

16. STATUS OF CORAL REEFS OF MESOAMERICA – MEXICO, BELIZE, GUATEMALA, HONDURAS, NICARAGUA AND EL SALVADOR

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ABSTRACT

The coral reefs of this region have changed considerably following a series of major natural disturbances and the impacts of human stresses. Reefs on the Atlantic side were battered by hurricanes in 2000, 2001 and 2002, which struck the reefs from the Mexican Yucatan Peninsula to Honduras, destroying corals with some losses up to 75% in Belize. These impacts follow closely on the heels of the extreme coral bleaching event and Hurricane Mitch in 1998, which also caused widespread damage to the region's reefs.



Throughout large parts of the region, there are intense fishing pressures and major threats to reefs from poor land-use practices and unregulated coastal development. A region-wide survey in 2001 found that coral cover had not increased since the 1998 disturbances and coral diseases were found throughout the region. The Mesoamerican Barrier Reef System (MBRS) Initiative has gathered considerable support for public and private conservation efforts in the region. This regional cooperation program between Belize, Guatemala, Honduras and Mexico is addressing: key aspects of marine protected areas (MPAs); environmental information systems; environmental monitoring of coral reefs and associated ecosystems; public awareness and formal and informal education. Capacity to monitor and manage coral reefs varies enormously in the region, from advanced to basic. The MBRS Initiative and the WWF Ecoregional Conservation Program are working with national, regional and international partners to improve management of the coral reefs and fisheries resources in these countries, and to understand and address land-based sources of marine pollution, and to resolve trans-boundary management issues.

INTRODUCTION

Coral reefs along the Caribbean coasts of Mesoamerica are well developed with relatively high biodiversity, whereas those on the Pacific side are usually smaller, less diverse, and with an isolated or patchy distribution. Most of the Pacific reefs are off central Mexico, and these are limited by frequent cold, nutrient-rich upwellings and El Niño events which result in localised extinctions. In addition, many rivers dump sediments on the coastal shelf from southern Mexico south to the Gulf of Fonseca, and Nicaragua. There is little reef development until further south in Costa Rica.

Reefs on the Caribbean side are well-developed and extensive, and include the Mesoamerican Barrier Reef System (MBRS) which is the second longest barrier reef system in the world, extending over 1000km through Yucatan, Mexico, Belize and east to the Bay Islands in Honduras. There are also many patch, fringing, and atoll-like reefs, which have high biodiversity of fishes, invertebrates, birds, plants, sea turtles, and mammals. There are several distinctive areas on the Caribbean coast: SW Gulf of Mexico; extensive fringing and barrier reefs along the Yucatan and Belize coast; 4 unique atolls (Banco Chinchorro, Turneffe Island, Lighthouse, and Glovers Reef); small coral communities along mainland Guatemala and Honduras, and the Bay Islands; and extensive reef complexes in Nicaragua. All reefs are influenced by pressures from the land including the direct human pressures of coastal development, over-fishing, agricultural and industrial run-off, deforestation, land-use, and sewage pollution. Two major climate events in 1998 (El Niño mass bleaching and Hurricane Mitch) caused severe damage to reefs along the Mesoamerican Corridor (Yucatan, Belize, Guatemala, Honduras).

Coastal activities have traditionally been relatively minor within national economies, which are mostly based on agriculture and small industries. However, the rapidly growing tourism industries, focused primarily on coastal centres and the emerging cruise industry, have recently become the major economic force in much of the region, particularly in Belize and Mexico.

There is little available information on the status of Central American reefs, except for those in Yucatan Mexico, Belize, and the Bay Islands. Little is known of the extensive reefs

and coral communities of Nicaragua, along the mainland of Honduras and Guatemala, on offshore islands and banks like Swan Islands and the Mysteriosa banks in Honduras, parts of the Belize reef complex, and other reefs in the eastern Pacific coast. Some of these gaps will be filled during the development of the MBRS project, which is a regional conservation program involving Belize, Guatemala, Honduras, and Mexico. It is funded by the Global Environment Facility, implemented by the World Bank and executed by the Comisión Centroamericana de Ambiente y Desarrollo (CCAD) and headquartered in Belize. This has started the first 5 years of the planned 15 years. There are also significant NGO counter-part programs addressing regional conservation efforts, such as the World Wildlife Fund (WWF) MesoAmerican Caribbean Reef Ecoregional Conservation Program, which is focused on: supporting MPAs and forming a representative MPA network; developing sustainable tourism and fisheries management; improving watershed management; and creating a long-term and sustainable funding. These efforts are complemented by other international NGOs (The Nature Conservancy, Wildlife Conservation Society, and IUCN- The World Conservation Union) and numerous local NGOs. The capacity to monitor and manage coral reefs varies enormously in the region, and all of these efforts seek to increase this capacity.

REEF DESCRIPTIONS

Mexico

There are three distinct coral reef areas in Mexico. The Pacific coast, Baja California and offshore islands, have 12 to 15 hard coral species on the coast and 18 species on the offshore Revillagigedo Islands. These reefs are not well developed and often restricted by cool temperatures. Reefs and coral communities are small and patchy with low abundance of soft corals, sponges, crustaceans, and echinoderms.

The Southwest Gulf of Mexico contains about 20 reefs off Veracruz, which are influenced by high turbidity from the coast. The coral diversity is low with only 45 species. The reefs on the Campeche Bank are better developed in the cleaner water, but suffer from over-fishing and oil exploration.

There is an extensive fringing reef along the Yucatan Peninsula from Isla Contoy south to Xcalak, including offshore islands and the Banco Chinchorro atoll. These reefs continue as the Belize barrier reef and have 56 hard coral species. Reefs in the north (Quintana Roo) have low coral cover (17%), but with prominent patches of dead and recovering *Acropora palmata*. There are better developed, shallow platform reefs in the central and southern areas, and Banco Chinchorro is a large (46km x 14km) atoll, surrounded by well-developed reefs. Tourism is a major activity in Quintana Roo, and is expanding rapidly, imposing new threats to these reefs.

Belize

It has the second longest barrier reef in the world (250km long) with a mix of lagoon patch reefs, fringing reefs, and offshore atolls. The northern reefs are well developed and continuous from Mexico to Caye Chapel, and then discontinuous and less developed south to St. Georges Caye. The central reefs are continuous and well developed, whereas the southern reefs are discontinuous and less well developed. The many patch reefs to the

south of the central barrier are dominated by *Montastraea annularis*. Lighthouse, Turneffe, and Glovers are offshore atolls with different coral communities on leeward and windward slopes. Turneffe has extensive mangroves in a shallow lagoon, while the others have deep lagoons and many patch reefs. Belize is relatively sparsely populated and the coral reefs are important for commercial and artisanal fishing, and aquaculture. Tourism and the export of marine products are increasing rapidly, but the coastal populations are decreasing.

Guatemala

Most of the coastline is on the Pacific, where there are few reefs. The narrow coast in the Caribbean has many mangroves, seagrass beds and coastal lagoons. Major rivers limit reef development to isolated coral communities and small patch reefs in the Gulf of Honduras. Coastal communities use the reefs for food and transport and also rely on catching fish in Belize waters.

Honduras

Coral reefs on the Caribbean coast are restricted by sediment runoff from the mountains, with the best reefs around the 60 offshore Bay Island groups: Roatan, Utila, Guanaja, and Cayos Cochinos. These reefs grow to 9-12m depth before a deep wall to 75m. The dominant coral is *M. annularis*, with some *Acropora palmata* and *Agaricia tenuifolia* on the shallow fringing reefs. There are fringing reefs around the Swan Islands, and small fringing and patch reefs near the Mosquitia Cays and Banks. There are no reefs on the Pacific coast. The indigenous communities rely on subsistence fishing, and now tourism is developing on the Bay Islands.

Nicaragua

Little is recorded of the extensive reefs that grow on the broad carbonate banks (Miskito Bank, Man O'War Cays, Crawl, Taira, Pearl, and Set Net Cays and Little and Big Corn Islands) of the Caribbean coast, whereas near-shore reef growth is limited by high sedimentation with about 10% coral cover. The Miskito Cays are mangrove islands surrounded by fringing coral reefs, extensive seagrass beds, with abundant corals on the seaward slopes. There are also patch reefs, large pinnacles and fringing reefs, but these are poorly known. The Pearl Cays have thickets of *A. palmata*, and the large Corn Islands have three fringing reefs on the northeast side along with numerous patch reefs. *A. palmata* and *M. annularis* are the major reef building corals, averaging 25% coral cover. Reef development is limited on the leeward side of the islands. There are virtually no corals on the Pacific side, except isolated patches of *Pocillopora* corals and scattered gorgonians. Reefs are largely ignored in this mostly agricultural country with only 10% of the people living on the Caribbean coast where they harvest marine resources from their traditional land and sea territories. The Miskito Indians are mostly subsistence fishers within the Miskito Coast Marine Reserve.

El Salvador

There is a small rocky system at Los Cobanos, in Sonsonate, that has some coral communities on the Pacific coast, but little is known about these. This is the smallest country in Central America with 6 million people, mostly Mestizo Indians.

STATUS OF THE CORAL REEFS

The coral reefs in this region clearly show the effects of severe recent disturbances; Hurricanes Keith (2000) and Iris (2001) damaged reefs along Belize and Hurricane Isidore hit the northern part of the Yucatan Peninsula in September 2002, affecting large areas inland. There have also been recurrent bouts of coral bleaching throughout the 1980s and 90s, which have resulted in major changes in the coral populations on both sides of

THE MESOAMERICAN CARIBBEAN REEF ECOREGION EXPEDITION

The expedition was the first time regional scientists collaborated on coral reef surveys of the entire Mesoamerican Reef System, from Mexico to Honduras. The goal was to gather information to refine an Ecoregional Conservation Plan and assist local NGOs, government departments, policy makers and affiliated projects in the region with their conservation efforts. The expedition was organised by the WWF (World Wildlife Fund - USA) Mesoamerican Caribbean Reef Program in late 2001, along with researchers from Amigos de Sian Ka'an and SEMARNAP (Mexico), Coastal Zone Management Institute and Belize Audubon Society (Belize), Honduras Coral Reef Fund and DIGEPESCA (Honduras). The main goals were: to determine the ecological status of reefs throughout the region; monitor recovery from 1998 disturbances; and give local researchers ecoregional perspective and training. They examined 36 sites in 4 sub-regions and found that the reefs had an average live coral cover of 15.2% (range 2.6% to 39.7%). The density of recruits or juvenile corals was 7.5 per m² (range 1.0 to 14.6 per m²). There were 26.7 (range 18 to 33) hard coral species on average per site, and 3.3% of 3,692 corals showed active disease infections (range 0-11.5%). The most common were 'white plague' and 'dark spot' diseases, with 'dark spot' and 'white band' more common in the 2 northern sub-regions, while 'black band' and 'white plague' were more common in the south. It is hoped that these disease data can help pinpoint specific impacts or conditions in these zones that may help explain the causes. Overall the average recent mortality (including parts of colonies that died in the last year) was 1.7% (range 0.2 to 4.4%). The expedition discovered some interesting trends e.g. coral diversity is highest in the south, while coral abundance (adults and juveniles) is higher in the north. Of particular concern was the relatively low coral cover in many sites, particularly in the Honduras and Belize sub-regions. Coral cover of 25-30% would be considered good for the Caribbean, and recent patterns of coral diseases and coral mortality are very complex. Diseases were highest in the North Honduran Coast subregion, and lowest in Belize, and the Sian-Ka'an / Ambergris region had high variability in disease levels, potentially indicating that some local stresses and not regional problems are the major influences e.g. possibly local development. Whereas in Honduras, widespread stresses like agricultural run-off may explain the consistently high disease levels. While Belize had the lowest average disease rate, there was relatively high recent mortality, suggesting other causes of mortality such as bleaching and hurricane damage. The participants welcomed the opportunity to study reefs of their ecoregion in a relatively short timeframe, which gave them invaluable insights and perspectives. These data will help WWF and partner organisations monitor the performance of conservation efforts. Contact: Melanie McField, mcfield@btl.net.

Central America. These climate related events have also resulted in major impacts to the agricultural and other food producing industries in the State of Yucatan, which was among the five main national producers of pork, chickens, eggs, etc. The losses in these agro-industries are estimated to be up to 80%. The full impact of hurricane Isidore on the marine resources has not been evaluated as yet. The combined effects of this event and the resulting flooding and sedimentation in the region, along with white band and bleaching events are expected to have long-term ecological consequences for the coral reefs.

The MBRS has a long-term monitoring program to assess the health of the coral reefs and associated ecosystems (mangroves, seagrass beds and other coastal wetlands). A reef expedition was organised by WWF to assess the reefs from Mexico to Honduras (see below). These fore-reefs (15-17m depth) still show the impacts of the severe disturbances of 1998, with little recovery apparent. Average live coral cover for the region was 15%, substantially lower than pre-1998 values. The region is divided into 6 sub-regions, with the 4 examined containing the majority of the reefs.

Summary of the 2001 Expedition averaging coral data from the 36 sites in 4 regions.

Sub-Region	Coral species	% Coral cover	Juveniles per m ²	% Coral disease	% Recent mortality
North Quintana Roo	24.5	24.5	12.2	3.0	2.7
Sian Kaan/Ambergris	26.4	20.3	7.0	3.7	1.1
Belize	26.5	12.9	7.6	2.3	1.9
North Honduras	27.6	10.1	6.9	4.4	1.8
Overall	26.7	15.2	7.5	3.4	1.6

Mexico

Reefs on the Pacific and the Atlantic coasts are under pressure from tourism activities, which include boat groundings, alteration to the coastal fringe, potential loss of mangrove and the resulting loss of protection from storms. Coral diseases continue to be present in the Yucatan area, including both some of the highest and lowest infection rates found in the region (ranging from 0%-11%). In general, coral cover and juvenile density is higher but species richness is lower than in other parts of the MBRS. Mexican reefs have received considerable attention and researchers from government and NGOs conduct coral reef research and monitoring in the country. Recently, the Comisión Nacional de Areas Naturales Protegidas (CONANP) organised a workshop to develop a Mexican Monitoring Protocol, which was presented to the MBRS Initiative as the Mexican contribution to the regional monitoring effort. These new activities should greatly enhance the existing knowledge of the reefs.

Belize

Coral reef monitoring has been conducted in several key areas by a combination of government agencies, NGOs and universities. Some monitoring activities have involved short and longer-term efforts, which have generated considerable information on the status of reefs and some of the key species in the area. Coral reef monitoring had been constrained by funding, logistics and manpower. New activities in 2000 included the pilot phase of a coral reef monitoring component of the Caribbean Planning for Adaptation to Global Climate Change Project (CPACC), which assessed the fore-reefs of the Hol Chan,

South Water Caye and Glovers Reef Atoll marine reserves. These surveys showed low coral cover, less than 20% at all sites. Cover of macro algae was also low, which is encouraging. To ensure the recovery of coral cover, it will be necessary to implement sound management to improve water quality by controlling coastal developments. Maintenance of fish populations is also crucial to control macroalgal growth. A follow up project,

CONSERVATION OF GLOVERS REEF, BELIZE: A REMOTE CARIBBEAN ATOLL

Glovers Reef is one of 3 atolls off Belize and it has 6 sandy cays and some of the best developed reefs of high diversity in the Caribbean. The atoll has an emergent reef crest, with 3 channels that open into the 6-18m deep lagoon with 700 patch reefs. Outside the lagoon, the water drops to 1000m. Although it is 45km offshore, the reefs are subject to increasing direct and indirect human pressures, including over-fishing, coral bleaching, diseases, fleshy algal dominance, and increasing tourism damage. The Government of Belize declared the Glovers Reef Atoll as a Marine Reserve in 1993 and as part of the Belize Barrier Reef World Heritage site in 1996. The Reserve aims to conserve ecological processes, preserve genetic diversity and sustainable yields through informed management of species and their habitats, maintain natural areas for education and research, and provide social and economic benefits through ecologically sensitive tourism and recreation. There are 3 management zones: a small wilderness zone, where resource removal is prohibited; a larger no-take, conservation zone where non-extractive uses are permitted; and the general use zones, where fishing is allowed. The Wildlife Conservation Society (WCS) established the Glovers Reef Marine Research Station on Middle Cay in 1993 to promote the long-term conservation and management of the reefs through research, cooperative management, training and education. The research station also serves as the marine park headquarters for the Government of Belize. Monitoring has shown that key target fish species are more abundant and larger inside the reserve than outside e.g. the Nassau grouper (*Epinephelus striatus*) aggregates to spawn on the northern tip which has been temporarily closed by the Belize Fisheries Department. However, fishing has probably reduced the numbers of aggregating grouper by 90%. This indicates that continued protection of grouper aggregation sites is essential for long-term conservation. Another indication of over-fishing is higher grazing by the sea urchin *Echinometra viridis* in open areas where urchin predators have been over-fished. In the early 1970s, the patch reefs were dominated by hard coral (*Porites*, *Acropora* and *Montastrea*), but algae are dominant now, probably due to white-band disease killing the *Acropora* corals, and to reduced populations of herbivores that allow the algae to overgrow the corals and prevent larvae settling. Hurricanes normally hit the Belize coast about every 10 years, and the major Hurricane Mitch passed near the atoll in 1998 and caused severe damage to the windward slopes, but little damage to the patch reefs and the leeward slopes. The major themes of the Station are research and capacity building with an internship program for students of the University College of Belize. From: Liz Lauck, The Wildlife Conservation Society, New York <llauck@wcs.org> and Tim McClanahan, The Wildlife Conservation Society, Mombasa, crcp@africaonline.co.ke; Glovers Reef Marine Research Station Manager, glover@btl.net.

Mainstream Adaptation to Climate Change (MACC), has recently started, and Belize will be a full participant.

The 50% reduction in live coral cover that occurred between 1997 and 1999 (mainly attributed to hurricane Mitch and the coral bleaching event) has remained relatively unchanged in 2001. The disease infection rate was the lowest in the region although some sites, particularly near Ambergris Caye, had up to 12% colonies infected. The density of juveniles (7.6 per m²) for Belize sites was comparable to results in 1999. The coral cover and species richness were about average for the ecoregion, and the site with the highest species richness, Goffs Caye, is found in the central zone of the reef.

Guatemala

There have been no surveys of the distribution and condition of coral communities. The reefs were probably heavily impacted by Hurricane Mitch, especially from storm run-off and the 1998-bleaching event. Hurricane Iris in 2001 caused major flooding and sedimentation in the Rio Motagua area.

Honduras

The reefs of the Bay Islands and Cayos Cochinos had the highest coral species richness in the ecoregion, although the coral cover and juvenile density were lower than other areas of the MBRS. In addition, the coral disease infection rate ranged from 2.1%-8% with the highest mean for the region (4.4%). It appears that the impacts of Hurricane Iris in 2001 on the reefs north of Honduras were not as severe as those in Belize. Apparently no major direct damage was suffered by the reefs in the Bay Islands, however, there was major damage in the river areas of the Rios Chamelecon and Ulua by increased flooding and sediment release. The full effects of Iris on the reefs and coastal areas need to be evaluated.

Nicaragua

The Caribbean coastline is not highly developed nor studied in depth, however there has been considerable deforestation inland which has resulted in increased sediment loads that have degraded coastal reefs. There are also problems with excessive and damaging fishing and pollution from untreated sewage. Coral cover is generally low, around 25%, with 5% soft corals. Little is reported on the status of the more extensive reef of Pearl Cays, or the extent of damage from Hurricane Mitch. Damage, however, is likely to have been substantial as the hurricane passed over the Bay Islands and caused considerable flooding on land.

El Salvador

No new information has been received on the Los Cobanos coral reefs.

STATUS OF CORAL REEF FISHES AND FISHERIES

Coral reefs in Mesoamerica provide important animal protein foods for subsistence populations. Fishing pressures have intensified with increasing demand and better fishing gear. Spawning aggregations in the entire Mesoamerican region are particularly at risk since their location depends intimately on recognisable features of cayes and reefs. Fishing pressure has been particularly high on some of the spawning aggregations e.g. the Nassau Grouper, which is currently on the IUCN Red List of Threatened Animals.

Over-fishing, illegal fishing, destructive fishing and lack of enforcement of fisheries legislation have remained a problem in the region, although there are several initiatives to address this situation. Most of the reef fisheries rely on healthy reefs, however, coastal development has continued in the region, particularly on the northern part of the Yucatan Peninsula. Anthropogenic impacts to the coral reefs and associated ecosystems in the Mesoamerican Region are being monitored within the MBRS Project, and complemented by international and local NGOs, and universities researching in the region.

Mexico

There are 346 reef-associated fishes in Mexico, of which at least 245 reef fish are found on the Atlantic coast of Mexico: 68% of these in the Gulf of Mexico; and 92% along the Yucatan Peninsula. Herbivores are dominant on the Gulf of Mexico reefs, carnivores are more abundant in the Caribbean, and important families include Scaridae, Pomacentridae, Labridae, Acanthuridae, Lutjanidae, Haemulidae and Serranidae.

Belize

The highest fish diversity in the region occurs in Belize with more than 317 reef fish species with large numbers of surgeonfish and parrotfish. There is a small but expanding commercial fishery in Belize as well as considerable subsistence fishing. The Fisheries sector ranks third as a foreign exchange earner and earned over US\$35 million in 2000. Farmed shrimp were the most valuable component (US\$23million), but lobster exports (\$9.5 million) and conch (\$2.5 million) have both increased from 1999 to 2000, and have been relatively stable over the last two decades. The impacts of Hurricane Keith on the fishing industry were substantial, with the loss of revenue greater than US\$6 million. Hurricane Iris further added to the stress in southern Belize. There is a good legislative basis for effective marine fisheries management, in particular the prohibition of fishing with scuba gear, or using nets along the reef or traps outside the reef, or breaking closed seasons and size limits for conch and lobster. The challenge is to enforce such regulations, reduce illegal fishing and maintain the infrastructure required to patrol the large reef area. A coalition of local and international NGOs has recently spearheaded an effort to enact legislation in Belize to protect the Nassau grouper spawning sites and declare a closed season or even protect the species. The government of Belize is expected to make the final decision before the 2002-2003 spawning season. The year-round closure of these spawning sites will help conserve a range of species, which use the spawning sites. This legislation will set an important precedent in the region and efforts will be made to replicate the strategy in other countries.

Guatemala

There are 218 reef fish species in Guatemala, and there is a minor commercial fishing sector. There are small-scale fisheries for fishes, sharks, rays and skates, and the yellowleg and *Penaeus* shrimps on the Pacific side. On the Caribbean side the main fish include manjua, shrimp, red snapper, mutton snapper, billfish, jack, tarpon, and snook. Little is reported on the fish resources and fishing levels, but there are indications of over-exploitation.

Honduras

There are at least 294 reef fish species in Honduras and 226 in Cayos Cochinos Biological Reserve, and there is some evidence of over-fishing by small-scale local fisherman and industrial fishing fleets. Around 78% of all households in the northern region have a family member involved in fishing, either industrial or artisanal; 29% of the households are involved in artisanal fishing and only 10% are completely dependent on industrial fishing for their livelihoods. Occasional fishing occurs continuously by many industrial fishers outside the main fishing seasons. A ban on lobster fishing using scuba gear was recently enacted within the Cayos Cochinos Natural Monument, after the fishermen participated in a WWF coordinated exchange program with the managed lobster fishery in the Banco Chinchorro Biosphere Reserve, Mexico. As in many other countries, it is difficult to separate fin fish and aquaculture catch statistics from the industrial catches.

Nicaragua

Much less is known about the reef fishes in Nicaragua, although the species composition is probably similar to reefs in adjacent Caribbean countries. Fish are important for local and domestic consumption, and fish stocks continue to be under serious pressure. Lobsters are the most valuable product, but there are also fisheries for fish, shrimp and aquarium species. Many turtles are harvested for local consumption and sale.

El Salvador

There are commercial and artisanal fisheries on the reefs, and the total annual landings registered between 1991 and 2000 were greater than 13,000 tons; 72% of which was from artisanal fishers. The net value of the fisheries production for 2000 was US\$29 million. A marked increase in the exploitation of coastal resources out to 100m depth, has stimulated the development of a new legal framework to incorporate appropriate management measures for these resources. These include new models of participatory management and the establishment of conservation measures. There are 552 marine fish species in Salvadorian marine and coastal waters, of which 128 are reef associated species. However, the proportion of reef fish in the catch is unknown. The shrimp fishery continues to be the most important revenue earner, with most of them exported to the USA, and there are indications that the stocks are being over exploited.

Summary of the known status of the marine and reef-associated fish species in Mesoamerican countries from FishBase and IUCN sources.

Country	Marine	Reef Associated	Threatened	Threatened Marine	Under Treaties & Conventions
Mexico	1725	353	114	35	28
Belize	554	237	21	20	14
Guatemala	763	218	16	15	22
Honduras	924	286	14	14	15
Nicaragua	1013	260	19	19	18
El Salvador	552	128	4	4	15

ANTHROPOGENIC THREATS TO CORAL REEF BIODIVERSITY

The greatest threats to coral reef biodiversity are derived from human activities, compounded by natural disturbances. This was emphasised in 1998, when there was a mass climate change bleaching event and Hurricane Mitch, which severely damaged the reefs. The impacts of the Hurricane were exacerbated due to massive loads of sediment flowing into coastal waters from poor land-use practices. The long-term recovery of these reefs will depend predominantly on the ability of governments and managers to reduce the level of anthropogenic disturbances, otherwise there will be severe ecological and socioeconomic consequences.

The GEF/World Bank MBRS Initiative identified the main threats to the coral reefs of Belize, Guatemala, Honduras and Mexico as: 1) inappropriate coastal/island development and unsustainable tourism; 2) inappropriate inland resource and land use and industrial development; 3) over-fishing and inappropriate aquaculture; 4) inappropriate port management, shipping and navigation practices; and 5) natural oceanographic and climate meteorological phenomena. The process also identified locations of significant trans-boundary hot spots that threaten the shared reef resources of these countries, which is now a special focus for remediation.

The main threats along the Pacific coastlines are excessive sedimentation from deforestation, anchor and other diver-related damages, and illegal fishing. The remote Caribbean coast of Nicaragua has limited development, except by the indigenous communities, although there is some over-fishing, coral extraction, oil pollution, deforestation, soil erosion and sedimentation, and water pollution. Untreated sewage, fish processing and industrial activities have resulted in poor water quality around coastal communities and inhabited cays. Sedimentation and eutrophication from deforestation in Honduras are damaging the Miskito Coast Marine Reserve, and there is intense foreign fishing for lobster, fish and turtles, especially from nearby Honduras. There are similar threats in El Salvador e.g. deforestation and soil erosion, water pollution, soil and water contamination from toxic wastes, and frequent earthquake and volcanic activity.

POTENTIAL CLIMATE CHANGE EFFECTS ON CORAL REEFS

The major signal of potential climate change threats occurred during the 1990s which was the warmest decade with a series of extreme El Niño events. These resulted in considerable coral bleaching and mortality in the region with major alterations to the composition and structure of the coral reefs. Added to this were several major Hurricanes, including Mitch, which was the most severe on recent record. The predictions for future increases in global temperatures, added to the additional anthropogenic stresses indicate that recovery from these acute disturbances may be delayed, and major shifts in community structure, including losses of live coral cover, can be anticipated.

CURRENT MPAs, MONITORING PROGRAMS AND CONSERVATION MANAGEMENT CAPACITY

The awareness for conservation and sustainable use of coral reefs is increasing in the region and programs or regulations are being developed for improved land use and control of coastal development, sustainable fisheries exploitation, pollution control, and sustainable tourism. Mexico and Belize have developed conservation programs for coral

HURRICANE IRIS IMPACTS ON BELIZE REEFS

Belize lies right in the path of many late season hurricanes, with the largest, Hurricane Mitch, slamming into the barrier reef and Glovers Reef in 1998 with windspeeds approaching 300km per hour. Mitch battered the coastlines and degraded many shallow reefs. Just 2 years later in October 2001, Hurricane Iris hit the southern coast of Belize with maximum sustained winds of 220km per hour. This storm, however, moved along a narrow tract in a southwest direction and hit Monkey River Town. Hurricane force winds extended only 30km from the centre affecting southern Glovers Reef and South Water Caye Marine Reserves, patch reefs southeast and west of South Water Caye Marine Reserve, the barrier reef section north of Gladden Split, Gladden Split Marine Reserve, Laughing Bird Caye National Park and barrier reef section north of Sapodilla Cayes Marine Reserve. The Belize Coastal Zone Management Authority and Institute surveyed 3 MPAs and found that the greatest impact was to the fore-reef of Laughing Bird Caye with average mortality of 19.6% and 'mechanical' damage to 70.7% of coral colonies. The fore-reef of South West Caye, Glovers Reef showed 12.2% recent mortality and 52% mechanical damage, and there was much less impact on the back-reef of Laughing Bird Caye (6.2% mortality, 26.7% damage), Gladden Split (1.0% mortality, 6% damage), and patch reef near South West Caye (4% mortality, 28% damage). The greatest mechanical damage was to *Acropora cervicornis* (staghorn coral), and species of *Porites*, *Montastraea* and *Siderastrea* corals, particularly tumbling damage to colonies e.g. 53% of colonies were knocked over on the fore-reef of Laughing Bird Caye. Gorgonians were also damaged by the hurricane, especially near South West Caye, where many were toppled or completely detached. The damage from Hurricane Iris will have long-term consequences for the Laughing Bird Caye National Park, which is a main tourist destination for Placencia, because the fore-reef has been devastated. Further assessment and monitoring is planned by the Authority to distinguish damage from natural causes and those that management can control e.g. fishing and coastal development. From: Nadia Bood, Coastal Zone Management Authority and Institute, Belize, czmbze@btl.net.

reefs; while there is some progress in Honduras, Guatemala and Nicaragua. The Belize Coastal Zone Management Authority and Institute is a model of integrated coastal management for the region and the country's system of 13 MPAs is well-established, with almost all the parks now under active management.

Marine Protected Areas

There are over 100 MPAs in Mesoamerica, covering 45,000km² of marine resources, including coral reefs, with most of them designed to protect fishery resources or critical habitat from damaging human activities. Mexico and Belize have a mix of both government and NGO management of MPAs, whereas management in Guatemala and Honduras is mostly through NGOs. Management effectiveness is very variable, ranging from 'moderately satisfactory' in Belize and Mexico, with reasonable success in reducing human impacts on coral reefs, whereas most others in the region remain as 'paper parks', due to inadequate funds to manage the resources. These issues remain the two greatest

challenges for the region's MPAs. An investigation is currently being conducted in El Salvador to review the System of Protected Areas.

Regional initiatives are fostering a broader perspective of the importance of a functional network of marine protected areas. Support is being developed for planning, management and monitoring of the effectiveness of the MPAs; institutional strengthening and financial sustainability mechanisms. The MBRS Initiative is working with 15 priority MPAs in the 4 participating countries, and there is major training of MPA personnel on several key issues under its objectives, including co-management of MPAs and preparation of management plans. WWF has identified 9 highest priority biodiversity areas in the ecoregion, which often encompass several protected areas. A regional initiative is currently under development to increase funding mechanisms and building human capacity, in order to tackle both in-country problems and trans-boundary threats.

Coral Reef Monitoring

Until recently, the capacity to monitor reefs varied considerably across the region. Most monitoring and research was done through a combination of local NGOs, MPA biologists, GCRMN, AGRRA, REEF, Reef Keeper and Reef Check, CARICOMP and numerous local and national programs, many of them short-lived. There has been recent monitoring in Belize and Mexico, and Honduras with a mix of government, NGO or academic involvement, but virtually none in Guatemala and Nicaragua. There had been poor coordination and data sharing among monitoring programs, with few successes in using the data for conservation decision-making. Most government agencies lack the funds and capacity for extensive monitoring programs.

COMMUNITY CONSERVATION EFFORTS IN XCALAK, MEXICO

The Meso-American Barrier Reef system is a focus for many agencies seeking to conserve some of the best coral reefs in the Caribbean. The U.S. Agency for International Development (USAID) has provided funds to the Coastal Resources Center at the University of Rhode Island to work in the State of Quintana Roo, near the Belize border. This is a small-scale success story that can be used as a model in the region. The community of Xcalak became greatly concerned in mid-1990s, about the decline in fish catches along their coast. Fishermen were spending more time on the water to catch the same amount of fish that they had caught a few years earlier in much less time. Then the community was informed about a government sponsored tourism development. The Xcalakeños participated throughout the process of designating the 17,000 hectares around the barrier coral reef as a National Park. The Xcalak Marine Park was officially declared in June 2000, making it one of the first locally initiated marine parks in Mexico. Community members are now implementing some of the components, including water zoning to separate fisheries and tourism activities, fisheries monitoring, and training to help local people engage in the ecotourism industry. The combined promotion of low-impact tourism development, linked to protection and conservation of the barrier reef through the marine park, has made Xcalak a learning example in coastal management for its neighbours on the Mesoamerican Reef system. Contacts: Lynne Hale, Izhale@gso.uri.edu; Richard Volk, rvolk@USAID.gov

A summary of marine and coastal protected areas in North Central America, with an assessment of their state of management (where information was available).

Country	No. of MPAs	Status of MPAs	Progress Since 2000
Belize	13 (marine) 7 (coastal)	11 of the 13 MPAs have active management, most through agreements with local NGOs.	Increasing support for MPAs Swallow Caye Wildlife Sanctuary established (2002) Many MPAs newly under active management
El Salvador	2	A System of Natural Protected Areas is under consideration for legislation by Government & the President.	Inclusion of Areas de Reserva Acuática (Aquatic Reserve Areas) in Sistema de Areas Naturales Protegidas is being considered
Guatemala	4	Established the first Manatee Protected Area, which has a management plan & staff administered by Universidad de San Carlos.	Increasing support for MPAs
Honduras	25	Some of the existing management plans need updating.	Increasing support for MPAs
Mexico	44 (marine & coastal)	Most MPAs have a management plan. Enforcement of legislation is improving & monitoring being developed.	Increasing support for MPAs National coral reef monitoring protocol developed
Nicaragua	4	Miskito Cay Marine Reserve is community managed.	No details available
TOTAL	91		

Monitoring programs in Mexico have included CARICOMP, AGRRA, REEF, Reef Keeper and Reef Check, and conducted by a range of institutions (academic, government and NGO). Similarly in Belize, monitoring activities have involved CARICOMP, AGRRA, CPACC and REEF methodologies and been conducted by MPA staff. Guatemala has few coral reef resources, and most monitoring is of land impacts or via a tourism perspective. NGOs have done virtually all the monitoring in Honduras and Nicaragua. The first region-wide reef survey was sponsored by the GEF MBRS Initiative in 1999 to assess damage following hurricane Mitch and coral bleaching. A second region-wide survey was coordinated by WWF in 2001 to determine the extent of recovery and any subsequent impacts.

Monitoring in Belize, Guatemala, Honduras and Mexico will increase within the MBRS Project, which has substantial funding and established harmonised and standardised monitoring methodologies for the region. Monitoring will focus on three core areas: coral reef ecology and associated ecosystems; marine pollution (from land-based and marine sources); and physical oceanography and models. The MBRS Initiative will develop a 3-D oceanographic model for the entire region to assist management understand current patterns in the region, interconnectivity between reefs, transport of eggs and larvae and dispersion of pollutants. The monitoring will involve the active participation of many partners from government agencies, NGOs, academia and coastal communities. The data and meta-data will be included in an environmental information system.

GOVERNMENT POLICIES, LAWS AND LEGISLATION

While most governments have signed major international agreements pertinent for coral reef biodiversity conservation, the most significant have been regional plans for government cooperation, especially the Declaration of Tulum and the Cartagena Convention. The Tulum Declaration was signed by the leaders of Belize, Guatemala, Honduras and Mexico to protect and conserve the fragile ecosystems of the Mesoamerican Barrier Reef, as a precursor to a large Global Environment Facility project to conserve these resources across national boundaries. Capacity within each country varies considerably, but generally there is insufficient infrastructure and institutional ability to implement international agreements and enforce national environmental laws. Funding of conservation policies and MPAs is an ongoing issue that is being addressed by the creation of a regional Mesoamerican Reef Environmental Fund which will establish a long-term endowment to support these activities.

Mexico has extensive legislation and is developing capacity to manage natural resources, with an effective protected areas program containing numerous ecological zoning programs responsible for regulating coastal activities. Belize has the legal and institutional policy framework to manage coral reefs, but may lack the long-term funding for enforcement and monitoring of the extensive system of MPAs. There is considerable reliance on international government and NGO support. There are few laws or regulations for coral reefs in Guatemala, but this is being remedied through the Declaration of Tulum and follow-on activities. Similarly in Honduras there are few laws and regulations on coral reef resources, and enforcement of these is weak. Nicaragua has no national legislation or institutional framework to conserve coral reefs. There are a few small MPAs, which are managed as partnerships between public and private sectors. In El Salvador, there is no legislation for coral reefs as there are few reef resources.

INFORMATION GAPS, MONITORING AND RESEARCH NEEDS

Although significant efforts have been made to address the lack of information on key issues to manage coral reefs and minimise human impacts, there are still large gaps in capacity and political will. The MBRS Initiative recommended 5 target areas that require further focus.

CONCLUSIONS

- The best developed reefs are on the Atlantic coast; Pacific reefs are poorly developed. Major information gaps remain for Nicaragua, Honduras and Guatemala, and offshore areas like Swan Islands, Mysteriosa banks and offshore Pacific reefs. Future monitoring programs should adopt the regional methodology being developed to aid in data analysis and comparison of results.
- Human threats to regional reefs continue: inappropriate and unsustainable land use; expanding tourism (especially in Mexico and Nicaragua), and industrial development; over-fishing and impacts from aquaculture; pollution from poor sewage treatment, waste disposal, agricultural runoff, and other land-based sources; poor port management, shipping and navigation practices; as well as global climate change and coral bleaching.

Gaps Identified In 2000	Activities Since 2000
1) Sustaining Fishery Resources <ul style="list-style-type: none"> • Fishing activity (effort, catch) • Status of fisheries resources (population, life history data) • Location, size and exploitation of nursery and spawning areas • Economic alternatives to fishing 	MBRS is conducting a regional assessment of spawning aggregations with training and will launch an environmental awareness campaign on sustainable fishing in Nov 2002; WWF is promoting the 'value of fully protected marine reserves as a fishery management tool in the Mesoamerican reef' and training in alternative livelihoods Dec 2002-Oct 2003.
2) Conserving Coral Reefs <ul style="list-style-type: none"> • Status, distribution and connectivity of coral reefs • Water temperature trends and patterns 	MBRS monitoring will assess health of the reef and associated ecosystems, and larval flows. WWF will repeat 2001 reef survey.
3) Sustainable Development <ul style="list-style-type: none"> • Current and projected land use • Tourism levels and potential sustainable expansion • Agricultural development and impacts 	Belize is the focal point for studies; Mexico completed land development plan for Quintana Roo WWF has sustainable tourism project in Costa Maya & studies in Hol Chan, Belize, Banco Chinchorro and Xcalac, Mexico; MBRS Initiative developing tourism certification and Tourism Forum; WWF developing best practices in watershed management in Honduras & Guatemala
4) Improving Water Quality <ul style="list-style-type: none"> • Status of water quality & sources of contamination • Water discharges and flows, minimize water pollution 	Belize has a comprehensive water quality program; to extend to all countries; flow rates have been modelled & continuing.
5) Environmental Awareness and Public Education	The MBRS Initiative developing an environmental awareness campaign to focus on issues above. WWF has sponsored regional journalists workshops.

- Fishing pressures are increasing for most target species (conch, lobster, grouper) and over-exploitation is evident throughout the region, although data are patchy. Fishery regulations are not enforced, management is fragmented, and communities are being provided with few alternatives to fishing. The countries are seeking trans-boundary solutions.
- Coral reefs in the region declined in the 1980s and 1990s due to coral diseases and mortality of the sea urchin *Diadema antillarum*; mass coral bleaching, and hurricanes. There has been some recovery since then, but not to former levels of cover, diversity and health.
- The long-term recovery after the damage will depend on the ability of corals to recruit, adapt, and persist, and whether there are repetitions of similar disturbance events. Human pressures (inappropriate coastal development, land-use etc.) are impeding recovery from natural stresses.
- Monitoring and research capacity is improving via the MBRS Initiative and an environmental information system will be developed to assist conservation efforts.
- There are many MPAs but many lack financial sustainability and trained personnel to be effective. Some countries have effective legislation and some enforcement; other countries have neither.
- The Tulum Declaration (1997) has enhanced the prospects for conservation and the injection of funds into the MBRS Initiative by the Global Environmental Facility and collaborative NGO ecoregional conservation programs have greatly accelerated prospects for improved conservation of the coral reefs.

RECOMMENDATIONS

Coral Reefs and Adjacent Ecosystems (to complement current activities)

- A regional comparable monitoring program needs to be strengthened to better identify, characterise, and monitor the extent and condition of coral reef habitat and associated organisms.
- An extension of surveying and monitoring is needed to cover less known areas and countries not assisted by the MBRS Initiative such as Nicaragua, offshore islands and banks like Swan Islands and Misteriosa banks, and reefs in the eastern Pacific.
- Further studies are required on coral reef recovery, reef vulnerability, and resiliency, especially in response to coral bleaching and climate change associations, and hurricane impacts.
- There is a need to gather information on coastal and oceanic currents and circulation patterns and water temperature trends and patterns to track larval flows.
- It is essential to identify areas that warrant immediate protection, in particular those with high biological productivity; sources of larval corals, fishes, and other important reef organisms; biodiversity hot spots; nursery and breeding areas; and areas at high risk of human impacts.
- Improved information is required on the distribution and status of adjacent ecosystems (mangroves, seagrasses, lagoons, bays, and wetlands). Some of this information can be gathered using remote sensing techniques, although there are limitations, which will have to be rectified by direct field observations.

Critical and Endangered Species

- Further assessments and monitoring are required on the populations of the West Indian manatee and American crocodile, especially feeding habitats of the manatee and crocodile nesting sites. There are large data gaps on dispersal and survival of juveniles, interactions with humans, and current deliberate or accidental catch rates.
- Information on sea turtle populations, migration patterns, nesting beaches and hatching success rates, feeding habitats and ranges, illegal fishing, and impacts of coastal development is a priority requirement.

Fisheries and Fishers

- There is a need for improved understanding of the growth and reproductive parameters of target fish species (snapper, grouper, pelagic fishes, conch and lobster populations), particularly information to identify juvenile nursery areas, spawning aggregation sites, larval transport pathways, and migration corridors.
- Current fishery statistics are inadequate across the ecoregion, although some countries do have statistics on key species. There is a need for uniform reporting standards and yearly updates of fishery statistics.
- Specific data are required on: fishing activity (number of fishing boats, effort, catch volume); major fishing areas; types of gear used; artisanal, sport, and destructive or illegal fishing practices.
- The enforcement of existing fishery regulations is essential and education to improve compliance is needed. There is a need to design new regulations to

reflect an ecosystem approach to management, and ensure that regulations are harmonised throughout the region.

- There is a need to designate more and larger no-take marine reserves and develop financial mechanisms to plan and manage these protected areas.
- Economic alternatives to fishing need to be developed to reduce effort and eliminate unsustainable fishing practices. Involving fishers in conservation and research efforts is an essential mechanism to reduce effort and increase compliance.

Socio-economic Data and Coral Reef Users

- Improved understanding and better regulation of and local participation in control of planning of coastal development is required, including current and projected land use of forests, wetlands, coastal areas, shrimp aquaculture, land tenure, tourism and industrial and agricultural activities.
- Another specific need is an understanding of water use and the effects on water quality, especially point and non-point sources of contamination, discharge and flow rates and trans-boundary pollution.
- Information on tourism is lacking in some countries, thus surveys should focus on the number of tourist rooms, location of diving sites, and cruise operators in the area.
- Information is patchy on how local communities interact with coral reefs and the economic benefits from goods and services the reef provides. Specific assessments should include how human are affected culturally and economically by natural disturbances like hurricanes that damage ecosystems. Analyses of short-term losses and long-term gains in the designation of 'exclusion' and 'no-take' areas are required.
- Improved documentation and planning is required on the impacts of the oil industry and pipelines, and shipping and port activities.
- There is a need to develop mechanisms for gathering, archiving and transmitting critical data on coral reefs and related ecosystems to all stakeholders, including user communities. This will require the construction of national databases and mechanisms of interpreting these data for general use.
- There is a need to assess the vulnerability of communities and governments to global climate change and mechanisms for adaptation.
- Investigations are required on how to improve institutional infrastructure and financial sustainability to implement effective conservation and maintain MPAs, such as the Mesoamerican reef fund being developed.
- Environmental awareness campaigns are needed to inform communities and the public of the need for and value of conservation of natural resources, especially their coral reefs.
- Finally there is a need for frank assessments of the effectiveness, roles, capacity and willingness of governments, training institutes and NGOs to implement natural resource conservation and management and ability to continue into the future.

REVIEWER

Marea Hatzios, World Bank, Washington USA.

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SIAN KA'AN BIOSPHERE RESERVE, MEXICO – ICRAN DEMONSTRATION SITE

Sian Ka'an, a 5,300km² Biosphere Reserve on the Caribbean coast of the Yucatan Peninsula, was designated a World Heritage area in 1987. The area contains saltwater, brackish and freshwater lagoons and limestone sinkholes fed by underground rivers and springs. Sian Ka'an also includes one of Mexico's largest protected coastal wetlands for thousands of species of plants and animals, many of them endangered. There is also a MPA with approximately 150,000ha of coral reefs, which are renowned for their sportfish populations of tarpon, bonefish, snook and permit. It is in the 2nd largest barrier reef in the world and contains considerable biodiversity. Fishing is the major activity and many of the people are involved in fishing, with spiny lobster the main catch (75%) that sells for about US\$15 per kilo for a total yearly catch of 80 tons over the last 11 years. Most is exported to the USA and Japan. Long-term conservation plans for the Reserve focus on fisheries and tourism in the coastal zone. Uncontrolled growth of tourism is a major threat, but the local management agencies and stakeholders believe that the future of Sian Ka'an lies in small scale tourism such as sport fishing, snorkelling, kayaking, nature walks, camping and wildlife observation. The paramount management goals of the area include: preserving the physical integrity of the area; promoting reasonable use of the natural resources; fostering social integration; spearheading research and education; and securing financing for the operation of the area.

Zoning: The reserve is divided into: a *Core Zone*, containing the best preserved areas for conservation and limited scientific research; *Buffer Zone*, where low-impact human activities and sustainable use of natural resources are permitted within reserve boundaries; and *Cooperation Zone*, which includes those lands and human settlements located adjacent to the boundaries of the reserve, where natural resource management measures are also applied.

Ecological Monitoring: During the last decade of reef monitoring in Sian Ka'an, changes in the number of species, coral cover, algae and fish, have been noted in every monitoring station, but these changes are not statistically significant. This variation is attributed to hurricanes, El Niño, and bleaching.

Socio-economic Monitoring: A socio-economic assessment is being implemented to elucidate the changes in the coastal communities of the Reserve. This ICRAN project aims to demonstrate the value of community-based management along the coast line. This project will also provide baseline data to contribute to the implementation of a long term socio-economic monitoring program.

Monitoring Effectiveness: Long-term ecological monitoring of Sian Ka'an has contributed valuable scientific data that has been crucial for decision making and the development of management measures. It has provided information on the ecosystems and resource conservation status, as well as on the trends related to human impacts.

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Coral reefs are 30% of the natural resources.

Ecological Monitoring is effective.

Socio-economic Monitoring is effective.






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HOL CHAN MARINE RESERVE, BELIZE – ICRAN DEMONSTRATION SITE

The Reserve is on Ambergris Caye, about 6km south of San Pedro Town in northern Belize, and contains coral reefs, seagrass beds, and mangrove forests. The main feature is a natural break in the reef, the Hol Chan Cut. The Hol Chan Marine Reserve was established in 1987 with protected areas designated for no-fishing, no dredging of seagrasses, and no cutting of mangrove forests, and aimed at protecting the reefs and habitats for commercially important species. The Reserve is multi-use and divided into 4 zones: A - includes the barrier reef and is a no-take zone; B - consists of seagrass meadows where traditional fishing is allowed, but spear fishing and nets are prohibited; C - includes the southern tip of Ambergris Caye and 7 mangrove islands, where the cutting of mangroves and disturbing wildlife is prohibited; and D - Shark and Ray Alley, with 2 'Exclusive Recreational Areas' where diving and snorkelling are allowed. Tourism has become the major income activity in Belize, however, environmental pressures are increasing and damaging the resources that attract tourists. Over-fishing of lobster and conch result from an increased demand for seafood. Tourism developments have involved dredging, cutting of mangroves, and pollution.

Ecological Monitoring: The monitoring program of the Reserve staff is not fully effective or consistent due to a lack of finance and manpower. Funding from Caribbean office of UNEP and the ICRAN project, is upgrading monitoring by training park staff to dive instructor level so that they will train volunteers from San Pedro town to form the core monitoring group and undertake public education campaigns. Lobster and conch populations are monitored, and fish populations assessed with a visual census technique. Corals are monitored using a line intercept technique and the CARICOMP methods. Some data are available e.g. there was 25% live coral cover at Tackle Box, Ambergris Caye in 1994, and 20% cover at Gallows Reef in 1992. The shallow Mexico Rocks patch reef off Ambergris Cay had 84% coral cover in 1993, but this dropped to 66% in 1995, due to the 1995 coral bleaching event, and coral cover in Hol Chan was estimated at 39.6%.

Socio-economic Monitoring: Visitor impacts are assessed by observing recreational divers for half an hour.

Monitoring Effectiveness: The Hol Chan MPA was established in 1987 as a response to the decline in fish stocks. An assessment program selected the preferred area with good coral reefs, mangroves and seagrass beds. Since the establishment, there has been an improvement in fish stocks, and monitoring enables the management to demonstrate that the MPA is fulfilling its objectives compared with adjacent areas. The current monitoring program aims is to show fishers any spill-over effect with increased fish, lobster and conch populations being available in nearby fishing areas. Monitoring results are used to stimulate interest among stakeholders and to convince visitors and locals of the benefits of the MPA. Plans are underway to extend the Hol Chan MPA, and create additional reserves, with support from the Tour Guide Association and local fishermen, largely stimulated by monitoring data that demonstrate benefits from the MPA.

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Coral reefs are 60% of the natural resources.

Ecological Monitoring is effective.

Socio-economic Monitoring is effective.

REEFS AT RISK IN THE CARIBBEAN

The project aims to raise awareness about threats to coral reefs by compiling and analysing information similar to the process for Southeast Asia. The goal is to guide management interventions at national and international levels using data on location, status and protection of coral reefs across the Wider Caribbean, coupled with estimates of threats from human activities. The analysis collates different threats, and combines them into a region-wide indicator of human pressures on coral reefs. This is a project of the World Resources Institute, the UNEP Caribbean Environment Program (UNEP-CEP) and other partners, including the International Coral Reef Action Network (ICRAN). The following threats are being analysed:

Coastal Development: Poorly managed coastal development can threaten coral reefs both through direct impacts (dredging and land-filling) and indirect impacts (sewage discharge, and runoff from constructions). This threat is evaluated via population and infrastructure development along coasts;

Sediment and Pollution from Inland Sources: Land-use change and agriculture far inland can damage coral reefs. A region-wide watershed-based analysis will incorporate information on slope, precipitation, land cover and soil type to estimate relative erosion rates (for all areas in each watershed) and sediment delivery by watershed;

Marine-based Sources of Pollution: Pollution threatens coral reefs from ports and oil spills, ballast and bilge discharge, dumping of garbage, and direct damage by groundings and anchor damage. These threats are assessed by location of oil infrastructure and size of ports, and shipping patterns;

Overfishing: Over-fishing results in reductions in fish size, abundance and species composition, and alters the ecology of reefs. Information is integrated from fisheries agencies of over-fishing indicators developed by the Atlantic and Gulf Rapid Reef Assessment (AGRRA) and coastal population density;

Coral Bleaching: This is an increasing threat to coral reefs as global temperatures rise, and the relative resistance to coral bleaching will be evaluated based on proximity to deep water, degree of enclosure, water movement, cloudiness, and turbidity;

Coral Disease: The incidence and patterns of the many coral diseases attacking Caribbean coral reefs will be assessed.

The analysis will explore the natural vulnerability of coral reefs to pollution and sedimentation, based on the physical oceanography, particularly the degree of flushing. A revised coral reef map for the Wider Caribbean is being developed by UNEP - World Conservation Monitoring Centre. Additional components include:

Management Effectiveness – revised maps of MPAs in the region with indicators of management effectiveness, in collaboration with UNEP-WCMC and UNEP-CEP;

Economic Valuation - information on the sustainable economic value of healthy coral reefs and losses that follow damage will be assessed in collaboration with the WorldFish Center. Production is scheduled for early 2004; contact Loretta Burke, World Resources Institute, LAURETTA@wri.org or www.wri.org\reefsatrisk