Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Accounting for Scale Bias in Marine Minerals Studies (MM-23-03)
Administered by	Marine Minerals Program
BOEM Contact(s)	Deena Hansen (Deena.hansen@boem.gov)
Procurement Type(s)	Cooperative Agreement
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2023–2025
Final Report Due	TBD
Date Revised	April 1, 2022
PICOC Summary	
Problem	The scale of Marine Minerals Program (MMP) studies affects the interpretation of results and understanding of impacts (Grothues et al. 2021). The scale of the research footprint may not match the scale of habitat and species' scales. This can lead to mischaracterizing species distributions or habitat associations that are necessary to assess dredge impacts.
Intervention	Existing data from prior studies and dredge-related monitoring should be analyzed at various scales to find the best correlative fit.
Comparison	Habitat and species distribution relative to BOEM activities should be compared at different scales (e.g., gradually coarser) to better understand "scale bias."
Outcome	Applying the appropriate scale to study and monitoring results will improve the accuracy of previous study interpretation, while informing the design of future MMP studies resulting in data sets that may better inform environmental analyses and leasing decisions.
Context	Atlantic and Gulf of Mexico Outer Continental Shelf to 50-m depths.

BOEM Information Need(s): BOEM has invested over $1 billion in studies since beginning in 1973. These data and results have informed BOEM decisions and driven additional research. To maximize these results and apply them more accurately, BOEM must understand how the scale of research and activities matches (or mismatches) the scale of habitats and species distributions (Grothues et al. 2021). The importance of this study was echoed by Dr. Kevin Stokesbury at a Committee on Offshore Science and Assessment meeting in fall 2021. The outcome of this study could improve the methodological approach for studying the potential impacts of MMP authorized actions resulting in new data sets and approaches to assessing the environmental implications of MMP leasing decisions.

Background: Scale can be both temporal and spatial. Temporal scale can vary between short-term (0–5 years), intermediate term (5–10 years), and long-term (10–25+ years); spatial scale from near (10s of meters), mid (10s of kilometers), to far (100s of kilometers) (B. Jensen, pers. comm.). Within a habitat, animals often fluctuate between scales depending on habitat use (e.g., large spatial scale for migrations but small spatial scale for reproduction). "Scale bias" is the extent to which the temporal or spatial scale

that an experiment or survey is conducted, which influences the results (Levin 1992; Mashintonio et al. 2014, cited in Grothues et al. 2021). Scale affects how we analyze results (e.g., power analysis) and interpret study results (Knorr 2017). It also impacts how we interpret effects from a disruption, like dredging. See figure below for a diagrammatic representation.

In several BOEM-funded literature syntheses (Michel et al. 2013, Rutecki et al. 2015, Grothues et al. 2021), findings reveal a variety of fish-habitat associations over the last 30+ years that are relevant when evaluating the potential impacts associated with dredging activities. Though this comprehensive literature base exists, not all studies have tested various scales in the study design or during results interpretation. Correlations might have been calculated at a fine-scale resolution (e.g., species distribution to a specific sand feature in one season) but not tested further at other scales (e.g., a species guild in a larger area over years). The finest scale may still have the best correlation, but the strength of that fit is unknown until "zooming out." There may also be significant species-habitat associations at both small and regional scales, though they mean different things ecologically (Mashintonio et al. 2014). Furthermore, under current sea level rise projections, the size, scale, and frequency of dredging efforts required to support future coastal resiliency initiatives is changing so future research must adapt to changes in dredging.

The proposed study will address this "scale" data gap and could implicate future assessments and studies by leading to more accurate applications of BOEM research findings. This study could also serve as a pilot effort to inform a follow-on study reviewing scale bias in BOEM's renewable energy and oil and gas programs.

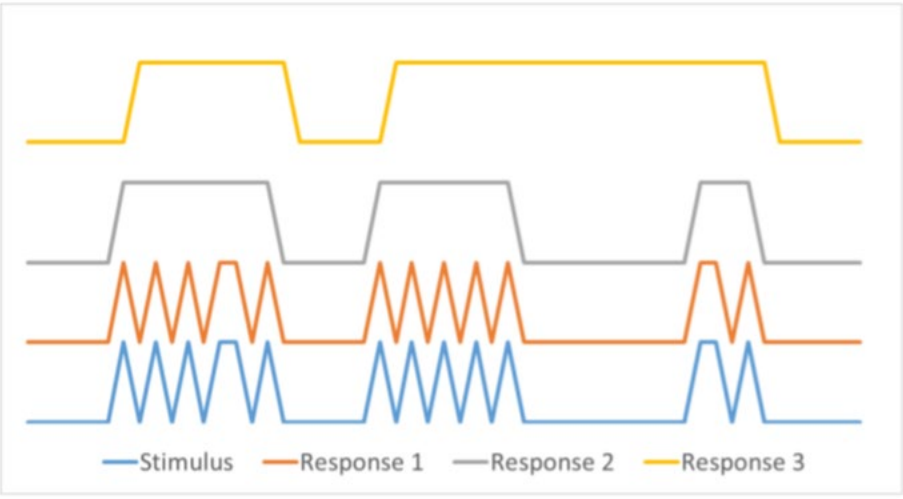

Figure 21. Diagrammatic representation scaled response
In the figure above, a hypothetical perturbation (e.g., storm, dredging, trawling) is represented as an oscillating state (lower blue line, up is disturbance, down is no disturbance) along a time line (x-axis). Three possible response patterns (upper three curves) show the effect of scale in eliciting or detecting a response. The uppermost hypothetical response is least correlated to the stimulus unless the stimulus signal is resampled to a lower resolution and also lagged, but remains plausible as a response, for instance if fish evacuate an area on the basis of frequent disturbance, rather than in response to just one event. The same pattern holds true if the x-axis is understood to depict a spatial measurement (e.g., meters). In that case, fish may vacate a wide area that has a high density of habitat disruptions even if they do not avoid any individually disturbed area. The conceptual figure also holds for attractor stimuli (e.g., concentration of shell hash), in which case the response is positive.

Figure from Grothues et al. 2021

Objectives: Identify how well the spatial and temporal scales of MMP research and authorized activities match (or mismatch) the scales of habitat and fish distribution. Provide recommendations and propose existing or new methods that consider relevant scales for future MMP research.

Methods:

- A Methods Paper would first outline data requirements and proposed execution of how to identify scale bias in MMP studies. This paper will also identify the spatial and temporal scale(s) of potential impact from BOEM-authorized dredging activities.
- Based on these recommendations, existing datasets on fish and habitat from relevant BOEM studies, plus data from partners like USACE or local communities, would be reviewed for data richness. Potential BOEM studies include fish-habitat associations researched off New England (MM-17-05), New York Bight (BOEM 2021-036), eastern Florida (BOEM 2019-043), and Louisiana (GM-14-03-10).
- Of these, a qualifying subset would go through an iterative process to identify the effects of scale. As described in Section 6.4 of Grothues et al. 2021, habitat variables like bathymetry, sediment, and infauna would be described at the finest scale possible. Overlaid on this is fish species distribution, again at the finest scale possible. Correlations between habitat and species distribution are then measured. From here, the resolution is downgraded, or made coarser, and correlations recalculated (Mashintonio et al. 2014). The best fit indicates the appropriate scale.

Specific Research Question(s):

1. How does scale affect MMP's research results? What are the appropriate scales among various studies?
2. How can the appropriate sampling and statistical methods be determined in order to detect change at the appropriate scale (or different scales)? How can BOEM determine the sufficiency of study footprints to answer objectives?
3. What temporal and spatial ranges best reflect MMP activities, and the habitats and species potentially impacted?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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