

# Science-based design of coral protected areas in the Gulf of Mexico

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**Abstract.** The Flower Garden Banks National Marine Sanctuary (FGBNMS) contains the northernmost coral reefs in the continental United States, associated with a discontinuous arc of topographic features located along the outer continental shelf margin in the northwestern Gulf of Mexico. The coral reefs here are among the healthiest in the region, in spite of being located within one of the most intensely developed offshore oil and gas exploration areas in the world. Based on a recent management review process, FGBNMS proposes to expand its boundaries to include at least nine additional reefs and banks, in order to provide increased protection to coral communities and associated mesophotic coral habitat. This proposal would increase the area of the FGBNMS from 145.6 to 728.2 km<sup>2</sup>. To accomplish this, FGBNMS worked extensively with the public through a citizen-based advisory council, consisting of representatives from a variety of constituent and interest groups. The goal was to design a network of protected areas that, while large enough to provide essential protection for marine resources, would minimize the impact on the activities of primary user groups. The design methodology was based on information derived from over 30 years of science, monitoring and resource management of the FGBNMS. Base maps of all subject areas were developed utilizing high-resolution multibeam bathymetry. Primary habitats were characterized from direct surveys and predicted habitat suitability. Core biological areas were delineated and a range of buffer areas were considered, based on monitoring data from the East and West Flower Garden Banks. The resulting proposal balances the need for protection while allowing for necessary resource utilization.

**Key words:** Gulf of Mexico, Flower Garden Banks, Mesophotic Coral Ecosystems, Marine Protected Areas

## Introduction

The Flower Garden Banks National Marine Sanctuary (FGBNMS), located between 140 and 190 kilometers southeast of Galveston, Texas, contains some of the healthiest coral reefs in the western Atlantic and Caribbean region. The sanctuary includes three separate features. The East and West Flower Garden Banks, located approximately 22 kilometers apart, harbor 1.85 square kilometers of coral reefs between 17 and 40 meters depth, exhibiting from 50% to 70% living coral cover. Massive boulders of star and brain corals (*Montastraea*, *Diploria*, and *Colpophyllia*) dominate the reef. Stetson Bank, located 55 kilometers northwest of West Flower Garden Bank, contains distinct claystone pinnacles that rise to depths of 17 meters. Sponges, algae, and fire coral dominate here, but outcroppings of *Madracis decactis* and scattered hermatypic corals are also present. These three banks are positioned within one of the most intensely developed offshore oil and gas exploration regions in the world. They are part of a discontinuous arc of dozens of topographic features stretching along the edge of the outer continental shelf in the northwestern Gulf of Mexico (Fig.1).

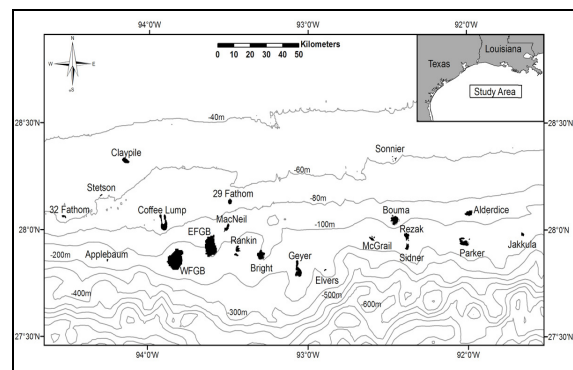


Figure 1: Reefs and banks of the northwestern Gulf of Mexico.

These topographic features harbor some of the most biologically important hard bottom habitat in the Gulf of Mexico. Many contain coral reefs and coral communities, as well as diverse coralline algal reefs, coral associated habitats and deepwater coral assemblages (Rezak et al. 1985, Schmahl et al. 2008). Although most do not contain as well-developed coral reefs as the Flower Garden Banks, they may serve as potential areas of future reef growth, especially in a

period of anticipated climate change. In addition, the reefs of FGBNMS and vicinity are important to the economy of the area (Ditton and Thailing 2003).

The FGBNMS was created in 1992, and is managed by the National Oceanic and Atmospheric Administration (NOAA). In 2006, the FGBNMS initiated a process to review and revise its management plan. The goal of this process is to establish management priorities, strategic actions and performance measures for management, research and education programs over a five to ten year time frame. It includes an extensive community-based public participation component. As part of the management plan review, FGBNMS held a series of public scoping meetings and received extensive public comment. In addition, a Sanctuary Advisory Council (SAC) was formed to facilitate and enhance public input related to sanctuary management issues. The council members represent the major constituent groups with interest in sanctuary resources, including Federal Agency partners. These groups include Recreational Diving, Diving Operators, Commercial Fishing, Recreational Fishing, the Oil and Gas Industry, Education and Outreach, Research, and Conservation.

During the management plan review process, many people expressed strong support for expanding the boundary of the FGBNMS, to include additional reefs and banks in the northwestern Gulf of Mexico. In response to public input, the SAC created a working group to address the issue of boundary expansion.

The purpose and need for expansion was described as follows: *“Potentially vulnerable geological and biological features associated with the FGBNMS are outside the current Sanctuary boundaries. In addition, numerous banks and associated features in the northwestern Gulf of Mexico may be ecologically linked to the FGBNMS and may be highly vulnerable to certain anthropogenic impacts. It is proposed that selected features be evaluated for inclusion under the management and protection of the FGBNMS.”* Sanctuary expansion was therefore included as a priority action strategy in the draft management plan released for public comment in October 2010. After review and consideration of additional public input, the final revised management plan was published in April 2012 (NOAA 2012). This plan includes a specific recommendation for boundary expansion put forward by the Advisory Council (Fig. 2).

The development of this recommendation for expanding the boundary of the FGBNMS is a case study in marine protected area design. The goal was to design a conservation network that, while large enough to provide essential protection for fragile marine resources, especially coral and coral communities, would also minimize the impact on the activities of a variety of user groups. The designation of these areas within a National Marine Sanctuary would fill in a jurisdictional gap that exists between current oil and gas, Federal fishing, and other regulatory measures.

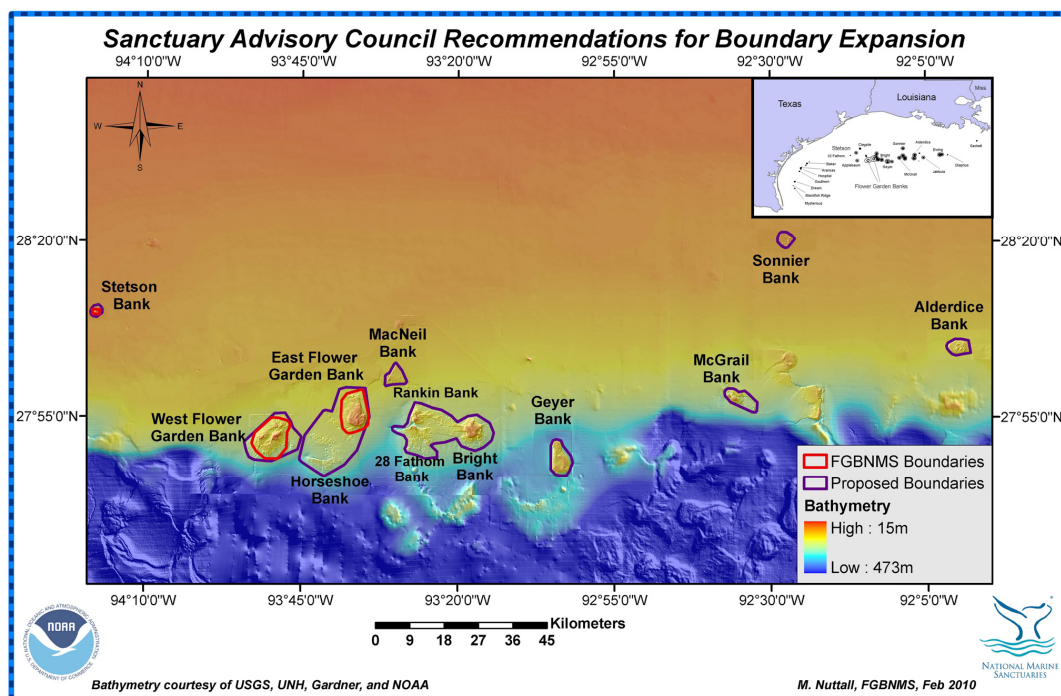


Figure 2: Proposed boundary expansion for the Flower Garden Banks National Marine Sanctuary.

## Material and Methods

The first step in the process was to identify the scope of the geographic area that should be considered for expansion. An initial list of suggested sites was compiled from public comments, advisory council input, staff recommendations, and the scientific literature. Based on public input, potential boundary expansion locations were identified throughout the Gulf of Mexico, from south Texas to Florida. For example, in addition to the reefs and banks in the vicinity of the FGBNMS, areas identified as in need of increased protection included the “South Texas Banks”, the Mississippi/Alabama Pinnacles, and locations off the West Florida Shelf such as the Florida Middle Grounds and Pulley Ridge. However, the working group recommended that the geographic scope for sanctuary expansion be restricted to the reefs and banks of northwestern Gulf of Mexico. Although areas from other parts of the Gulf of Mexico are important, they should be considered under a process other than expansion of the FGBNMS. Therefore, the boundary expansion working group evaluated 15 areas in the northwestern Gulf of Mexico for inclusion in the FGBNMS. In addition, boundary modifications to the existing banks within the FGBNMS were considered.

A ranking criteria matrix was developed to evaluate the proposed new locations. The matrix included the following criteria:

- 1. Resource Priority** – Biological and/or geological significance and/or uniqueness based on published information and recent FGBNMS data.
- 2. Structural Connectivity** – Physical connectivity to current FGBNMS features (ridges, scarps, etc.)
- 3. Biological Connectivity** – Proximity to other protected or proposed sites, including connectivity through adult movement and larval dispersal (Cowen et al. 2006, Steneck 2006)
- 4. Threat Level** – Level of threats known or perceived (visitation, fishing, debris, structural fragility, and renewability)
- 5. Public Interest** – Level of interest expressed by the public to incorporate site.

Each criteria index was assigned a numerical score by the boundary expansion working group. Each index was given a score from 1 to 3, with 1 being the lowest. After scoring, the sites were ranked in order of priority, and grouped according to rank order.

The evaluation of potential areas was greatly enhanced by information obtained from past studies and recent FGBNMS research activities. The reefs and banks of the northwestern Gulf of Mexico were extensively studied in the late 1970’s and early 1980’s in response to the interest of offshore oil and gas development in this area. These studies were supported by the Minerals Management Service (now

the Bureau of Offshore Energy Management – BOEM), and resulted in many publications, summarized by Rezak et al. (1985). Between 2001 and 2011, the FGBNMS has conducted extensive additional research in these areas, including submersible and remotely operated vehicle (ROV) surveys in the deeper water habitats.

The other piece of critical information that informed this process was the availability of high-resolution multibeam bathymetry and backscatter data for most of the areas of interest (Gardner et al. 2005). Utilizing this high-resolution multibeam bathymetry and the biological information obtained in the ROV surveys and previous studies, a series of benthic community habitat maps have been generated for the East and West Flower Garden and Stetson Banks. Based on this information, general habitat delineation could also be projected for most of the other reefs and banks under consideration for boundary expansion.

The establishment of proposed boundary lines for each area was determined as follows. First, “core biological zones” were identified for each bank based on seafloor topography and known or projected biological habitat. The primary benthic habitat types associated with these areas include coral reef, coral communities, coralline algal reefs, and deep coral assemblages (Schmahl et al. 2008). In general, the core biological zone is comprised of the primary geologic formation and its associated “prominent features” (scattered outcrops, scarps, and ridges). Prominent features were defined as hardbottom outcrops greater than 3 meters in vertical relief and 25 meters in diameter. The boundary of each core biological zone was established by using the outermost extent of the prominent features as landmarks, forming the vertices of an irregular polygon (Figure 3).

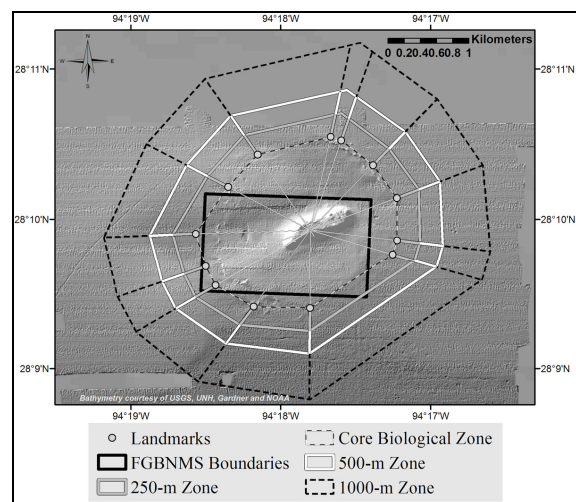


Figure 3: Stetson Bank expansion boundary development, showing the “core biological zone” and buffer zone options.

After the core biological zones were determined, buffer zones of various widths were evaluated, using the outer landmarks of the core polygon, radiating from an approximate midpoint of the bank (Figure 3). The analysis included 1000 meter, 500 meter, and 250 meter buffer zones based on information pertaining to the fate of drilling discharge materials in oil and gas development (Kennicutt et al. 1995), and sea turtle tracking data (Hickerson 2000).

## Results

Each proposed location for boundary expansion was evaluated and scored by the working group using the methodology described above. After all areas were evaluated, seven of the original fifteen areas were identified as the highest priority for inclusion: Stetson (boundary adjustment), Bright, McGrail, Geyer, Horseshoe, Sonnier and Alderdice Banks. These areas were found to include habitats and resources that were highly significant. In addition, three other banks (MacNeil, Rankin, 28 Fathom Banks) were identified as being physically and biologically connected to areas within the existing FGBNMS, and should also be considered.

The boundary expansion working group also recommended that the boundaries for new sanctuary areas be as small as possible around each feature while still providing adequate protection for critical habitat areas. The biological assemblages considered as critical habitat include coral reefs, coral communities, coralline algal reefs, and deep coral assemblages. After consideration of several buffer options, the working group recommended that a 500-meter buffer around the core biological zone be included to provide a necessary margin of protection. This buffer recommendation was based on literature detailing dispersal patterns and the likely range of effects of pollutants associated with shunted drilling lubricants and cuttings released during oil and gas exploration and production (Kennicutt et al. 1995). Finally, for each bank under consideration, oil and gas infrastructure was identified and recommendations were made to include or exclude those portions with existing platforms and other infrastructure. The final council recommendation includes four oil and gas production platforms within the recommended expansion boundaries.

The ultimate advisory council recommendation for sanctuary expansion, with boundaries based on the core biological zone area plus a 500-meter buffer zone, includes modifying the existing boundaries of East and West Flower Garden and Stetson Banks, and adding nine new areas: 1) Horseshoe Bank, 2) McGrail Bank, 3) Geyer Bank, 4) Bright Bank, 5) Sonnier Bank, 6) Alderdice Bank, 7) MacNeil Bank, 8) Rankin Bank, and 9) 28 Fathom Bank (Fig. 2).

## Discussion

The proposal to expand the boundary of the FGBNMS represents a significant increase in the amount of coral and potential coral communities under protection in the Gulf of Mexico. If the recommendation described in this paper is adopted, it will increase the size of the FGBNMS from 145.6 to 728.2 square kilometers. In order to implement this recommendation, NOAA must proceed with an additional action to establish the boundaries through a regulatory process. This process will entail the development of a detailed environmental impact statement and will involve considerable public involvement. However, the recommendation contained in the final management plan represents a solid foundation from which to continue forward and provides a clear intention for future action.

It would not have been possible to develop the boundary expansion proposal without the agreement and consensus of the primary constituent groups. This consensus could not have been reached without strong scientific information derived from over 30 years of research, exploration and monitoring of the reefs and coral communities of the FGBNMS and northwestern Gulf of Mexico. Information provided from high-resolution multibeam mapping, exploratory research and long-term monitoring programs allowed the development of boundary delineation for the expanded areas based on sound scientific principles, and was essential for the success of the proposal.

The protection of additional coral reefs, coral communities and deepwater coral resources in the northwestern Gulf of Mexico emerged as one of the priority issues during the FGBNMS management plan review process. A number of reasons were raised as to why additional protection is necessary. First, there is a significant concern about impacts from anchoring and other disturbances on the sensitive biological resources and geological features associated with many reefs and banks in the area. Specific examples were identified that indicate certain areas, such as Sonnier Bank, have already been injured as a result of indiscriminate anchoring. Second, several areas, such as Sonnier, Bright and Geyer Banks, are becoming popular sites for recreational diving, especially as technical diving technologies allowing divers to go deeper become more available. Third, some areas contain special features that require high levels of protection. These include McGrail Bank, where a unique deepwater coral reef is located (Schmahl and Hickerson 2008), and Alderdice Bank, where prominent basalt spires arise from the seafloor, a feature of significant geological interest. Finally, there are areas, such as Bright Bank, where significant damage has occurred as a result of activities that are not properly regulated (e.g., excavation in search of



submerged historical resources). For these and other reasons, a comprehensive management approach offered by National Marine Sanctuary designation could provide the necessary protection to these critical habitats.

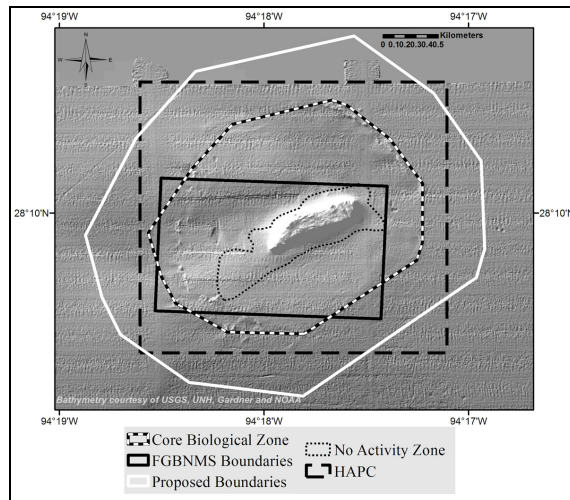


Figure 4: Recommended boundary expansion for Stetson Bank (white line), showing locations of other regulatory boundaries.

High-resolution multi-beam bathymetry has revealed the reefs and banks outside FGBNMS form an interconnected network of habitat in the northwestern Gulf of Mexico. In addition to the high relief topographic features known in the region, there are comparatively low relief ridges that connect some of the banks, particularly those near the shelf edge. Many of these hard bottom features are structurally connected to the banks of the sanctuary and are likely important in maintaining the integrity of the sanctuary ecosystem through habitat and species connectivity.

Observations made during submersible and ROV surveys suggest that fish species occupy and may move preferentially along these features from bank to bank. The ridges and outcrops provide habitat for many other species that are prey for larger migratory species. Thus, these “habitat highways” are critical to the ecological integrity of the reefs and banks of the northwestern Gulf of Mexico. In addition, numerous banks and associated topographic features have unique or unusual structural features, including brine seeps and flows, fragile outcrops and reef cavities, and spawning aggregation sites. Some features may be vulnerable to certain anthropogenic impacts that alter the physical, chemical, biological, or acoustic environment. Although many banks have some level of protection through the Bureau of Offshore Energy Management (BOEM) “Topographic Features Stipulation”, or through the Gulf of Mexico Fishery Management Council “Habitat Areas of Particular Concern” (HAPC) designations (Fig. 4), it is evident

that additional resource protection provided by sanctuary status may be warranted.

Pre-existing and potentially incompatible uses complicate the expansion of FGBNMS. A primary concern is the intense level of oil and gas development in the northern Gulf of Mexico. However, long-term monitoring of the coral reefs of FGBNMS demonstrates that certain oil and gas exploration and production activities can occur (barring a catastrophic incident such as the Deepwater Horizon oil spill) within close proximity of sensitive marine environments if careful criteria are adhered to. This principle was utilized to establish proposed boundaries for new areas that will allow certain activities to continue while providing reasonable protection. Using scientific information obtained through extensive research and monitoring, consensus was reached on an approach to establish an expanded network of protected areas in the Gulf of Mexico.

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