

**THE GULF OF MEXICO ECOSYSTEM: LINKING SHARED MARINE RESOURCES
ACROSS INTERNATIONAL BORDERS THROUGH THE GULF'S SPECIAL PLACES**

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The Gulf of Mexico (Gulf) ecosystem, like its geography and resource management challenges, is vast and diverse. It is an enormous reservoir of biodiversity that is bound together in an interwoven network of physical and biological connections, and critical habitats.² The Gulf's unique geology and productive ecosystem has given our human economy a rich ocean environment teeming with spectacular species, special places, and abundant economic resources.

As the stewards of the Gulf's marine species, places, and resources, it is essential that government agencies work across jurisdictional and political boundaries as they manage resource use and protection, because the shared resources have no regard for those boundaries. Failure to recognize these trans-boundary connections has consequences for everyone.

The 2010 Deepwater Horizon oil spill was a stark awakening to how lives, communities, and ecosystems can be harmed when responsible use and adequate protection of our ocean is lacking. This tragedy clearly showed that the Gulf's ecological and human environments are interwoven. As a result, resource use and ecosystem protection strategies must work closely together if such accidents, and their costs, are to be avoided in the future.

Unfortunately, the spectacular ocean life of the Gulf is often unrecognized by the public, but its petroleum and fisheries riches are well known. This presents challenges to creating adequate policies to protect the Gulf's environment as its

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²Darryl L. Felder & David K. Camp, eds., GULF OF MEXICO ORIGIN, WATERS, AND BIOTA: VOL. I, BIODIVERSITY (Tex. A&M Press 2009).

economic wealth is tapped, and for people to see what it means if its environment is damaged or lost.

The extent of the Gulf's biological riches are on full display at a number of special places, particularly at the Flower Garden Banks National Marine Sanctuary (Sanctuary), 100 miles southeast of Galveston, Texas.³ This sea floor habitat, on which some of the healthiest coral reefs in the Western Hemisphere grow, is home to abundant and diverse invertebrate and fish life. Sanctuary management uses scientific programs to understand and monitor the conditions of these coral reefs.⁴ Comparing its condition with other reefs in the Caribbean shows that the Flower Garden Banks have coral abundance that exceeds most other coral reefs in the region. This large amount of coral has been maintained since observations began in the 1970s.⁵ However, to ensure these reefs stay healthy, it is important to look beyond the borders of the Sanctuary to ensure the ecological connections in the region also stay healthy.

The Sanctuary is surrounded by one of the most industrialized ocean areas in the world. The fact that the Sanctuary is in such good condition is a credit to the Sanctuary managers working together with the oil and gas industry, scientific colleagues, and regulatory agencies, such as the Bureau of Ocean Energy Management (BOEM) and the Bureau of Safety and Environmental Enforcement, to ensure it stays that way. In addition, the National Oceanic and Atmospheric Administration (NOAA), as manager of the Sanctuary, is considering bringing sanctuary protections to some of the other reefs and banks in the region. In evaluating this expansion, NOAA has consulted with multiple stakeholders.⁶ This process ensures that protecting these areas will be a balance of allowing ocean uses and ensuring these areas maintain their ecological function.

Many of the sea floor features that surround the Sanctuary have shallow coral reef communities that are linked ecologically to the Flower Garden Banks.

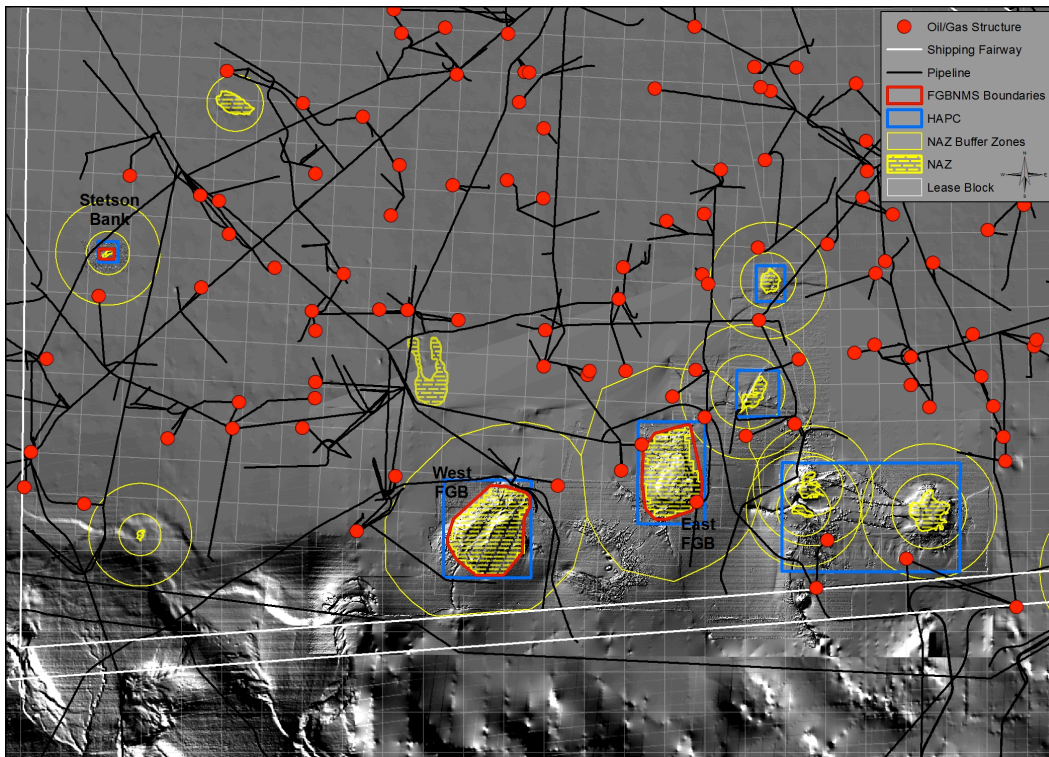
³ *Flower Garden Banks*, FLOWER GARDEN BANKS NAT'L MARINE SANCTUARY, <https://flowergarden.noaa.gov/> (last visited June 6, 2018).

⁴ *Science*, FLOWER GARDEN BANKS NAT'L MARINE SANCTUARY, <http://flowergarden.noaa.gov/science/science.html> (last visited June 6, 2018).

⁵ NOAA OFF. OF NATL. MARINE SANCTUARIES, LONG-TERM MONITORING AT EAST AND WEST FLOWER GARDEN BANKS NATIONAL MARINE SANCTUARY: 2014 ANNUAL REPORT (2015), https://nmsflowergarden.blob.core.windows.net/flowergarden-prod/media/archive/document_library/scidocs/ltn2014report.pdf (last visited June 6, 2018).

⁶ *Management Plan Review*, FLOWER GARDEN BANKS NAT'L MARINE SANCTUARY, https://nmsflowergarden.blob.core.windows.net/flowergarden-prod/media/archive/document_library/mgmtdocs/mprfactsheet.pdf (last visited June 6, 2018).

Also, deep water (mesophotic) communities occupy deep hardground habitats that physically link the banks to one another. In addition to those physical features, the area has a complex regulatory overlay that includes fishery Habitat Areas of Particular Concern, oil and gas No Activity Zones and lease blocks, shipping fairways, and sanctuary boundaries. All of these management jurisdictions need to work together if any environmental protections or resource management strategies are to succeed.



The East and West Flower Garden Banks (FGB) and Stetson Bank that make up the Flower Garden Banks National Marine Sanctuary are shown on a gray background of bathymetry. The map also shows oil and gas infrastructure and overlapping management jurisdictions in the area, including BOEM lease blocks and No Activity Zones (NAZ), NOAA national marine sanctuary boundaries, NOAA fisheries Habitat Areas of Particular Concern (HAPC), and U.S. Coast Guard shipping fairways. (Map by Marissa Nuttal, NOAA)

In the same way that looking outside management boundaries is important to successful stewardship of the ecosystem, the United States, Mexico, and Cuba also need to look outside their boundaries if the resources of the Gulf are to be safely and sustainably utilized, and its ecosystem is to be protected. The Harte Research Institute and its partners at the Ocean Foundation, Mote Marine Lab,

Environmental Defense Fund, and other non-governmental organizations all recognize this need to look beyond borders and have led the Trilateral Initiative (3NI) to build scientific and conservation strategies among the three nations that surround the Gulf.⁷ This initiative has brought together marine scientists and resource managers from the three nations to share knowledge and conduct joint research projects. Focused areas of research include coral reefs, fish populations, whales, sea turtles, and sharks. It has also been fundamental in facilitating the development of NOAA's Office of National Marine Sanctuaries' engagement with Mexico and Cuba on marine protected areas. This tri-national engagement has helped to identify research needs based on the ecological connections that exist between the three countries and build a foundation for why preserving those connections is so vital.

Examples of the many ecological connections between distant parts of the Gulf include the following:

- In 2003 and 2005, new colonies of *Acropora palmata* (elkhorn coral) were discovered at the Flower Garden Banks after being absent from these reefs for centuries.⁸ The larvae of these colonies had to originate in the southern Gulf on the reefs of Mexico and/or Cuba where *Acropora palmata* is well established.
- Like the larvae of invertebrates, a number of large charismatic species, including whale sharks, move freely throughout the Gulf. Whale sharks periodically come together in large impressive, feeding aggregations. Tracking studies⁹ have identified aggregations that migrate from waters off the Yucatán to the northern Gulf.

⁷ *Trilateral Initiative for Marine Science and Conservation in the Gulf of Mexico and Western Caribbean*, TRI-NATIONAL INITIATIVE, <http://www.trilateralinitiative.org> (last visited June 6, 2018).

⁸ William E. Kiene, *The Coral Reefs of the Flower Garden Banks: Sentinels of Change in the Northwestern Gulf of Mexico*, 5 S. CLIMATE MONITOR 2 (2015), http://www.southernclimate.org/documents/SCIPP_Monitor_August_2015.pdf (last visited June 6, 2018).

⁹ Robert E. Hueter, John P. Tyminski, & Rafael de la Parra, *Horizontal Movements, Migration Patterns, and Population Structure of Whale Sharks in the Gulf of Mexico and Northwestern Caribbean Sea*, 8 PLOS ONE 8 (2013), <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0071883> (last visited June 6, 2018).

- The same is true for whale species. Sperm whales have been known to travel throughout the Gulf of Mexico and have been identified to have distinct core feeding areas and home ranges.¹⁰
- The invasive Indo-Pacific lionfish has spread throughout the Caribbean and is now resident in the Gulf.¹¹ Other invasive species, such as the orange cup coral *Tubastrea micranthus*,¹² and diseases¹³ have propagated on the ecological links the Gulf has with the wider Caribbean.

A good illustration of how the entire Gulf is physically connected is shown by real-time animations of sea surface temperature, height, and salinity modeled by the U.S. Naval Research Laboratory.¹⁴ These data show the currents flowing through the Gulf, which transport the offspring of invertebrates and fish, nourish the environments these organisms inhabit. This flow also means that no part of the Gulf is isolated from contaminants or alien species that may be introduced anywhere in the region.

The connections in the Gulf mean that places do not function in ecological isolation. Successful management and protection of any special place or species requires concern for the conditions of other places throughout the region. For example, deep-water coral communities have been documented throughout the Gulf.¹⁵ The factors that determine their locations and how they get there are poorly understood. However, their concentration at key places surrounded by great distances of deep-water biological “deserts” shows that even at great depths organisms and their offspring are able to locate or be transported to the special

¹⁰ A. JOCHENS ET AL., SPERM WHALE SEISMIC STUDY IN THE GULF OF MEXICO: SYNTHESIS REPORT (2008), <https://www.boem.gov/ESPIS/4/4444.pdf> (last visited June 6, 2018).

¹¹ Michelle A. Johnston et al., *Rapid Invasion of Indo-Pacific Lionfishes *Pterois volitans* (Linnaeus, 1758) and *P. miles* (Bennett, 1828) in Flower Garden Banks National Marine Sanctuary, Gulf of Mexico, Documented in Multiple Data Sets*, 5 BIOINVASIONS REC. 115 (2016), http://reabic.net/journals/bir/2016/2/BIR_2016_Johnston_etal.pdf (last visited June 6, 2018).

¹² Paul W. Sammarco, et al., *Population Expansion of a New Invasive Coral Species, *Tubastrea micranthus*, in the Northern Gulf of Mexico*, 495 MAR. ECOL. PROG. SER. 161 (2014), http://www.int-res.com/articles/meps_oa/m495p161.pdf (last visited June 6, 2018).

¹³ H.A. Lessios, *The Great *Diadema antillarum* Die-Off: 30 Years Later*, 8 ANNU. REV. MAR. SCI. 267 (2016), <https://www.ncbi.nlm.nih.gov/pubmed/26048480> (last visited June 6, 2018).

¹⁴ See *Gulf of Mexico Movies and Snapshots of the 1/12° Global HYCOM*, U.S. DEP'T OF THE NAVY, <https://www7320.nrlssc.navy.mil/GLBhycom1-12/glfmex.html> (last visited June 13, 2018).

¹⁵ CONTINENTAL SHELF ASSOCIATES, INTL., CHARACTERIZATION OF NORTHERN GULF OF MEXICO DEEPWATER HARD BOTTOM COMMUNITIES WITH EMPHASIS ON *LOPHELIA* CORAL (2007), <http://www.data.boem.gov/PI/PDFImages/ESPIS/4/4264.pdf> (last visited on June 6, 2018).

places they need and to connect to other deep-water habitats. This is also true for the spectacular chemosynthetic communities that are found associated with hydrocarbon seeps and brine flows on the deep seafloor in the Gulf.¹⁶

So how does understanding these connections help us manage the Gulf's ecosystem? NOAA's Office of National Marine Sanctuaries has formed an international alliance of marine protected area management across political boundaries based on biological and ecological links. This network of "sister sanctuaries" is meant to focus common research and management strategies on shared conservation challenges at key sites around the Gulf.

While each of the network sites have unique experiences and components of the Gulf's ecosystem, each site in the alliance is invested in the conservation of the others. As a result, the sister sanctuary network is conceived to strengthen the management capacity and, as a consequence, the ecosystem integrity at each of the sites in the network, which will help to maintain the ecological connections between the sites.

In June 2015, United States and Mexico protected area managers met together in Merida, Mexico to create a work plan for cooperation linking the Flower Garden Banks and Florida Keys National Marine Sanctuaries with seven protected areas in Mexico: Yum-Balam Flora and Fauna Protected Area, Whale Shark Biosphere Reserve, Isla Contoy National Park, Isla Mujeres, Punta Cancún and Punta Nizuc National Park, Arrecife Alacranes National Park, Veracruz National Park, and Lobos-Tuxpan Flora and Fauna Protected Area. This successful meeting established areas of mutual interest and need, as well as personal working relationships between managers from some of the most ecologically significant places in the Gulf.

¹⁶ NOAA OCEAN EXPLORATION & RESEARCH, LESSONS FROM THE DEEP: EXPLORING THE GULF OF MEXICO'S DEEP-SEA ECOSYSTEMS EDUCATION MATERIALS COLLECTION (2009), http://oceanexplorer.noaa.gov/edu/guide/gomdse_edguide.pdf (last visited June 6, 2018).



The “Sister Sanctuary” Network in the Gulf of Mexico.¹⁷

This relationship between the United States and Mexico, and engagements facilitated by the 3NI, provide a basis for cooperation between nations through marine protected area management. The U.S. government used this potential for cooperation when it opened the door to improving relations and official engagements with Cuba in 2014. Marine Protected Area (MPA) cooperation was the basis for one of the first official meetings between the United States and Cuba in early 2015. Then, in November 2015, NOAA, the U.S. National Park Service, and Cuba’s Ministry of Science, Technology, and Environment came together in Havana to sign a Memorandum of Understanding on MPA cooperation,¹⁸ which includes sister sanctuary relationships between Cuba’s Guanahacabibes National Park and Florida Keys National Marine Sanctuary, and between Cuba’s Banco de San Antonio and Flower Garden Banks National Marine Sanctuary. This reestablishment of relations between Cuba and the United States through MPAs is fitting, since the fifty years of politics that have separated the two countries is

¹⁷ Map created by the author.

¹⁸ *U.S. and Cuba to Cooperate on Conservation and Management of Marine Protected Areas*, NAT’L OCEANIC AND ATMOSPHERIC ADMIN., <http://www.noaanews.noaa.gov/stories2015/111815-us-and-cuba-to-cooperate-on-conservation-and-management-of-marine-protected-areas.html> (last visited on June 6, 2018).

overshadowed by the 500 years of social and economic history that has connected Cuba and Mexico to the United States through the Gulf.

An example of these historical connections is an exciting discovery made on the deep sea floor south of the Flower Garden Banks- an early 19th century shipwreck full of arms, trade goods, and artifacts of life on the sea¹⁹ that shows how the Gulf has been the conduit for cultures and commerce for a long time. Archeologists and biologists have worked closely together to document how the Gulf's biology has interacted with this shipwreck. It and two more nearby shipwrecks have artifacts that link them to Mexico and possibly Cuba. The ships are thought to have been a privateer and its two captures, all sunk in a storm. Studying the shipwrecks demonstrates how collaborative interdisciplinary and international study of the Gulf can reveal much about the history of the relationships between the three countries and how to design those relationships in the future.

The Gulf unites rather than separates Mexico, Cuba, and the United States. The Gulf's abundance of life moves freely across international borders and the connections that bind its ecosystem together link key places and species in the three countries. The marine protected areas in Mexico, Cuba, and the United States are the reference points for how distant parts of the Gulf are interconnected, and for the strategies to protect them. Already, plans are in place for joint science missions and for implementing common habitat mapping procedures and condition reports for the sister sites. These collaborative efforts, and the ecological interconnections between the sites they are characterizing, bridge the political boundaries that occur between the nations that surround the Gulf. These bridges of joint stewardship of natural resources will be critical to realizing the full benefits of the Gulf of Mexico.

¹⁹ Lauren Hilgers, *All Hands on Deck: Inviting the World to Explore a Shipwreck Deep in the Gulf of Mexico*, ARCHAEOLOGY (2014), <http://www.archaeology.org/issues/124-1403/features/1811-gulf-of-mexico-monterrey-shipwreck> (last visited on June 6, 2018).