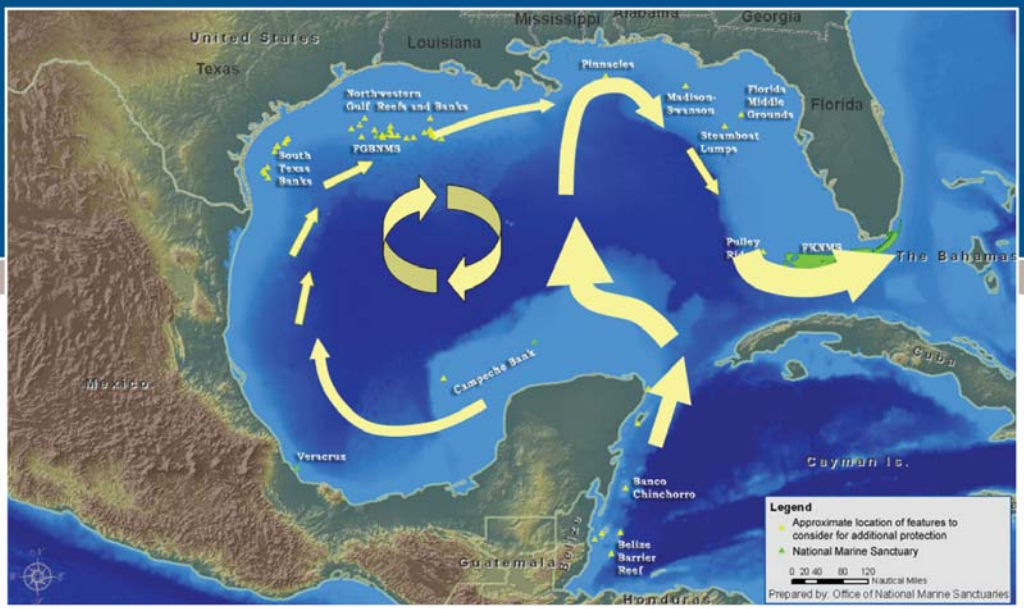
THE GULF OF MEXICO



A CONNECTED SYSTEM

The Gulf of Mexico is a semi-enclosed oceanic basin that fits nicely between latitudes 18-31 degrees North and longitudes 82-98 degrees West. The Gulf has one major current system, the Loop Current, which connects it to the Caribbean waters south of it. The Loop Current flows roughly northward from the Caribbean Sea between the Yucatan Peninsula and the western end of Cuba, and somewhere in the middle of the eastern Gulf it "loops" to the east, and then flows southward parallel to the west coast of Florida. After it passes the Dry Tortugas, the Loop Current turns sharply to the east, becoming the southern end of the mighty Gulf Stream as it passes through the Florida Straits.

Like the Gulf Stream, the Loop Current can occasionally form pinch-off eddies that can move around the western Gulf for months after they are formed, further circulating the warm Caribbean waters throughout the Gulf. Spinning clockwise at 2 or 3 mi an hour, some eddies are more than 100 mi in diameter. They carry their warm water westward over several months, strongly affecting currents in the western Gulf, but eventually lose steam and break apart when they hit the continental shelf off Texas or Mexico. Three or four such eddies may exist in the Gulf at any one time. In areas of the western Gulf without eddies, circulation is influenced mostly by wind and rivers. These currents are not nearly as strong as within or near the eddies, but they do affect life in the Gulf.

Though the names may change along the way, the Yucatan Current, the Loop Current, the Florida Current, the Gulf Stream, and all of the countercurrents and eddies they spawn carry with them the larvae and spores of tropical species from Belize, Mexico and other Caribbean locales. Ocean currents cast plant spores, animal larvae, and even adult creatures over huge expanses, sometimes between distant, isolated islands. Currents are the ocean's version of the breezes that disperse the seeds of dandelions and maples, and the spores of mushrooms. They are the "liquid wind" that supplies and replenishes habitats of every kind in the ocean realm.

Because of the current system that begins along the Yucatan Peninsula, hard-substrate (also called hard-bottom) features lucky enough to be downstream from the Caribbean have become prime real estate for thousands of species of corals, sponges, fish and other tropical species--regional outposts displaying an unexpected tropical flair. One of the major suppliers in the Caribbean, the Meso-American Barrier Reef System lies off the coasts of Belize and Mexico. It may represent what scientists call a center of diversity for the region, which means that it contains nearly all of the reef species present in the region.

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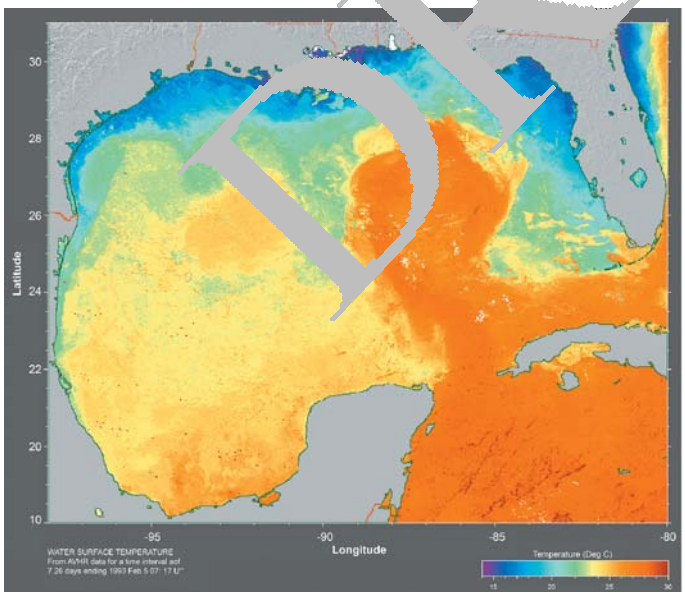
The Gulf of Mexico has a variety of hard-bottom areas around its periphery. In shallow waters, above 100 ft or so, are rocky outcrops along the Mexican coast of the southwestern Gulf. There are also a few shallow offshore banks in the northwest Gulf formed by upwardly migrating domes of 160-million-yr-old salt. Any such features that might be in the central part of the northern Gulf are covered by sediments discharged by the Mississippi, so they offer little in the way of hard substrate. East of the Mississippi is the West Florida Shelf, offering vast expanses of carbonate hard bottom for reef creatures.

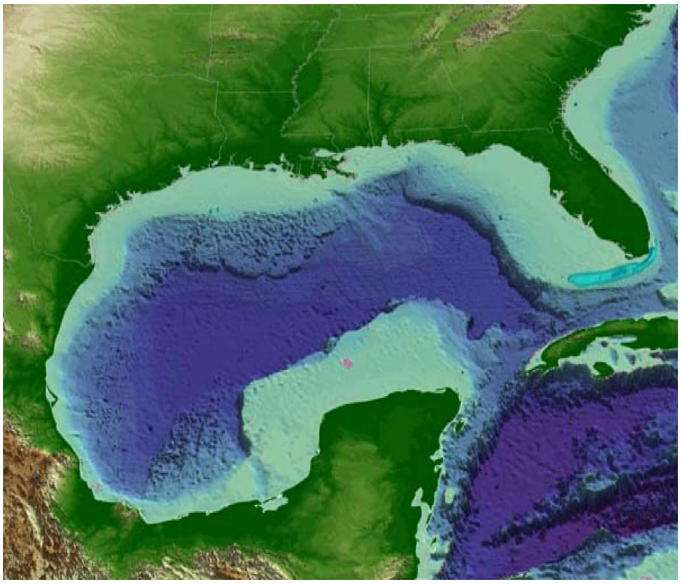
At depths near 300 ft in the Gulf is a veritable "bathtub ring" of hard deposits. During the last ice age, the sea surface was at this level. Shorelines eroded, sand dunes formed and hardened along beaches, and reefs grew near shore. When sea level rose again with the melting of the glaciers, the ocean left these features below. Today, they serve as northern detachments of the Caribbean fauna and flora--an extension of the tropics.

Deeper still are other hard-bottom areas, but few have been explored. There are reefs formed by deep-water corals, and carbonate rocks, ledges and cliffs. There are, undoubtedly, undiscovered oases of life that may show us new ways in which animals on Earth survive.

A map for the Gulf of Mexico and the Caribbean Sea with schematic cartoons showing the Caribbean and Loop Currents, Loop Current eddy and the Gulf Stream. The isobaths shown are in meters.



AVHRR (Advanced Very High Resolution Radiometry; http://fermi.jhuapl. edu/avhrr/gm/averages/index.html) seven-day composite sea-surface temperature (SST) for day ending on Feb/05/1998, showing the Loop Current in an extended location into the Gulf.



The Gulf of Mexico in 3D perspective. From NOAA Ocean Exploration located at http://www.oceanexplorer.noaa.gov/technology/tools/mapping/media/gis_gulf.html

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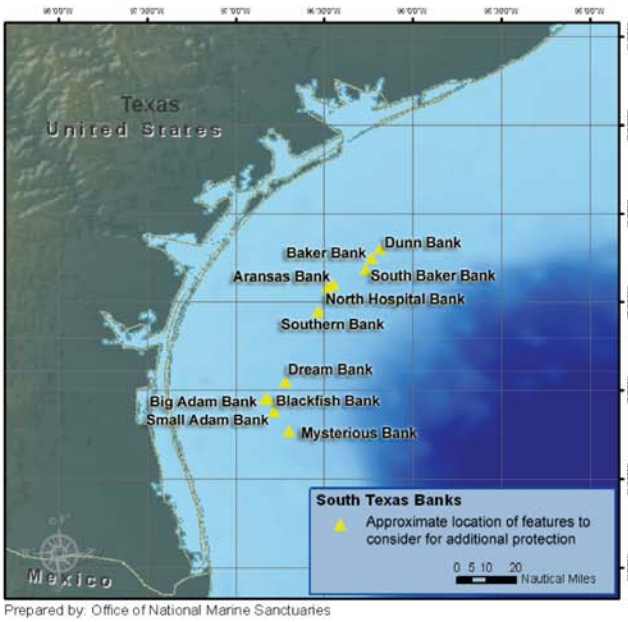
SOUTH TEXAS BANKS



Prepared by: Office of National Marine Sanctuaries

PHYSICAL SETTING

Shelf Setting

- The South Texas, or "snapper banks," located approximately 40 miles from shore
- Mid-shelf region.

Water Depth

- The plateaus of the banks are at 200 ft to 280 ft

Geologic Structure

- Formed by coral reefs along a Late Pleistocene shoreline roughly 18,000 years ago
- These relict reefs range in size from 1500 ft in diameter (Blackfish Bank) to nearly a mile across (Southern Bank). They are low-relief features with about 65 ft of relief on average.
- Relatively flat topped, consisting of large, rubble covered, coral-algal limestone outcrops separated by channels and depressions
- Southern Bank is a typical example of the relict reefs found on the south Texas shelf. It is circular with a diameter of approximately 4000 ft, and rises from a depth of 260 ft to a crest at 200 ft.

Ecosystem

- Low relief hardbottom invertebrate community supporting a significant fish population
- Adapted to high turbidity
- Mix of temperate and tropical species

Oceanographic Setting

- Variable current and seasonal temperature regime

BIOLOGICAL CHARACTERISTICS

Benthic Biology

- Antipatharian sea-whips and large white *Thesea* sea-fans are common, as well as smaller paramuricid soft corals and agariciid hard corals. The American thorny oyster thrives on the crests of some banks. Mobile fauna include arrow crabs, hermit crabs, Spanish lobster, octopus, basket stars, sea urchins, sea cucumbers, and fireworms.
- Rock outcrops support a number of epifaunal species such as cup-shaped and encrusting sponges, gorgonians, and crinoids.
- Clusters of the scleractinian coral, *Oculina diffusa*, have been observed on the rocky outcrops. This species tends to thrive in habitats exhibiting low light and high sedimentation. It forms twisted, rather low-relief colonies.

Fish Species

- Large schools of yellowtail snapper aggregate around the reef structures, along with roughtongue bass, spotfin hogfish, reef butterflyfish, wrasse bass, bigeyes, tattlers, hovering gobies, and angelfish.
- The groundfish assemblage is similar in composition and magnitude to the fishes frequenting the coral reefs and deep-water zones of Flower Garden Banks and other northwestern Gulf banks.
- Large migratory fishes also occur, including greater amberjacks, groupers, cobia, barracuda, and some of the most important commercial and game fishes, including red snapper and vermilion snapper. These aggregations earned the features the nickname "snapper banks".

Ecological Significance

- The South Texas Banks exist in an area of high turbidity and sedimentation. The temporal dynamics and the importance of this turbidity to the banks' existence and or limits are poorly understood, but their presence within these conditions emphasizes the uniqueness of these ecosystems.
- The banks attract abundant nektonic species that utilize the overlying water column.

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THREATS

Extractive Uses

- Trawling
- Potential overfishing
- Oil and gas exploration/production

MANAGEMENT

Regulatory Agencies

Existing Regulations

Protection Needs

KEY REFERENCES:

- Bright, J.T. and R. Rezak. 1976. A Biological and Geological Reconnaissance of Selected Topographical Features on the Texas Continental Shelf. 377 pp. http://www.gomr.mms.gov/PI/PDFImages/ESPIS/4/4107.pdf
- Rezak, R., T.J. Bright, and D.W. McGrail. 1985. Reefs and banks of the northwestern Gulf of Mexico. Their geological, biological, and physical dynamics. John Wiley and Sons, New York. 259pp.
- Rezak, R. and T.J. Bright. 1981. Northern Gulf of Mexico topographic features study. 5 vols. http://www.gomr.mms.gov/PI/PDFImages/ESPIS/0/523.pdf
- Gulf of Mexico Fishery Management Council. 2004. Final Environmental Impact Statement for the Generic Essential Fish Habitat Amendment to the following fishery management plans of the Gulf of Mexico (GOM). http://www.gulfcouncil.org/beta/gmfmcweb/downloads/Final%20EFH%20EIS.pdf

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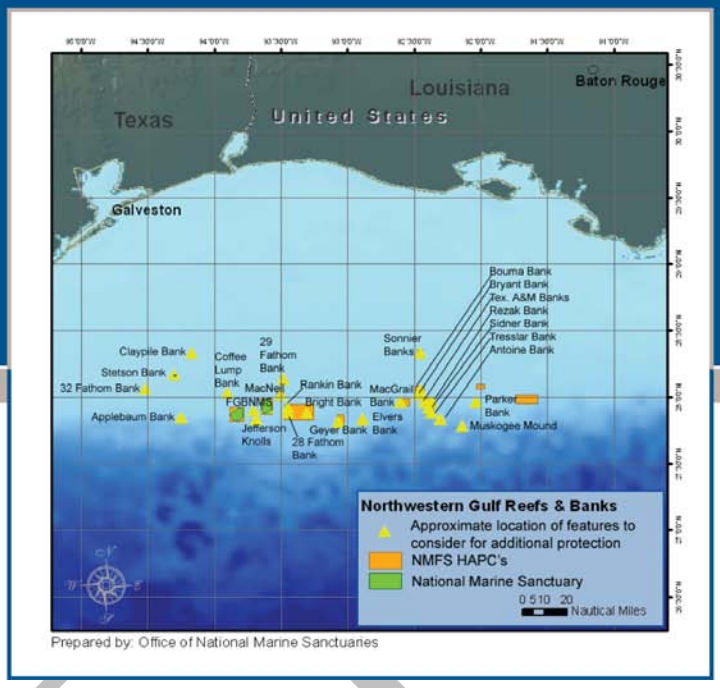
Northwestern Gulf of Mexico Reefs and Banks



PHYSICAL SETTING

Shelf Setting

- Mid and outer continental shelf of the northwestern Gulf of Mexico, 60-100 miles off the coasts of Texas and Louisiana.

Water Depth

- 55 – 450 ft

Geologic Structure

- High vertical relief.
- Formed by the uplifted domes of underlying, Jurassic-age salt.
- Composed primarily of sandstone, claystone, siltstone, or Holocene limestone
- Up to several miles in diameter.
- Unique geological features (e.g. brine seeps, mud volcanoes, and methane seeps)
- Rich outposts of tropical marine life

Ecosystem

- Coral reefs
- Deep tropical hard bottom assemblages
- Isolated sulfur-based chemosynthetic communities

Oceanographic Setting

- Eastern banks occasionally directly influenced by the warm waters of the loop current.
- Westerly drifting anti-cyclonic (clockwise) eddies derived from the loop current periodically modify weaker wind, temperature and salinity driven flows
- Generally south of influences from impacts related to Texas and Louisiana riverine inputs

BIOLOGICAL CHARACTERISTICS

Benthic Biology

- Solitary and colonial hard corals, black corals, gorgonians, sponges, encrusting algae, and diverse invertebrates

Fish Species

- Hundreds of species, including many commercially and recreationally important fish species
- Comparatively high abundance of certain species that are rare elsewhere in their range

Ecological Significance

- Ecologically linked and probably depend on each other for continued recruitment and replenishment
- Reservoirs of Caribbean biodiversity. Tend to resist or recover from coral bleaching and diseases when they occur, in part due to isolation from shore-based influences
- McGrail Bank has nearly 30% cover of one particular reef-building coral – a concentration for that species that has been found nowhere else to date.
- Alderdice Bank is the only known bank in the Gulf of Mexico where basalt spires and ancient volcanic chimneys are found.
- Several of the banks in the chain contain mud volcanoes, gas vents, and brine seeps, which are unusual features supporting distinct biological assemblages and habitats.
- In addition to being unusual and potentially vulnerable habitats, these banks serve a critical role as "habitat highways." Recent research suggests connectivity, both structural and genetic, among the banks of the NW Gulf of Mexico. There is evidence that commercially and recreationally important snapper and grouper species aggregate to spawn over some banks. Some features appear to serve as nurseries for bank-associated fish species. Outcrops between some banks harbor an abundance of prey species that are food for transitory fish that move between the region's banks.

THREATS

Extractive Uses

- Excessive and targeted harvesting
- The banks harbor some rare species that could be targeted by collectors; some species occur in higher abundances than elsewhere in their range.

Disease/Climate Impacts

- Coral bleaching, but to date not as severe as in other parts of the Western Atlantic region.

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- Coral diseases, but to date not as severe as in other parts of the Western Atlantic region

Introduced/Invasive Species

- Pacific orange cup coral (*Tubastraea coccinea*) documented. Spread facilitated by oil and gas platforms
- Platforms have also promoted the spread of shallow water and southern Gulf of Mexico species to the offshore northwestern Gulf of Mexico
- Movement of platforms from other parts of the world poses a threat for future introductions

Pollution

- Lost commercial fishing gear affects habitat quality
- Potential for pollutant discharge from ships and vessel operations (e.g. lightering)
- Potential for spills from oil and gas pipelines and drilling operations
- Occasionally influenced by river discharges

Other

- Destruction by treasure hunters is uncontrolled, and has already destroyed the coral community on Bright bank
- Anchoring by vessels destroys large areas of hard bottom habitat on the tops of the banks
- Offshore aquaculture and artificial reefs could alter dispersal throughout the region and affect disease frequency and severity among natural populations
- Piles of discarded bycatch have been reported on some banks, left by fishing boats that moor on the banks to fish and to sort their catch
- Shipping and transport continue to increase, with accidents, discharges, and noise as potential threats

MANAGEMENT

Regulatory Agencies

- Minerals Management Service
- Environmental Protection Agency
- National Marine Fisheries Service
- National Marine Sanctuary Program

Existing Regulations

- Fishery management plans are developed by the Gulf of Mexico Fishery Management Council
- Four banks in the NW Gulf of Mexico are identified by NOAA Fisheries as *Coral Habitat Areas of Particular Concern (HAPC)* – East and West Flower Garden Banks (FGB), Stetson and McGrail Bank. The first three compose the Flower Garden Banks National Marine Sanctuary. Activities prohibited year round are fishing with a bottom longline, bottom trawl, buoy gear, pot or trap, and bottom anchoring by fishing vessels. East and West FGB HAPC and sanctuary regulations also prohibit the use of dredge gear.
- Portions of some banks contain Minerals Management Service designated *No Activity Zones* (Stetson, Claypile, Applebaum, Coffeelump, East and West FGB, MacNeil, 29 Fathom, Rankin, Bright, Geyer, Elvers, McGrail, Bouma, Sonnier, Rezak, Sidner, Alderdice, Parker, Fishnet, Sweet, Jakkula and Ewing Banks). No Activity Zones prohibit operations, anchoring, structures or any activity that results in physical impacts. Outside the No Activity Zones, additional restrictive zones are established where oil and gas operations could occur, but where drilling discharges would be shunted to the bottom to eliminate surface sediment plumes.
- Facility discharges are regulated by EPA and MMS
- Some of these features are currently being considered as part of an expansion of Flower Garden Banks National Marine Sanctuary (Stetson Ring, McGrail, Geyer, Bright, Sonnier, Horseshoe Reef, and Alderdice)

Protection Needs

- NOAA Fisheries designated additional banks as Habitat Areas of Particular Concern, but these have no regulations associated with them (29 Fathom, MacNeil, Rankin, Bright, Geyer, Bouma, Sonnier, Rezak, Sidner, Alderdice and Jakkula).
- Loopholes in existing regulations that leave some banks vulnerable to impacts (e.g. treasure salvage operations at Bright Bank, and anchoring at Sonnier Bank).
- Visitor use is currently not monitored or controlled, and damage is not mitigated by management actions (e.g., mooring buoy installation and maintenance)

KEY REFERENCES:

- Bright, T.J. and L.H. Pequegnat (eds.). 1974. Biota of the West Flower Garden Bank. Gulf Publishing Co., Book Division, Houston, TX. 435 pp.
- Rezak, R., T.J. Bright, and D.W. McGrail. 1985. Reefs and Banks of the Northwestern Gulf of Mexico: Their Geological, Biological, and Physical Dynamics. John Wiley and Sons, N.Y. 259 pp.
- Rezak, R., S.R. Gittings, and T.J. Bright. 1990. Biotic assemblages and ecological controls on reefs and banks of the northwest Gulf of Mexico. *American Zoologist* 30(1):23-35.

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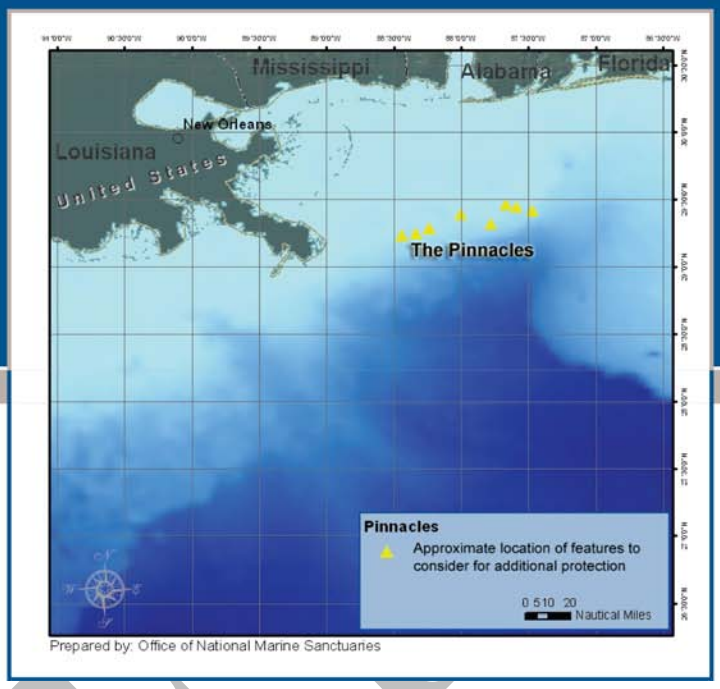
PINNACLES



PHYSICAL SETTING

Shelf Setting

- Shelf edge, 62 miles off Mississippi and Alabama between Mississippi River Delta and Desoto Canyon

Water Depth

- 262 -360 ft

Geologic Structure

- Dozens of relic reefs formed by corals and other skeleton-forming animals and plants after the last ice age
- Highly variable in shape and size
- Some are small, averaging 100 to 300 ft in diameter, are shaped like modern-day coral patch reefs, and densely packed in clusters in some places
- Others are spire-like pinnacles, up to 60 feet tall, with bases hundreds of meters across
- Still others are flat-topped reefs with steep, rugged faces; at least one is over 1600 feet in length
- Margins are highly eroded with abundant cryptic habitats, including arches, overhangs, and shallow caverns

Ecosystem

- Rich outposts of both temperate and tropical marine life, particularly deep tropical hard bottom assemblages
- Probable locations for spawning by commercially important species

Oceanographic Setting

- Tropical species are brought to the area by the periodic intrusion of the warm Loop Current into the gulf
- Downstream flow is to the southeast over the West Florida Shelf and along its escarpment
- Mississippi River flow occasionally envelops the banks, but most flow stays to the west and south of the area

BIOLOGICAL CHARACTERISTICS

Benthic Biology

- Deep tropical hard bottom assemblages with densities of soft corals, sponges, and solitary and colonial hard corals, all of which provide habitat for associated invertebrates and fish

Fish Species

- Large predatory species commonly found here include scamp and snowy grouper, red snapper, and amberjack
- Features harbor dense populations of prey species (especially small seabass) that support larger predators

Ecological Significance

- Havens, spawning locations, and diverse habitat for larvae, juveniles and adults of many sport and food fish species
- Given their location relative to currents, the Pinnacles area may be a center of dispersal for these organisms in the Gulf of Mexico, acting as a nursery for other features at similar depths around the gulf. This region could be one of the first encountered by larvae and spores on their trip northward from Caribbean source areas. Adults and their progeny may then be dispersed by the highly variable coastal and offshore currents impinging on the area, by the southeast outflow of the Loop Current and by eddies of the Loop Current that move west through the gulf.

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THREATS

Extractive Uses

- Over-fishing
- Bottom tending fishing gear, whether commercial or recreational, is a threat to hard bottom habitats and the invertebrates that inhabit them; these habitats and animals are the basis for the rich fauna that inhabits these features

Pollution

- Proximity of the Mississippi and other rivers, and coastal cities makes the area vulnerable to excessive nutrients, debris and other watershed pollutants

Other

- Anchoring

MANAGEMENT

Regulatory Agencies

- Minerals Management Service
- National Marine Fisheries Service

Existing Regulations

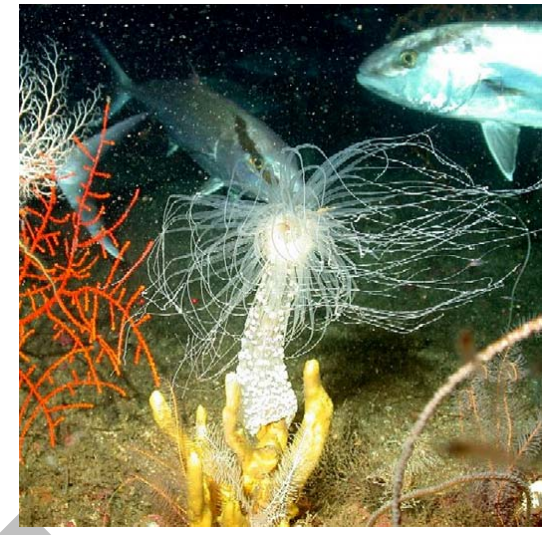
- MMS restricts exploration and development activities in the vicinity of features in this region of the Gulf; no bottom-disturbing activities may occur within 100 feet of any hard bottoms/pinnacles that have vertical relief of eight feet or more. If the live bottom survey required of the operator determines that the live bottom may be adversely impacted by the proposed activity, certain measures, such as relocation or monitoring, may be required

Protection Needs

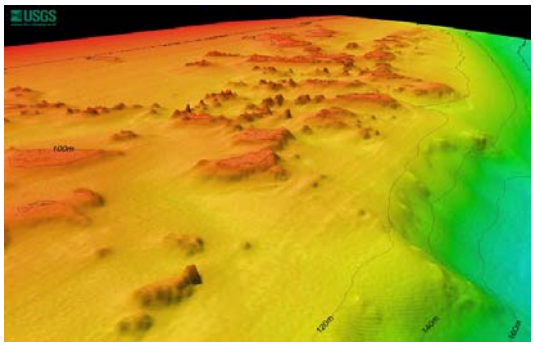
- Recreational activities are presently not regulated.
- No anchoring or use of bottom tending fishing gear within certain zones containing hard bottom features.

KEY REFERENCES:

- Gittings, S.R., T.J. Bright, W.W. Schroeder, W.W. Sager, R. Rezak, and J.S. Laswell. 1992. Biotic assemblages and ecological controls on topographic features in the northeast Gulf of Mexico. Bull. Mar. Sci. 50(3):435-455.
- Sager, W.W., W.W. Schroeder, J.S.Laswell, K.S. Davis, R. Rezak, and S.R. Gittings. 1992. Mississippi-Alabama outer continental shelf topographic features formed during the late Pleistocene-Holocene transgression. Geo-Marine Letters 12:41-48.



Tube worm colonies are associated with hydrocarbon and brine seeps in deepwater areas of the Gulf of Mexico, and occur in the deeper waters surrouding the Pinnacles. This image was taken by Dr. Sylvia Earle at 1800' during the Islands in the Stream expedition.



Pinnacles Bathymetry: *Shaded-relief bathymetry of part of the Pinnacles area, a deep-reef complex in the northern Gulf of Mexico about 100 km south of Alabama. View is looking northeast. Foreground pinnacle is 10 m high. Distance across bottom of image is 1,200 m. Vertical exaggeration 5X. Contour interval 20 m.*

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MADISON-SWANSON MARINE RESERVE

PHYSICAL SETTING

Shelf Setting

- Outer shelf
- 58 miles southwest of Port St. Joe, Florida
- 152 sq mile area

Water Depth

- 200 – 315 ft deep

Geologic Structure

- One of several features on the northwestern Florida Shelf that were formed approximately 25-60 thousand years ago by river deltas deposited during a period when sea level was approximately 165-245 feet lower than at present. Coral reefs formed on these delta features as sea level rose, but they were not able to grow fast enough to keep pace with the rising sea level. The limestone platforms they left behind are key biological habitats on the seafloor today.
- Scattered, low (2-3 ft in height) and somewhat higher-relief (6-8 ft) rocky outcrops
- There is a relatively high-relief (~50 ft) ridge on the northeast, trending to the northwest, and a series of pinnacles, each roughly 30 ft in height off the bottom.

Ecosystem

- Deep coral community
- Possible fresh water seeps

Oceanographic Setting

- Margin of the West Florida Shelf, periodically in the path of the Loop Current

BIOLOGICAL CHARACTERISTICS

Benthic Biology

- Invertebrates on the rocks include encrusting sponges, sea fans, corkscrew sea whips, and scattered clusters of *Oculina* and other non-reef-building corals. Where not covered with sediment, many of the limestone features are covered with crustose coralline algae. Mobile invertebrates include arrow crabs, crinoids, hermit crabs, and basket stars.

Fish Species

- Scamp, red grouper, Warsaw grouper, speckled hind, red snapper, red porgy, amberjack, snowy grouper, red barbier, reef and bank butterflyfish, roughtongue bass, and many others.

Ecological Significance

- Grouper spawning area

THREATS

Extractive Uses

- Targeted by commercial and recreational fishers before closure

MANAGEMENT

Regulatory Agencies

- National Marine Fisheries Service
- Gulf of Mexico Fishery Management Council

Existing Regulations

- Possession of Gulf reef fish prohibited year-round, except in possession aboard a vessel in transit with fishing gear appropriately stowed.
- From November 1 through April 30, all fishing prohibited.
- From May 1 through October 31, fishing activity is restricted to surface trolling only.

Protection Needs

- Full compliance and enforcement of fishing closure
- Full characterization to determine extent of area and level of development of benthic and pelagic communities

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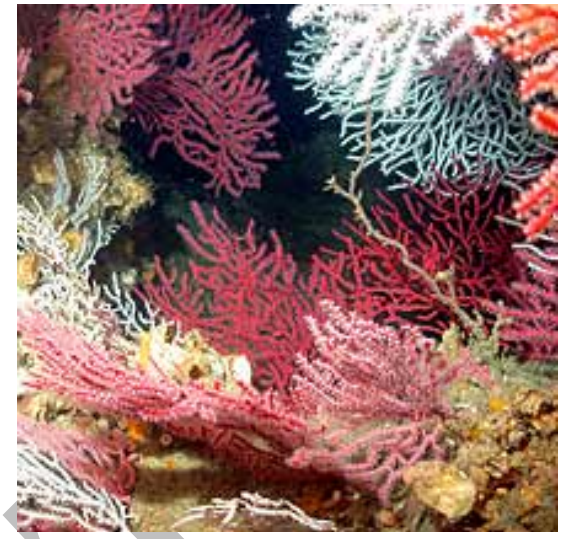
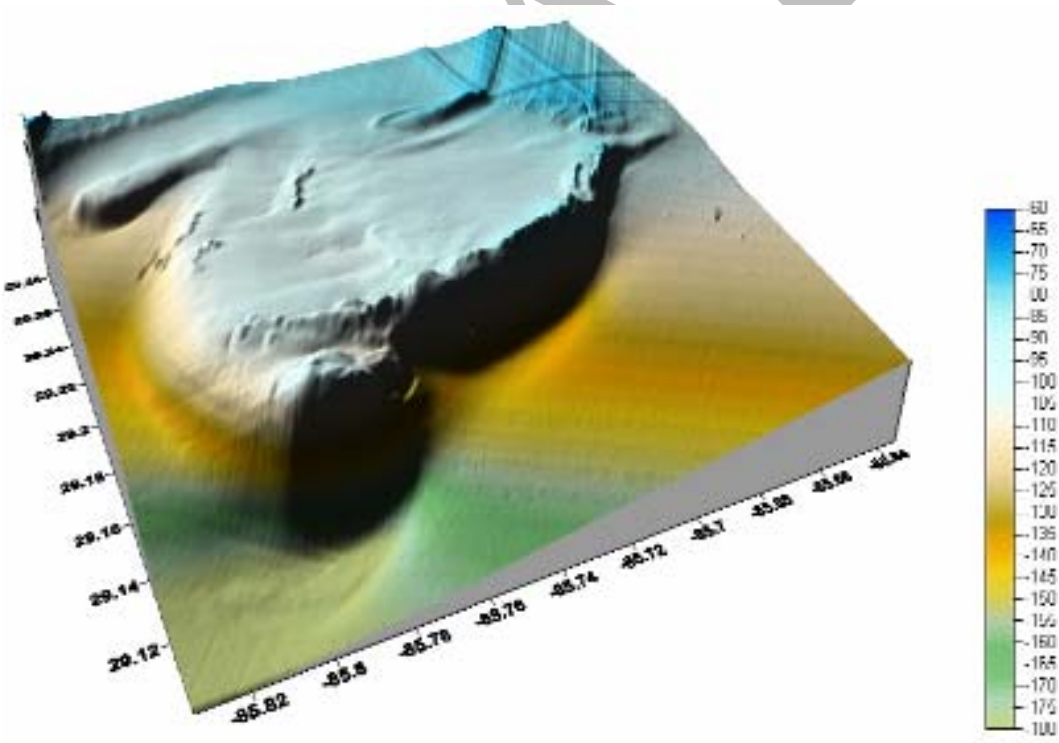
KEY REFERENCES:

- http://www.oceanexplorer.noaa.gov/explorations/islands01/log/jun20/jun20.html
- http://www.rinr.fsu.edu/summer2003/coverstory.html

- Gardner, J.V. Gardner, P. Dartnell, and K.J. Sulak. 2005. Multibeam mapping of the West Florida Shelf, Gulf of Mexico, USGS Open-File Report of02-005 (http://geopubs.wr.usgs.gov/open-file/of02-005/)
- Gardner, J.V., P. Dartnell, L.A. Mayer, J.E. Hughes Clarke, B.R. Calder, and G. Duffy. 2005. Shelf-edge deltas and drowned barrier-island complexes on the northwest Florida outer continental shelf. Geomorphology 64: 133-166.



Deep-sea corals at Madison-Swanson (photo courtesy Lance Horn, University of North Carolina)



http://www.ngi.msstate.edu/resources/NMFS%20-%20Devries%20Project.ppt
Depth scale in meters.

STEAMBOAT LUMPS

PHYSICAL SETTING

Shelf Setting

- Outer shelf
- 115 miles south-southeast of Port St. Joe, Florida
- 138 sq mile area

Water Depth

- 230 – 330 ft deep

Geologic Structure

- Like Madison-Swanson, one of several features on the northwestern Florida Shelf that were formed approximately 25-60 thousand years ago by river deltas deposited during a period when sea level was approximately 165-245 feet lower than at present. Coral reefs formed on these delta features as sea level rose, but they were not able to grow fast enough to keep pace with the rising sea level. The limestone platforms they left behind are significant biological habitats on the seafloor today.
- The southwestern portion of Steamboat Lumps includes a series of five northwest-southeast-trending terraces that increase in depth to the southwest. The shallowest terrace lies at depths of 230-240 ft and resembles the outer edge and slope of a delta, with a 6 ft-high rim. The surface of this platform and its flank has a series of large depressions ranging from 2 to 3 ft deep. The 260 ft terrace is 5 miles wide and has 3 to 6 ft deep depressions. The deeper terraces are at depths of 300-320 ft (~0.5 mile wide), 380-390 ft (165 ft wide), and 400-425 ft (950 ft wide); each terrace has scattered depressions (Figure 1)

Ecosystem

- Deep coral community
- Possible fresh water seeps

Oceanographic Setting

- Margin of the West Florida Shelf, periodically in the path of the Loop Current

BIOLOGICAL CHARACTERISTICS

Benthic Biology

- Invertebrates on the rocks include encrusting sponges, sea fans, corkscrew sea whips, and scattered clusters of *Oculina* and other non-reef-building corals. Where not covered with sediment, many of the limestone features are covered with crustose coralline algae. Mobile invertebrates include arrow crabs, crinoids, hermit crabs, and basket stars.

Fish Species

- Scamp, red grouper, Warsaw grouper, speckled hind, red snapper, red porgy, amberjack, snowy grouper, red barbier, reef and bank butterflyfish, roughtongue bass, and many others

Ecological Significance

- Grouper spawning area

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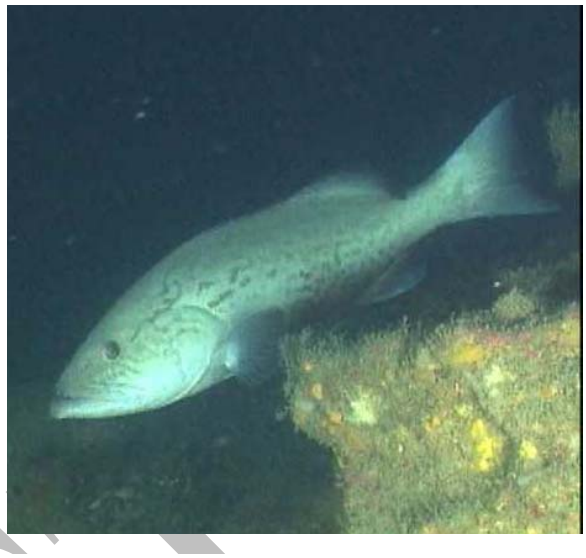
- Full characterization to determine extent of area and level of development of benthic and pelagic communities



Gag grouper observed at Steamboat Lumps dive area. http://oceanexplorer.noaa.gov/explorations/islands01/log/jun20/media/gag_600.html

KEY REFERENCES:

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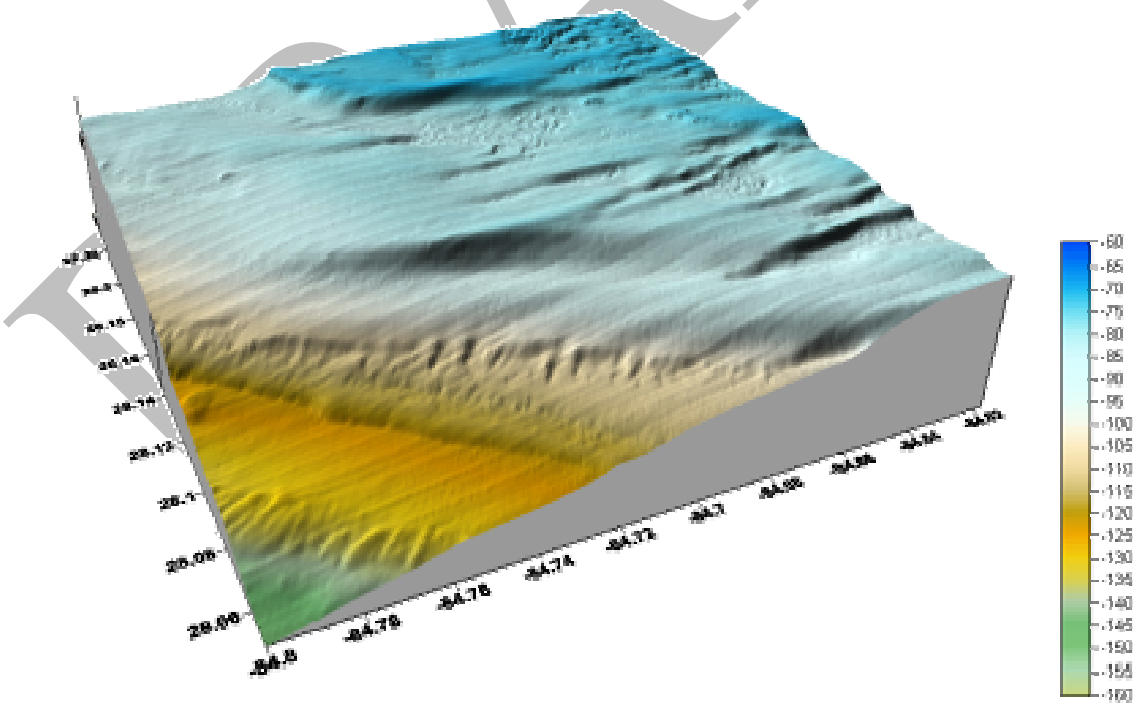

Fig. 1. Multi-beam image of Steamboat Lumps (depth scale in meters).
http://www.ngi.msstate.edu/resources/NMFS%20-%20Devries%20Project.ppt

Florida Middle Grounds

PHYSICAL SETTING

Shelf Setting

- Mid-Shelf
- 85 miles south of Apalachicola and 80 miles northwest of Tarpon Springs, Florida
- 40 miles long by 10 miles wide

Water Depth

- Margins to 150 ft; bank tops at 80 ft

Geologic Structure

- 460 square mile area
- Pleistocene limestones and peat, mantled by Holocene corals and sediment
- Two north-to-northwesterly parallel ridges separated by a valley
- Most extensive area of high relief (> 6 ft) hard-bottom in the northeastern Gulf in less than 200 ft depth
- Margins are highly eroded with abundant cryptic environments, including arches, overhangs, and shallow caverns
- Low-relief hard-bottom environments occur in the south, standing 10 to 15 ft above the surrounding shelf environment. High-relief hard bottoms occur in the north, standing 40 to 50 ft above the surrounding shelf environment.

Ecosystem

- Tropical coral/gorgonian/sponge dominated community; the northernmost well developed coral community on the North American continental shelf

Oceanographic Setting

- Directly influenced by the extent of northward penetration of the warm Loop Current into the gulf
- Winter water temperatures can dip to 60°F, well below that required for coral reef development

BIOLOGICAL CHARACTERISTICS

Benthic Biology

- Coral cover up to 30%
- 23 species of stony corals (Figure 1), 103 species of algae, about 40 sponges, 75 molluscs, 56 decapod crustaceans, 41 polychaetes, 23 echinoderms

Fish Species

- 170 species of fish (Figure 2)

Ecological Significance

- Coral and associated species diversity comparable to high latitude coral reefs
- Important habitat for sport and food fish

THREATS

Extractive Uses

- Because the shallower areas of the Florida Middle Grounds are within diving depth, ease of access to the Florida Middle Grounds subjects the ecosystem to potential overfishing and physical damage.
- Because the shelf-edge habitats of the West Florida Shelf have been fished for over 100 years, it is possible that direct as well as indirect or incidental impacts have already impacted their benthic communities and habitat features. Protection would allow the ecosystem to develop to its full potential and enhance its resilience.

Pollution

- Depending on flow conditions, the area can be in the path of runoff from the Mississippi River and rivers draining through Alabama and northwest Florida.

Other

- Direct effects including anchor, longline, and trawl impacts will continue without enforcement.

MANAGEMENT

Regulatory Agencies

- National Marine Fisheries Service

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- Gulf of Mexico Fishery Management Council

Existing Regulations

- Designated a HAPC by the Gulf of Mexico Fishery Management Council, under their Essential Fish Habitat Authority.
- Prohibition on bottom anchoring to protect coral reefs, but this applies only to fishing vessels.
- Prohibition on bottom trawling in the HAPC.
- Prohibition on longlines, buoy gear, and all traps/pots to protect the coral communities.

Protection Needs

- Protection of the Florida Middle Grounds would benefit marine communities downstream, along the West Florida Shelf, to the Florida Keys.
- Provide protection to the coral communities from non-fishing related activities such as anchoring of diving vessels, diving activity and possible destructive extraction activities ranging from spearfishing to sand mining.

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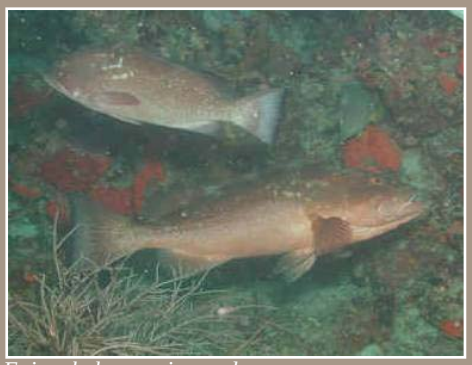
http://www.agu.org/meetings/os06/os06-sessions/os06_OS26I.html

Figure 1. Two of the 23 species of stony corals present at the Florida Middle Grounds

Dichocoenia stokesii

Millepora alcicornis

Figure 2. Two of the 170 species of fish present on the Florida Middle Grounds.



Epinephelus morio - red grouper

Cantherhines macrocerus- whitespotted filefish

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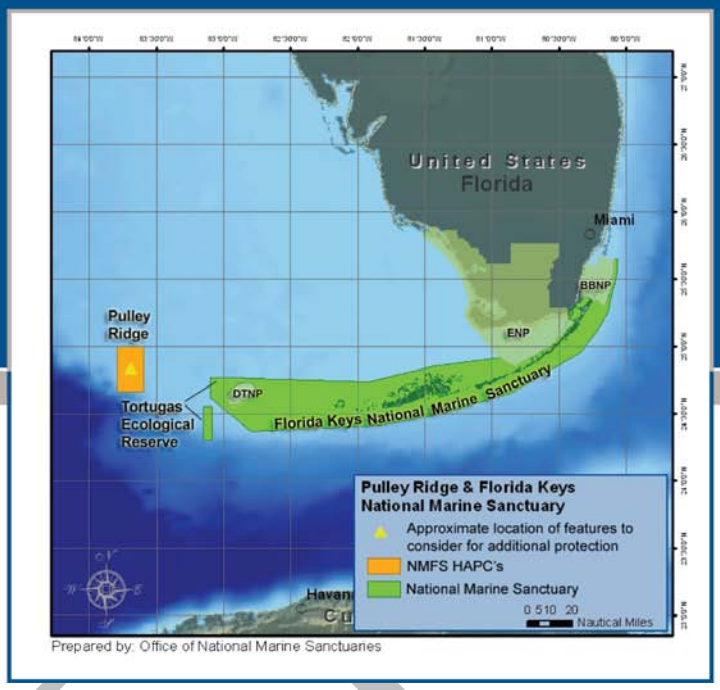
PULLEY RIDGE



PHYSICAL SETTING

Shelf Setting

- 150 miles west of Cape Sable, Florida
- 400 square miles
- Outer shelf

Water Depth

- 200 – 260 ft

Geologic Structure

- 60+ mile-long series of north-south trending, drowned (Pleistocene) barrier islands on the southwest Florida Shelf
- Subtle feature about 3 miles across with less than 30 ft of relief
- The underlying drowned barrier islands provided both elevated topography and lithified substrate for the hard bottom community

Ecosystem

- Unusual variety of zooxanthellate scleractinian corals, green, red and brown macroalgae, and tropical fishes typical of much shallower depths

Oceanographic Setting

- The region is dominated by the Loop Current, which brings relatively clear and warm water to the southern ridge and links the area to the wider Florida Shelf, Gulf of Mexico and Caribbean.

BIOLOGICAL CHARACTERISTICS

Benthic Biology

- The corals *Agaricia* sp. (Fig. 1) and *Leptoceris cucullata* are most abundant, and are deeply pigmented in shades of tan-brown and blue-purple, respectively. These corals form plates up to 50 cm in diameter and account for up to 60% live coral cover at some localities.
- Less commom species include *Montastrea cavernosa*, *Madracis formosa*, *M. decactis*, *Porites divaricata*, and *Oculina tellena*.
- Sponges, calcareous and fleshy algae, octocorals, and sediment occupy surfaces between the corals.
- Coralline algal nodule and cobble zones surround much of the ridge in deeper water (greater than 250 ft).
- In addition to coralline algae, other abundant macroalgae include *Halimeda tuna, Lobophora variegata, Ventricaria ventricosa, Verdigellas peltata, Dictyota* sp., *Kallymenia* sp., and particularly striking fields of *Andaymonene menzeii*.
- Pulley Ridge corals appear to have built an accumulation that is at least a few meters thick, although corals may not account for the bulk of the topography. The most abundant corals on the ridge are reef building, but they are lying, mostly unattached, on the surface.

Fish Species

- The fishes of Pulley Ridge comprise a mixture of shallow-water and deep-water species sharing this unusual habitat. More than 60 species have been identified.
- Commercial species include *Epinephelus morio* (red grouper) and *Mycteroperca phenax* (scamp).
- Typical shallow-water tropical species include *Thalassoma bifasciatum* (bluehead), *Stegastes partitus* (bicolor damselfish), *Cephalopholis fulva* (coney), *Lachnolaimus maximus* (hogfish), *Pomacanthus paru* (French angelfish), and *Holocanthus tricolor* (rock beauty).
- The deepwater fauna is represented by *Chaetodon aya* (bank butterflyfish), *Sargocentron bullisi* (deepwater squirrelfish), *Bodianus pulchellus* (spotfin hogfish), *Pronotogrammus martinicensis* (roughtongue bass), and *Liopropoma eukrines* (wrasse bass).
- *Malacanthus plumieri* (sand tilefish) and several other species construct large burrows and mounds that serve as refuge for multiple species. Mounds and pits larger than 10 ft^2 are apparent on side-scan sonar images and have been counted in excess of 100/$mile^2$ for parts of the ridge.

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Ecological Significance

- The ridge is subject to periodic upwelling, which provides nutrients shallow habitats of the West Florida shelf.
- The extent of algal cover and abundance of herbivores suggest benthic productivity is moderate to high on parts of the ridge. Such productivity is unusual, if not unique at this depth in the Gulf of Mexico and Caribbean.
- Although the community is clearly one adapted to low light conditions, the variety and extent of photosynthetic organisms between 200 and 230 ft depth is impressive.
- This largely photosynthetic community appears to be thriving on 1-2% of the available surface light and about 5% of the light typically available to shallow-water reefs.
- The corals generally appear to be healthy, with no obvious evidence of coral bleaching or disease, making the area an important refuge from impacts that are commonly observed on shallow water coral reefs.

Figure 1. *Abundant colonies of Agaricia sp. are present on Pulley Ridge.*

THREATS

Extractive Uses

- Long-line and trawl fishing

Other

- Anchoring
- Impacts from divers (Fig. 2)

Figure 2. *Technical Divers exploring the recently "re-discovered" Pulley Ridge deepwater coral reef.*

MANAGEMENT

Regulatory Agencies

- National Marine Fisheries Service
- Gulf of Mexico Fishery Management Council

Existing Regulations

- Pulley Ridge has been designated a HAPC by the Gulf of Mexico Fishery Management Council, under their Essential Fish Habitat Authority.
- Prohibition on bottom anchoring to protect coral reefs (applies only to fishing vessels)
- Prohibition on bottom trawling in the HAPC
- Prohibition on longlines, buoy gear, and all traps/pots to protect coral community

Protection Needs

- The unique and strategic setting of the Pulley Ridge ecosystem means it is an important refuge for its invertebrate and fish communities. Protecting this area from damage, fishing and other extractive uses will preserve a key habitat and source for larvae that will directly benefit marine communities around the Florida Shelf, Gulf of Mexico and beyond.

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