BOEM Bureau of Ocean Energy Management

Accounting for Scale Bias in Marine Minerals Studies

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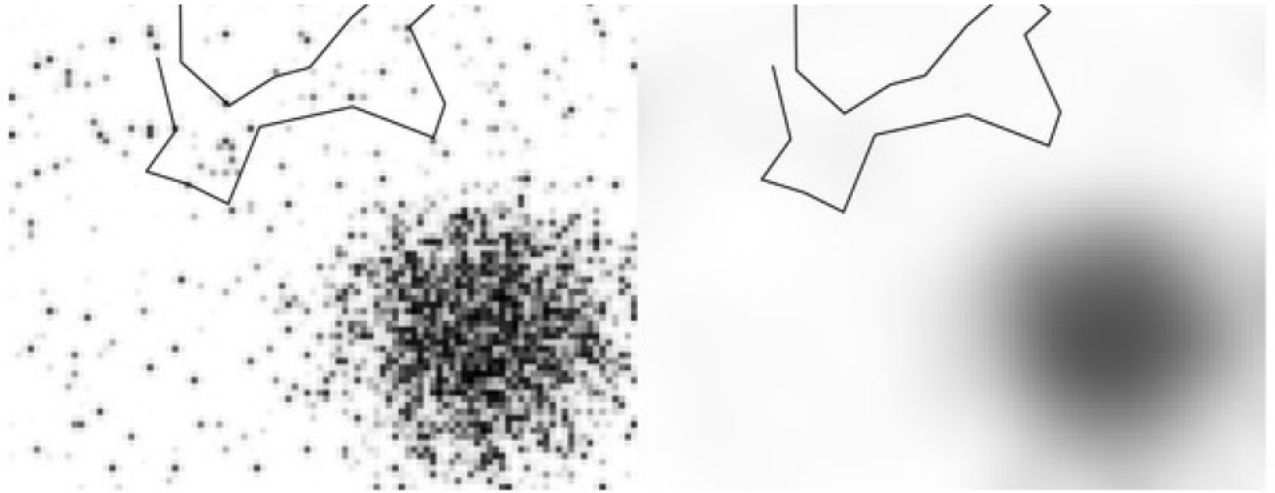
BOEM Information Need

- Are we asking the “right question” at the “right scale?”
- “Scale bias” is the extent to which the temporal or spatial scale of a study influences the results
- Need: to better understand how the scale of research and activities matches (or mismatches) the scale of habitats and species distributions



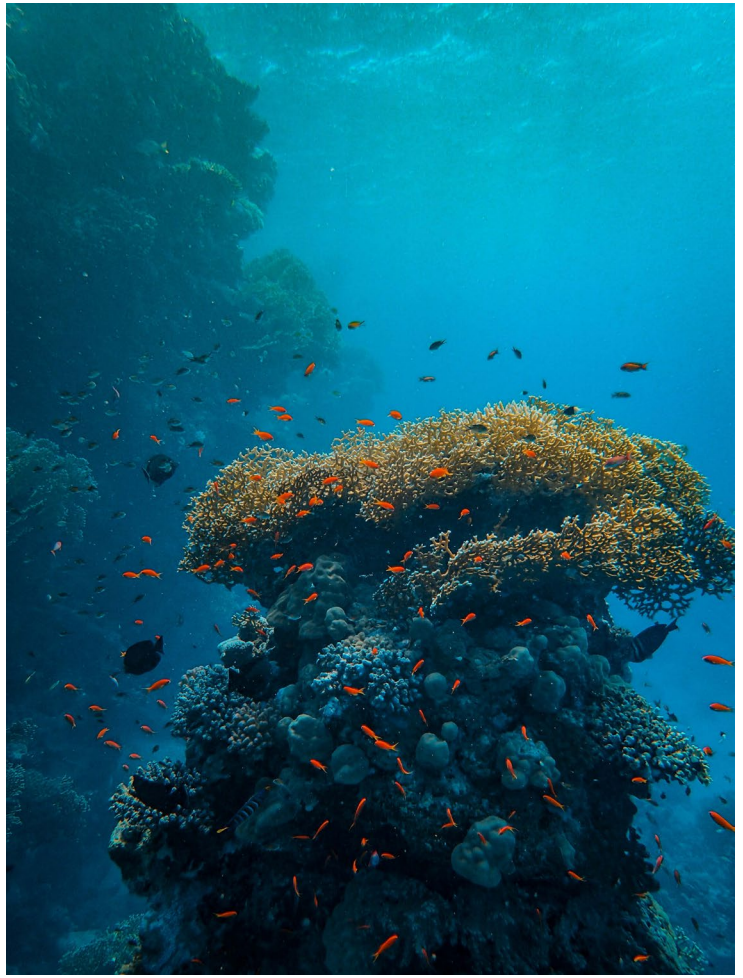
Mashintonio et al., 2014

PICOC Summary

Problem	Research at the “wrong” scale can mischaracterize animal distributions and habitat associations important to assessing impacts
Intervention	Existing data should be analyzed at various scales to find the best fit
Comparison	Relationships should be compared at different scales
Outcome	Previous results will have better context, and future studies will be more accurate
Context	Atlantic and Gulf of Mexico OCS to 50-m depths

Background

- Species distributions (and indicators) differ with scale
  - Coral reefs: oceanographic processes determined settlement at “large” scales, while physical/habitat preferences determined settlement at “small” scales (Caselle and Warner 1996)
  - Elephants: during the dry season, habitat variables are more influential at a small scale; multi-scale models better predict habitat preferences (Mashintonio et al., 2014)



Background

Trifonova et al., 2022

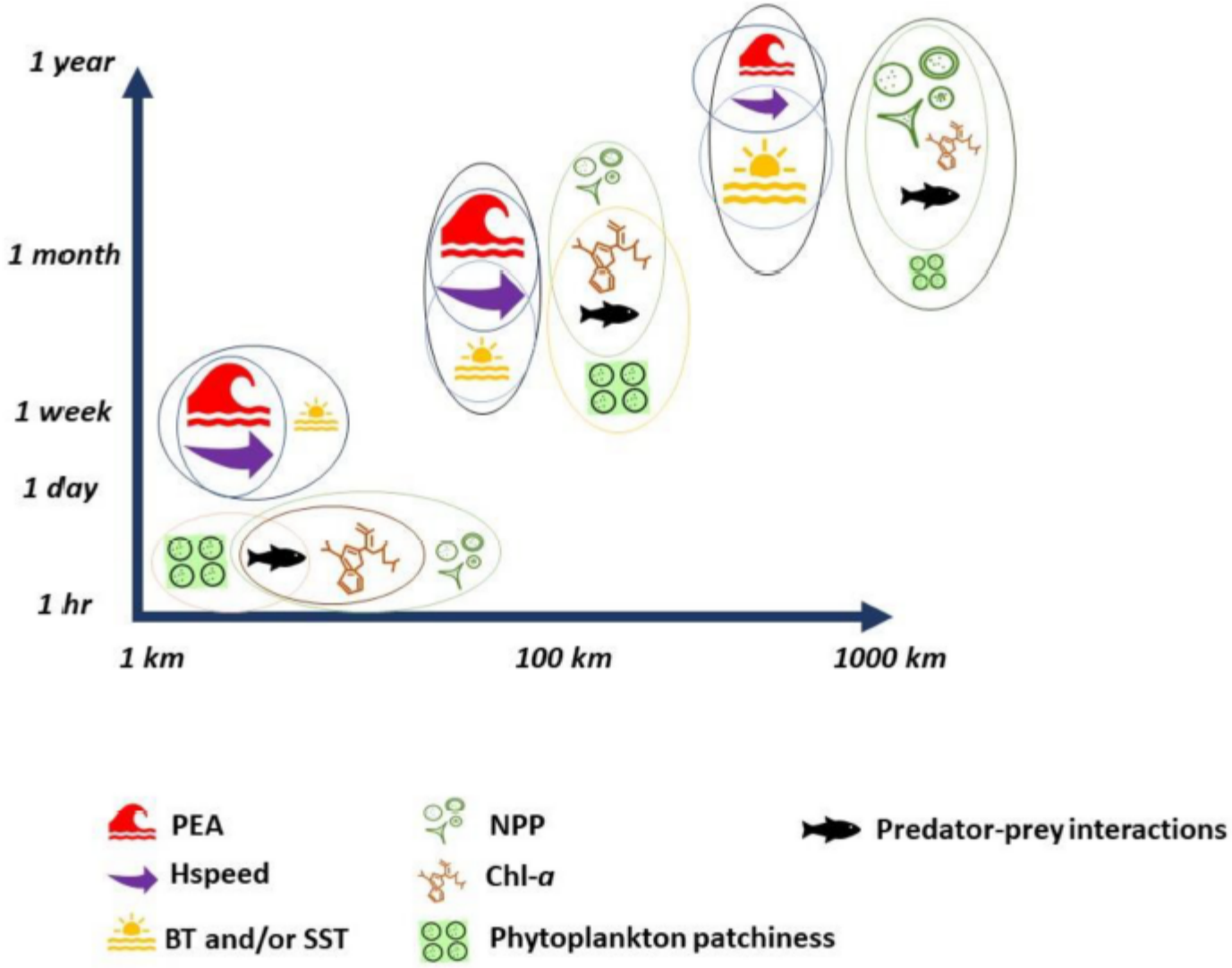


FIGURE 5 | Physical and biological indicators and their overlap (represented by colored circles) across spatial and temporal scales. The size of the symbol represents the relevant "importance" of each indicator at each scale, which was determined, based on all the reviewed literature for this study.

Background

- Indicators (and models) also vary with fish guild
  - Physical and secondary production variables were important across fish guilds
  - Most guilds have their own set of predictors relevant to life history

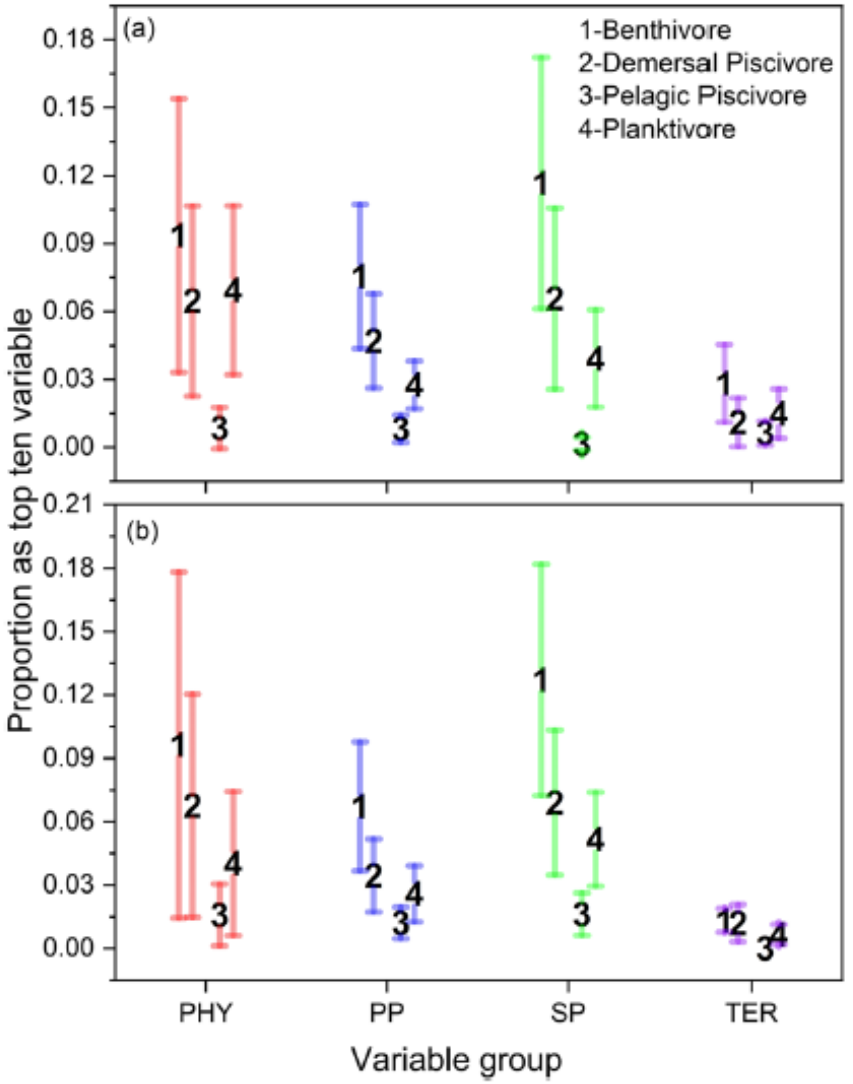


FIGURE 7 The proportion of spring (a) and autumn (b) models in which a variable was among the top 10 model variables present from variable classes physical (PHY), primary production (PP), secondary production (SP), and terrain complexity (TER), by functional group. Error bars are 95% confidence intervals. Physical, primary production, secondary production, and terrain variables are represented in red, blue, green, and purple, respectively

Friedland et al., 2020

Background

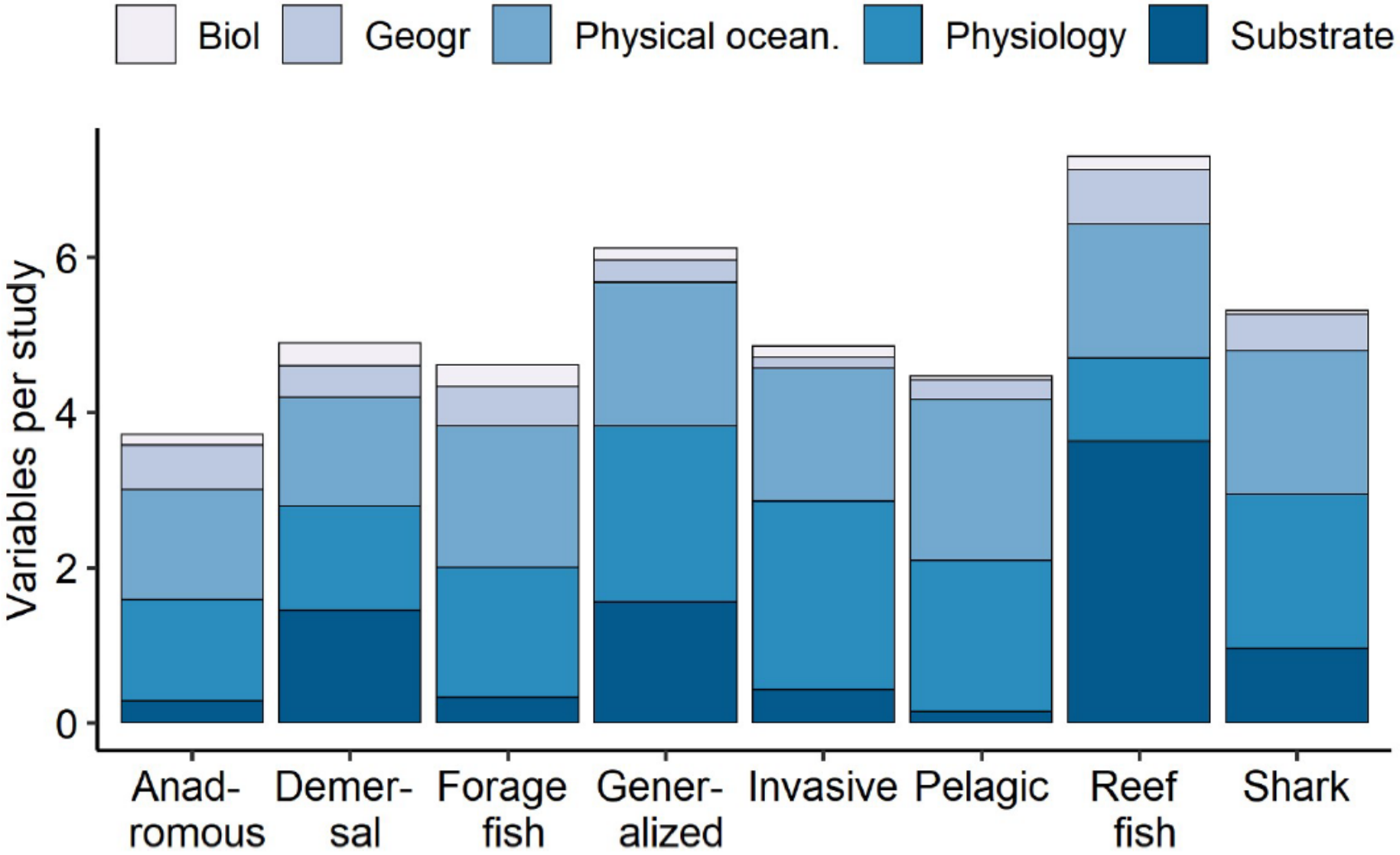


Fig 3. Frequency of predictor variable categories tested by fish guilds. For each fish guild (x-axis), predictor variables were summarized into categories of biological (Biol), geographic (Geogr), physical oceanographic (Physical ocean.), physiology-based oceanographic (Physiology), or substrate ($n = 224$).

Pickens et al., 2021

Study 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 new methods that consider relevant scales for future MMP research

Methods

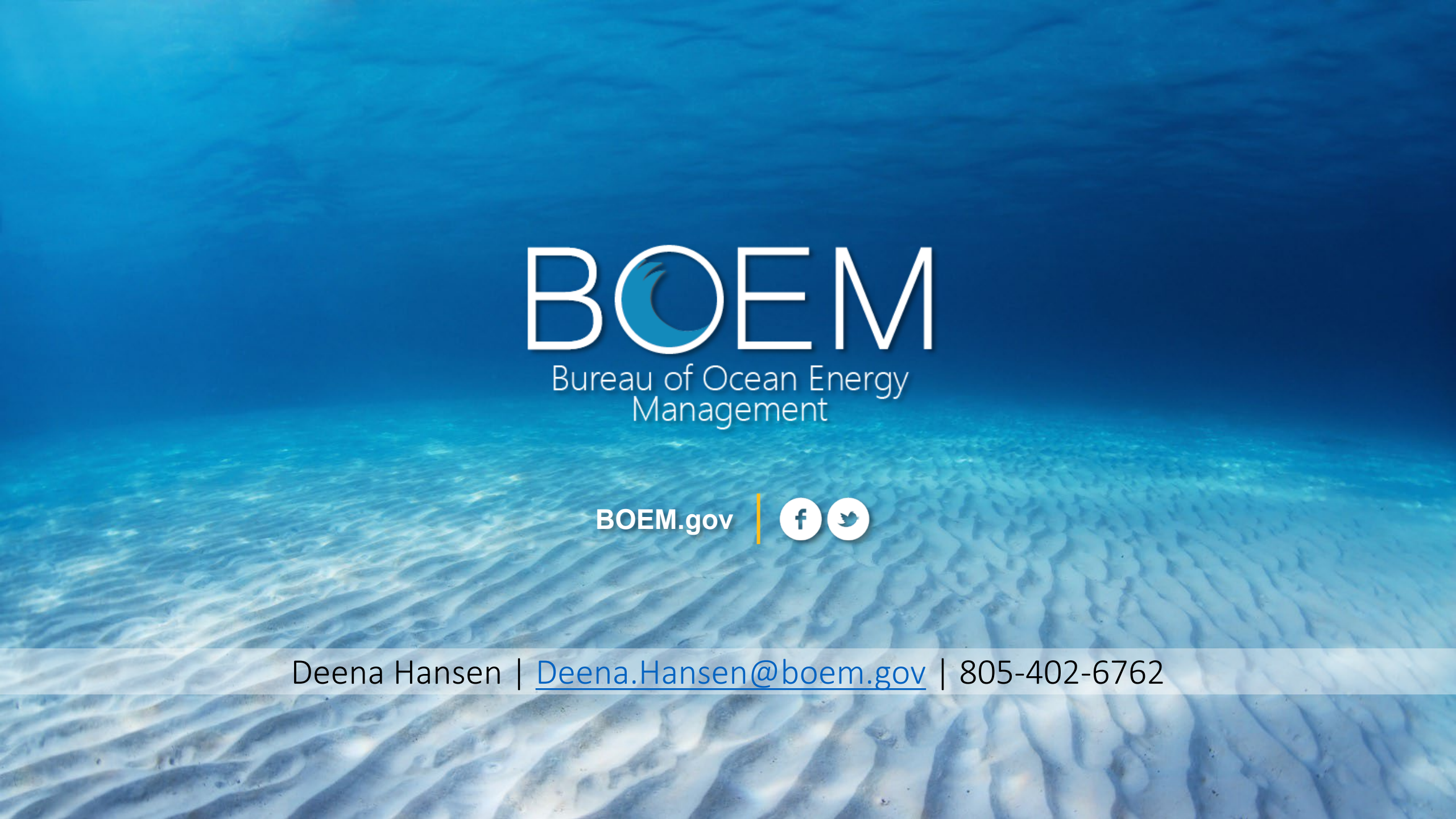
- Methods paper outlines data requirements and proposed execution
- Existing datasets on fish and habitat from BOEM and partners' studies reviewed for data richness and relevance
- A qualifying subset would go through an iterative process to identify the effects of scale. E.g., habitat variables like bathymetry, sediment, and infauna would be described at the finest scale possible. Overlayed 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.

Research Questions

- How does scale affect MMP's research results? What are the appropriate scales among various studies? Are study footprints sufficient to answer objectives?
- What temporal and spatial ranges best reflect MMP activities and the habitat and species potentially impacted?

Discussion Questions

- How to define scale?
  - Ecosystems: regional (1000s of kms) based on populations and management, local (100s of km) based on base of food webs, fine (<1 km) for individual behavior (Trifonova et al. 2022); benthic habitat on smaller scales, all <1 km (e.g., Greene et al., 1999)
- How to identify indicators?
  - Literature reviews (e.g., Friedland et al., 2020; Trifonova et al., 2022) highlight specific variables like stratification, temp, current speed, productivity, and predator-prey interactions
  - Can MMP rely on these variables or do we need an independent review?
- How to integrate multiple species?
  - Different models and variables apply to different species and guilds (e.g., Friedland et al., 2020; Pickens et al., 2021)
  - How to integrate across, or prioritize, species/guilds?



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References

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