**ASSESSING THE RELATIONSHIP BETWEEN GEOMORPHOLOGY AND DEEP-SEA CORAL COMMUNITY AND MESOSCALE HABITAT SUITABILITY MODELS FOR STONY AND BLACK CORALS ON THE WEST FLORIDA SHELF**

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**ABSTRACT**

Stony coral and Black coral are foundational ecological groups common on the West Florida Escarpment in the Gulf of Mexico. The distribution of these corals, and most other deep-sea coral, depends primarily on depth, presence of hard substrate, and vertical relief of the seafloor, but less is known about how deep-sea coral assemblages vary with different geomorphologic features. The primary goal of this study is to compare abundance and diversity of deep-sea coral assemblages as they relate to specific geomorphologic features. This study focuses on three Habitat Areas of Particular Concern (HAPC) recommended for regulation by the Gulf of Mexico Fishery Management Council with depths between ~200 and 1000 m. High-resolution multibeam echo sounder data from a survey by NOAA Ship *Nancy Foster* (2008) provided environmental variables. Additionally, coral presence-absence data from ROV images collected by NOAA Ship *Nancy Foster* in August 2017 and NOAA Ship *Okeanos Explorer* in November 2017 and April 2018 are used to enumerate and identify assemblages on flats, mounds, and ridges. A non-parametric multidimensional scaling ordination (nMDS) was used to visually separate communities by composition. Understanding the relationship between specific geomorphologic features and deep-sea coral communities will better inform managers regarding which geographic areas are critical to the protection of these animals.

As an exploratory analysis into the modeling potential of stony and black coral distribution, depth, backscatter intensity, slope, aspect, and benthic position index (BPI) derived from *Nancy Foster’s* multibeam survey (2008) were used as inputs in a logistic regression to predict habitat suitability throughout the survey area. This is the first mesoscale habitat suitability model for stony and black corals in the Gulf of Mexico.

**INTRODUCTION**

*Gulf of Mexico Management Efforts*

*West Florida Shelf Geomorphology*

*West Florida Shelf Deep-Sea Coral Diversity*

*Deep-Sea Coral Habitat Suitability Modeling*

**MATERIALS AND METHODS**

This study investigated geomorphology and deep-sea coral communities on the continental slope (180 – 3,000 m) of the West Florida Shelf in the Gulf of Mexico. The study area was defined by a NOAA Ship *Nancy Foster* survey (2008) and three proposed Habitat Areas of Particular Concern (pHAPCs) recommended for regulation by the Gulf of Mexico Fishery Management Council (GMFMC) with depths between 200 and 1,000 m (Figure 1).

*Seafloor Mapping and Geomorphology*

Bathymetric data were collected in 2008 by NOAA Ship *Nancy Foster* with a Simrad EM 1002 multibeam echo sounder. The data from that survey were archived in, and downloaded from, the National Center for Environmental Information. The ship’s survey lines were imported into Caris HIPS and SIPS 10.2.1 and cleaned to create a 10-meter resolution CUBE surface and 10-meter backscatter intensity mosaic of the seafloor. 10-meter slope and aspect surfaces were derived from the CUBE surface. All four surfaces were saved as .geotiffs (more generally referred to as rasters) and imported into ArcMap 10.4.1 (Figure 2).

10-meter contour lines were generated in ArcMap and used to identify and enumerate mounds and ridges (Figure 3). Mounds were defined as any location with at least one isobath in a concentric circle with an elevated center, and classified by vertical relief (e.g.,10 – 19 m, 20 – 29 m, or 30 – 39 m). ***Define a Ridge.***

*ROV Image Analysis*

ROV images were compiled from three different expeditions at various locations within the study area: NOAA Ship *Nancy Foster’s* in August 2017 (ROV *Odysseus*), and NOAA Ship *Okeanos Explorer’s* in November 2017, and April 2018 (ROV *Deep Discoverer*) (Figure 4). ROV *Odysseus* collected images every 5 seconds while the seafloor was in view, attempted to maintain a speed of 0.5 knots and an elevation of 1 – 3 m off the seafloor. In total, ROV *Odysseus* collected 6,131 images at depths of 345 – 710 m. ***BLANK* images from NOAA Ship *Okeanos Explorer* in November 2017 and *BLANK* images from NOAA Ship *Okeanos Explorer* in April 2018.**

To streamline identifications, the images were linked to a Microsoft Access database, called “MadBat.” First, the images were annotated as presence or absence, then all the presence images were annotated for species identification and abundance - each taxa was a new observation. Deep-sea coral were identified to the lowest possible taxon; the least resolved coral classifications were at the family level (i.e.,Isididae, Aquaumbridae, and Stylasteridae). All sponges were identified to phylum Porifera. Only cnidarians and poriferans were included in this study. ***Do we include porifera?***

*Mesoscale Habitat Suitability Models*

Coral presence-absence observations from the order Antipatharia were isolated and analyzed independently because antipatharians are currently managed by the GMFMC. Depth, slope, aspect, and backscatter intensity rasters/surfaces were projected onto the ellipsoid WGS 84 World Mercator and overlaid with coral observation points. Depth, slope, aspect, and intensity were extracted for each coral observation in RStudio using the “extract” function in the “raster” package. The resulting vectors of environmental variables were used as inputs in a binomial logistic regression to determine if they significantly affected black coral presence. The same analysis was done for the order Scleractinia, which was only represented by *Lophelia pertusa*.

*Quantifying Lophelia pertusa* ***(planned)***

For most animals, enumeration simply meant tallying the number of individual colonies, but for the reef-forming stony coral, *Lophelia pertusa*, tallying the individual reefs would under-represent how much surface area the animal covered relative to the other taxa. ***Quantify Lophelia.***

*ROV Transect Analysis* ***(planned)***

After processing the ROV images, abundance estimates were aggregated into discrete 100 m transects. Transects were determined based on three criteria: the ROV must have traveled at a relatively constant rate of speed, maintained a relatively constant elevation off the seafloor, and passed over a geomorphologic feature of interest. Each transect was considered a replicate that had a community matrix associated with only one flat, mound, or ridge. A non-parametric Multidimensional Scaling Ordination (nMDS) was used to determine which assemblages were most similar and dissimilar.

**RESULTS**

*Antipatharia Mesoscale Habitat Suitability Model*

Preliminary results indicate there was a class-imbalance problem that causes binomial logistic regression to predict almost all absences. Only 81 observations out of 3,511 contained black coral. More presence data will be added moving forward. The best model included depth\*\*\*, slope\*, aspect\*\*, and intensity as predictors; all except intensity were significant (*P* = 5.51e-07\*\*\*, 0.048\*, 0.004\*\*, 0.102). The model did not fit the data very vell (McFadden’s R2 = 0.07), although it did appear to predict absences accurately (RMSE = 0.02). Despite the low RMSE, the model’s predicted probability of occurrences in areas with black coral did not significantly differ from the predictions in areas without black corals.

*Scleractinia Mesoscale Habitat Suitability Model* ***(planned)***

*nMDS* ***(planned)***

**DISCUSSION**

*Geomorphology and Deep-Sea Coral Diversity*

*Antipatharia Habitat Suitability Model*

*Scleractinia Habitat Suitability Model*

*Management Implications*

*Future Studies*

**CONCLUSIONS**

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**FIGURES**

**TABLES**