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STUDY TITLE: Long-Term Monitoring of the Flower Garden Banks, 2004-2005

REPORT TITLE: Long-Term Monitoring at the East and West Flower Garden Banks 2004-2005 -- Interim Report: Volume I: Technical Report and Volume II: Appendices

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PROJECT MANAGER: Don R. Deis

AFFILIATION: PBS&J

ADDRESS: 7406 Fullerton St. Suite 350, Jacksonville, FL 32256

PRINCIPAL INVESTIGATORS*: W. Precht, R. Aronson, and K. Deslarzes

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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.

OBJECTIVE: To monitor the East and West Flower Garden Banks in accordance with the long-term monitoring protocol, ensuring that the protective measures established by MMS continue to be effective.

DESCRIPTION: Monitoring cruises were conducted aboard the *M.V. Fling* in September and November 2004, and June 2005. The general locations of the study sites are marked by permanent mooring buoys: FGBNMS permanent mooring number 2 at the East Bank and mooring number 5 at the West Bank. Subsurface buoys were installed at the corners of the 100 m x 100 m study sites at each bank to facilitate underwater relocation. Establishment of the perimeter and crosshairs subdivided each study site into four quadrants. To estimate the areal coverage of benthic components, sixteen 10 m long transect tapes were randomly positioned at each study site. Benthic coverage was estimated from these transects using videography. Four coral cores were extracted from *Montastraea faveolata* colonies at each bank in June 2005. Coral cores are used to determine annual coral growth rates as well as document changes in growth rates that may be correlated with environmental changes. *Diploria strigosa* is the second largest contributor to coral cover at the Flower Garden Banks. For this reason, *D. strigosa* lateral growth margins were monitored and photographed to detect changes, either as retreat or growth of colony margins from year to year. Repetitive 8 m^2 quadrats were photographed and analyzed using random dot analysis (percent cover and coral condition) and planimetry (measure growth or loss of coral tissue over time) in order to monitor changes in coral reef community structure. Perimeter lines were videotaped each year to document change at known locations along the perimeter and within the study site. A general sense of coral condition and fish populations were obtained and compared from year to year. Physical and chemical characteristics of the seawater overlying the reef

caps at the Flower Garden Banks were assessed by monitoring temperature, salinity, dissolved oxygen, pH, turbidity, and content in chlorophyll *a*, dissolved inorganic nitrogen, dissolved organic nitrogen, and inorganic phosphorous. These water quality parameters were selected to characterize the environmental background in which the Flower Garden Banks coral reef resources exist. Surveys of fish assemblages were conducted at each bank in order to determine relative abundance and diversity of species. Surveys of sea urchins and lobsters were performed at night to determine abundance and distribution of populations.

SIGNIFICANT CONCLUSIONS: The East and West Flower Garden Banks coral reefs continue to thrive and remain the highest coral cover dominated reefs in the Caribbean and Gulf of Mexico. The reef communities have remained stable for the monitoring period 1988-2005, while other reefs in the region have declined. Continued monitoring of these reefs will document their long-term condition and be useful for studies focused on the dynamics of the robust benthic communities and the fish populations they support.

STUDY RESULTS: Monitoring results for 2004-2005 highlighted the continued stability of Flower Garden Banks reefs, expressed as consistently high coral cover with a mean of 57.12% for both Banks and both years, as well as the continuing trend of coral growth seen in repetitive quadrats and lateral growth of individual colonies of *Diploria strigosa*. Robust fish populations and oligotrophic water conditions persisted while occurrences of disease and bleaching were low, ranging from 0-0.57% at both Banks in both years. Sea urchins continued to occur at low densities, averaging $0.03/m^2$ (both Banks, both years). Herbivorous fishes appear to control algal cover as they represented the largest fish guild on both Banks.

Total coral cover, recorded by random transect videography, at the East Bank was 64.13 ± 2.70% in 2004 and 49.55 ± 3.01% in 2005. Coral cover was similarly high at the West Bank in 2004 (60.41 ± 2.94%) and 2005 (54.41 ± 3.13%). The *Montastraea annularis* complex was the predominant component of coral cover at both Banks in both years, with 30.14 ± 4.76% and 26.8 ± 4.09% cover at East Bank in 2004 and 2005 and 31.70 ± 2.70% and 36.20 ± 3.50% at the West Bank in 2004 and 2005. *Diploria strigosa* was the next most abundant species, ranging from 13.41 ± 1.74% at the West Bank in 2004 to 6.68 ± 1.29% in 2005. The East Bank estimates were 12.13 ± 2.82% and 5.95 ± 1.26% in 2004 and 2005, respectively. Repetitive quadrats showed changes in coral cover and coral condition (disease, paling, bleaching, and fish biting) from 2004 to 2005. The prevalence of paling and bleaching were low at both Banks in both years; none of these metrics were above 0.57%, and there was no evidence of disease in any of the repetitive quadrats analyzed. Nine deep repetitive quadrats (32-40 m depth) were established on the East Bank in April 2003 and photographed in September 2004 and June 2005. Coral cover was high at these deep sites, 82.47% overall. The *Montastraea annularis* complex (55.87%) and *M. cavernosa* (8.71%) were the dominant species at the deep sites. Lateral growth stations were monitored to measure changes in *Diploria strigosa* colonies. Overall there was a 14% increase in *Diploria strigosa* margins from 2004-2005. Sclerochronology was used to measure the accretionary growth rates of *Montastraea faveolata*. Yearly growth rates ranged from 2.75 to 14.54

mm and did not differ significantly between Banks. A mean of 57 fish species were observed per bank per year in 2004 and 2005. Herbivores were the dominant fish guild, with Pomacentridae (damselfish) and Labridae (hogfish/wrasse) representing the largest portion of these. Urchin surveys documented low densities of *Diadema antillarum* at both Banks in both years, as well as a low abundance of lobsters.

STUDY PRODUCT: Precht, W.F., R.B. Aronson, K.J.P. Deslarzes, M.L. Robbart, D.J. Evans, B. Zimmer, and L. Duncan. 2008. Long-Term monitoring at the East and West Flower Garden Banks 2004-2005 -- Interim report: Volume I: Technical Report (OCS Study MMS 2008-027) 136 pp. and Volume II: Appendices (OCS Study MMS 2008-028) 1335 pp. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, Louisiana.

*P.I.'s affiliation may be different than that listed for Project Managers.

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