

ID: W3004223567

TITLE: Predictive modeling of suitable habitat for deep-sea corals offshore the Northeast United States

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ABSTRACT:

Deep-sea corals (DSCs) are important living marine resources, forming both oases of biodiversity and three-dimensional habitat structure for fishes and invertebrates. However, because of logistical difficulties and expense of deep-sea exploration, much less is known about the distribution of DSCs than is known for their shallow-water counterparts. Predictive modeling, therefore, is essential for estimating the extent of DSC habitat in areas that are unexplored in order to support conservation efforts, to provide information for effective management of offshore activities affecting the seafloor, and for future exploration and research. In support of research and management efforts in the U.S. Northeast (Cape Hatteras, NC north to the Canadian border), we developed a comprehensive set of habitat suitability models covering this entire geographic region for nine taxonomic groups of DSCs (Alcyonacea, gorgonian corals, non-gorgonian corals, Scleractinia, Caryophylliidae, Flabellidae, Pennatulacea, Sessiliflorae, and Subselliflorae). Maximum entropy (MaxEnt) models were fit to DSC presence records and spatially-explicit environmental predictors depicting depth and seafloor topography, surficial sediment characteristics, and oceanography. A stepwise model selection procedure was then implemented to identify the set of predictor variables that maximized predictive performance for each taxonomic group. To allow for comparisons across taxonomic groups, the standard MaxEnt logistic predictions were converted into calibrated classes of habitat suitability. Overall, model performance was high for all taxonomic groups. Model fit was best for Caryophylliidae, Sessiliflorae, and Flabellidae, whereas model stability was greatest for the three taxonomic groups of Alcyonacea. Model results reported here corroborate known distributions of corals in the region. For example, large structure-forming taxa are predicted to occur mainly in canyon environments, particularly in areas of steep slope ($>30^\circ$); sea pens in softer sediments of the continental shelf and slope. Additionally, the models successfully predicted DSC locations during field testing. Despite the limitations of presence-only data, several novel extensions to the traditional MaxEnt analysis workflow improved model selection, accuracy assessment, and comparability of results across taxonomic groups. This approach, when integrated with management processes, could be a powerful tool for science-based conservation, management, and spatial planning for these marine resources.

SOURCE: Deep-sea research. Part 1. Oceanographic research papers/Deep sea research. Part I, Oceanographic research papers

PDF URL: <http://manuscript.elsevier.com/S0967063720300170/pdf/S0967063720300170.pdf>

CITED BY COUNT: 18

PUBLICATION YEAR: 2020

TYPE: article

CONCEPTS: ['Gorgonian', 'Habitat', 'Oceanography', 'Geography', 'Ecology', 'Taxonomic rank', 'Fishery', 'Geology', 'Coral', 'Biology', 'Taxon']