

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

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PROJECT MANAGER: Stephen R. Gittings

AFFILIATION: Geochemical and Environmental Research Group, Texas A&M University

ADDRESS: Geochemical and Environment Research Group, Texas A&M University, 833 Graham Road, College Station, Texas 77845

PRINCIPAL INVESTIGATOR: Stephen R. Gittings

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BACKGROUND: Environmental threats posed by substantial hydrocarbon development and other human activities on the outer continental shelf (OCS) in the northwest Gulf of Mexico, and the sensitivity of coral reefs to unfamiliar environmental change, prompted the Minerals Management Service to initiate a long-term monitoring program at the Flower Garden Banks, two OCS banks harboring coral reefs. The East (EFG) and West (WFG) Flower Garden Banks are located on the edge of the continental shelf, slightly over 175 km SSE of Galveston, Texas. The banks are topographic expressions of uplift caused by underlying salt domes originating from Jurassic, Louann evaporite deposits 15 km below the seafloor. The crests of these isolated banks, which are 19 km apart, are occupied by submerged coral reefs which rise to within 15 m of the surface. Together the bank zones containing high diversity coral reefs cover over 450 acres.

A monitoring program was designed to address concerns regarding the potential for both gradual and catastrophic deterioration. This is important in light of the November 1991 Flower Garden Banks National Marine Sanctuary designation. Recreational use of underwater areas has historically increased following the establishment of areas as marine parks, preserves, or sanctuaries. A long-term data base and standardized data collection and analysis techniques may allow for the identification of impacts caused by the expected increase in recreational use as well as those caused by escalating industrial activity in the vicinity.

OBJECTIVES: (1) To provide relevant and timely environmental data to those charged with developing policies concerning oil and gas exploration and development in the vicinity of these sensitive ecosystems; (2) to document long-term changes in coral and associated communities at the Flower Garden Banks caused either by impacts of petroleum exploration and development or other human activities; and (3) to document long-term natural variation in reef-building and associated communities on the banks.

DESCRIPTION: The establishment of monitoring stations at the East Flower Bank involved first delimiting a 100 m by 100 m area containing reef communities considered representative of those inhabiting the high diversity zone of the bank. This was followed by implanting and mapping one hundred twenty (120) permanent stations for monitoring encrusting (lateral) growth of *Montastraea annularis* (mountainous star coral) and *Diploria strigosa* (brain coral; 60 stations for each species), forty (40) permanent posts to mark 8 m² repetitive sampling station for monitoring individual coral colonies, and thirty (30) permanent accretionary growth spikes in coral colonies. This resulted in a study site comparable to that established by Continental Shelf Associates, Inc. in the West Flower Garden Bank in the summer of 1988 during monitoring efforts conducted for Union Oil Co. Photographic and video field work was conducted at both banks semi-annually.

During each sampling effort, twenty, 10-meter stratified random transects were photographed at each study site. Percent cover data were acquired planimetrically for all coral species, leafy algae, sponges and reefrock on the photographs. Also calculated was the number of colonies of each species, relative dominance of each coral species (percent cover relative to total coral cover), species diversity, and evenness.

At each site thirty spikes implated in the tops of cologines of *M. annularis* were repeatedly measured to monitor accretionary growth. In addition, sclerochronology was used to determine accretionary growth rates in four *M. annularis* colonies (two from each bank).

Core samples were also analyzed for their trace metal content by Instrumental Neutron Activation Analysis. A preliminary study of barium incorporation rates in coral skeletons was conducted to assess the possibility of using barium to document long-term water quality changes resulting from oil and gas exploration.

Each permanent station for monitoring the encrusting growth of *M annularis* or *D. strigosa* was established by implanting two nails 23 cm apart near colony borders. A diopter framer attached to an underwater camera and placed directly over the nails allowed photography of a repeatable 13.3 by 19.7 cm area. Growth and retreat were analyzed by projecting sequential margins onto the same surface, and by planimetric measurement of areas of growth and retreat, and border lengths over which the changes occurred.

Permanent posts were installed to mark repetitively photographed 8 m² areas for monitoring changes in individual colonies. Single slides were produced for each station during each sampling effort using a 2 m tall, T-shaped camera frame equipped with a down-looking camera, wide angle lens, two strobes, a compass, and a bubble level. The photos were taken at a compass heading of 000⁰ with the bubble level centered above the station post. Laboratory tests indicated high repeatability and precision. Growth, disease, bleaching, algae-mediated or algae/sediment mat-mediated retreat, unexplained mortality, and mechanical damage were quantified, as were their effect (mortality, recovery, or no effect).

Two videotaped transects of 100 m length were acquired at each study site during each cruise to record the general conditions of the coral community at the sites. The video was taken from approximately two meters above the bottom at an angle of 45⁰. Video transects were taken along 100 m lines tautly strung along two sides of each survey area.

Ancillary measurements included dissolved oxygen, salinity, temperature, and light. Samples and measurements were made at one meter depth and one meter above the bottom. Light was also measured above the surface. Sea surface temperature data between 1979 and 1990 were collected from records of AVHRR satellite transits. In addition, thermographs were installed in 1990 on the banks on the banks to record bottom temperature every two hours.

SIGNIFICANT CONCLUSIONS: Virtually no significant long-term changes have been detected in coral reef populations, cover, or diversity at the Flower Garden Banks since quantitative surveys of the reefs began. Those differences that have been identified are not considered to represent trends or evidence of deterioration of habitat quality. Conditions for accretionary and encrusting growth on the banks appeared to be favorable for both *montastraea annularis* and *Diploria strigosa*. Data indicate limited effects from factors other than those which naturally control coral growth. Monitoring of the occurrence and effects of coral bleaching (the expulsion of symbiotic algae essential to vigorous growth) and diseases suggests that disease was the more important cause of coral mortality even though more coral cover was affected by bleaching than by disease. The observations of mass spawning by three coral species on the East Bank in 1991, as well as the studies of recruitment, and observations of reef corals on petroleum platforms imply that the Flower Garden Banks harbor wholly functional coral communities. This suggests that the reefs are capable of self-seeding, and may not

required gene flow from outside sources for recovery following natural or human-induced disturbance. Parrotfish abundances appeared to have increased since the early 1980s. This may be a result of the 1983-1984 mass mortality of the long-spine sea urchin, *Diadema antillarum*, and consequent changes in benthic algae availability on the banks. A review of the potential effects of industrial activities on the reefs indicated that tanker spills and spills resulting from platform accidents, as well as the application of dispersants during clean-up operations, pose the most realistic threats to reef corals at the Flower Gardens. Discharges of produced waters and drilling fluids were not considered to pose substantial threats because of existing regulations in the vicinity of the banks and dilution by intervening water masses.

STUDY RESULTS: Coral cover, relative dominance, diversity, evenness, and accretionary and encrusting growth rates were monitored from 1989 through 1991. Several differences existed between study sites, particularly with respect to diversity and evenness, but these do not necessarily imply differences between the banks. No significant trends were observed in any parameters during the study. Comparison with data from population and growth studies conducted between 1978 and 1982 suggested no significant long-term trends. However, research plans include reanalysis of archived transect photographs using current methodologies to reduce variability of historic data. Coral bleaching was observed every summer during the study, but mortality was seldom associated with bleaching. Only 7% of bleached colonies exhibited any tissue loss; where it did occur, loss was limited to small portions of the bleached colonies. Diseases occurred on less than 2% of all corals analyzed, but relatively high levels of tissue mortality occurred; 69% of diseased colonies exhibited tissue loss. Late summer bleaching followed temperature maxima that exceeded 30°C. Coral growth on the banks was characterized by relatively high growth rates, net tissue gain over the study period, and a high proportion of advancing margins on *Montastrea annularis* and *Diploria strigosa*, the two dominant corals on the banks. Mass spawning (synchronous gamete release) by three coral species, *M. annularis*, *M. cavernosa*, and *D. Strigosa* was observed in 1990 and fully documented in 1991. Both events occurred eight evenings after August full moons, and were limited to two to three hour periods.

STUDY PRODUCT: Gittings, S.R., G.S. Boland, K.J.P. Deslarzes, D.K. Hagman, and B.S. Holland. 1992. Long-term monitoring at the East and West Flower Garden Banks. OCS Study MMS 92-0006. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Regional Office, New Orleans. 206 pp.

13 quarterly progress reports, 12 cruise reports, three project presentations, two presentation summaries, three presentation slide sets, project video.