Field	Study Information
Title	Modeling Food Web Effects from Dredging (MM-25-03)
Administered by	Marine Minerals Program (MMP)
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Procurement Type(s)	Interagency Agreement
Performance Period	FY 2025–2028
Final Report Due	TBD
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Problem	Primary producers and primary consumers are a critical component in coastal and shelf food webs. The effects of dredge-related reduction or removal of both primary producers and first-level consumers to the food web is unknown.
Intervention	Model the reliance of higher trophic levels on primary producers and primary consumers.
Comparison	Model the reduction of benthic primary producers and primary consumers to existing food webs. Determine the spatial and temporal extent of when reduction is no longer measurable.
Outcome	We expect to quantify the effects of dredging on primary producers and primary consumers of a local food web.
Context	Gulf of Mexico and South Atlantic OCS, <30-m depths

BOEM Information Need(s): Dredging assumes complete removal of primary producers and primary consumers within the relatively small dredge footprint (Michel et al. 2013). This depletion of the base of the food web is well documented, but the effects to higher trophic levels is harder to detect (e.g., Iafrate et al. 2022). In addition to existing field-based evidence, modeling the effect of the removal of a prey base on higher trophic levels would help elucidate whether the effect exists yet is difficult to measure, or whether the effect does not meaningfully transfer to higher trophic levels. This study would attempt to link the small-scale (space and time) perturbation with the potential for scalable ecosystem effects (e.g., Lewis et al. 2021). This information would be used by BOEM analysts in NEPA and EFH documents, and by resource management agencies (e.g., Fishery Management Councils), when considering how the removal of primary producers and primary consumers affects marine benthivores and piscivores.

Background: Primary producers (e.g., benthic macroalgae, diatoms, etc.) support a variety of primary consumers (e.g., benthic infauna, epifauna, and plankton), which link to higher trophic levels such as fishes, crustaceans, and birds (Lewis et al. 2021). Benthic primary producers and primary consumers are typically found in MMP dredging areas. Dredging therefore may affect a variety of linkages and guilds.

Several food web models have been developed on regional scales (Figure 1, SAFMC 2016). These models help elucidate important relationships between predator and prey. For example, Okey et al. (2014) found that in the South Atlantic Bight an increased biomass of striped bass, bluefish, large coastal sharks, small coastal sharks, and highly migratory species correlated with the increase in forage fishes like Atlantic menhaden and squids (reviewed by Pickens et al. 2020). Disruptions to these food webs are less understood, however.

In Figure 1, for example, if the food web exactly overlaps a dredge site, some of the nodes on the lowest trophic level may be severely depleted or completely removed. Presumably when an area is dredged, any accumulated and/or settled detritus could be lost by either removal by the dredge or relocated by mobilization into currents, potentially having a large effect on the food web. As primary consumers, like infauna and echinoderms, recolonize an area, if they lack a prey source, the habitat may be unsuitable. If they are a specialist and cannot substitute the food source, they may experience decreased fitness. If they are generalists and can easily switch to alternative prey items, there may be no effect. On a larger spatial scale that more accurately represents a foraging range, there may be no effect regardless of specialist compared to generalist feeding strategies. Similarly, after time, those lowest trophic levels will rebuild such that effects will no longer be measurable. Because these scenarios are difficult and expensive to measure in the field, a model based on existing data would allow BOEM to simulate different scenarios, timeframes, and seasons and then estimate the outcome (i.e., effects and resilience).

Objectives: Leverage existing datasets to quantify effects of removal of primary producers due to dredging, and how that affect primary consumers and higher trophic-level fishes in two environments. Test scenarios over different timeframes (days to months) and seasons when possible.

Methods: This study would leverage other ecosystem studies funded by BOEM (e.g., Ecological function and recovery of biological communities within sand shoal habitats within the Gulf Of Mexico [NSL# MM-19-01] and Natural habitat associations and the effects of dredging on fish at the Canaveral Shoals, East-Central Florida). These recent and ongoing studies include field data on primary production, as well as primary consumers and higher trophic level fishes, in two different environments. If food web models from these two studies can be manipulated such that components can be removed or reduced and we can measure that effect, BOEM would prioritize these existing models to better understand the effects of dredge to trophic relationships at two geographically distinct dredge sites (i.e., east-central Florida and Gulf of Mexico). Alternatively, if they are static, a new model or Ecological Network Analysis may re-analyze food web carbon flows and effects of dredging. Using a pre-dredge model, researchers could simulate different types of dredge-related disruptions (e.g., the removal of primary producers and/or primary consumers). By first modeling the removal of a food web component, changes to related nodes can be estimated. These measurable impacts should be investigated over different spatial scales, timeframes, and seasons, as the data allow. Spatial scales should seek to represent both the perturbation (i.e., dredge footprint) as well as different foraging ranges. This may include inshore coastal or estuarine areas. When the removal of benthos from a simulated perturbation is no longer detectable through time, or swamped by natural variation, we can assume the system has recovered. Because nodes can be altered, it would also be possible to change the food web to reflect changes in a community, for example in response to climate change. Products include a summary of different scenarios and outcomes in a report or publication, as well as up to two dynamic food web models that can be manipulated by a BOEM analyst using instructions on inputs and controls.

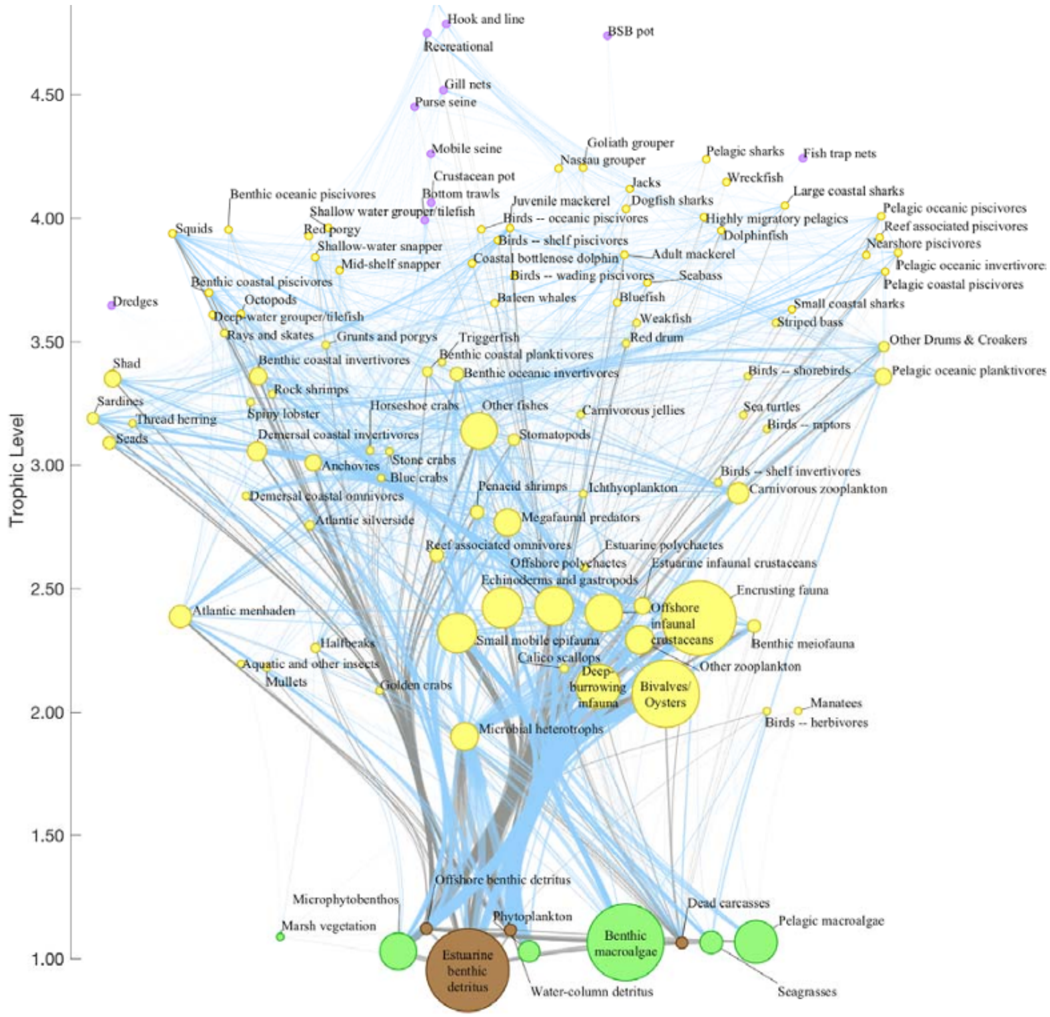

Figure 1. South Atlantic Bight Food web. Nodes are colored based on type (green = producer, brown = detritus, yellow = consumer, purple = fleet). Blue for all edges except flows to detritus, which are grey. (SAFMC 2016).

Specific Research Question(s):

1. How does a decrease or removal of primary producers and/or primary consumers (e.g., from dredging) affect energy flow to other parts of a food web? What is the spatial scale, timeframe, and seasonality of this effect?
2. At what trophic level or guild is an effect to energy flow due to decreased or removal of primary producers and/or primary consumers no longer measurable?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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