Environmental Studies Program: Ongoing Study

Field	Study Information
Title	Extrapolating Benthic Recovery Estimates Beyond Single-project Constraints (MM-24-03)
Administered by	Marine Minerals Program
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Procurement Type(s)	Contract
Conducting Organization(s)	Research Planning, Inc.
Total BOEM Cost	$299,809
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Problem	Dredging activities directly remove the benthos from the immediate dredge cut area, which may affect productivity and food webs. Field monitoring at every site and for every dredge event is not feasible, so a model will allow for more accurate estimates of recovery. Current impact assessments infer recovery patterns without incorporating quantifiable estimates based on the vast amount of field data that has been collected.
Intervention	If rate of recovery relative to dredging conditions (considering natural fluctuations) can be better quantified, BOEM can improve impact assessments and make more appropriate recommendations for dredge operations.
Comparison	This study aims to model benthic recovery relative to different dredge frequencies and environmental conditions using existing datasets that have monitored pre- and post-dredge benthic communities.
Outcome	An empirical formula that allows BOEM to input different dredge project parameters to estimate, including uncertainty, benthic recovery on both small and large scales.
Context	Atlantic and Gulf of Mexico Outer Continental Shelf (OCS) waters 50-m depths.

BOEM Information Need(s): To inform assessments and decisions for dredge events in all MMP regions, BOEM needs to quantitatively estimate how different dredge activities impact benthic invertebrate recovery when site-specific data are not available. In the process of excavating sediment, dredges can remove, bury, or otherwise potentially harm benthic invertebrates (mostly infauna but also some epifauna), a source of biomass that is important prey to higher trophic animals. Benthic invertebrates can recolonize within months to years, depending on operational and environmental factors, including the frequency of impacting events (i.e., time between events), depth of dredging (i.e., “cuts”), and ecosystem characteristics. While many site-specific studies have quantified post-dredging recovery, benthic monitoring of every project site (from undisturbed baseline to recovered or modified system) is inconsistent due to project timing, inherent system variability in physically dominated settings, budget, etc. These short-term studies may also miss larger scale patterns such as impacts from successive dredging or changes in recruitment trends. An empirical model to quantify estimated recovery rates will improve benthic impact assessments, including related to mesoscale and cumulative impacts, for all potential dredging projects (Atlantic and Gulf of Mexico OCS).

Background: Various studies have investigated the recovery of benthic communities following a disruption like trawling or dredging (e.g., Crowe et al. 2016; see Michel et al. 2013 for a review). Nearly every dredge project has monitored pre- and post-dredge benthos at least once, resulting in a large and geographically diverse dataset. These data from individual studies, however, have not been synthesized into a broader, mesoscale model of recovery.

In addition to how physical and environmental conditions affect potential recovery to a pre-disturbed state, the frequency of dredge events may also affect how the benthos recolonize. While benthic recovery should consider a return to pre-dredge biodiversity, this study focuses on a return to pre-dredge biomass based on the assumption that biomass provides the basic energy input to the food web (Gascuel et al., 2005). Hiddink et al. (2017) found that the depletion, and subsequent recovery, of seabed macroinvertebrates was correlated to the depth of disruption by different bottom trawls. Relative abundance of biota (i.e., biomass abundance *B* relative to carrying capacity *K*) is then calculated as:

$$\frac{B}{K} = 1 - F * \frac{d}{r}$$

where *F* is trawling frequency, *d* is the depletion of biota (as a proportion), and *r* is the recovery rate. This study aims to adapt this formula using dredge parameters. Full recovery would occur when post-dredge abundance matches carrying capacity (i.e., *B*=*K*) and thus the ratio =1. It is hypothesized that more frequent dredging would lead to greater depletion of benthic invertebrates, longer recovery rates, and therefore lower relative abundance of biota.

Objectives: The study aims to quantify benthic invertebrate biomass recovery after dredging (*F*), along with other parameters (e.g., *d* and *r*), and receive an estimate (plus uncertainty) of benthic recovery (the ratio *B/K*). With this model, it would be possible to estimate recovery more accurately when (1) field data are not collected, (2) successive dredging occurs, and (3) availability of adjacent undisturbed area changes.

Methods: This model will investigate how benthic invertebrate biomass recovery is related to dredge depth and frequency using existing datasets from dredge projects or studies (e.g., "Natural Habitat Associations And The Effects Of Dredging On Fish At The Canaveral Shoals, East-Central Florida," "Ecological Function And Recovery Of Biological Communities Within Sand Shoal Habitats Within The Gulf Of Mexico," and dredge-related surveys funded by the U.S. Army Corps of Engineers [USACE]). No new data or field work will be executed as part of this study. The study would start with a data synthesis of known recovery rates and processes, related to dredge frequency when possible. Relevant data include benthic grabs, invertebrate composition (e.g., biomass, abundance, and richness), sediment profile imaging, grain size analysis, dredging activity, bathymetry, and a variety of environmental variables like season and hydrodynamics. As feasible, the model will include covariates to account for environmental and seasonal fluctuations. Environmental covariates will be tested for significance, then built into calculations of inputs (e.g., *d* and *r*). All experimental data will be mined from BOEM-funded studies, USACE, academia, and state resource managers, among others. These data will be analyzed to calculate both an empirical formula, as well as input parameters.

The final product will be a logistic growth model that represents how benthic recovery varies with dredge frequency, depletion, and recovery, including measures of uncertainty (similar to the formula above). Existing data would be used to calculate input parameters *F*, *d*, and *r* (see Hiddink et al. 2017 for details). For example, the results of a BOEM-funded study to characterize the intensity of dredging (OCS Study BOEM 2018-019, "Using Dredge Plant Operational Data to Measure Cumulative Use and Cumulative Impacts") could be used to calculate dredge frequency *F*. These inputs would then quantitatively estimate relative abundance. The model will be validated using several "set aside" datasets, as well as ground-truthed with future projects. It will also be compared to the model developed for post-trawling recovery (Hiddink et al. 2017) to see how recovery differs between the two different types of activities. This model will support a user interface so that any BOEM analyst may generate an estimate of benthic invertebrate recovery. An instruction manual will accompany the interface so that a BOEM analyst is prompted to input relevant information from the proposed project (e.g., location, season, dredge cut depth). These values will feed into the model and calculate recovery.

Specific Research Question(s):

1. How does recovery of benthic invertebrate biomass vary with dredge frequency?
2. What are the quantitative estimates, range, and dimensions of benthic recovery for different dredge depths and frequencies?
3. How do successive dredge events cumulatively affect benthic invertebrate biomass recovery?

Current Status: Data compilation and model formulation is underway.

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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