variations in coastal waters dependent on the season and proximity to large island drainage systems.

The tidal range in Belize is small, averaging only .5 meters. While tidal influences on coastal current patterns are small, exceptions exist in the cuts between reef segments and cays where tidal effects are significant.

Coastal And Offshore Variation

The predominant coastal vegetation in Belize is mangrove. Wright (et al) described at least three complexes which exist in the country: a button wood, red-white mangrove assemblage found on soils which are periodically inundated with sea water; a red mangrove stand which is permanently inundated; and a red-white mangrove association with occasional black mangrove in areas where salt water rarely intrudes. No inventory of

this resource has been undertaken, but 1981 forestry statistics based on aerial photo interpretation classified approximately 2584 km² as mangrove and swamp vegetation or 11% of the 22,868 km² of forested area.

The four species of mangrove described for Belize are Rhizophora mangle (red); Aricecnnia nitida (black); Laguncularia racemosa (white); and Conocarpus erecta (button wood). In addition to occurring in the coastal area of Belize, mangroves can be found inland bordering several of Belize's rivers where salt water influences internal waters. Offshore, many of the cayes have been colonized principally by the red mangrove, often on the lagoon side of the caye.

While no inventory of mainland coastal vegetation exists, Stoddart et al (1982) completed one for the cayes. In his inventory 178 species of vascular plants were recorded including 32 non-native species. It was observed that native woodlands of the cayes had been greatly disturbed by introduction of coconut tree plantations which often resulted in their total disappearance. In general, plants on the large mangrove cayes were distinct from the sand cayes along the reef edge in possessing many more grasses, sedges and succulents. Factors affecting the occurrence of these species include rain gradient, degree of exposure, degree and *interval* of the last, most recent disturbance (natural and human) and substrate. Aside from the mangroves, other prominent species of vegetation include Spartina (salt grasses), Cocos nucifera (coconut palm), Thrinax (palmetto), and Ipomora (beach morning glory).

Areas of Special Interest

In most coastal waters there exist special interest areas which require added measures of concern when planning development activities. Most commonly these areas are so designated due to: the presence of resources and habitats which provide the basis for supporting commercial activities; the presence of organism and/or habitat highly sensitive to human-induced environmental

perturbations.

Belize is fortunate to possess the coastal and marine resources that meet most of these criteria. Few countries have both the extent and diversity of highly productive tropical coastal ecosystems characteristic of Belize. (Fig. 5). These include:

coastal lagoons: These areas so prevalent in northern Belize provide nursery and feeding grounds to many coastal fish species, act as sinks for terrestrial run-off, provide significant sources of nutrients to coastal waters and provide critical habitat to many species of Belize wildlife, including the manatee.

mangroves: Mangrove has been documented as a significant source of nutrients enriching coastal waters, providing habitat for nursery and feeding purposes to many coastal fish species, acting as sediment traps to terrestrial run-off, and providing a buffer between marine-generated storms and island areas. Most of Belize's coastline is fringed with mangroves as are many of the off-shore cays.

seagrasses: Marine grasses are significant in binding sediments providing a stable substrate for benthic organisms, as primary producers in tropical waters, as sources of food for many herbivores, and in providing substrate for epibionts which support Belize's second most important commercial fishery, the corals (Strombus gigas).

coral reefs: Together with the tropical rainforests, these ecosystems are commonly described as the most diverse communities on earth. Besides signifying a highly productive ecosystem, Belize's coral reefs provide a zone of protection from incoming swell, support the country's single most economically important fishery and entertains an ever-growing tourist trade as a "world class" resource.

In addition to these ecosystems, many of the same and other coastal resources deserve special management status for meeting other criteria (Fig. 6). These include providing critical habitat for the country's threatened or

endangered non-pelagic coastal mammals and reptiles and nesting sites for coastal birds. Both subjects are treated in greater detail in the wildlife section of the C.B.P.

Other important resources include known archaeological sites, shipwrecks (both historical and modern) and unique natural resources. These latter include Belize's barrier reef which constitutes the second largest reef in the world, three of the Caribbean Basin's 14 atolls and the Blue Hole (located in Lighthouse Reef), a collapsed Karst dome forming a vertical cave reaching a depth of 125 meters.

Control and Ownership of Belize's Coastal and Marine Lands and Waters

The coastal area of Belize is predominantly in the hands of private owners (Fig. 7). National lands are located in the northern and southern areas of Belize and include a forest reserve bordering Port Honduras. A significant step was taken in 1939 to exert public control over the coastal zone. A strip measuring one chain (66') from near high tide inland was decreed as public lands. This guaranteed the individual the right to walk along or use the area freely.

Offshore the continental shelf is considered public lands. The majority of the cayes are still in public hands though the figures are misleading as many public cayes have parcels owned privately. The country's largest caye (Ambergris) and many of the most attractive cayes (Long and Northeast Cayes) are privately owned.

Foreign speculation in coastal lands has been and may continue to pose a problem. To dampen speculative pressures, a series of Ordinances have been passed which include the Land Tax Ordinance (1966), Aliens Landholding Ordinance (1973), Land Utilization Ordinance (1981) and the most recent Land Tax Act of 1982. The objective of the '82 Tax Act was to place a tax on all private lands based on their unimproved value. It is too early to discern the effect of the new Act, but one potential issue may be to tax traditional land owners on values of their lands determined by foreign buying pressures. The two areas most vulnerable to this possibility are Placencia and San Pedro.

Another issue that appears to be increasing in significance, though localized, is that of beach access. Despite the existence of public lands along the beach, there are no provisions for right of access to the beach. This has rarely been a problem among Belizeans who have been casual towards the issue. However, in areas where foreign interests have bought coastal frontage for hotels and housing purposes, conflicts have occurred in the enforcement of a non-traditional value system. Caye Caulker and Ambergris Cayes appear to be the principal areas where the issue surfaces.

It has been the general policy of the government to refrain from selling offshore cayes during the last decade with few exceptions for special development schemes. Caye exchanges have been between private owners and buyers.

Belize's marine boundaries are presently defined by a three-mile territorial sea, a legacy from the British era. The country has recently signed the Law of the Sea (L.O.S.) Treaty which upon ratification by the Belizean Parliament will increase jurisdiction to a 12-mile territorial sea and a 200-mile exclusive economic zone (E.E.Z.). Belize's position on expanding jurisdiction is complicated by the territorial dispute with Guatemala. According to the L.O.S. median line definition, Guatemala will lose its access to the Caribbean Sea to Honduras and Belize. This was one of the major issues agreed to be discussed in the Heads of Agreement signed in 1981 between the U.K., Guatemala, and Belize. A second issue has been the "use and enjoyment" clause by Guatemala of the Anguana and Sapodilla Cayes, a source of present tension between the two countries. There has been little progress on resolution of these issues since the signing of the agreement.

Coastal Demographics and Issues

Based on comparisons between the 1970 and 1980 census, the percentage of Belize's population that lives on the coast grew at a smaller rate than the national population (Table 3). Nevertheless, in 1980 rural and urban coastal inhabitants comprised 48% of the nation's population of which 35% was concentrated in Belize City.

Other trends indicated a coastal urban population growing at a slower rate than the national average, but a coastal rural population which far exceeded it (Fig.8). In the urban areas Belize City grew very little over the last 10 years while Corozal grew almost by 50 per cent and Dangriga actually lost population. In the smaller villages, San Pedro, Chunox and Mango Creek, population grew the most rapidly over the last decade.

In any country where such a high percentage of the national population lives on or near the coastal area there exist significant issues that need to be addressed by policy and decision makers. In Belize these issues include the overloading of existing infrastructure required to provide needed services to the community, surpassing carrying capacity of natural resources supporting human settlements; the design and implementation of an effective evacuation plan for large urban populations and small isolated communities in case of natural disasters; despoilation of pristine productive ecosystems by human waste; and conversion of natural areas to provide needed additional housing (Fig. 8).

Many of these issues are best observed in Belize City. Situated on a small peninsula covered with mangrove, continued urban expansion has created significant modifications to the landscape. Major projects which are presently in process include the clearing of mangrove for development of industrial sites on the northern peninsula, and housing development projects on both sides. Other projects which will entail large-scale mangrove loss include the expansion of the port facility and the building of a sewage treatment plant on the southern shore.

A continuing growing demand for potable water in the coastal area has also been a significant issue. In Belize City a new water plant was opened in 1981 at Double Run to serve the city's growing needs. In other towns new wells have been dug and towers built to increase water supply and storage capabilities. In many of the villages, notably on the cays and sandy peninsulas of the country, rapidly increasing populations have resulted in water shortages. Drawing down the water table has resulted in salt water intrusion in some areas and has become

particularly acute in San Pedro.

With increased water demand and use there is a similar increase in its disposal. Currently most of Belize City still dumps raw sewage into the sea through collector canals though a new sewage disposal system currently being built should reduce this practice.

In the remainder of the country waste water disposal is primarily handled by septic tanks, pit latrines and outhouses. Contamination of the potable water supplies through overloading of these systems has been reported for both San Pedro and Placencia. In the latter case ground water contamination is threatening the water supply of the Placencia Fishing Cooperative, the principal employer and economic force in the village.

Solid waste is also beginning to become increasingly prevalent on the Belizean landscape. Belize City, San Pedro, Placencia and other towns use mangrove areas as a dumping ground for all wastes without burial facilitating toxic waste runoff and leachates entering into coastal waters.

Though Belize is not a fully industrialized society its manufacturing sector is the largest of the Caribbean LDC's. As such, industrial pollution affecting coastal waters is significant but localized. Belize City is the principal location of most of the country's industries. Of particular concern are the battery and nail manufacturing plants located on the Belize River. Arsenic laden wastes associated with the galvanizing process of nails has been dumped three times, each resulting in widespread fish kills. Stann Creek River is another area where chronic dumping of citrus wastes has caused fish kills.

Coastal Agriculture

With the exception of coconut production there has been very little coastal agricultural activity in Belize. In the 1930s coconuts were grown principally on the cayes and coastal areas and constituted the country's only plantation crop. At its peak Belize exported 6 million whole nuts per year to the U.S.

Production began to fall in the 1940s due to diseases and the 1942 hurricane.

In 1961 Hattie damaged an estimated 2,869 acres of palm. Since 1972 however, there have been attempts to revive the industry. This is being done through encouraging better husbandry practice and the introduction of a fast-growing dwarf form of coconut tree. Present production is estimated at 1 million nuts per year exported to the U.S. The principal production areas are the Corozal District, the cayes, Cayo District and the coastal areas south of Belize. An oil production facility is planned for the future.

The Fishing Industry

In 1982 the fishing industry exported 718 tons of fish product valued at 6.2 million U.S. (Table 3). Based on export value, the industry ranks third behind sugar and citrus products as an earner of hard currency.

The mainstay of the export industry is spiny lobster (Panulirus argus) which accounted for 305 tons valued at \$5 million U.S. or approximately 80 percent of fish product generated export income. The industry was first established in 1945 and has maintained an average annual production of 200 tons for the past 10 years.

The export product second in terms of economic importance is the Queen conch (Strombus gigas). This mollusc accounted for 157 tons exported in 1982 valued at \$668,000 U.S. or 11 percent of total fish exports. This is a relatively young industry first exporting little more than 50 tons in 1985. Exports peaked at 425 tons in 1972 and have been declining with catch to a low of 125 tons in 1985. Last year represents the first increase in catch in 10 years.

The remaining fish exports include whale and filler fish (fresh water and marine), shrimp and stone crab and salt water aquarium fish.

The fishing industry is composed of approximately 800 fisheries, which provide the country's four cooperatives' catch for export. In addition, there are approximately 400 independent fishermen who fish primarily scale-fish for their markets.

The principal fishing grounds are the grass beds and reefed areas inside the barrier reef and the outer atolls (Fig. 9).

The two principal methods employed for fishing lobster are spearfishing (using snorkel) and trap fishing. Beach weirs are also used on the shallow water cays in the north. Conch is harvested by diver.

Much of the success of Belize's export fishery is due to the development of fishing cooperatives. The cooperatives secure export markets each year and collect, process and package all products for export. In addition, they provide members with storage facilities and loans when needed.

TO assure that local markets are satisfied the government requires that cooperatives sell 10 and 5 percent of their conch and lobster respectively in Belize. Finfish must be sold on a monthly quota of 30,000 lbs/month.

Mariculture is a new activity in Belize and still in the pilot stage. One operation has recently harvested its first year's production of penneid shrimp near Monkey River. The two species of shrimp, Penaeus stylirostris and P. nannamei, are introduced species from Ecuador. Two other concessions have been applied for and approved for similar activities.

There is another pilot activity located on Turneffe which will attempt to expose the American lobster, Homarus americanus to Caribbean waters for the purposes of enhancing growth rates.

There are three international activities which are presently ongoing in Belize relevant to fisheries. The CARB project is attempting to diversify Belizean fisheries through promoting education and training activities to get fishermen to harvest alternative fish resources. The project, founded by CIDA, is entering its next cycle funding scheduled for a second three years. Despite a certain degree of receptivity by the fishing cooperatives, CARB's failure to work closely with the Fisheries Unit and obtain a vessel for fishing trials has impeded progress.

In another program CIDA has sponsored Belizean fishermen to travel to Nova Scotia to learn alternative fishing methodologies.

Finally, in still a third CIDA funded project, the population dynamics of conch and their significance to the development of effective management strategies

has been the objective of a field study in San Pedro.

Fisheries management has evolved into a unique and relatively sophisticated mix of the private and public sectors. The primary administrative body is the Fisheries Unit located in the Ministry of Health, Housing and Cooperatives. It presently consists of 12 employees of which 8 are trained technicians or administrators. In addition, there exists a Fisheries Advisory Board which is composed of 11 members from the government, fishing and business communities which acts in an advisory capacity on fisheries matters to the government. Finally, there is the Belize Fisherman's Cooperative Association which represents the interests of the cooperatives and their members.

Significant legislation which the Fisheries Unit is charged to enforce includes:

Lobster:

- A closed season for lobster between the dates March 15 to July 14.
- Size/weight limit of 3½" carapace length or 4 oz. tail weight.
- Protection of berried and soft shell lobsters.
- Total export quota of 270 tons.

Conch:

- In response to the continued declines in the conch industry new regulations were passed in 1977 providing for:
 - 7" shell length and 3 oz. market clean net weight.
 - 3 month closed season extending from July 1 to September 30

Other:

- All fishermen and boats are required to be registered.
- It is prohibited to use traps outside of the barrier reef.
- There is a closed season for turtles from June 4 to August 31 and it is prohibited to take underweight turtles or turtles and eggs from the beach.
- A license is required to harvest coral.
- The use of toxics is prohibited for fishing.
- The minimum net mesh size is 1½" for finfish.

An important amendment to the fisheries ordinance was passed in February 1983

which have the Minister of Health, Housing and Cooperatives the power where required to designate any area in Belize waters a marine reserve and prohibit people from entering said reserve.

Despite a solid legislative basis for sound management, the lack of enforcement capabilities appears to be a principal constraint to an effective management program in Belize. This implies minimally a boat (or boats), the budget to purchase the fuel to operate them and the will to enforce present regulations. At present these requirements appear to be lacking.

The draft Fisheries Development Plan for 1983-88 identifies several areas for potential development. These are diversal species occurring on the outer continental slope between 360 and 900 feet; a pelagic resource consisting of bonito, mackerel, and small tuna and a deep water Crustacean and finfish complex.

Aquaculture is another area which is identified in the new Development Plan as showing potential particularly with such species as the characid Brycon guatemalensis, the freshwater crayfish Procambarus clarkii and P. acutus and local species of marine shrimp P. schmitti and P. duoganum.

Of the significant identified in the Development Plan, the one of greatest consequence may be that of illegal poaching of lobster and conch across the southern border into Guatemala and Honduras. In this market all lobsters are vulnerable to harvest regardless of size, sex, state of maturation or season. The significance of this drain on the fishery and its management has yet to be determined. Several of the cooperatives however, are beginning to suffer from their members shifting to the more lucrative alternative of illegal markets rather than continuing to sell locally. A recent raid on the trade resulting in one dead has at least momentarily acted as a deterrent. There exist hopes that the new "marine "marine wing" of the Belize Defense Force will provide the needed capability to enforce the existing management legislature.

Mineral Resources

There exist few data concerning Belize's coastal and marine mineral resources.

Belize presently has neither the technical nor financial resources to prospect for potential mineral wealth. As a result, prospecting agreements are awarded to foreign companies for periods of up to four years. Awards may be made either in response to solicited bids or unsolicited proposals. Non oil and gas mineral prospecting activities have been limited and no new licences have been issued since 1980. Based on a superficial mineral survey in 1976 one company found indication of commercial quantities of barite and hauzite that may exist in the coastal margin. No other exploratory efforts are known to exist (Gardner, *personal communication*)

Due to Belize's total dependence on oil exports to meet every need, exploration began back in 1938. Despite the long history of exploratory activity in Belize however, only 40 wells have been drilled. Of these, only a few have been drilled offshore with the majority (5) off of the Dangriga Area. In addition, holes have been drilled on Glovers and Turneffe atolls. Seismic profiles have been taken in the past employing explosives leaving scars which remain to this day (*notably* in the drowned cays area).

At present most of the inshore areas are covered under an active concession (Fig. 10). In most cases these concessions require some level of effort before expiration or the concession is terminated prematurely. In several of the rear-shore concessions activities are scheduled over the next two years. Further offshore, there exist several concession tracts which remain vacant.

Present government administrative responsibilities for mineral development and management rests with the Ministry of Natural Resources Petroleum Office. The present oil development program is a two phase effort consisting of development of a data base from existing information and its interpretation and training of Belizean petroleum scientists and engineers.

At present there exist no environmental guidelines in the Petroleum Office for use by prospecting oil companies for mitigation of environmental impact associated with exploratory activities.

Tourism

Coastal tourism in Belize is based on the presence and uniqueness of the country's barrier reef and associated atolls and cays . The principal coastal tourist areas are San Pedro de Ambergris (for beaches, swimming, snorkeling and scuba) ; Belize City (for trips to nearshore cays) ; Dangriga (trips to the cays and reef) ; and Placencia (beach, trips to the cays, reef and outer atolls) . In addition to the mainland sites there exist tourist facilities on Ambergris Cay, Cay Chapel, St. George's Cay, Cay Caulker and Middle and Long Cays on Glovers Reef .

Tourism statistics are poor and visitor arrival data fail to make distinctions of purpose of visit . Arrivals between the period 1971 and 1977 have increased from 45 to 55 thousand of which 30% were estimated to be tourists (World Bank 1978) . In 1981, of the approximately 157,000 arrivals in Belize an estimated 56,000 were tourists .

The recent trends in total number of hotels and beds available in Belize demonstrate an increase in both categories to meet demand (Table 4) . Of the 140 hotels registered in Belize in 1981, 85% were located in the coastal area and 31% in Belize City .

Government revenue generated by the hotel industry comes from two sources : a registration fee for each room paid annually and a tax on accommodation charges . In 1982 these revenues amounted to \$ U.S. 88,500 .

Estimates of gross foreign exchange earnings attributed to tourism indicated an increase from \$ U.S. 5.2 million in 1971 to \$ U.S. 8.7 million in 1982 . (CCPU 1982) .

Recreational areas for local tourists are limited . Belizeans living off of Ambergris Cay and Placencia must compete and pay to travel to these and other offshore areas with foreign tourists . In Belize City there exists only a sports facility on Birds Isle . Goff's Cay is presently being considered as a site for a small recreational facility for local use . Other traditional areas such as

the Barracks and Belize Beach have become health hazard areas due to poor water quality .

Belize has recently been approached by cruise ship lines investigating the potential for the country as a port of call .

The responsibility of government for tourism management and development falls under the Ministry of Trade and Industry . Within this Ministry there exists the Belize Tourist Board which acts in an advisory capacity to the government in affairs concerning tourism . In addition, the primary functions of the Board are to administer the Hotels Ordinance Act, collecting and tabulating statistical data and supervising tourist development projects .

Tourism development in the 1980/83 Economic Plan of Belize identifies as its main objective the orderly and systematic growth of an industry controlled, where possible, by Belizeans while mitigating the negative social and economic impacts associated with tourism . To implement this policy the government uses a general guideline in evaluating applications for the development of tourist facilities . The guideline stipulates the number of tourist beds should not exceed 25 per cent of the population in any locale .

Currently there is a 10 year Tourist Development Plan being completed by the Belize Investment Center with technical assistance provided by U.N.D.P. One of the recommendations from the Tourist Board to be included in the Plan is the investigation of alternative strategies for tourism development which mitigate the ecological and social impacts associated with the industry . There is some basis for this recommendation . Already conflicts are beginning to appear which have been highlighted in other sections of this analysis . They are: rights to beach access, degradation of reef and associated community, rapid appreciation of land values as a result of foreign speculation, and over-consumption of local resources, specifically water .

The major needs of the industry include a basic origin/destination compilation and interpretative program (including reason for visit, length of stay,

types of hotels used, percent occupancy); an assesment of coastal resources and their potential for tourism attractions; a set of guidelines to be used by the industry for use in site selection and construction of facilities which focus on minimizing impact to the surrounding environment .

Ports

Up until 1980 the country's major port consisted of a lighterage facility in Belize City . On July 1, 1980 a new port facility was opened situated approximately one mile south of the city center . The facility consists of a single 214 foot pier head at the end of a 2500 foot long pier .The new port can accommodate ships up to 181 in draft . Deeper draft ships must still anchor $1\frac{1}{2}$ miles or further offshore to be served by lighters and barges .

Belize's second principal port is located in Commerce Right south of Dangriga . The pier which opened in October 1980 handles mainly citrus exports and fertilizer imports as break bulk cargo .

The country's remaining port facilities are privately or municipally owned and administered and consist of small finger piers and longshore wharves .

Despite the country's recently increased capacity to handle cargo, several constraints remain . The presence of a new port facility in Belize has only partially filled the need for a deep water port . The new facility was not designed for low lighters creating the need for the construction of a second pier . Present delays in completion of cargo handling procedures are the following:

break bulk cargo - 2 to 3 days
 lift on/lift off - 6 to 12 hours
 roll on/roll off - 2 to 6 hours

Due to the costs associated with delays in lightering the larger ships and unloading of break bulk cargo, fewer ships are arriving in Belize (Table 5) . If this trend continues, Belize will become increasingly dependent on the Port

facilities of Puerto Cortes .

Barge traffic is prevalent in Belize due to the shallowness of nearshore waters and limited entry . Access for ocean-going vessels is limited to English Cay and the southern end of the barrier reef near Punta Gorda .

Present shipping patterns are relatively simple . Sugar is shipped by barge from Libertad (site of the Corozal sugar factory) to be stored in Belize before being lightered to a ship for export . Citrus produce from Commerce Bight is carried by boat directly to export markets . Banana exports are transported by covered barge to Puerto Cortes for re-export from that point .

There is very little coastal trade but occasionally small passenger ferries run between Belize City and Placencia . Barge traffic can travel up the Belize River from Haulover Creek to the industrial belt located to the west of the city .

There appear to be few substances shipped through Belizean waters considered hazardous to the marine environment (Table 6) . Figure 11 illustrates trends in three toxic substances shipped by sea identified from cargo operation statistics . Cement and fertilizer imports are dropping in part due to increased indigenous capacity to produce these products . Oil, however, continues to grow as a necessary import . All oil comes into Belize through the Bssco facility located near the new port . Belize has no refinery capacity so it must import both crude and refined products alike . While Bssco imports these products it makes them available to other companies operating in the country through various product-exchange arrangements . Most of these are now re-distributed by land transport .

No incidents involving oil spills have been recorded in Belize . Tar balls , however, are becoming increasingly frequent in Placencia and Ambergris Cay . In all likelihood these have been the product of dumping of ballast and tanker wash-

ings from ships outside of Belizean waters . Two fertilizer boats have run aground on the barrier reef, one near San Pedro and one on Lighthouse Reef . The environmental consequences of these wrecks are not known .

The government body responsible for administering the two national ports is the National Port Authority . Created in 1976 under the Ministry of Works it is responsible for pier construction, port management, dredging and maintenance . In 1980, new regulations made it unlawful to discharge or dump ballast, sewage, garbage, liquids, etc. in Belize's territorial waters . Despite these regulations it has been hampered by lack of funds and resources for regulation enforcement .

Future development plans for Belize City port include the filling in of wetlands near the Esso storage facility for the siting of new sugar storage warehouses, dredging a deeper channel to accommodate deep draft sugar vessels, building a second jetty to provide for two-way vessel traffic, enlarging the present pier head to handle more ships, developing 35 acres behind the present port site . These development projects will cost an estimated \$75 million U.S. and if funded will occur over the next 10 years .

For the Commerce Right facility planned improvements include the construction of a new floating jetty to provide roll-on/roll-off capabilities .

Dredging plans are being considered for Big Creek to enable ships to enter the mouth of the river to load bananas . Dredging activity will be contingent on the on the well-being and continued growth of the industry . More immediately dredging is planned for the port area to increase channel depth to 24' .

There is no evidence that environmental considerations are examined prior to initiation of required port maintenance and development activities . Notification of other ministries of proposed activities appear to be an informal procedure .

Natural Disaster Preparedness

The principal factors which make hurricanes so destructive are the initial wave surge preceding the storm and the high winds and rain which accompany it. Belize is particularly vulnerable to hurricanes as most of the country's urban centers are located on the low-lying coastal plain. In Belize City the storm surge associated with Hattie was estimated to be 12 feet above sea level. The damage wrought by hurricanes in Belize appears to have increased since the early 20th. century due in part to better record keeping as well as increased growth of the country's coastal towns and cities (Table 7).

Impacts on Belize's reefs from direct breakage and suffocation by sediment can be severe. Hattie caused as much as 80 percent die off/disappearance in some areas with the heaviest loss suffered by rapid growing fragile coral species (Acropora, Porites).

The impacts of hurricanes on the sand cays can signify a drastically altered morphology including reduction in size, breakup or disappearance. Stoddart (1961) estimated that Hattie caused Goff's Cay to decrease in area from 2100 yds² to 950 yds². The most vulnerable cays appear to be the small narrow cays stripped of vegetation and altered by man.

In response to the continued vulnerability of Belize to hurricanes, the G.O.B. has developed an elaborate Hurricane Plan. The Plan identifies a central emergency organization which is charged with directing and coordinating preparedness and relief activities. Eleven sub-committees have been designated to develop specific preparedness plans addressing such areas as housing, food and water. Procedures have been developed for communications, public information, provision of shelter, etc. Hurricane Plans are reviewed and amended where required annually.

Belize is unique among the countries of the region in possessing a low population density. This low density figure is similarly reflected in the

demographics of its coastal area . Though 43 percent of Belize's population lives on the coast this amounts to only 62,500 inhabitants of which 40,000 live in Belize City . Small coastal populations, together with large areas of the coast which are inaccessible for lack of roads, are the principal factors explaining the undisturbed state that characterizes much of the coastal zone . To be sure, problems do exist but are generally localized . Chief among these problems are: solid and liquid waste disposal (both urban and industrial), ground water depletion and contamination, urban expansion, illegal fishing and beach access . The two areas where one or more of these problems are most prevalent are the larger urban centers (principally Belize City and Dangriga) and the smaller coastal towns which have dramatically increased in size over the last decade (San Pedro and Placencia) .

Offshore, Belize is fortunate to have one of the world's great barrier reefs . Among its many uses includes: supporting Belize's principal fisheries — which accounted for the third largest source of hard currency in 1982; providing the basis for the country's growing tourism industry; and serving as a natural break-water for inshore navigation purposes .

Despite a significant local awareness of the importance of this resource some areas of stress are beginning to appear on the reef . These include reefal portions whose commercial fish stock has been overfished and a decreasing presence of other residents of the reef community due to souvenir hunters or sellers .

The country's coastal and marine resources will play a significant role in the future development of Belize . The largely virgin coastal area may support renewed efforts at establishing coconut and tannin industries, the latter based on Belize's large mangrove resources . Initial results from a shrimp mariculture pilot effort indicate the potential exists for productive and profitable utilization of the wetland savannah areas behind the mangrove

fringe . The country's coastal and marine areas have yet to be adequately surveyed for mineral resources and may hold the key to reducing Belize's dependence on imported oil . Tourism promises to be a growth industry in light of the abundance of coastal and cay beaches and the uniqueness of the barrier reef and outer atolls . Finally, the potential exists for supporting alternative fisheries in Belizean waters .

While the development of these new resources and uses should be fully supported, it must be recognized that failure to regulate and manage the development process could result in resource use conflicts, environmental degradation and ultimately loss of future economic opportunities . To avoid that possibility the primary recommendation of this report is for the G.O.B. (and A.I.D. as appropriate) ^{to} make it their priority to increase the administrative, monitoring enforcement and educational capacity of the country to meet the demands associated with the development process . This is crucial in order to preserve the country's coastal and marine resource base for its continued sustainable utilization .

Presently in Belize the legislative base regulating coastal and marine resources and uses is broad and fairly comprehensive . Legislation now exists to address coastal lands speculation, provide for public ownership of the coastal area and require a "setback" in any proposed coastal construction . Legislation governing fisheries is equally broad and has recently been strengthened to provide the means to declare any area within the marine waters of Belize a marine sanctuary . This ordinance provides a suitable counterpart to the existing wildlife protection act which applies to the offshore cays and is administered by the Ministry of Natural Resources . While no comprehensive legislation exists governing marine pollution, a draft ordinance is now being prepared by the Ministry of Health, Housing and Cooperatives . This should pass its second reading in the first part of 1983 . Specific legislative areas where changes are

recommended are:

- the complete protection of marine turtles;
- a provision for granting the right of public access to Belizean beaches and coastal areas;
- further definition of the relevant forestry legislation to specify mangroves as a resource requiring a license for its harvesting or removal;
- establishing a means to regulate the future development of cays now in private holdings effective upon the next change in ownership .

On an institutional basis the G.O.B. appears weak in effectively managing the country's coastal and marine resources . This is due to a host of factors, the most significant being: the lack of human and financial resources within the government to enforce the existing legislative mandate; natural resource administrative units which are institutionally misplaced; and the need for a multisectoral approach to the administration of the coastal area .

Of the factors identified above , the lack of sufficient enforcement capabilities may be the biggest constraint in preventing effective resource management . This constraint affects the coastal regulatory spectrum and includes administrative units responsible for fisheries, ports, public lands and tourism . Belize is presently in a transitory phase shifting the burden of responsibility for protecting the country's sovereign rights from the U.K. to Belize . With the establishment of the "marine wing" of the R.D.F. it is hoped that many of the enforcement problems can be resolved . This approach can be assisted through provision of short briefing courses for the B.D.F. covering existing legislation and the associated technical points sponsored by the respective sector administrative units . In addition, enforcement officers from these units should be allowed to accompany R.D.F. patrols to increase patrol effectiveness .

As presently constituted, the Fisheries Unit (F.U.) is administrative ly

housed in the Ministry of Health, Housing and Cooperatives . This configuration was based on the rationale that the F.U. should be in administrative proximity to the department responsible for the well-being of the cooperatives, many of which are fishing cooperatives . However, if it is the F.U.'s primary responsibility to manage the nation's fisheries, then the possibility exists for the Unit to be placed in a compromising situation whenever a management decision required to preserve a fishery stock adversely affects the fisherman .

Further, in the context of a multisectoral approach to coastal area management, the F.U. would be better housed in the Ministry of Natural Resources where several other bodies responsible for coastal affairs exist (Dept. of Forestry - mangroves, Petroleum Office - offshore exploration, Lands and Surveys - coastal zone, cays and continental shelf ownership and development) .

To complete this multisectoral approach it is further recommended that study be given to an interministerial body composed of representatives from the M.N.R. and other government bodies with coastal administrative interests (notably the Tourism Board, Department of Archaeology, Water and Sewerage Authority and Port Authority) . The primary objective of the body would be to provide a better means of coordination and communication between government agencies responsible for managing the coastal area . Furthermore, the body could provide a review function of proposed government and private sector activities in the coastal area to assess environmental significance and recommend modifications where appropriate . Finally, it could be the responsibility of the proposed body to develop a management plan for the country's barrier reef regulating its future use .

In recognition of the importance of education in natural resources management, as a final recommendation the G.O.B. should begin to expand on the present limited curricula in both primary and secondary schools . In light of the importance of Belize's coastal and marine resources, special emphasis should be

placed in this area . The University of the West Indies with an office in Belize would be a particularly valuable resource for developing such a curriculum, as Jamaica's Mona campus is well known for its high level of competence in marine ecology .

Table 1

Morphological Types of Cays Found in Belizean Waters
(Source: Stoddart et al 1982)

Unvegetated Sand Cay	Small ephemeral islands often forming and reforming following hurricanes.	Paunch and Curlew Cays
Vegetated Sand Cay	Larger islands with a vegetation of strand scrub and woodland.	Nicolas and Tobacco Cays
Unvegetated Shingle Cay	Small ephemeral cays located in exposed situations.	
Vegetated Shingle Cay	Small cays located in exposed conditions often on small patch reefs.	North Spot and Ragged Cays
Sand and Shingle Cay	Smaller stable islands in exposed conditions. These are vegetated with a windward shingle ridge and leeward sand area.	Northeast Sapodilla Cays
Mangrove Cays	Cays found in the lagoon colonized by <u>Rhizophora mangis</u> .	Jack's Cay
Shelf Islands	Islands formed through sediment accretion on submerged topographic features in northern part of the lagoon.	Cay Chapel and Cay Caulker
Mangrove Cay with Dry Sand Areas	Mangroves islands with sand flats on the windward side usually in protected areas.	Wild Cave and Frenchman's Cays
Mangrove Range	Extensive and complex array of mangrove islands separated by partially enclosed bays and lagoons.	Tobacco Range and Drowned Cays
Moat Islands	Association of leeward sand areas, interior mangrove swamp, lagoon and windward shingle ridge.	Snake Cays
Coastal Barrier Islands	Barrier beaches or separated headlands.	Harvest Cay

Table 2

Comparisons Between Coastal and Total Populations in Belize .

District/Coastal Urban Center	1970	1980	% Increase
Belize/Belize City	39,050	39,771	0.2
Corozal/Corozal Town	4,682	6,899	47.0
Stann Creek/Dangriga	6,967	6,661	-4.0
Toledo/Punta Gorda Town	2,131	2,396	12.0
Sub Total	52,830	55,727	5.0
District/Coastal Rural Villages			
Belize/Ambergris Caye	739	1,136	35
Belize/Caye Caulker	410	435	8
Corozal/Chunox	280	439	36
Corozal/Consejo	55	60	8
Corozal/Copper Bank	129	190	32
Corozal/Sarteneja	700	1,005	30
Stann Creek/Hopkins-Commerce Bight	601	749	20
Stann Creek/Mango Creek-Independence	827	1,474	44
Stann Creek/Placencia Village	290	334	13
Stann Creek/Riversdale	54	54	0
Stann Creek/Seine Bight	500	465	-8
Stann Creek/South Stann Creek	-	61	-
Toledo/Barranco	259	229	-13
Toledo/Cattle Landing	125	97	-29
Sub Total	4,969	6,728	26
Total Coastal Population	57,799	62,455	7
Total Population	119,934	145,353	17

980 Ratio	Coastal Urban Population: Total Coastal Population =	89
	Coastal Urban Population: Total Population =	38
	Coastal Rural Population: Total Population =	5
	Total Coastal Population: Total Population =	43

TABLE 1
Belize Fisheries Production and Value Exported in 1982
 (Source: Fisheries Unit)

Commodity	National	Northern	Caribena	Placencia	Sartaneja	Independence	Total
Lobster							
weight (lbs.)	198,360	199,560	152,200	39,800	20,190	-	610,110
value (\$U.S.)	1,636,470	1,646,370	1,255,650	328,350	166,567	-	5,022,407
Conch							
weight	109,000	66,400	24,800	64,500	49,650	-	314,350
value	231,625	141,100	52,700	137,062	105,506	-	667,992
Shrimp							
weight	-	-	5,950	1,600	-	-	7,350
value	-	-	29,750	8,000	-	-	37,750
Fish Fillet							
weight	3,400	5,960	5,500	7,450	-	-	22,310
value	6,375	11,175	10,321	13,968	-	-	41,831
Whole Fish							
weight	117,750	153,992	16,450	173,500	-	-	461,692
value	88,312	115,494	12,337	130,125	-	-	346,269
Salt Water Aquarium Fish							
weight	-	-	-	-	-	8,325	8,325
value	-	-	-	-	-	6,244	6,144
Freshwater Fish							
weight	-	-	-	-	-	1,960	1,960
value	-	-	-	-	-	1,225	1,225
Freshwater, Fillet							
weight	-	-	-	-	-	12,700	12,700
value	-	-	-	-	-	16,050	19,050
Stone Crab (claws)							
weight	-	1,475	-	-	-	-	1,475
value	-	4,793	-	-	-	-	4,794
Total Value							6,158,564

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Trends in Hotel Development and Bed Availability in Belize.

(Source: Abstract of Statistics 1981)

Area	No. of Hotels					No. of Beds				
	1978	1979	1980	1981	1982	1978	1979	1980	1981	1982
Coastal Hotels (Mixed Clientel)										
Corozal	7	6	5	7	7	85	94	108	139	139
Belize City Area	31	44	47	45	42	630	759	796	772	767
Stann Creek	4	5	4	6	6	77	84	81	95	94
Punta Gorda	3	5	5	5	5	36	44	58	56	56
(Primarily Tourist Clientel)										
Ambergris Caye	19	21	25	33	32	344	401	421	529	548
Turnoffe Area	2	2	2	2	2	28	30	34	36	32
Placencia	2	2	2	6	5	24	24	26	47	44
Caye Chapel	1	1	2	1	1	47	46	49	49	46
St. George's Caye	1	1	2	1	1	12	18	31	21	21
Caye Caulker	9	14	12	12	15	78	152	160	158	193
Sub Total	79	101	105	119	116	1,363	1,637	1,764	1,902	1,940
Inland Hotels										
Cayo	8	10	7	13	14	101	147	134	171	206
Belmopan	1	1	1	1	1	6	6	6	6	6
Orange Walk	4	3	5	7	7	56	46	64	86	82
Sub Total	13	14	13	21	22	163	199	204	263	294
Total Belize	92	115	118	140	138	1,526	1,836	1,968	2,165	2,234

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Ship Arrivals for Belizean Ports (1)

Ship Type	Draft	No. of Vessels (2) 7/80 - 3/81	Draft	No. of Vessels 4/81 - 3/82	Draft	No. of Vessels 4/82-3/83
Lo/Lo (Breakbulk Cargo)	9'-16'	144	9'-16'	163	9'-16'	116
Lo/Lo (Container Cargo)	12'-16'	31	12'-16'	58	11'-16'	53
Ro/Ro	12'-16'	12	11'-14'	33	10'-14'	29
Sugar Vessels	13'-17'	20	15'-18'	22	14'-24'	18
Fuel Tankers	17'-19'	6	17'-19'	8	18'-19'	8
Caroline Vessels	23'-25'	25	23'-26'	34	23'-26'	32
Total		238		318		256

- (1) Only for Belize City and Commerce Bight Ports.
 (2) Belize Port did not open until July 1980.

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Table 6

Import/Export Statistics for Belizean Ports (1)
(Source: Belize Port Authority)

<u>Imports</u>	
Breakbulk	6,596.48
Container	46,321.35
Fertilizer	2,683.54
Cement	4,970.49
Lumber	
Fuel	61,394.85
Wheat	6,631.45
<u>Total</u>	<u>128,598.16</u>
<u>Exports</u>	
Breakbulk	2,084.62
Lumber	6,330.99
Sugar	113,821.60
(2) Citrus	6,682.77
Container	4,536.64
Molasses	47,059.38
<u>Total</u>	<u>180,516.00</u>
<u>Total Cargo Throughput</u>	
(2) Citrus	6,682.77
Breakbulk	8,681.10
Container	50,858.00
Fertilizer	2,683.54
Cement	4,970.49
Lumber	6,330.99
Fuel	61,394.85
Sugar	113,821.60

Table 6
(Cont.)

Wheat	6,631.45
Molasses	47,059.38
Total	309,114.17

(1) Only for Belize City and Commerce Bight
Ports .

(2) All citrus is exported through Commerce
Bight Port .