Assessing changes in bottom fish community before, during, and after the Block Island Wind Farm development

Rhode Island Marine Fisheries Institute

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Introduction – Block Island Wind Farm

RIDEM issued a dredge permit and water quality certificate to Deepwater Wind LLC. for the construction of the Block Island Wind Farm. Within those permits, we required the following:

- Before-After-Control-Impact (BACI) study of biological conditions for 2 years before construction, 1 year during construction, and 2 years post construction.
  - Construction took 2 years and a 3rd year was added post-construction resulting in 2 pre, 2 during, and 3 post construction sampling years.
- Data collected via a ventless lobster survey and a demersal trawl survey – both conducted aboard commercial fishing vessels

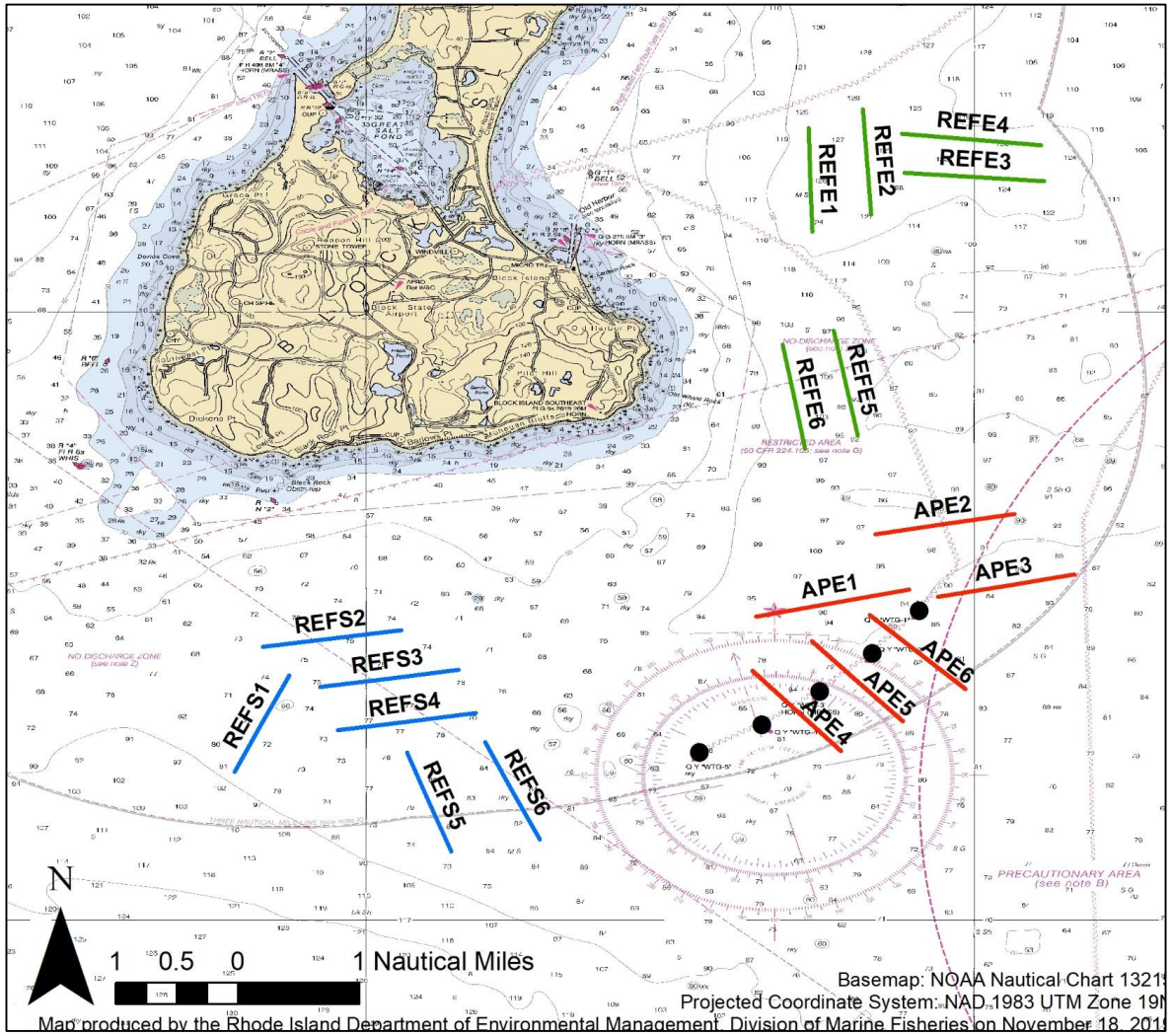
Trawl survey setup - modeled after NEAMAP protocol

- FV *Virginia Marise* with Captain Rodman Sykes
- Data collection done by INSPIRE Environmental (formerly CoastalVision/SeaPlan) consultants
- 412 x 12 cm, four-seam whiting trawl with 66-inch Thyburon otter doors and a 1 inch (2.54 cm) knotless cod end liner to ensure retention of the smaller fish
- 20-minute tows

Introduction – INSPIRE Environmental Sampling

BIWF Survey Blocks: 2 trawls sampled per block per month

- APE Block
  - In and around wind turbine generators and the inter-array cable
  - Tow lines arranged N-S and E-W around and across the WTG area and inter-array cable
  - **Tows ranged from 78 – 100 feet in depth**
  - Silty sand, sand and gravel substrate
- REF S Block
  - South of Block Island and west of the APE
  - Separated by a ridge of glacial moraine (till, boulders and cobbles)
  - Tow lines arranged N-S and E-W within the block
  - **Tows range from 60 – 90 feet in depth**
  - Primarily sand and gravel substrate
- REF E Block
  - East of Block Island and north of the APE
  - Tow lines arranged N-S and E-W within the block
  - **Tows ranged from 80 – 130 feet in depth**
  - Primarily silty sand and silt substrate



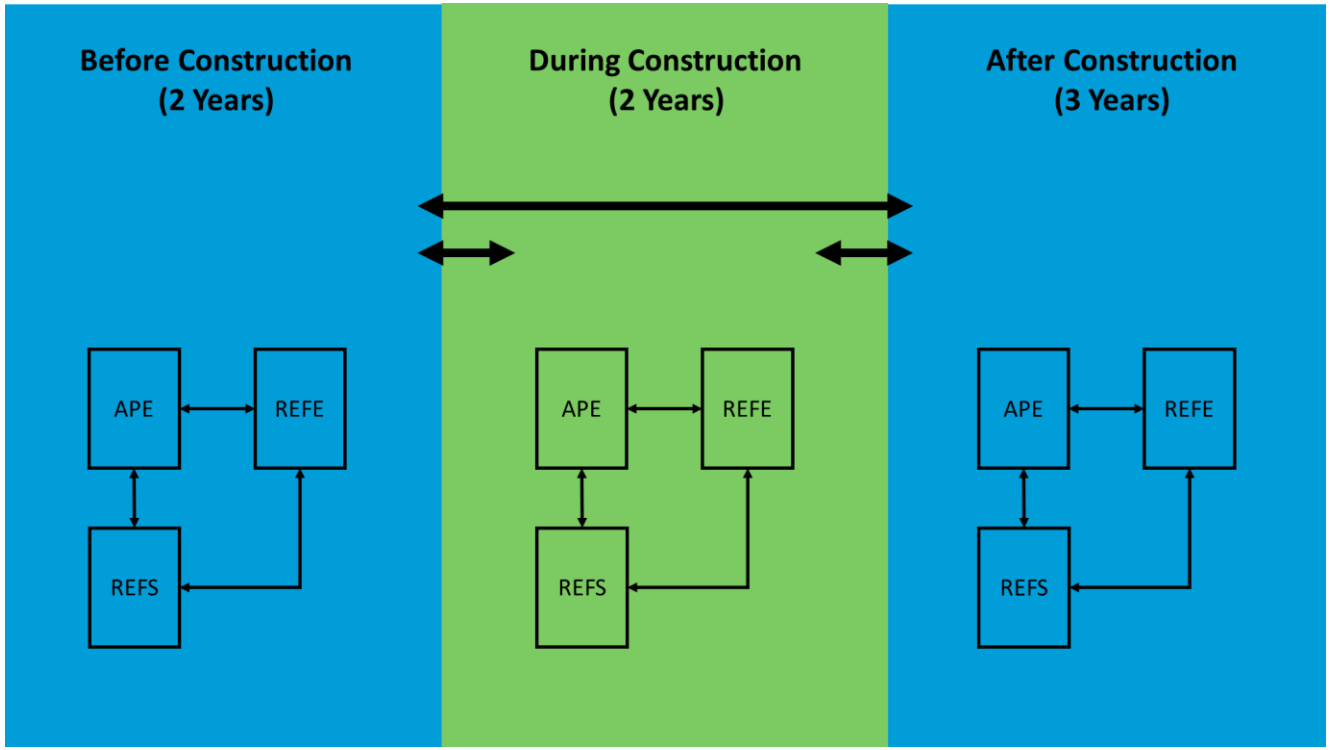
Methods – General Data Analysis

- Community Analysis - data grouped by season and year
  - Non-metric multidimensional scaling
  - Hierarchical cluster analysis
  - Analysis of Similarities (ANOSIM)
  - Similarity Percentages (SIMPER)
  - Species richness
  - Diversity indices
    - Shannon-Wiener
    - Simpsons
- No clear changes in fish community among sampling sites or construction stages seen through 2018 data

- Individual Species Analysis
  - Length
    - Kolmogorov-Smirnov (KS) tests between years and between sites
    - Generalized linear models (GLMs) including year (or construction phase), sampling block, and environmental variables (temperature, salinity, etc.) as covariates
  - Abundance/Biomass
    - Generalized Linear Mixed Models (GLMMs)
- No clear changes in size distributions or species' lengths among sampling sites or construction stages seen through 2018

Methods – Generalized Linear Mixed Models

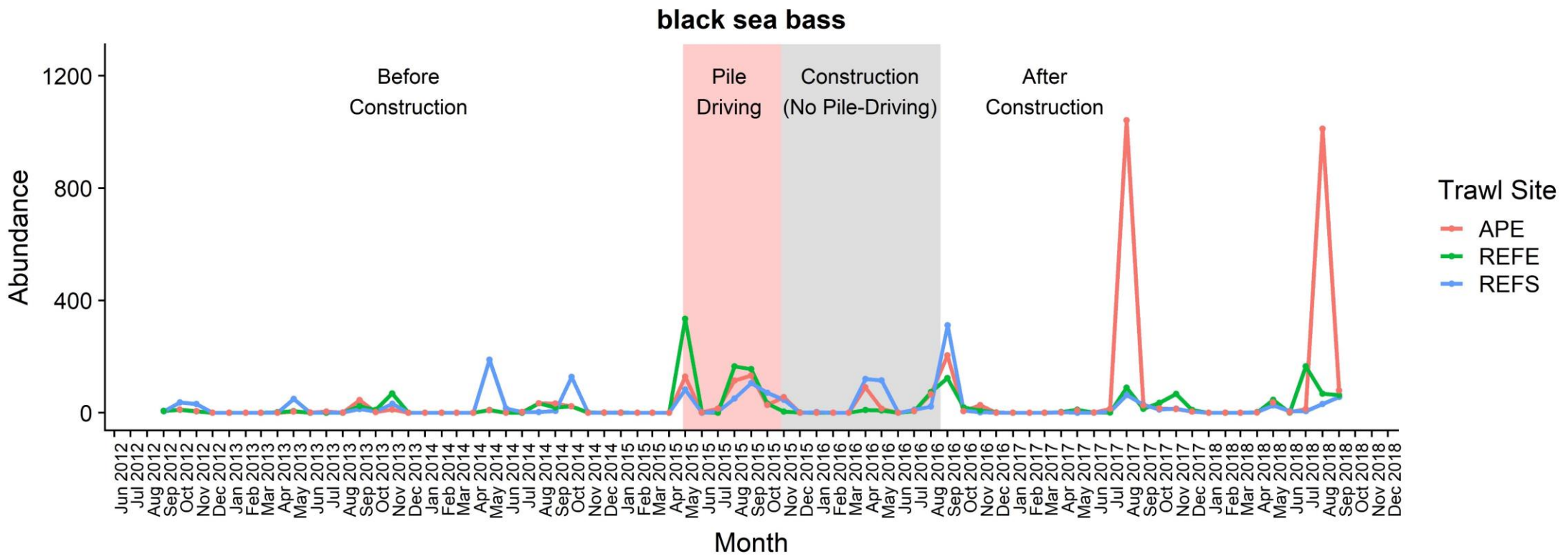
- GLMMs are suited to analyze unbalanced datasets and are therefore applicable to our BACI dataset with one impact site and two control sites



- GLMMS can effectively model non-normal data
- GLMMs allow for incorporation of random effects
  - In our case to account for correlation between observations taken at the same time or in the same area

Methods – Species Selection

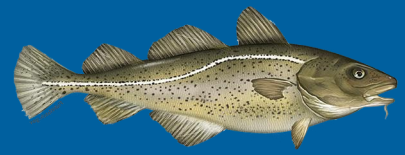
Data visualization



Methods – Species Selection

- More systematic selection of species by:
  - >10% observance in monthly samples
  - Eliminated all tropical species
  - Removed pelagic species
  - Selected only fish (removed inverts)
- Chose to include any species of particular importance to fishing that did not make the list (e.g., longfin squid, sea scallop)
- Also chose to include species that we had heard about potential changes from industry via personal communication and/or ten Brink and Dalton 2018 (e.g., Atlantic cod)

Methods – Species Selection



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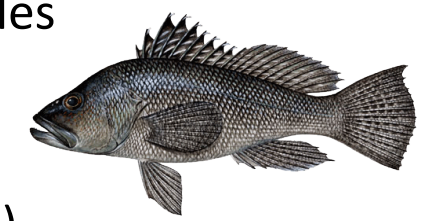

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Atlantic cod
black sea bass
fourspot flounder
little skate
longfin squid
longhorn sculpin
monkfish
northern sea robin
ocean pout
red hake
scup
sea raven
sea scallop
silver hake
smooth dogfish
spiny dogfish
spotted hake
striped sea robin
summer flounder
windowpane flounder
winter flounder
winter skate
yellowtail flounder

Methods – Abundance GLMMs

- Two trawls per sampling block per month were averaged into a single monthly abundance
- Created a BACI effect column – “CI_BA”
  - Date was recategorized as “Before”, “During”, or “After” construction
  - Blocks were recategorized as either “Effect” or “Reference”
  - An additional column “CI_BA” was created concatenating the construction stage and the survey block – 6 different groupings resulted
- Used a zero-inflated negative binomial model to account for the many tows where 0 of the target species were caught
- Block and year were treated as random effects, the BACI effect was treated as a fixed effect

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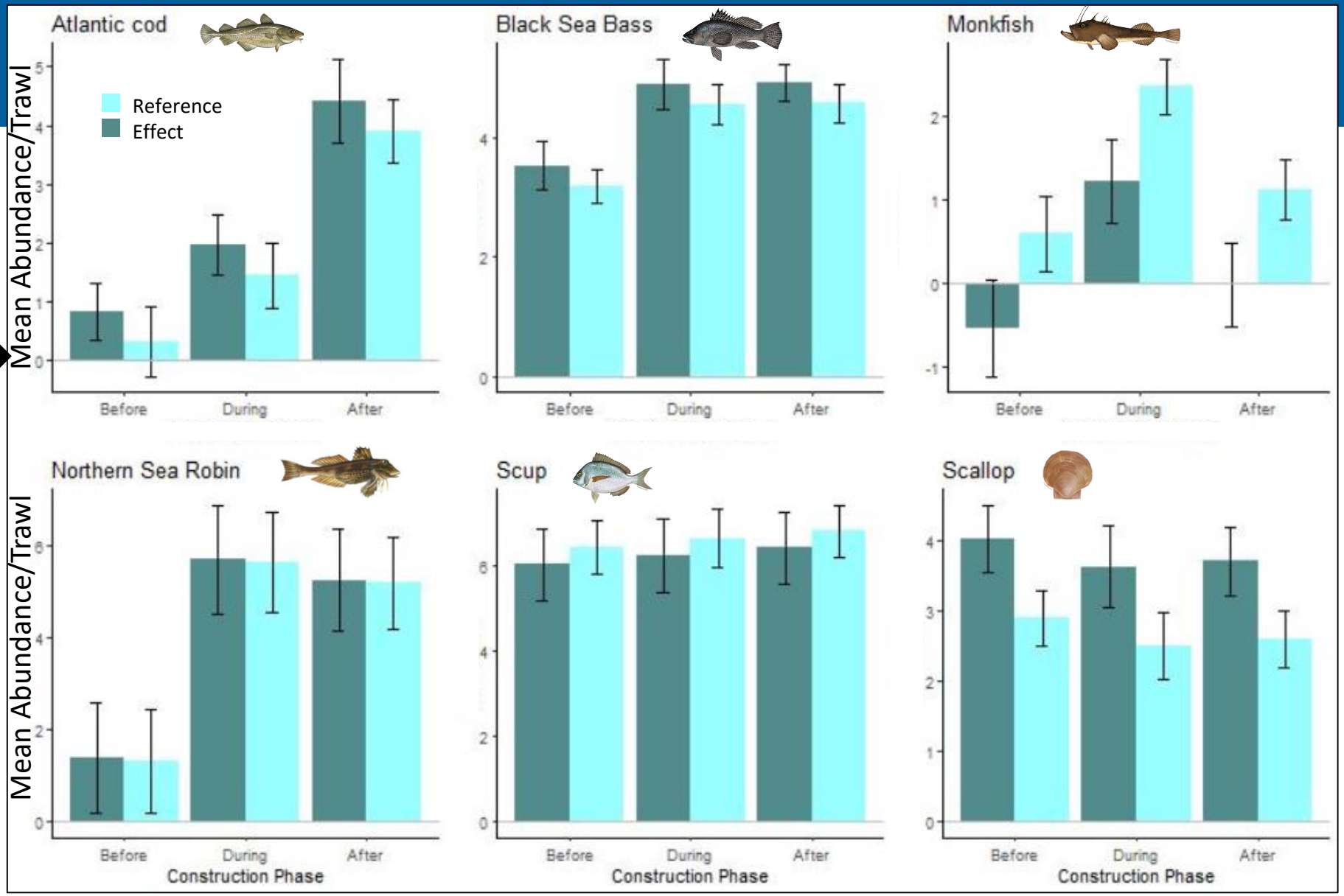
model <- glmmTMB(Abund ~ CI_BA + (1|Block) + (1|Year), data=abundDat, family=nbinom2, ziformula=~1)

Results

- Currently working on fitting GLMMs for all 23 species
- <u>Preliminary</u> results for a random assortment
- These models will help inform whether changes have occurred around the wind farm, but cannot tell us whether detected changes could have resulted from regional trends



Introduction | Methods | Results

Methods – NEAMAP Data

BIWF Survey Blocks:

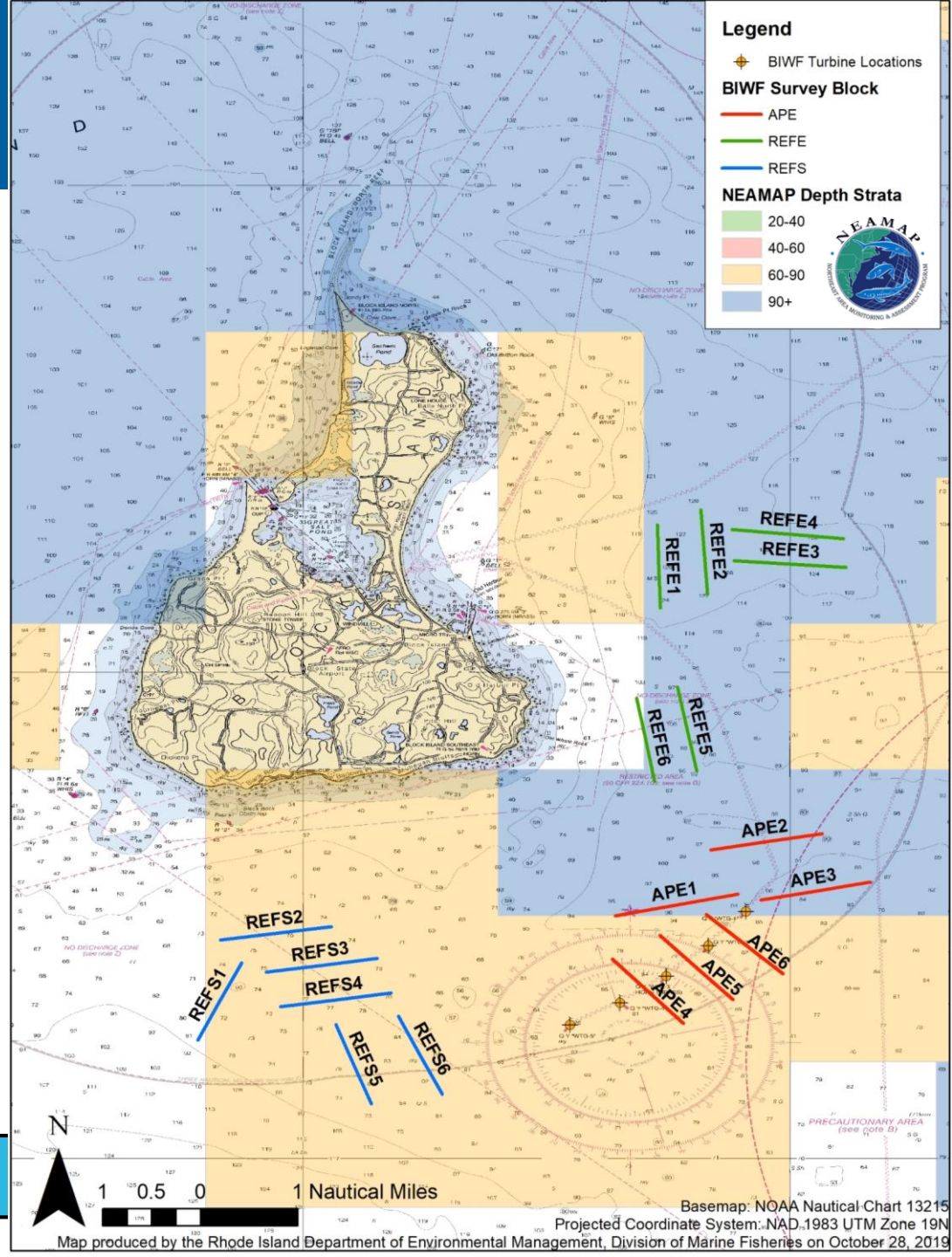
- APE Block - tows range from 78 – 100 feet in depth
- REF S Block - tows range from 60 – 90 feet in depth
- REF E Block - tows range from 80 – 130 feet in depth

NEAMAP Depth Strata:

- 20-40 feet
- 40-60 feet
- 60-90 feet
- 90+ feet

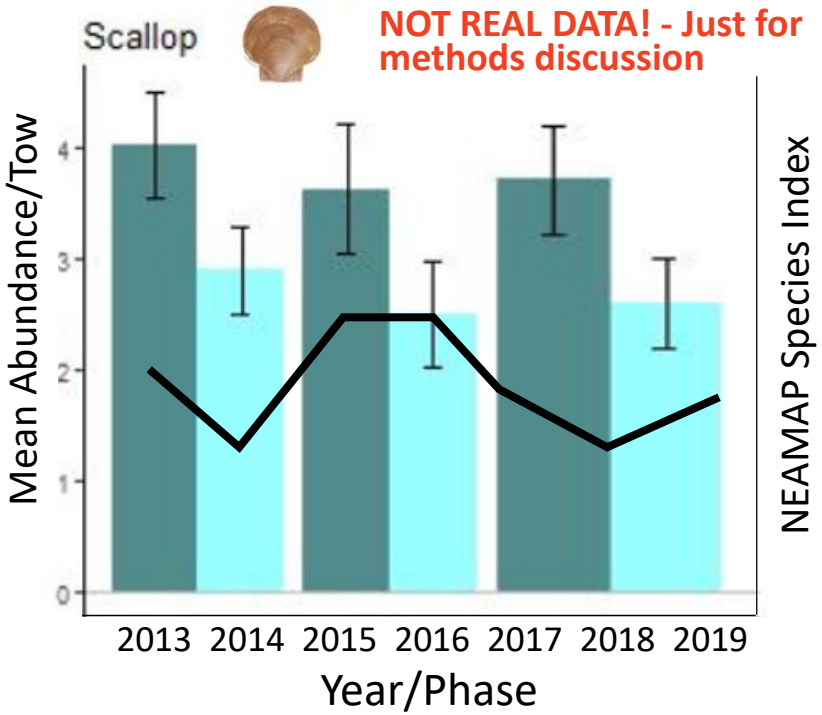
Overlap between the two is 60-90 and 90+ feet

- Requested and received data from NEAMAP for both strata for all 23 species discussed earlier



Results/Next Steps

- Current plan is to overlay the abundance index for the relevant survey strata over the GLMM predicted abundance results for each species
- Just starting to think about how to look at the two datasets side-by-side
  - One is fixed sampling sites and the other is randomly stratified



Questions or Suggestions?

Acknowledgements

- INSPIRE Environmental
- Deepwater Wind LLC
- DEM DMF (Conor McManus, Jason McNamee)
- Virginia Institute of Marine Science (NEAMAP - Jim Gartland)