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Modeling fish distributions with predictors at multiple scales to inform sand dredging management

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Abstract

Marine ecosystems are under increased pressure to accommodate multiple resource uses spanning from commercial and recreational fishing, offshore energy development, oil and gas extraction, and dredging of mineral resources. Yet, the spatial distribution and habitat relationships of fish are often not identified at the scales needed to assess potential impacts from human uses. Here, we used species distribution models to inform planning and assessment of sand dredging in the Gulf of Mexico, USA. We modeled select fish species to represent a variety of trophic levels and fish guilds, including shrimp, soft-bottom demersal fish, two juvenile reef-associated fish, and two shark species. Predictor variable development aimed to untangle the role of geomorphology, water chemistry, wetlands/estuaries, prey species, and oceanographic conditions in shaping species' distributions. We used machine-learning statistics to model the most influential variables and to map species' distributions. Our results demonstrate that important habitat relationships are revealed by using a wide range of predictors that characterize multiple scales of marine ecosystems. Examples of newly discovered habitat relationships quantified in our study include sharks associated with sediment grain size and nearby wetlands, reef-associated fish associated with sea surface temperature and sea surface height anomalies, and shrimp associated with estuaries. Recognizing a wide spectrum of marine ecosystem characteristics, particularly geomorphology and adjacent ecosystems, results in species distribution models that have a relatively fine scale and can help inform decision-making. The application here is for sand dredging, but such results could also inform spatial planning for a variety of marine ecosystem uses.

Keywords:

species distribution model, geomorphology, shoal, shark, demersal, juvenile

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