

STUDY TITLE: Deepwater Coral and Chemosynthetic Atlas and Modeling Program, Gulf of Mexico

REPORT TITLE: Characterizing spatial distributions of deep-sea corals and chemosynthetic communities in the US Gulf of Mexico through data synthesis and predictive modeling

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PROJECT MANAGER: John Christensen

AFFILIATION OF PROJECT MANAGER: US Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, National Centers for Coastal Ocean Science, Marine Spatial Ecology Division, Biogeography Branch

ADDRESS: 1305 East-West Hwy, SSMC-4, N/SCI-1, Silver Spring, MD 20910

PRINCIPAL INVESTIGATORS*: Matthew Poti and John Christensen

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BRIEF ABSTRACT: This study developed maps of the predicted spatial distributions of deep-sea corals and chemosynthetic communities in the US Gulf of Mexico to inform and support environmental risk assessments, environmental impact statements, and other decision documents related to the review of proposed offshore energy development in the region. A database of presence-absence observations of deep-sea corals and chemosynthetic communities was compiled using 22 datasets containing data from field surveys conducted using underwater vehicles between 1988 and 2018. These observations were integrated with spatial environmental predictors depicting seafloor topography, substrate, oceanography, and geography in statistical models (occupancy models) to predict and map the estimated distributions of 44 deep-sea coral taxa and 3 chemosynthetic communities throughout the study area. The maps identify areas where these organisms are more likely and less likely to occur. In addition, maps of predicted taxonomic richness were produced for selected taxa within orders Scleractinia, Alcyonacea, and Antipatharia. Information from the maps of predicted probability of occurrence and predicted taxonomic richness can contribute to assessments of the potential impacts of offshore energy development and other activities on these sensitive benthic biota.

BACKGROUND: The Bureau of Ocean Energy Management (BOEM) manages the development of US Gulf of Mexico (Gulf) energy and mineral resources in an environmentally and economically responsible way across the approximately 160 million acres (approximately 650,000 km²) of the Gulf Outer Continental Shelf (OCS) region. Offshore energy projects often include activities that may physically disturb the seafloor and could negatively affect benthic biota. BOEM has identified deep-sea corals (DSCs), also known as cold-water corals or deepwater corals, and chemosynthetic communities as sensitive deep-water biota and included requirements in their Notices to Lessees (NTL No. 2009-G40) for

oil and gas operators to avoid such habitats in the Gulf. DSCs can create local hotspots of biodiversity by providing three-dimensional structure that increases the complexity of habitats available for use by other organisms such as fishes and echinoderms. Recent reviews have highlighted the importance of DSC communities and the habitats they create as well as their vulnerability to impacts from human activities. Similar to DSCs, habitats created by chemosynthetic fauna at cold seeps (i.e., locations where fluids containing reduced chemicals like methane and sulfide emerge from beneath the seafloor) may increase habitat heterogeneity. Having the most comprehensive and up-to-date information on the spatial distribution of DSCs and chemosynthetic communities is essential for BOEM to assess the potential impacts of offshore energy development on the marine environment in the Gulf.

OBJECTIVES: The study had two main objectives. The first objective was to compile a database of presence-absence observations for DSCs and chemosynthetic communities with associated measures of sampling effort (i.e., the survey area associated with each sample). Next, records in the database were used in spatial predictive models to characterize and map the potential spatial distributions of these organisms across the entire Gulf (Figure 1).

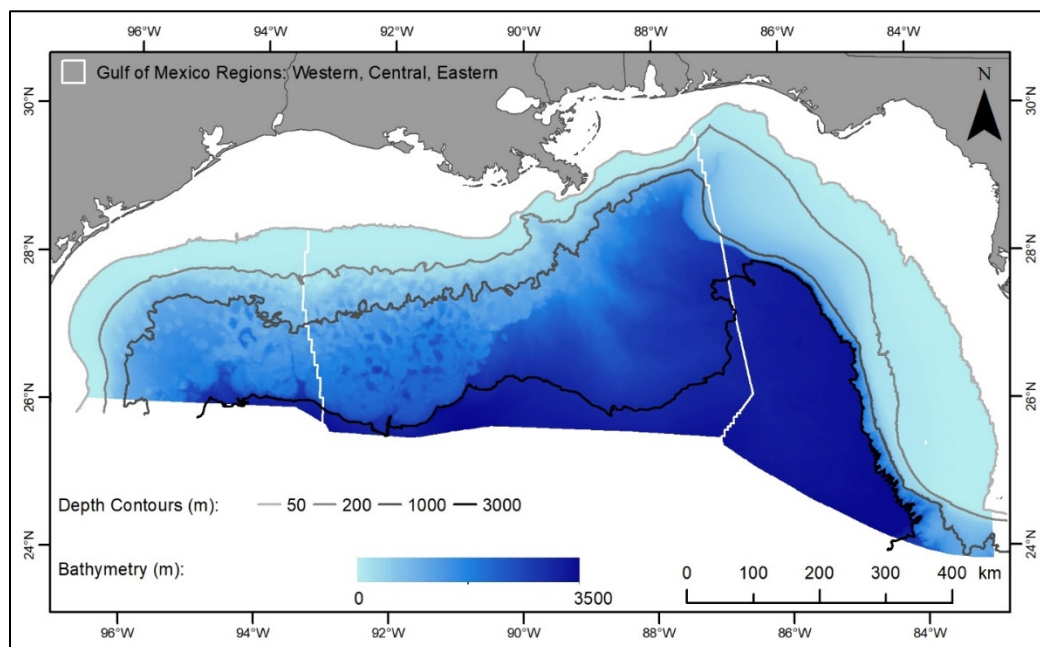


Figure 1. Study area. The study area included waters within the US Gulf of Mexico from 50 m depth to the boundary of the Gulf of Mexico OCS region.

Depth contours define the three depth zones within which deep-sea corals exist in the Gulf: mesophotic (50–200 m), upper bathyal (200–1,000 m), and lower bathyal (1,000–3,000 m).

METHODS: A relational database of presence-absence observations for deep-sea corals and chemosynthetic communities and measures of sampling effort was compiled from available datasets containing data from field surveys conducted using underwater vehicles between 1988 and 2018. When information on the sampling effort associated with observations was missing or incomplete in the original data or absence could not be inferred, the original still images or video were reanalyzed to obtain this information. The database records were integrated with ten environmental predictors characterizing the seafloor, oceanography, and geography of the region. Spatially-explicit hierarchical occupancy models were developed in a Bayesian framework to predict and map the probable distributions of deep-sea corals and chemosynthetic communities throughout the study area. The models attempted to account for imperfect detection and thus standardize estimates of occurrence across taxa to predict the biodiversity of

common and rare taxa. Variability in model predictions was also mapped for each taxon to provide a measure of the level of confidence in model predictions.

RESULTS: Maps of the predicted distributions of 44 deep-sea coral taxa and 3 chemosynthetic communities are presented, along with maps depicting predicted taxonomic richness for a multi-genus model of Order Scleractinia, a multi-family model of Order Alcyonacea, a multi-genus model of Family Isididae (Order Alcyonacea), a multi-genus model of Family Plexauridae (Order Alcyonacea), and a multi-genus model of Order Antipatharia. Corresponding maps of the coefficient of variation of model predictions provide a measure of the variability, or uncertainty, associated with the model predictions. In addition, metrics indicating model performance, the estimated detection and occupancy probability of each taxon, and the estimated magnitude and effect (e.g., linear or nonlinear) of each environmental predictor are presented. Finally, a map of the predicted genus richness for 28 genera of structure-forming stony corals, gorgonian corals, and black corals is presented and summarized by planning area and depth zone. Challenges with the data available for characterizing distributions of chemosynthetic communities limited the performance of the chemosynthetic community models. Predictions for chemosynthetic communities should be considered preliminary.

CONCLUSIONS: Multi-taxon hierarchical occupancy models offer a novel framework to estimate the spatial distributions and biodiversity of deep-sea coral and chemosynthetic communities using presence-absence data. The maps and data products developed for this study can be used to inform planning for ocean activities such as offshore energy development. The maps and data products can also be used to guide future survey design in the Gulf by highlighting priority areas for ground-truthing, maximizing survey effort, and improving predictive power.

STUDY PRODUCTS:

Goyert HF, Bassett R, Christensen J, Coleman, H, Coyne M, Etnoyer PJ, Frometa J, Hourigan, TF, Poti M, Salgado EJ, Williams, B, Winship AJ. 2020. Characterizing spatial distributions of deep-sea corals and chemosynthetic communities in the US Gulf of Mexico through data synthesis and predictive modeling. New Orleans (LA): US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2021-027. 315 p.