

**STUDY TITLE:** Long-Term Monitoring at the East and West Flower Garden Banks 2004

**REPORT TITLE:** Post-Hurricane Assessment at the East Flower Garden Bank Long-Term Monitoring Site: November 2005

**CONTRACT NUMBERS:** 1435-01-04-CT-33137; CT M04PC00033

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**APPLICABLE PLANNING AREA:** Gulf of Mexico

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**CUMULATIVE PROJECT COST:** \$499,849.93 (includes \$55,430.19 post hurricane assessment change order)

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**KEY WORDS:** Gulf of Mexico, Hurricane Rita, ecology, biology, coral, reef, bleaching, monitoring, survey, thermal anomaly, East Flower Garden Bank, *Montastraea annularis* complex

**BACKGROUND:** The Flower Garden Banks are located in the northwestern Gulf of Mexico and form part of a discontinuous arc of reef environments along the outer continental shelf. These coral reef banks are the largest charted calcareous banks in the northwestern Gulf of Mexico and are the northernmost coral reefs on the continental shelf of North America. Although coral and non-coral dominated communities exist on neighboring banks (e.g., Sonnier Bank, Stetson Bank), the reefs at Cabo Rojo, Mexico are the closest developed coral reefs in the Gulf of Mexico.

The topographic features of the Flower Garden Banks were created by salt diapirs of Jurassic Louann origin and the consequent uplifting of sedimentary rocks. The caps of these salt domes extend into the photic zone in clear, oceanic water where conditions are ideal for colonization by coralline algae, hermatypic corals, invertebrates, and fish species typical of Caribbean basin coral reefs. Though coral species richness is more depauperate at the Flower Garden Banks than Caribbean reefs, 21 species of

scleractinian corals and 177 species of tropical Atlantic fish are present at the Banks. Oceanic salinity conditions prevail at the Flower Garden Banks and range from 34 to 36 ppt, with water temperatures ranging from 18°C (mid-February) to ~ 32°C (August). Water clarity at the Banks is excellent, commonly 30 m or more, providing light to photosynthetic organisms.

Since 1973, the Minerals Management Service (MMS) has conducted a program of protective activities at the Flower Garden Banks. The topographic features stipulation (since 1973) was designed to protect sensitive biological resources from the adverse effects of routine oil and gas activities. The stipulation specifically protects the biota of the Flower Garden Banks from physical damage associated with oil and gas activities, including anchoring and rig emplacement, as well as potential toxic and smothering effects from drilling muds and cuttings discharges. The stipulation defines a No Activity Zone (NAZ) around each of the Banks and no oil or gas structures, drilling rigs, pipelines, or anchoring are allowed within the NAZ. From 1988 to 1995, the MMS monitored the Flower Garden Banks coral reefs on an annual basis to detect any changes that may be caused by oil and gas activities, as well as other incipient changes. In addition to the protective measures provided by MMS, the Flower Garden Banks were designated as a United States National Marine Sanctuary in 1992. Beginning in 1996, the National Oceanic and Atmospheric Administration (NOAA), Flower Garden Banks National Marine Sanctuary (FGBNMS), and the MMS partnered to continue the long-term monitoring at the Flower Garden Banks.

On September 23, 2005 Hurricane Rita (Category 3 Saffir-Simpson Index) passed within 50 miles of the East Bank on its route north to the mainland United States. Hurricane Rita's winds were as high as 125 miles per hour (mph) when it passed over the Flower Garden Banks and the closest weather buoy (buoy #42019), located 143 miles west of the Flower Garden Banks, recorded wave heights close to twenty feet. An October cruise, conducted by NOAA, revealed physical damage, including overturned and dislodged coral heads, coral heads damaged by projectiles, and the displacement of sand. Additionally, the summer of 2005 was unusually warm and sea surface temperatures in the Eastern Caribbean as well as at the Flower Garden Banks were high for an extended period of time. To document the effects of Hurricane Rita and the thermal anomaly, a post hurricane cruise was conducted at the East Bank in November 2005.

**OBJECTIVE:** To determine the effects of Hurricane Rita and the summer thermal anomaly on the East Flower Garden Bank benthic community.

**DESCRIPTION:** A post-hurricane cruise was conducted at the East Bank in November 2005. Repetitive 8 m<sup>2</sup> quadrats were photographed and analyzed using random dot analysis (percent cover and coral condition) and planimetry (growth or loss of coral tissue) in order to monitor changes in coral reef community structure. Nine deep repetitive quadrat stations (32-40 m depth) were established on the East Bank in April 2003 and photographed in November 2005. These stations were also analyzed using random dot analysis and planimetry. Perimeter lines were videotaped to document change at known locations along the perimeter and within the study site. A general sense of coral

condition, including obvious signs of hurricane damage, and fish populations were obtained and compared between years. Physical and chemical characteristics of the seawater overlying the reef caps at the East Bank were assessed by monitoring temperature, depth, pH, dissolved oxygen, specific conductivity, turbidity, and photosynthetically active radiation.

**SIGNIFICANT CONCLUSIONS:** Despite the physical damage caused by Hurricane Rita and the thermal anomaly that caused coral bleaching (~10%), the East Bank has maintained high coral cover, robust fish populations, and will most likely recover over the next few years.

**STUDY RESULTS:** During the post-hurricane assessment in November 2005, coral cover remained high at approximately 61% and coral species relative abundance showed continued stability with *Montastraea annularis* spp., *Diploria strigosa*, *Porites astreoides*, and *M. cavernosa* remaining as the dominant species (repetitive quadrat random dot analysis). In June 2005, macroalgae was high at 24%, while CTB was lower at 10%. After the passage of Hurricane Rita, an inverse relationship between macroalgae and CTB was evident in November 2005, with 24% CTB and 13% macroalgae. Macroalgal cover is seasonally influenced and, with the passage of Hurricane Rita, it is likely that macroalgae was removed from the substratum. The low levels of macroalgae in November 2005, more than a month after the storm's passage, is likely due to the seasonality of algal species. Coral cover at the deep site repetitive quadrats remained high (74.5%), and the dominant corals were *Montastraea annularis* complex, *M. cavernosa*, *Colpophyllia natans*, and *Diploria strigosa*.

In November 2005, approximately 1.5% of coral colonies photographed at the East Bank repetitive quadrat stations were missing and two colonies (~0.5% of coral colonies photographed) were missing at the deep stations, presumably due to the effects of Hurricane Rita. Overall, a total of ~4 m<sup>2</sup> of coral cover was removed between June 2005 and November 2005. Within the study site repetitive quadrats, ~10% bleaching of corals was documented. This is the highest level of bleaching reported at the Flower Garden Banks throughout the long-term monitoring project. In 1990, ~5% bleaching was reported in connection with the 1989 El Niño Southern Oscillation event that caused mass bleaching throughout the Caribbean. The bleaching documented during the November 2005 assessment was evident on nearly all coral species, but most prevalent on the *Montastraea annularis* complex, *M. cavernosa*, and *Millepora alcicornis*. Deep stations also exhibited bleaching, although to a lesser extent than the shallower sites (~3%). Adjacent to the deep stations, the expansive field of *Madracis mirabilis* (located outside of the study site) experienced catastrophic levels of breakage and toppling.

Corals along the north and east perimeter lines showed evidence of hurricane impacts, including the dislodgement, loss, or deposition of entire coral heads, coral breakage, and abrasion on the reef. There was evidence of bleaching and fish biting, while fish population levels remained stable. Most distressed corals were affected by bleaching (6.4%), with slightly fewer incidences of fish biting (1.2%). No evidence of coral disease was observed at the East Bank in November 2005.

Water quality results showed that the reef cap experienced elevated water temperatures for fifty days in the late summer of 2005, and that the passage of Hurricane Rita brought relief in terms of lower water temperatures. Mean daily significant wave height at NOAA data buoy 42019, located 143 miles west of the Flower Garden Banks, was 4.52 m during the passage of Hurricane Rita. The highest point of the storm took place at 2000 hours on September 23 when maximum wave height reached 5.9 m at buoy 42019. At the East Bank, from September 23 to 24, water was moving in a southeasterly and southerly direction at speeds ranging from 19.7 to 57.9 cm/sec. There was no evidence of damage from oil and gas production on the Banks as a result of Hurricane Rita.

**STUDY PRODUCT:** Precht, W.F., R.B. Aronson, K.J.P. Deslarzes, M.L. Robbart, B. Zimmer, and L. Duncan. 2008. Post-hurricane assessment at the East Flower Garden Bank long-term monitoring site: November 2005. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, Louisiana. OCS Study MMS 2008-019. 59 pp.

