Coral Reefs in Honduras: Status after Hurricane Mitch

Introduction:

Reef corals from around the world were severely affected from bleaching by the large El Niño event in 1997-1998. Mass bleaching events occur when prolonged high sea-surface temperatures stress corals, causing the expulsion of symbiotic zooxanthellae (plant-like organisms living within the coral tissue). Extended periods of bleaching may lead to an increase in coral mortality. It is estimated that ~16% of the world's corals were destroyed from this single bleaching event in 1998 (Wilkinson, 2000). Unfortunately, coral reef environments along the north coast of Honduras were about to face additional problems. On October 25, 1998, Hurricane Mitch (Figure 1) had formed into the fourth strongest Atlantic hurricane on record; a category 5 hurricane with 180+ mph wind speed and estimated wave heights of 50 feet. Mitch turned out to be the deadliest hurricane since the great hurricane of 1780 (http://www.ncdc.noaa.gov).

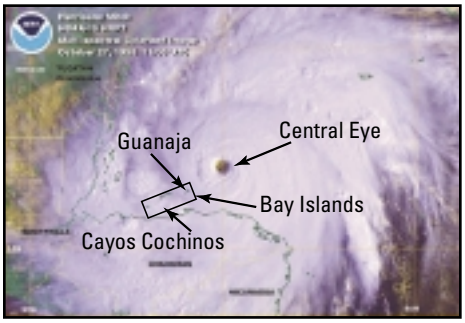

Figure 1. Satellite image of Hurricane Mitch on October 27, 1998 showing a very well developed central eye. Mitch was positioned just to the northeast of Guanaja, Honduras. Image provided by NOAA.

Figure 2. Index map (top) showing location of Cayos Cochinos and Roatán, Honduras and path of Hurricane Mitch. Aerial photograph of Cayos Cochinos (bottom) showing location of monitoring stations (red dots) and distribution of fringing coral reefs.

Mitch lost energy and became a category 4 hurricane on October 27 as it began to interact with the mountainous terrain on the Honduras mainland. Mitch passed over Roatán, Guanaja, and Cayos Cochinos on October 27 & 28 (Figure 2) with 130-mph winds and caused severe damage to buildings and onshore habitats. Mitch dropped over 6 ft of rain on the mainland causing severe flooding,

Figure 3. Photographs depicting various diseases observed throughout the Cayos region. (A) Black band disease on a brain coral (*Diploria* sp). This disease typically begins at one location and spreads out very quickly killing the coral as it grows and leaving only bare skeleton in its path. (B) Bleached *Meandrina* sp. coral. (C) *Montastrea* sp. that has been partially killed by white plague or white band disease and the remaining skeleton colonized by red algae.

landslides, and mudflows. In its wake, Mitch left about 11,000 people dead and 2 million people homeless throughout the countries of Honduras, Nicaragua, El Salvador, and Guatemala. In response to this devastation, funding for the project was provided through the U.S. Agency for International Development (USAID), from a supplemental Congressional budget allocation to provide assistance to Mitch-affected countries. USAID also earmarked funds for use by the U.S. Geological Survey (USGS) to establish a network of early detection systems (stream gauges, maps of landslide-prone areas, etc), collection of water-quality information, and assessment of post-Mitch damage to coastal resources such as coral reefs, seagrass beds, and mangrove forests. This study focuses on the impact of Mitch on the coral reef systems of Cayos Cochinos and Roatán, Honduras.

Study Location:

Four site visits were made between October 1999 and April 2001 to investigate and monitor the coral reefs around Cayos Cochinos and Roatán, Honduras (Figure 2). Cayos Cochinos Biological Reserve served as the primary study site with secondary efforts in the Roatán Marine Reserve. Cayos Cochinos is located on the continental shelf approximately 12 miles off the northern coast of Honduras and 18 mi south of Roatán in the Caribbean Sea. A deep trough (1400 ft) separates Cayos and Roatán.

Fringing coral reefs line the coasts of all the Bay Islands, providing protection from storms. This protection allows a tourism-based economy, supplemented by sustenance fishing for the indigenous people. Though the reefs of Roatán and Cayos Cochinos share many similarities, there are important differences. Historically, Roatán has been bathed in clear water (100+ ft visibility), which is a result of relatively strong oceanic currents that sweep past the island. However, during the past decade poor land-use practices and development have resulted in increased runoff and sediment deposition on the reefs (Mehrtens, C.J. and others, in press). Cayos Cochinos, on the other hand, is located on the shallow continental shelf and is persistently influenced by runoff from mainland rivers that result in salinity, temperature, turbidity and water-quality fluctuations. Land clearing and deforestation on the Honduras mainland has probably accelerated sediment loading, nutrient content, and frequency of flood events that eventually impact the marine environments around Cayos Cochinos, and to a minor extent, other Bay Islands.

Purpose of Study:

Investigation of coral reef damage from Mitch involved: 1) assessing the amount of coral breakage and displacement that occurred as high waves and strong currents impacted the reef and 2) identifying the effects of increased coastal sedimentation and nutrient-enrichment, which resulted from flooding after Mitch moved onshore. Monitoring and evaluating the damage to the reefs from Hurricane Mitch involved installing instruments around Cayos Cochinos (Figure 2) and Roatán,

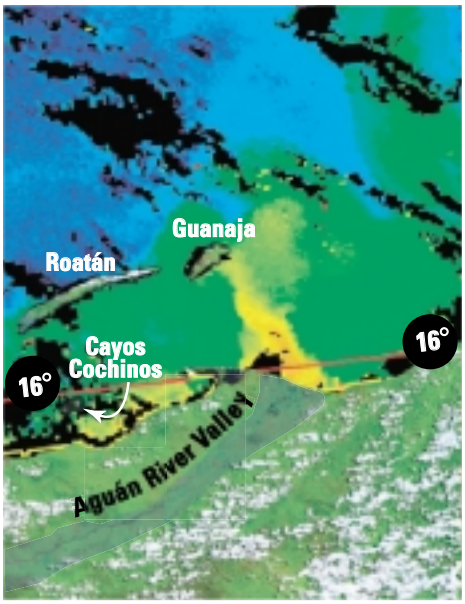

Figure 4. Color-enhanced satellite image (SeaWiFS) from November 1, 1998, showing the extent of the freshwater plume (yellow) that was induced by intense rainfall from Hurricane Mitch. SeaWiFS image provided by University of South Florida, St. Petersburg, Florida.

as well as photo documentation of coral disease, algae abundance, physical damage to corals, and overall reef health. Very little coral reef data exist for Cayos (e.g., Guzmán, 1998), so the data presented here are considered to be the first to be collected throughout the region.

Two instruments recording water salinity, temperature, and light intensity were installed on a shallow (-17 ft) reef at Cayos and Roatán. In addition, three sites throughout Cayos (Lions Head, Pelican Point and a shallow reef near the field station; red dots on Figure 2) were selected to house instruments measuring temperature only. These temperature loggers were placed on the reef in 17 ft and 66 ft water depths to measure upwelling events that might occur as a result of meteorologic or oceanographic changes and to measure extreme sea-surface temperatures on a shallow reef (-3 ft).

Status of Coral Reefs:

Physical damage to coral reefs from Hurricane Mitch may have been kept to a minimum because the reefs in this area are composed of robust head coral species such as brain coral (*Diploria* sp.) and star coral (*Montastrea* sp.). Sedimentation and freshwater runoff from the mainland most likely caused more damage to corals than did waves and currents. Divers observed widespread coral disease such as black band, white pox, and bleaching and an abundance of algae during the initial visit to Cayos in October 1999, one year after Mitch (Figure 3). The occurrence of these diseases and algae are thought to be a result of stress induced from a combination of pre-hurricane high sea-surface water temperatures, and post-hurricane high sedimentation and nutrient influx from the mainland. SeaWiFS (Sea-viewing Wide Field-of view Sensor) satellite imagery (Figure 4) taken November 1, 1998, shows a large plume of sediment-laden, high-nutrient river water flowing from the engorged Aguán River Valley directly to Guanaja. Portions of this large plume eventually inundated the Cayos Cochinos region. Coral reef communities typically thrive in clear, low-nutrient oceanic water and therefore are affected when subjected to water that has lower-than-normal salinity, increased sedimentation, and additional nutrients. Cayos Cochinos is regularly influenced by all of these factors, especially during the rainy season (August – February).

It is probable that Hurricane Mitch prevented further bleaching damage to the corals throughout the Bay Islands (Roatán, Guanaja, Utila, and Cayos Cochinos) during the fall of 1998. Upwelling of deep oceanic water lowered the surface temperatures by 4ºF as Hurricane Mitch passed over the Bay Islands (Jennifer Keck, pers. comm.). The drop in surface temperature most likely had a positive effect by reducing the severity of coral bleaching, thereby preventing further coral mortality. In addition, during the past two years (1999-2000), summertime sea-surface temperatures throughout the

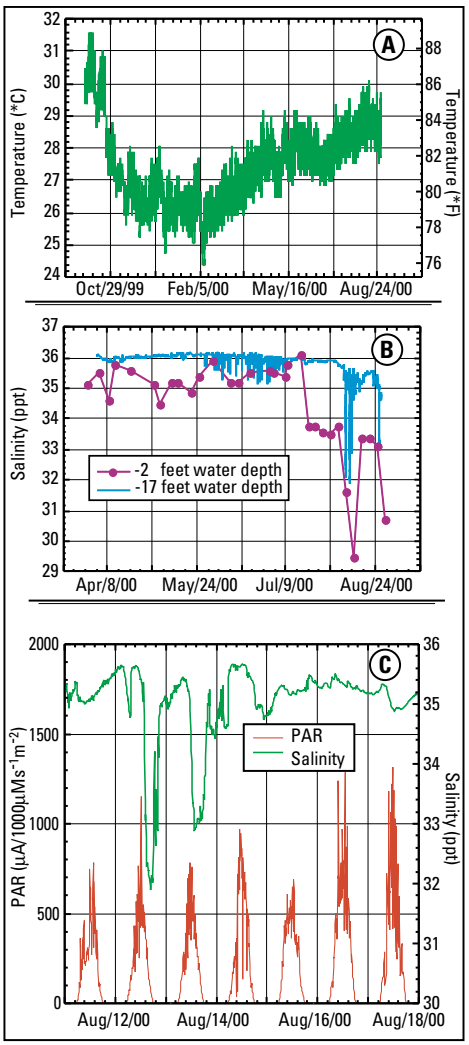

Figure 5. Examples of data collected at Cayos Cochinos. (A) 11-month record of sea-surface temperatures taken in a water depth of 5 ft. (B) Surface salinity recorded approximately once a week at the biological field station dock (-2 ft) on Cayos Pequeño and from the reef (-17 ft) at Pelican Point, which was collected at 15-minute intervals during the summer of 2000. (C) Light (PAR) record for a seven-day period showing decreasing light intensities with pulses of 'fresher' water.

Caribbean have receded below coral bleaching threshold temperatures (~86ºF) (Hoegh-Guldberg, 1999). Temperature data at Cayos confirms a trend of lowered sea-surface temperatures (Figure 5A). In October 1999 there was a brief period of high temperature (88ºF) that did not cause severe widespread bleaching. A recovery period was continuing in 2000 as the high appeared to stay below 86ºF.

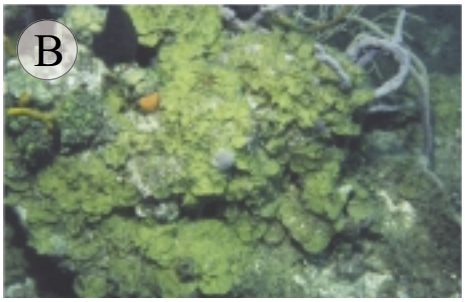

Figure 6. Photo depicting (A) a severe infestation of filamentous algae (species?) along the western side of Cayos Pequeño (photo taken October 1999). Infestation had disappeared by April 2000. (B) Fleshy algae (*Lobophora* sp.) are consistently present on all portions of the reef.

Coral reefs at Cayos Cochinos displayed fewer diseased corals in October 2000 than the previous year. This is an encouraging sign that the corals are recovering from the stresses induced by Hurricane Mitch. However, widespread turf and fleshy algae are still present throughout the Bay Island archipelago (Figure 6). Observations by previous researchers (Guzmán, 1998) suggest that coral diseases and algae were present before Mitch. Coral diseases, however, were not well documented prior to Mitch. On the other hand, algal persistence around Cayos has been well documented and may have resulted from repeated nutrification of surface waters, whether from land clearing, agricultural runoff on the mainland, or from local human sources (Guzmán, 1998). River discharge can be monitored by looking for low-salinity spikes (~29 parts per thousand, ppt; Figure 5B) or decreased light levels (Figure 5C). Continued monitoring of these parameters is essential to understanding the long-term impacts that sedimentation, nutrification and low-salinity events may have on coral reef health within the Cayos Cochinos Biological Reserve. Human impacts, such as over-fishing, poor sewage-disposal practices, and coral mining, though not investigated in this study, may also lead to the deterioration of coral reef environments.

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