Analysis of Deep Coral Mounds in Proximity to the Gulf Stream Axis on the Central Portion of Stetson Mesa

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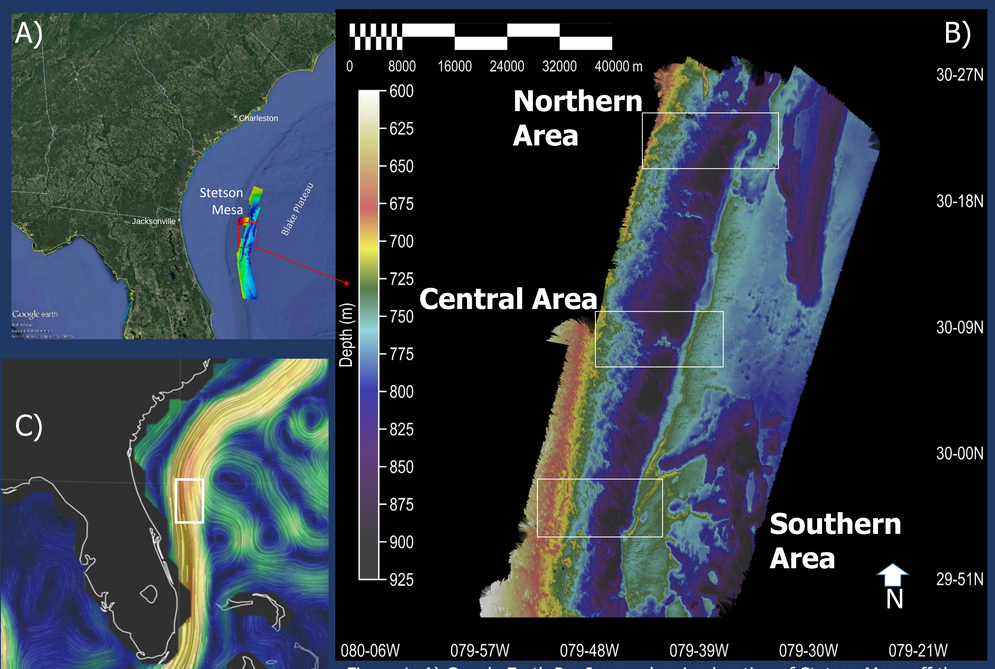


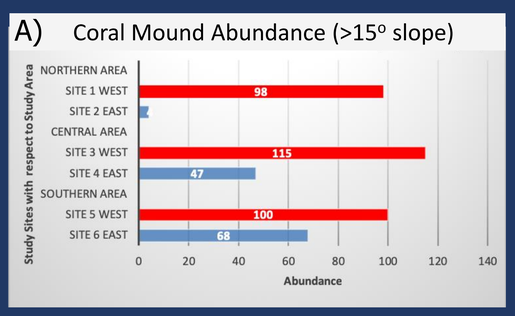
Figure 1: A) Google Earth Pro Image showing location of Stetson Mesa off the coast of Jacksonville, Florida. B) 2D Interpolated CUBE bathymetric surface for Central Portion of Stetson Mesa with resolution of 12.5m. Gulf Stream flow path February 2019 (earth.nullschool.net).

ABSTRACT

The NOAA Office of Ocean Exploration and Research's (OER) *Windows to the Deep 2018* expedition was conducted May-July on the Southeast U.S. Continental Margin aboard the NOAA Ship *Okeanos Explorer* exploration vessel. Scientists collected high-resolution video of the seafloor at dive sites along the Stetson Mesa on the western edge of the Blake Plateau for the purpose of locating deep sea coral and sponge habitats. The remotely operated vehicle (ROV) *Deep Discoverer* dove multiple sites to explore benthic habitat areas predicted by the South Atlantic Fisheries Management Council. The area of this study is located beneath the Gulf Stream on the central portion of Stetson Mesa, located 184 km east of Jacksonville's coast, where depths range 600 to 900 m. Sonar data from NOAA OER cruises EX1403 and EX1805 were used to make bathymetric, backscatter intensity, and slope surfaces to calculate the average shoalest depth of coral mounds mapped, for comparison with other mounds in proximity from the Gulf Stream axis.

METHODS

- Multibeam sonar data were collected by NOAA OER on cruises EX1403 and EX1805 by NOAA Ship *Okeanos Explorer* using a Kongsberg EM302.
- CARIS HIPS and SIPS 11.0 was used to post-process the data to generate a CUBE gridded surface with 12.5 m resolution.
- The mapped region was divided into three Study Areas: Northern, Central, and Southern.
- 5 km by 5 km Study Sites 1-6 were made using 12.5 m resolution CUBE gridded surfaces for the western and eastern portions of the three Study Areas, along the axis of the Gulf Stream.
- Coral mounds with slopes exceeding 15° were examined and counted.
- Average crest depths of coral mounds were measured.



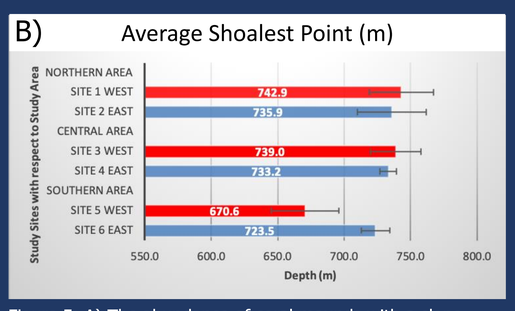


Figure 5: A) The abundance of coral mounds with a slope greater or equal to 15° at each site. B) Average Shoalest Point of coral mounds per site, displaying standard deviation bars.

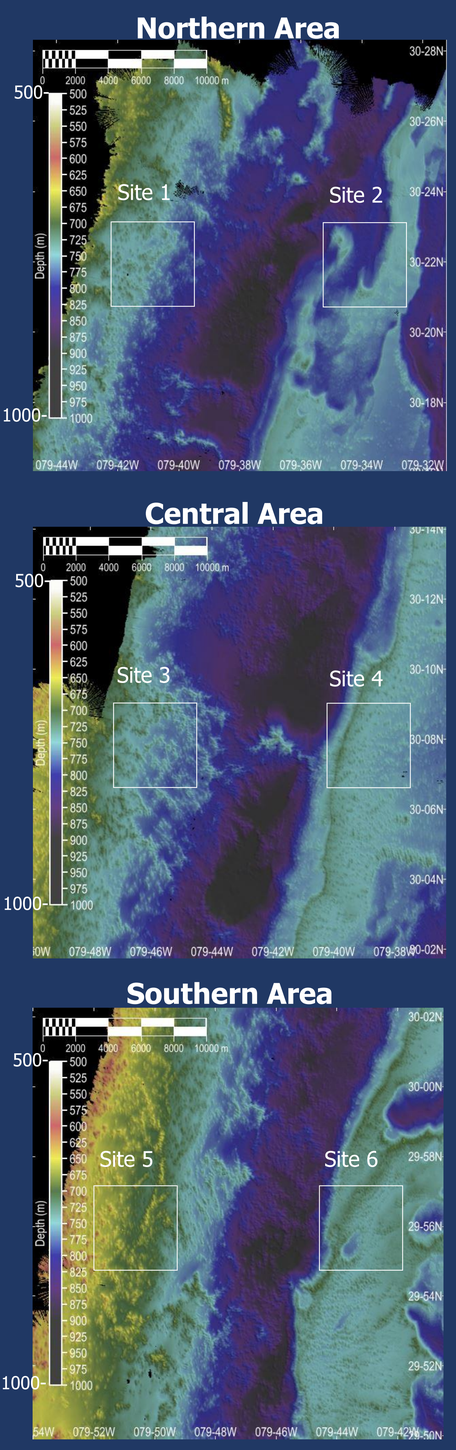
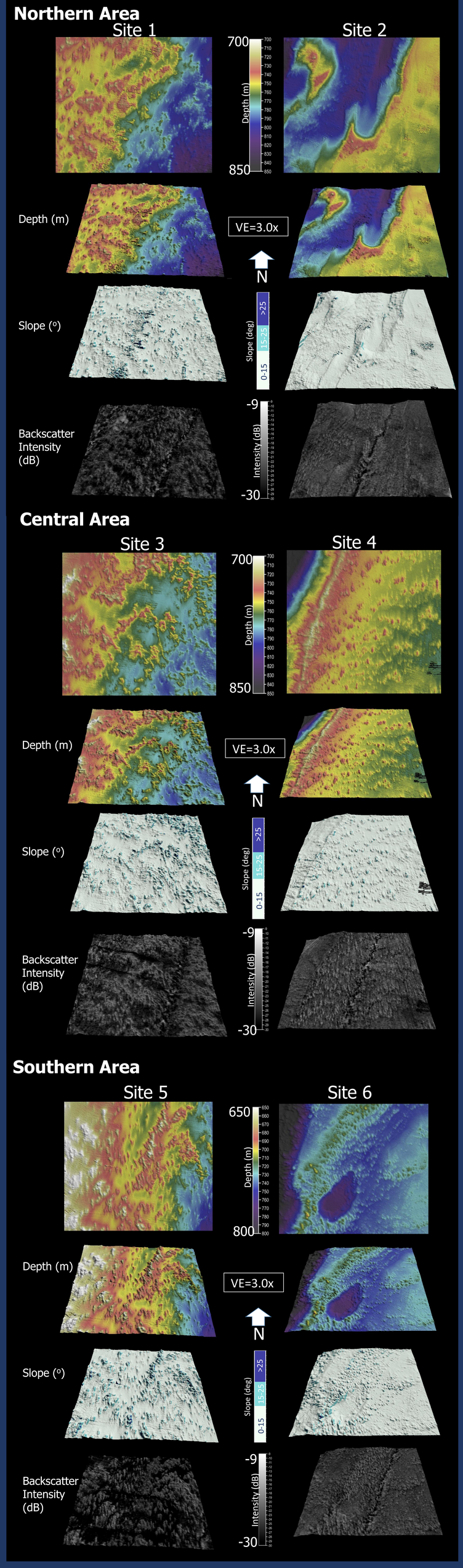


Figure 2. 2D CUBE interpolated bathymetric surfaces at 12.5 m for Western and Eastern Study sites.

Table 1. Coral mound abundance, average shoalest point, and standard deviation at each site.

Study Sites	Abundance	Average Shoalest Point (m)	Standard Deviation
Site 1 West	98	742.9	10.6
Site 2 East	5	735.9	25.6
Site 3 West	115	739.0	6.2
Site 4 East	47	733.2	18.9
Site 5 West	100	670.6	25.8
Site 6 East	68	723.5	24.2

Figure 3. 5km x 5km 2D 12.5 m resolution CUBE surfaces for western and eastern sites for the three study areas. 3D views (VE=3.0x) for each site show depth, slope and backscatter intensity. Vertical exaggeration on all 3D views is 3.0x. Note different depth scales for 3 Northern, Central and Southern Areas. High slopes on the classified slope surfaces were used to identify mound structures. Backscatter intensity surfaces show highest intensities as white.

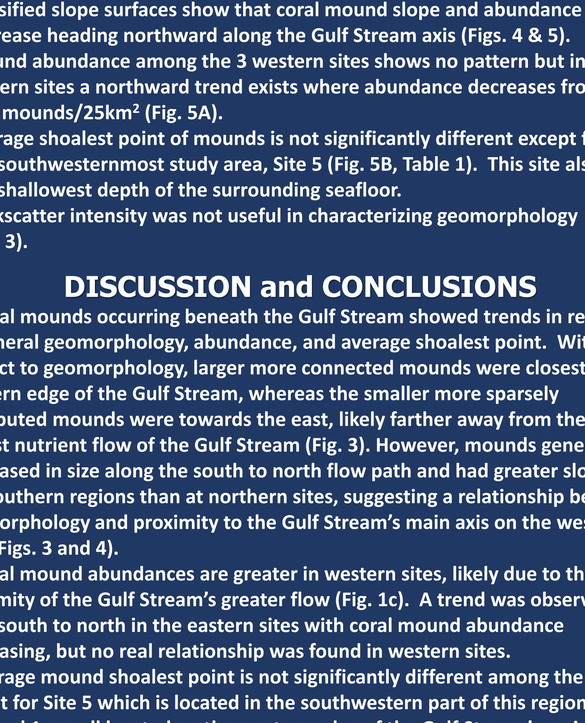


BACKGROUND

Stetson Mesa is a prominent feature found on the western part of the Blake Plateau, located 185 km east of Jacksonville, Florida (Fig. 1). The NOAA Office of Ocean Exploration and Research (OER) expedition *Windows to the Deep 2018: Exploration of the Southeast U.S. Continental Margin* explored Stetson Mesa and gathered reconnaissance data to characterize targeted sites. The NOAA Ship *Okeanos Explorer* mapped the ocean floor using multibeam sonar and used the ROV *Deep Discoverer* to create HD video and gather samples. The Blake Plateau is a broad, passive marginal plateau that lies between the North American continental shelf and the deep ocean basin and has a variety of interesting and unique seabed features. This area is largely unmapped in high resolution, and is virtually unexplored. Benthic habitats on the Stetson Mesa are significantly influenced by the Gulf Stream (Fig. 1) and were explored by the ROV, focusing on vulnerable marine habitats such as deep sea coral mounds. Deep sea coral mounds in the study area are representative of thousands of similar features mapped in the region. All coral mounds explored during EX1806 were strongly influenced by the Gulf Stream and are likely comprised of thick accumulations of dead coral rubble, the remaining skeletal framework of old *Lophelia pertusa* stony coral (NOAA OER, 2018). *Lophelia pertusa* is found in cold, deep, dark waters, and thousands of polyps form the coral colonies, which can develop these large reef frameworks (Roberts et al., 2003). The colonies are extremely slow growing and are known to live for more than 1000 years (www.oceana.org). The purpose of this study is to characterize coral mounds in the Central Stetson Mesa area with respect to their proximity to the Gulf Stream, abundance, and depth.

Classified Slope Surfaces

Figure 4. 2D classified slope surfaces highlight areas with slopes exceeding 15°, used to identify and measure mound structures.



RESULTS

- **The central portion of Stetson Mesa examined in this study has a total surface area of 2000 km², length of approximately 195 km along the Gulf Stream axis, where depths range from 600 to 900 m (Fig. 1).**
- **Coral mound geomorphology changed from west to east along the Gulf Stream axis, with larger, more connected mounds closest to the west side, and smaller more sparsely distributed mounds to the east.**
- **Coral mounds become smaller in size and less abundant from south to north (Fig. 3).**
- **Classified slope surfaces show that coral mound slope and abundance both decrease heading northward along the Gulf Stream axis (Figs. 4 & 5).**
- **Mound abundance among the 3 western sites shows no pattern but in the eastern sites a northward trend exists where abundance decreases from 68 to 4 mounds/25km² (Fig. 5A).**
- **Average shoalest point of mounds is not significantly different except for at the southwesternmost study area, Site 5 (Fig. 5B, Table 1). This site also has the shallowest depth of the surrounding seafloor.**
- **Backscatter intensity was not useful in characterizing geomorphology (Fig. 3).**

DISCUSSION and CONCLUSIONS

Coral mounds occurring beneath the Gulf Stream showed trends in relation to general geomorphology, abundance, and average shoalest point. With respect to geomorphology, larger more connected mounds were closest to the western edge of the Gulf Stream, whereas the smaller more sparsely distributed mounds were towards the east, likely farther away from the richest nutrient flow of the Gulf Stream (Fig. 3). However, mounds generally decreased in size along the south to north flow path and had greater slopes in the southern regions than at northern sites, suggesting a relationship between geomorphology and proximity to the Gulf Stream's main axis on the western side (Figs. 3 and 4).

Coral mound abundances are greater in western sites, likely due to the proximity of the Gulf Stream's greater flow (Fig. 1c). A trend was observed from south to north in the eastern sites with coral mound abundance decreasing, but no real relationship was found in western sites.

Average mound shoalest point is not significantly different among the sites, except for Site 5 which is located in the southwestern part of this region. Sites 5, 3, and 1 are all located on the western edge of the Gulf Stream's main axis. Site 5 was the shallowest area compared to other sites, indicating the average shoalest point is less dependent on geographic proximity within the Gulf Stream, but may instead be a function of average seafloor depth at the base of mounds (Figs. 3 and 5B, Table 1).

Based on the evidence above, coral mound geomorphology, abundance, and average shoalest point suggest that coral mounds are more abundant and larger in size in closest proximity to the western side of the Gulf Stream axis where water depths are shallower and currents may be stronger, providing food to coral communities.

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ACKNOWLEDGEMENTS
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