ACCESS NUMBER: 39574 (M06PC00003)

STUDY TITLE: Post-Hurricane Assessment of Sensitive Habitats of the Flower Garden Banks Vicinity

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CONTRACT NUMBERS: 1435-01-06-CT-39574 (M06PC00003)

SPONSORING OCS REGION: Gulf of Mexico

APPLICABLE PLANNING AREA: Central and Western

FISCAL YEARS OF PROJECT FUNDING: 2006-2007

COMPLETION DATE OF REPORT: July 2009

COSTS: FY 2006: $138,132.92; FY 2007: $175,273.80

CUMULATIVE PROJECT COST: $357,009.00

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KEY WORDS: Gulf of Mexico, ecology, biology, hurricane, mid-shelf bank, outer-shelf bank, shelf-edge bank, remotely operated vehicle, ROV, Sonnier Bank, McGrail Bank, Geyer Bank, Bright Bank, East Flower Garden Bank

BACKGROUND: The most active hurricane season on record in the Atlantic and Gulf of Mexico occurred in 2005, fueled by higher than normal sea-surface temperatures. Eleven tropical cyclones entered the Gulf of Mexico in 2005, including Hurricane Rita (a Category 5 storm on the Saffir-Simpson Scale). Hurricane Rita was a Category 3 storm when it passed near the shelf-edge banks on September 23, 2005. Several sensitive habitats within the northwestern Gulf of Mexico were close to the path of Hurricane Rita, including Sonnier Bank (15-mi or 24-km east), McGrail Bank (7-mi or 12-km west), Geyer Bank (36-mi or 58-km west), Bright Bank (47-mi or 75-km west), and the East Flower Garden Bank (58-mi or 93-km west). Hindcast hydrodynamic models estimated wave heights at 66-ft (20-m) or higher on these banks. This may have left some bank caps exposed, even at ~70- to 100-ft (20- to 30-m) depths. The implications for catastrophic damage to benthic community structure prompted the MMS to characterize the banks in their post-hurricane state.

Shallow banks in the Gulf of Mexico vary in terms of their geological and biological characteristics, but have been grouped into three main categories: mid-shelf banks, outer-shelf banks with carbonate reef caps, and relict carbonate reefs. The banks in this study are mid-shelf banks and outer-shelf carbonate reef caps, which are formed by salt diapir structures uplifting the seafloor into the photic zone. Mid-shelf banks, such as Sonnier Bank, are characterized by uncolonized open substrate, in which the bedding of Tertiary limestones, claystones, and siltstones is apparent. McGrail, Geyer, Bright, and East Flower Garden Banks are outer-shelf banks which contain carbonate reef caps.

Sonnier Bank consists of several peaks arranged in an arcuate pattern that rise from a depth of ~200-ft (60-m) up to within ~70-ft (20-m) of the sea-surface. Each peak is a fault block created by the collapse of a salt diapir. Sonnier Bank is characterized by hydrocorals and sponges as the dominant living benthic components. Nine species of scleractinian corals are found at Sonnier Bank, but these corals are not abundant. McGrail Bank is a deep shelf-edge carbonate bank positioned atop a salt diapir. Deep-water coral reef resources are characteristic of this bank, and coral cover is high on part of the reef cap (up to 30%) compared to other banks in the region. Abundant nodules of red coralline algae have been documented at McGrail Bank, as well as high fleshy macroalgal cover in the algal-sponge zone at depths of 148-154 ft (45-47 m). Geyer Bank is a shelf-edge carbonate bank with extensive reef communities. Geyer Bank is characterized by an abundance of *Sargassum* spp. and appears to be the only bank evaluated in this study with an established population of the invasive, non-hermatypic coral *Tubastraea coccinea*. It is important to note that scientists have observed one or two colonies of *T. coccinea* at Sonnier Bank; however, *T. coccinea* colonies were not observed in our Sonnier Bank transect video. Bare siltstone mounds interrupt the flat, coral cap of Bright Bank, which is dominated by sponges, macroalgae, and several species of scleractinian corals. The East Flower Garden Bank is a well-documented coral reef cap characterized by a high coral cover, low-diversity scleractinian assemblage. Diversity is lower than Caribbean reefs but higher than other banks in the area. Benthic cover is predominantly comprised of the *Montastraea annularis* species complex, *Diploria strigosa*, and *Porites* spp., with few sponges and little bare space.

OBJECTIVE: To characterize and compare the benthic habitats of four banks (Sonnier, McGrail, Geyer, and Bright Banks) and document potential hurricane damage at these banks and the East Flower Garden Bank.

DESCRIPTION: Monitoring cruises were conducted aboard the *M.V. Fling* in April and May 2007. To estimate the areal coverage of benthic components at Sonnier, McGrail, Geyer, and Bright Banks, videographic records were collected by SCUBA and remotely operated vehicle (ROV) at four depth ranges: 22-27 m, 30-36.5 m, 45-50 m, and 55-60 m (72-89 ft, 98-120 ft, 148-164 ft, and 180-197 ft). Divers videotaped transects within no-decompression diving limits, down to ~120-ft (36.5-m) depth. A ROV was utilized at depths greater than 120-ft (36.5-m). A TrackLink® 1500 High Accuracy Ultra Short Baseline acoustic positioning System (USBL) was used to track divers and ROV videotaping transects at Sonnier, McGrail, Geyer, and Bright Banks. Data were converted into a GIS format in order to visualize where diver and ROV transects were in

geographic space. Video transects were quantitatively analyzed for benthic composition and qualitatively assessed for evidence of hurricane damage. To document damage and recovery from Hurricane Rita at the existing long-term monitoring site on the East Flower Garden Bank, repetitive quadrat stations and perimeter line surveys conducted in November 2005 were compared to equivalent data collected after the hurricane in June 2006. In addition, major functional groups (corals, sponges, macroalgae, and CTB-crustose coralline algae, fine turfs, and bare space) were compared within repetitive quadrat stations at the East Flower Garden Bank between June 2005, November 2005, and June 2006.

SIGNIFICANT CONCLUSIONS: The unique biological characteristics of the benthic communities of Sonnier, McGrail, Geyer, Bright, and East Flower Garden Banks highlight their intrinsic value within the northwestern Gulf of Mexico ecosystem. The differences in the benthic biotas strongly suggest that these habitats are truly sensitive, because nearest neighbors may not be the source of recruitment. With predicted wave velocities of 8 knots or more acting on these banks during the passage of Hurricane Rita, the effects on the benthic communities could have been catastrophic. Sonnier Bank suffered a loss of benthic cover associated with the hurricane, but the community was recovering, with algae and sponges dominating live areas by April/May of 2007. McGrail, Geyer, and Bright Banks did not exhibit any obvious hurricane damage in the surveys; given that these banks are dominated by algae and sponges, any damage to the living benthos may be hard to detect after the twenty months between the passage of the storm and the survey. McGrail Bank, with its large *Stephanocoenia intersepta* colonies, exhibited no apparent coral damage, which may have been protected by their considerable depth (148-ft or 45-m).

STUDY RESULTS: Sonnier Bank, the only study bank located east of the storm track, exhibited the least live cover at all depth ranges (~2-38%) when compared to McGrail, Geyer, and Bright Banks (~17-86%). Qualitative analysis of video footage collected by divers at Sonnier Bank in 1996, 2002, and 2005 showed differences in benthic cover compared to video collected in 2007. In previous years, more live cover of a mix of algae and sponges was obvious. Another notable difference was the apparent disappearance of *Xestospongia muta* colonies from Sonnier Bank. This species was present in 1996, declined to one individual with disease-like characteristics in 2002, and then was not recorded in 2005 or 2007. McGrail Bank was approximately 7-mi (12-km) west of the storm track and has the deepest reef cap of any bank evaluated in this study (148-ft or 45-m depth). Live cover at McGrail Bank ranged from 17-38% and was dominated by macroalgae (red, green, and brown), algal nodules, and coral (predominately *S. intersepta*). Previous videos were not available for qualitative analysis. No apparent hurricane damage in the form of overturned or injured corals was observed. Live cover at Geyer Bank ranged from 30-60% and was mostly colonized by brown macroalgae (specifically *Sargassum* spp.), corals, and sponges. According to transect video, Geyer Bank is the only bank in this study with an established population of *T. coccinea*. It is important to note that scientists have observed one or two colonies of *T. coccinea* at Sonnier Bank; however, *T. coccinea* colonies were not observed in our Sonnier Bank transect video. Diver video collected at Geyer Bank in 2003 showed similar benthic cover to the video that was recorded in 2007 with no obvious signs of

hurricane damage. Bright Bank exhibited the highest live cover (86%) and was dominated by macroalgae, turf algae, and corals such as *Millepora alcicornis* and *D. strigosa*. Diver video taken in September 2003 revealed mostly bare substrate, low macroalgal cover, and few large coral colonies. No hurricane damage was observed at Bright Bank.

The Shannon Wiener Diversity Index (*H'*) was calculated for each bank at each depth range using the lowest taxonomic group possible. The highest diversity of these four banks was Sonnier Bank from 22-27 m (72-89 ft; *H'* = 2.86), largely due to the variety of sponges present there. Geyer and McGrail Banks exhibited their highest diversity values in the 45- to 50-m (148- to 164-ft) depth range (*H'* = 2.13 and *H'* = 2.08, respectively). The high species richness of brown macroalgae accounted for these high diversity values. At Bright Bank, *H'* = 1.81 for the 30- to 36.5-m (98- to 120-ft) depth range.

Multivariate statistical analyses were performed using benthic cover data at Sonnier, McGrail, Geyer, and Bright Banks. Analysis of Similarity (ANOSIM) tests showed significant differences between banks (Global $R = 0.54$, $P = 0.001$). Within site comparisons showed less dissimilarity between depths. Multidimensional scaling (MDS) highlighted the dissimilarities among banks, with depths within sites grouping more closely.

Repetitive quadrat stations were photographed at the East Flower Garden Bank in June 2005, November 2005, and June 2006 to document hurricane damage and recovery. Coral cover remained consistently high and relatively constant in June 2005, November 2005, and June 2006 (62.78% ± 2.60, 61.34% ± 2.75, 62.87% ± 2.32, respectively) and species relative abundance showed stability with *M. annularis* species complex, *D. strigosa*, and *Porites* spp. as the dominant species. In June 2005 macroalgae was high at 24%, while CTB was lower at 10%. After the hurricane, in November 2005, the inverse relationship between macroalgae and CTB was evident, with 24% CTB and 13% macroalgae. Macroalgae cover is seasonally influenced and with the passage of Hurricane Rita it is likely that macroalgae was removed from the substratum. Between November 2005 and June 2006, macroalgae increased by ~5.4%, while CTB decreased by ~6.9%.

Approximately 1.5% of coral colonies photographed within repetitive quadrats at the East Flower Garden Bank were missing in November 2005, most likely due to the effects of Hurricane Rita. However, this did not notably affect estimates of coral cover. The most obvious difference in November 2005 repetitive quadrats was the high level of bleaching: 9.74% ± 1.07 SE of assessed coral points were bleached. Paling and fish biting measurements were low at 1.5% or less and disease was not observed. The June 2006 data showed a decrease in the level of bleaching (0.62%) compared to November 2005 and a slight increase in the amount of fish biting (2.1%). Coral disease was not observed in the June 2006 repetitive quadrat photographs, although the identification of disease in these photographs is not reliable because of the 2-m distance from the substrate. Perimeter lines were videotaped at the East Flower

Garden Bank study site in November 2005 and June 2006 to document change at known locations along the perimeter and within the study site. Lower levels of bleaching and paling were seen in June 2006 compared to November 2005. These qualitative observations corroborate the quantitative results from the repetitive quadrat data.

STUDY PRODUCT: Robbart, M.L., R.B. Aronson, K.J.P. Deslarzes, W.F. Precht, L. Duncan, B. Zimmer, and T. DeMunda. 2009. Post-hurricane assessment of sensitive habitats of the Flower Garden Banks vicinity. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, Louisiana. OCS Study MMS 2009-032. 160 pp.

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