

STUDY TITLE: Long-Term Monitoring at the East and West Flower Garden Banks National Marine Sanctuary (2011–2012).

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BACKGROUND: Since 1995, the National Oceanic and Atmospheric Administration's (NOAA) Flower Garden Banks National Marine Sanctuary (FGBNMS) has partnered with the Bureau of Ocean Energy Management (BOEM) to monitor the health of the coral reefs of the East and West Flower Garden Banks (FGB). Located 193 and 172 km (East and West Flower Garden Banks, respectively) offshore from Galveston, Texas, the banks are remotely located topographic features on the outer continental shelf in the Gulf of Mexico that are capped with reef-building corals. The monitoring program was developed over a period beginning in the late 1970s, when BOEM recognized the need for a baseline assessment of the status of the coral reefs in anticipation of increased exploration and development of offshore oil and gas resources in the area.

OBJECTIVES: To assess the health of the East FGB and West FGB coral reefs, through the evaluation of changes in living coral and other benthic community cover, coral growth rates, reef fish population dynamics, water quality, and other indices of reef vitality.

DESCRIPTION: The benthos (with an emphasis on coral cover and algae) was examined along stationary repetitive photoquadrats to monitor changes in specific coral reef locations over time, and random transect lines were photographed to get estimates of coral cover. Sclerochronology was used to document the accretionary growth rate of *Montastraea faveolata* colonies, and photography was used at permanent stations to monitor the lateral growth of corals. General aspects of coral condition were documented along perimeter lines at the EFGB and WFGB. During each annual monitoring cruise, observations of general coral reef health, as well as notable biological and oceanographic events were qualitatively assessed and documented. Water quality parameters (including seawater temperature and salinity) were recorded using Sea-Bird 37-SMP MicroCAT datasondes to characterize the reef caps and water column environment of the FGBNMS. Fish surveys using the Bohnsack and Bannerot method were conducted at randomly located stations and sea urchin and lobster surveys were conducted along the study site perimeter lines.

SIGNIFICANT CONCLUSIONS: In more than 25 years of continuous monitoring, the coral reefs of the FGBNMS have maintained high levels of coral cover, suffered minimally from hurricanes, coral bleaching, and disease outbreaks, and supported relatively diverse and abundant fish populations as well as other vertebrate and invertebrate species. No significant long-term changes have been detected in coral cover or diversity at the FGB during monitoring efforts that have taken place since 1988, and likely not since the first measurements were made in the early 1970s. Based on the 2011 and 2012 data, the average coral cover on the FGB coral caps was 60%. The incidence and prevalence of disease and bleaching in comparison to other western Atlantic coral sites were low.

STUDY RESULTS: Based on the results of the random transect data, *Orbicella franksi* was the principal component of mean percent coral cover at both banks. Mean cover of *Orbicella franksi* at EFGB was estimated at 26% in 2011 and 26% in 2012. At WFGB, mean cover was 24% in 2011 and 26% in 2012. *Pseudodiploria strigosa* was the next most abundant species during this period, with 6% at EFGB in 2011 and 8% in 2012. WFGB estimates were 12% and 9% for the two years. The importance of the FGB, in terms of the Atlantic coral reef system as a whole, has been substantially elevated due to the NOAA Fisheries Endangered Species Act listing of all coral under the *Orbicella annularis* species complex as threatened, all of which are found at the FGB.

In 2011 and 2012, macroalgae mean percent cover was more abundant than crustose coralline algae, fine turf algae, and bare rock (abbreviated as Crustose/Turf/Bare or CTB), ranging from approximately 30–38% at EFGB and 29–31% at WFGB. Despite continued stability in mean coral cover, macroalgae mean cover has been increasing since 1999. The most dominant components of macroalgal cover were fleshy algae, *Dictyota* spp., and *Lobophora variegata*. CTB was the second-ranked non-coral category of mean substratum percent cover, ranging from approximately 9–12% at EFGB and 10–12% at WFGB from 2011 to 2012. Mean sponge cover continues to be extremely low at both banks (less than 1%). An ANOVA and ANOSIM revealed that no

significant differences between sites or years occurred at EFGB and WFGB, making the banks similar in terms of benthic composition.

Sclerochronology was used to measure the accretionary extension rates of *Orbicella faveolata* coral cores. Annual extension of *Orbicella faveolata* at EFGB averaged 6.5 mm/year (sample range = 4.6–9.6 mm/year). At WFGB, annual growth averaged 5.6 mm/year (range = 3.3–10.3 mm/year). Extension rates did not differ significantly between banks.

Repetitive quadrats stations were photographed in 2011 and 2012 to monitor changes in specific coral reef locations over time. Mean coral cover in the repetitive quadrats averaged approximately 63% for both banks in all years. Macroalgae and CTB cover showed reciprocal patterns between banks. An ANOVA on the proportional cover of sponge and CTB showed significant differences between both bank and year. The incidences of bleaching, paling, and fish biting were low (ranging from 0.00–0.63% of area assessed), and there was little evidence of coral disease. The coral assemblages remained consistent at both banks, with the dominant corals being *Orbicella franksi* and *Pseudodiploria strigosa*.

At repetitive photostations in 32–40 m depths, mean coral cover ranged between 72–76% in 2011 and 2012. *Orbicella franksi* and *Montastraea cavernosa* were the dominant species in this depth range. Macroalgae averaged 19% and CTB averaged 7%.

Seawater temperature and salinity were recorded at EFGB and WFGB using Sea-Bird 37-SMP MicroCAT datasondes from 2011 to 2012. During the 2011 to 2012 period, seawater temperature ranged from 18.62°C to 30.49°C from 2011–2012 at EFGB, and ranged from 17.92°C to 30.55°C at WFGB. High seawater temperatures were observed during the late summer months, exceeding the 30°C coral bleaching threshold; however, because only limited time was spent above this temperature, the risk of bleaching was low. Though most Chl-*a* and nutrient concentrations were below detectable limits, total Kjeldahl Nitrogen (TKN) was detected in all water samples collected at the banks in 2011, with concentrations ranging from 1.3–45.2 mg/l (above the 0.55 mg/l detection limit), and in 50% of the samples collected in 2012.

Fish surveys were conducted using a modified Bohnsack and Bannerot (1986) method in 2011 and 2012. Pomacentridae, Labridae, and Serranidae were the dominant fish families at both banks. Diversity varied between banks and years, with the greatest diversity occurring at WFGB in 2012. The most frequently sighted species during this study period were brown chromis (*Chromis multilineata*), closely followed by Spanish hogfish (*Bodianus rufus*), and bluehead (*Thalassoma bifasciatum*). Mean fish density (abundance per 100 m²) was highest at WFGB in 2012 and lowest at EFGB in 2012.

Invertivores were the dominant fish guild, with Pomacentridae and Labridae representing the largest density. The size-frequency distributions of invertivores were non-normally distributed, with the majority of individuals being small damselfish. The

greatest mean biomass was seen at WFGB in 2011, where the piscivores possessed the highest mean biomass for all surveys, with over 50% of total biomass. Following the pattern of coral species present at the FGB (low diversity compared to Caribbean reefs, but high coral cover), the fish assemblages reflect a similar trend of low diversity and high abundance (Pattengill-Semmens and Gittings 2003). Although no lionfish (*Pterois* spp.) were observed within the fish surveys conducted, lionfish were sighted within the study site in 2012 after first being observed to invade sanctuary waters in 2011.

Sea urchin surveys documented continued low densities of *Diadema antillarum* at WFGB in 2011 (3.75 per 100 m²) and 2012 (12.5 per 100 m²). No sea urchins were observed at EFGB. These populations have not recovered to pre-1984 levels, which were at least 140 per 100 m² at EFGB and 50 per 100 m² at WFGB (Gittings et al. 1998).

STUDY PRODUCT(S):

Johnston, M.A., M.F. Nuttall, R.J. Eckert, J.A. Embesi, N.C. Slowey, E.L. Hickerson, and G.P. Schmahl. **2015**. Long-term monitoring at East and West Flower Garden Banks National Marine Sanctuary, 2011–2012, volume 1: technical report. U.S. Dept. of Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, Louisiana. OCS Study BOEM 2015-027. 194 p.

Johnston, Michelle A., M.F. Nuttall, R.J. Eckert, J.A. Embesi, N.C. Slowey, E.L. Hickerson, and G.P. Schmahl. **2015**. Long-term monitoring at East and West Flower Garden Banks National Marine Sanctuary, 2011–2012, volume 2: appendixes. U.S. Dept. of Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, Louisiana. OCS Study BOEM 2015-028. 416 p.

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