

Modeling Living Resources to Support Chesapeake Bay Restoration

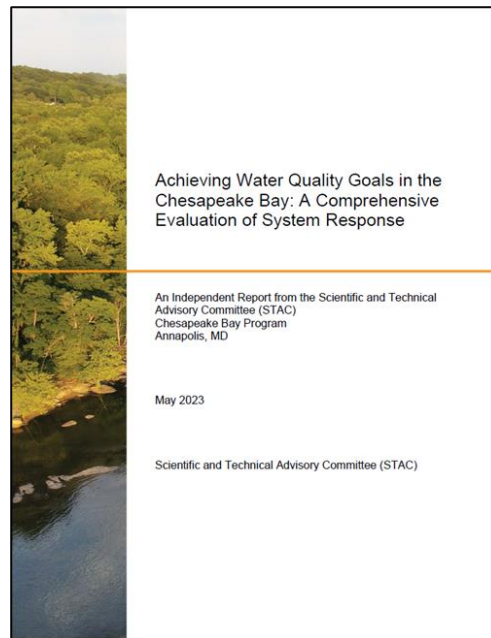
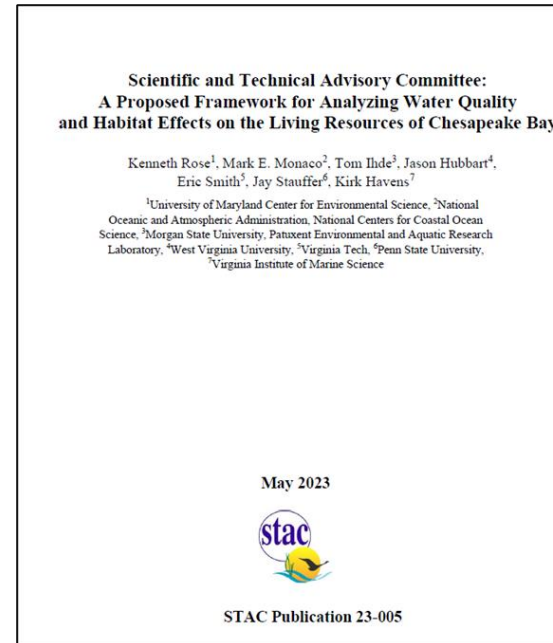
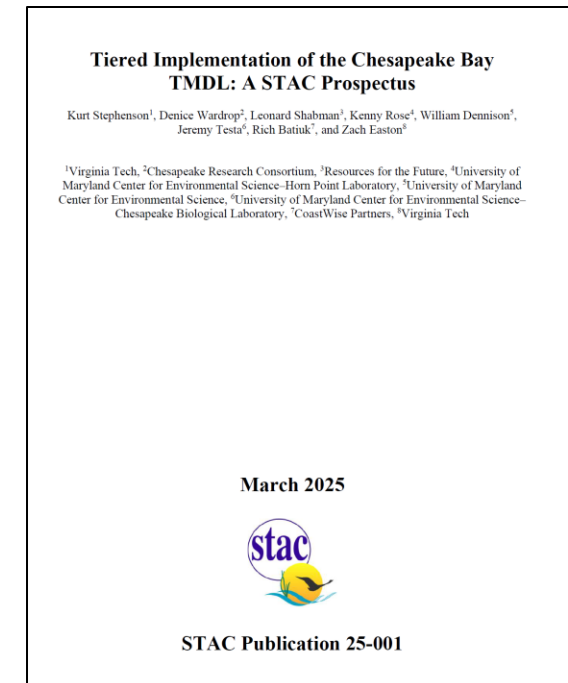
Kenneth Rose

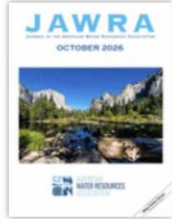
France-Merrick Professor in Sustainable Ecosystem Restoration
Horn Point Laboratory

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Modeling Workgroup October Quarterly Review







ISSUE

Achieving the Water Quality Goals of the Chesapeake Bay: A Comprehensive Assessment of System Response

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RESEARCH ARTICLE OPEN ACCESS

Improving Living Resource Responses in Ecosystem Restoration: An Illustration Using the Chesapeake Bay

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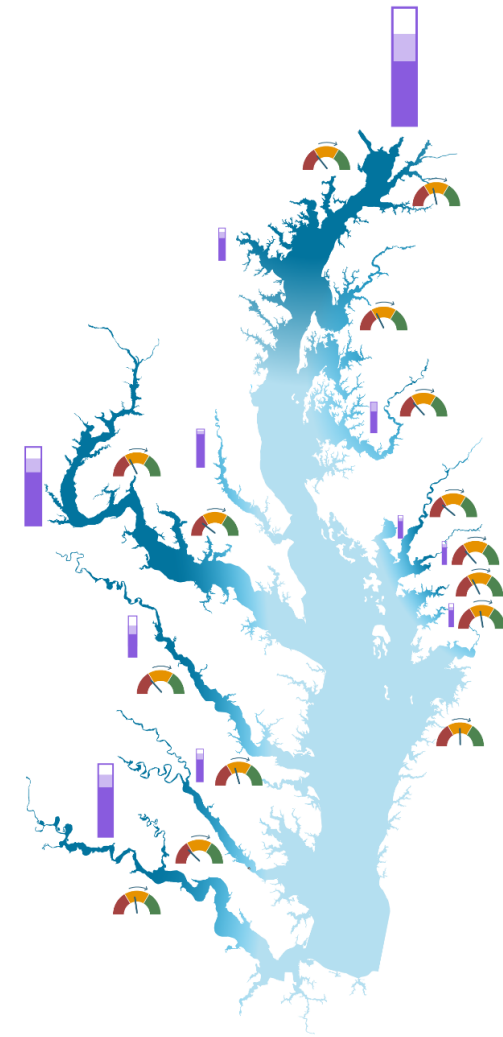
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A tiered implementation of the TMDL establishes intermediate term, spatially explicit pollutant load targets that would result in the greatest anticipated benefit to living resources on our way toward Attainment of the Chesapeake Bay water quality standards

Tiered Implementation

≠

Habitat Suitability



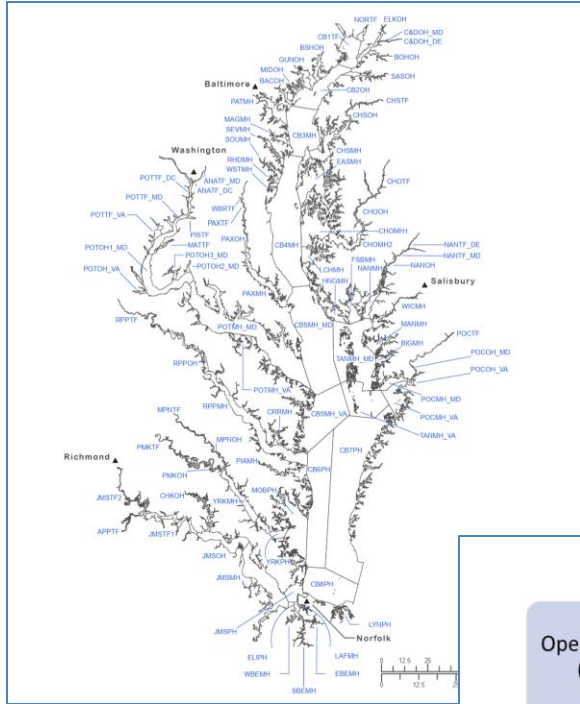
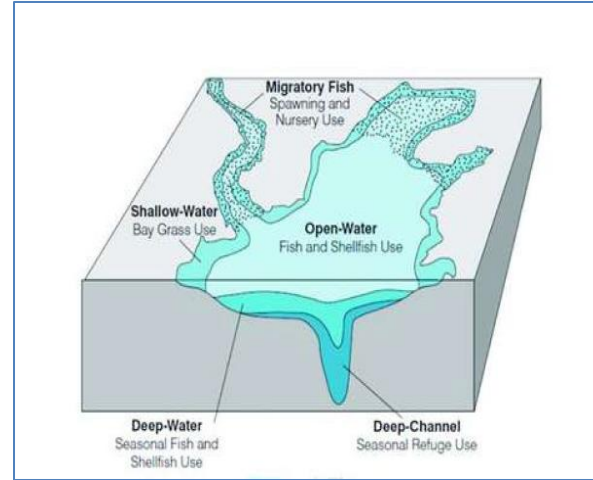
Identify areas where water quality improvements can improve high importance living resource habitats.



Identify influence of upstream N, P, or sediment on local water quality.

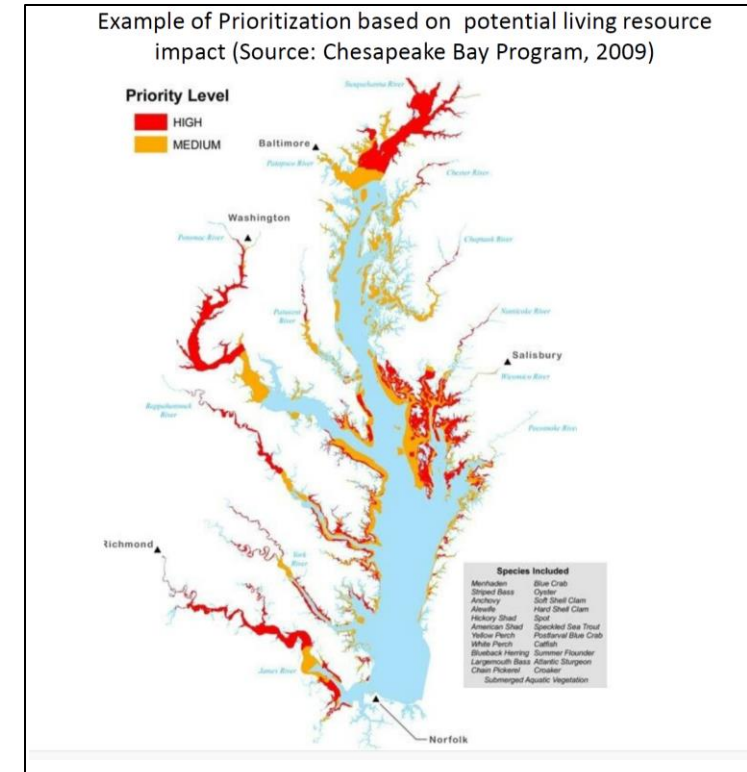


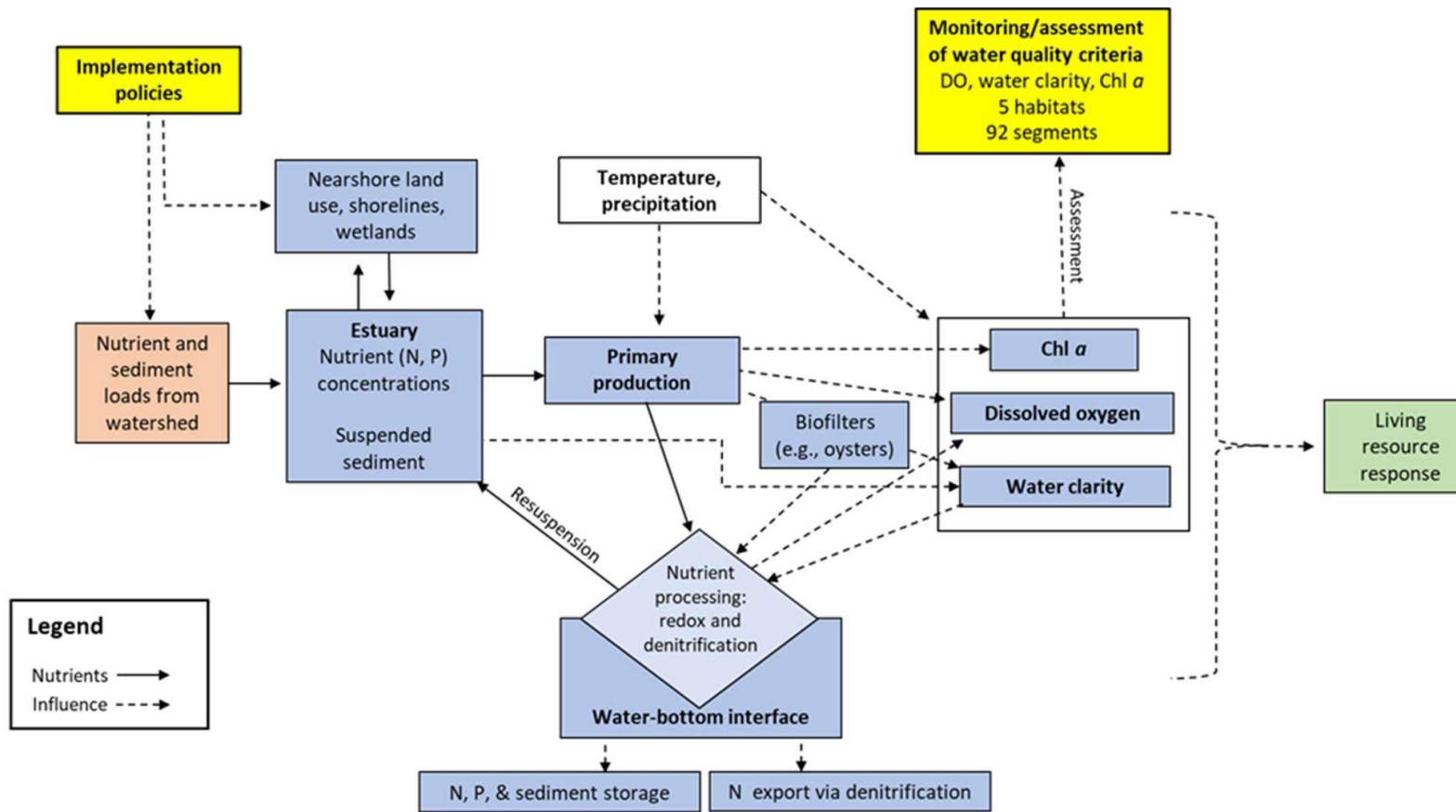
Set interim nutrient and sediment targets to achieve water quality improvements in priority areas.



Designated use/habitat (number of segments)

	Open water (92)	Deep water (18)	Deep channel (10)	Migratory spawning (73)	Shallow water (92)
<i>Water quality criteria</i>	DO instantaneous minimum (92)	DO instantaneous minimum/2 seasons (36)	DO summer criteria (10)	DO instantaneous minimum/2 seasons (146)	Water clarity; SAV or water clarity acres (92)
	DO 7-day mean (92)	DO 7-day mean/non-summer (18)	DO instantaneous minimum (10)	DO 7-day mean/2 seasons (146)	
	DO 30-day mean (92)	DO 1-day mean/summer (18)	DO 7-day mean (10)	DO 30-day mean/2 seasons (146)	
	Chl <i>a</i> /2 seasons; James R. in 6 segments (12)				
	Chl <i>a</i> /1 season; DO in 2 segment (2)				
	Chl <i>a</i> narrative criteria (84)	DO 30-day mean/2 seasons (36)	DO 30-day mean (10)		





EVOLUTION
not
REVOLUTION



Expert Opinion

Laboratory
Field studies
Other information



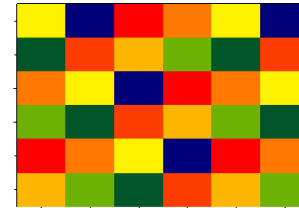
Empirical (statistical)

Fish survey data
Explanatory variables
Co-located

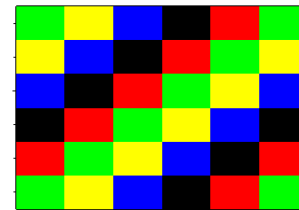


Explanatory Variables

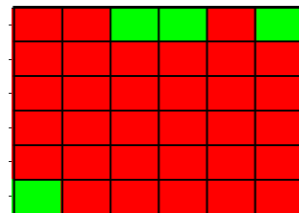
(from data or a model)



Temperature

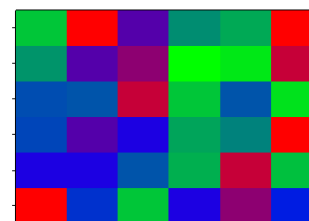
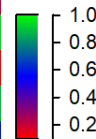
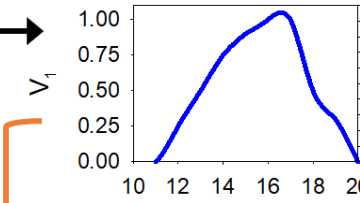


Substrate

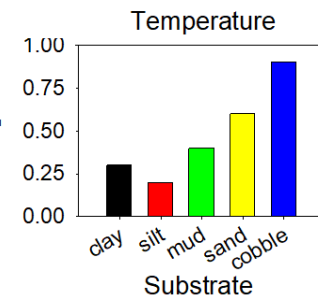


Shoreline vegetation

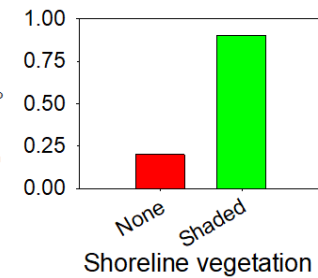
Habitat Suitability Map



Fitted Response Function



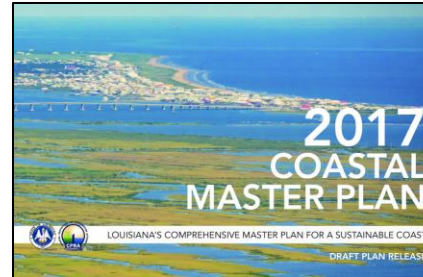
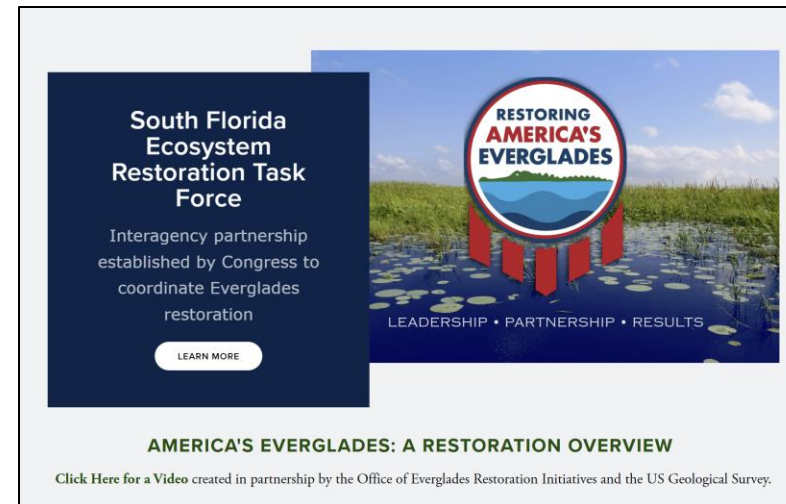
Fitted Response Function



Fitted Response Function

$$HSI_{i,j} = \begin{cases} \sqrt[3]{V_1 \times V_2 \times V_3} \\ \text{Statistical model} \end{cases}$$

Chesapeake Bay is not alone!



Example of Earlier Applications of the General Method

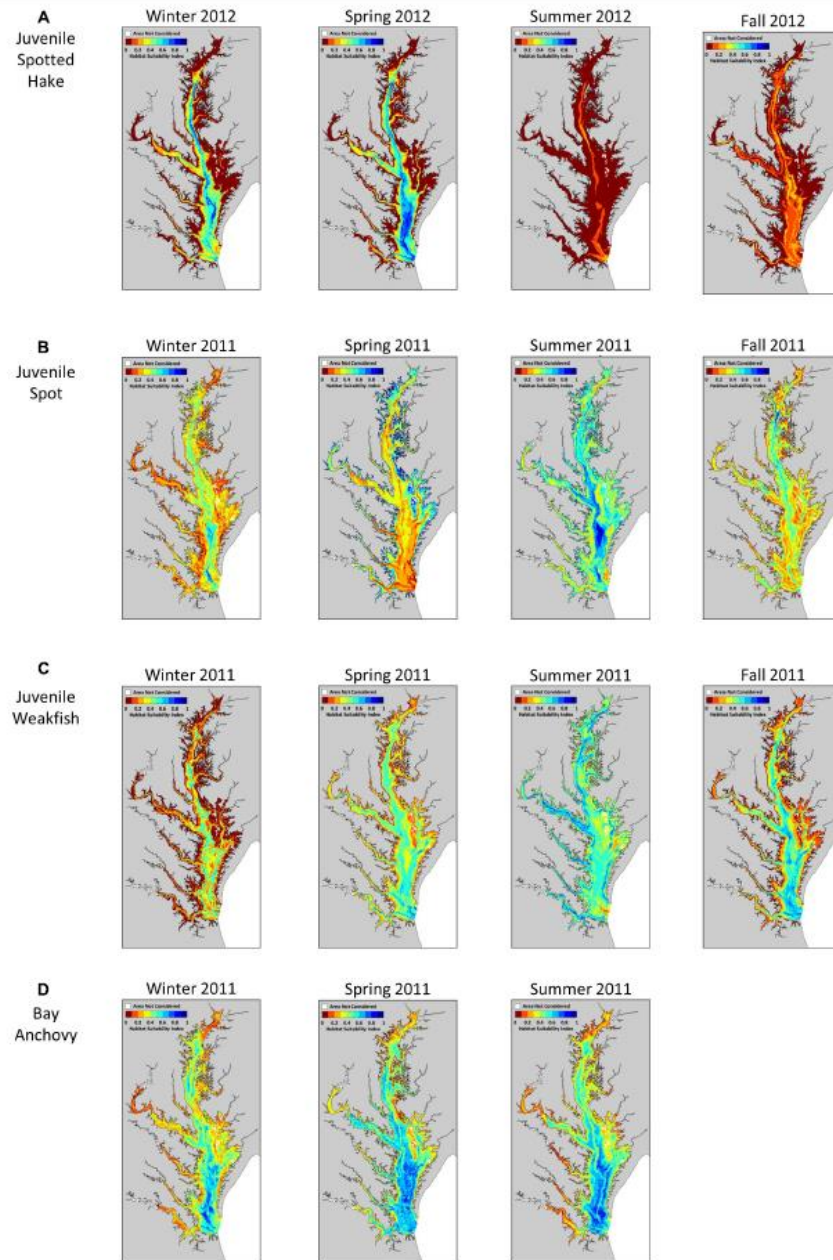
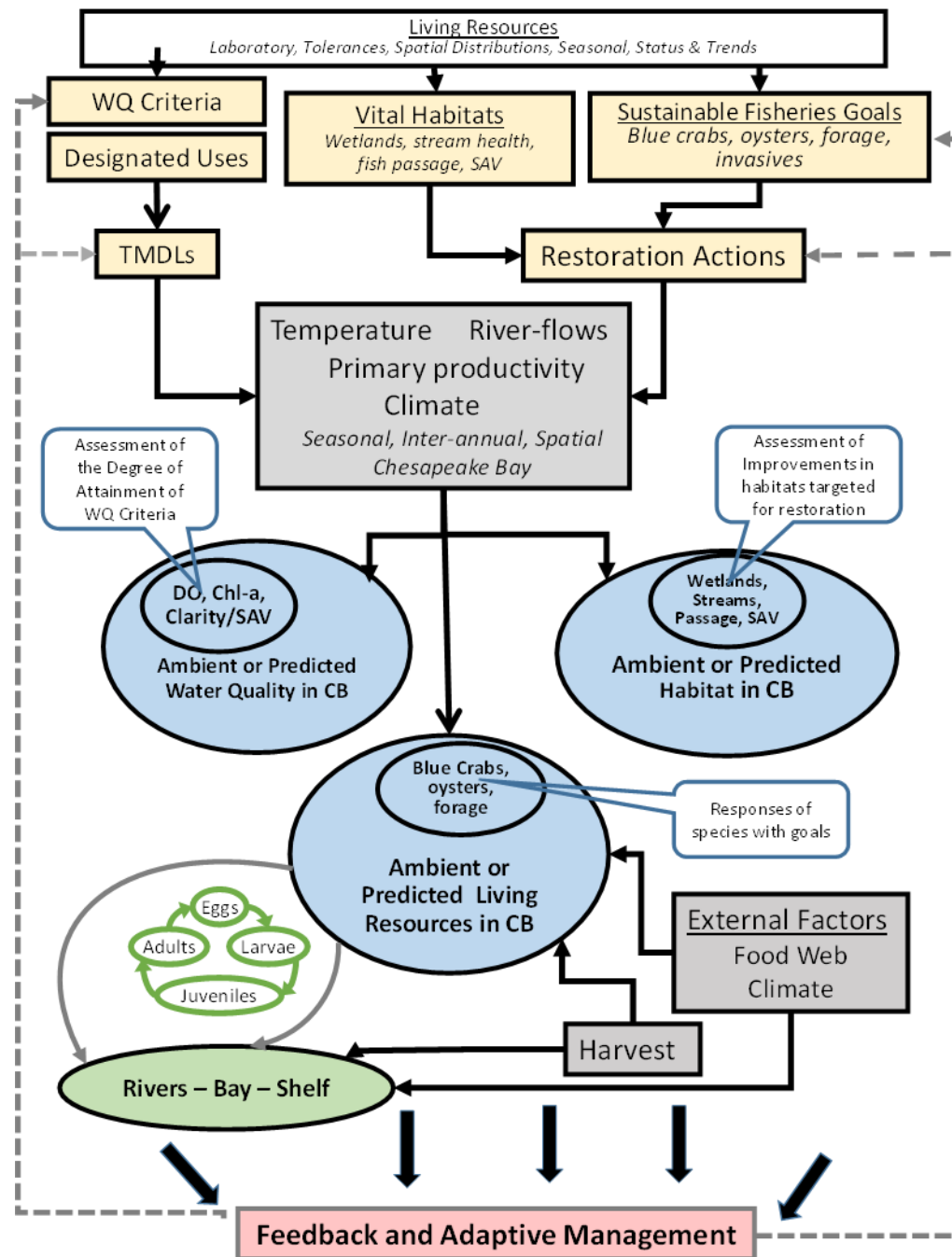
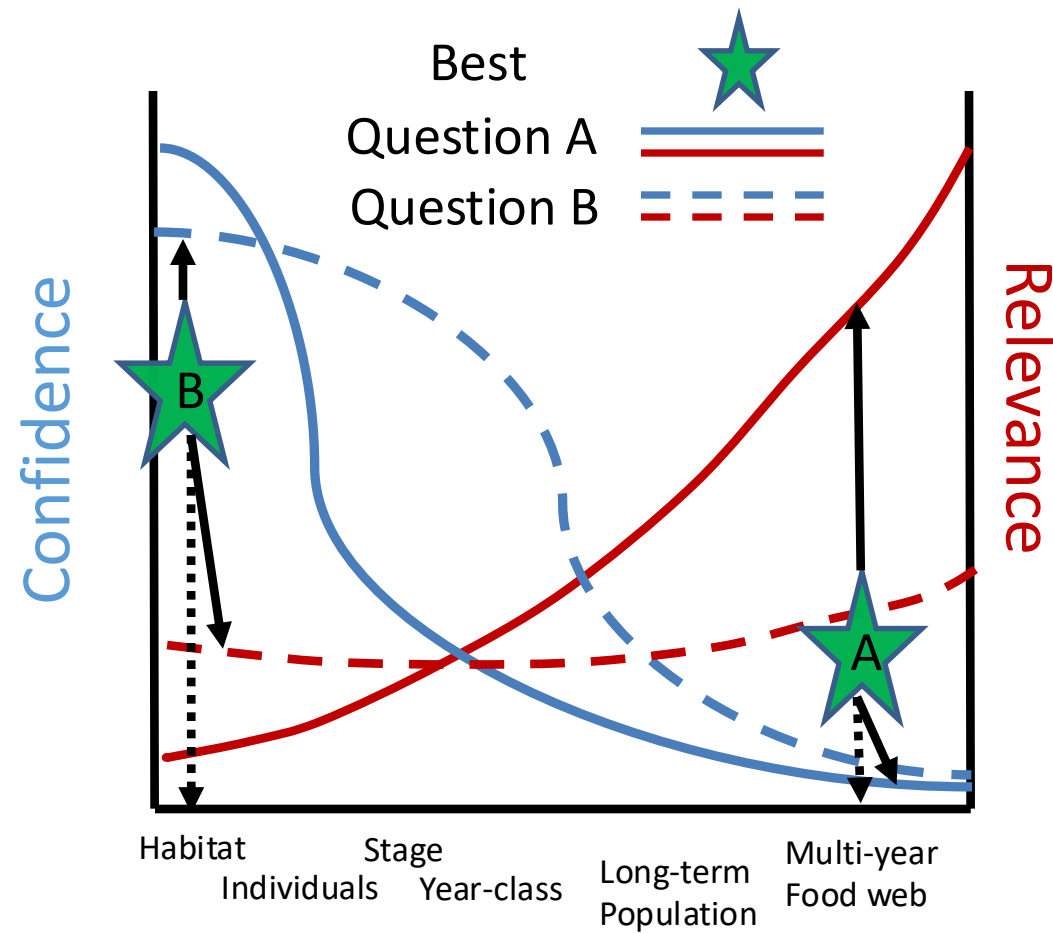


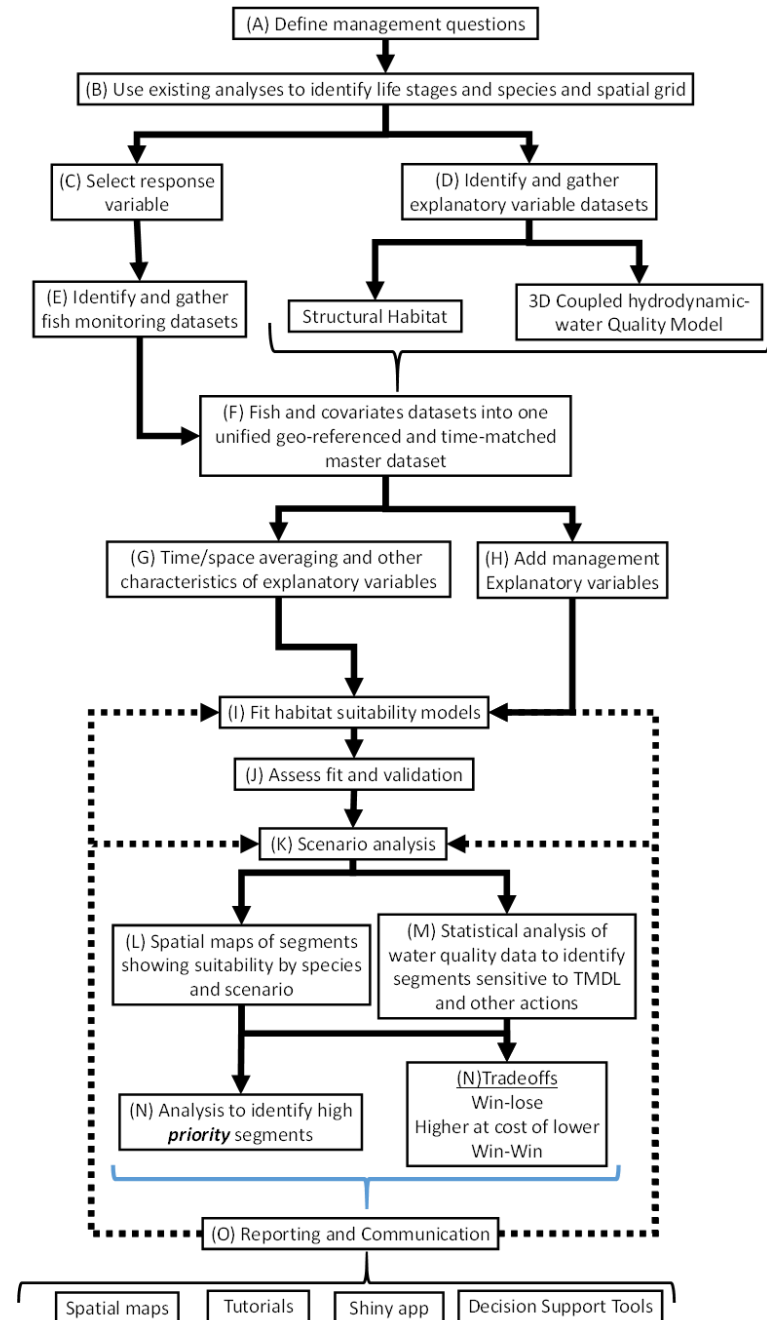
FIGURE 5 | Representative examples of seasonal variation in habitat suitability for (A) juvenile spotted hake, (B) juvenile spot, (C) juvenile weakfish, and (D) bay anchovy in Chesapeake Bay. The habitat suitability index ranges from 0 (red) indicating poor habitat to 1 (blue) indicating most suitable habitat.



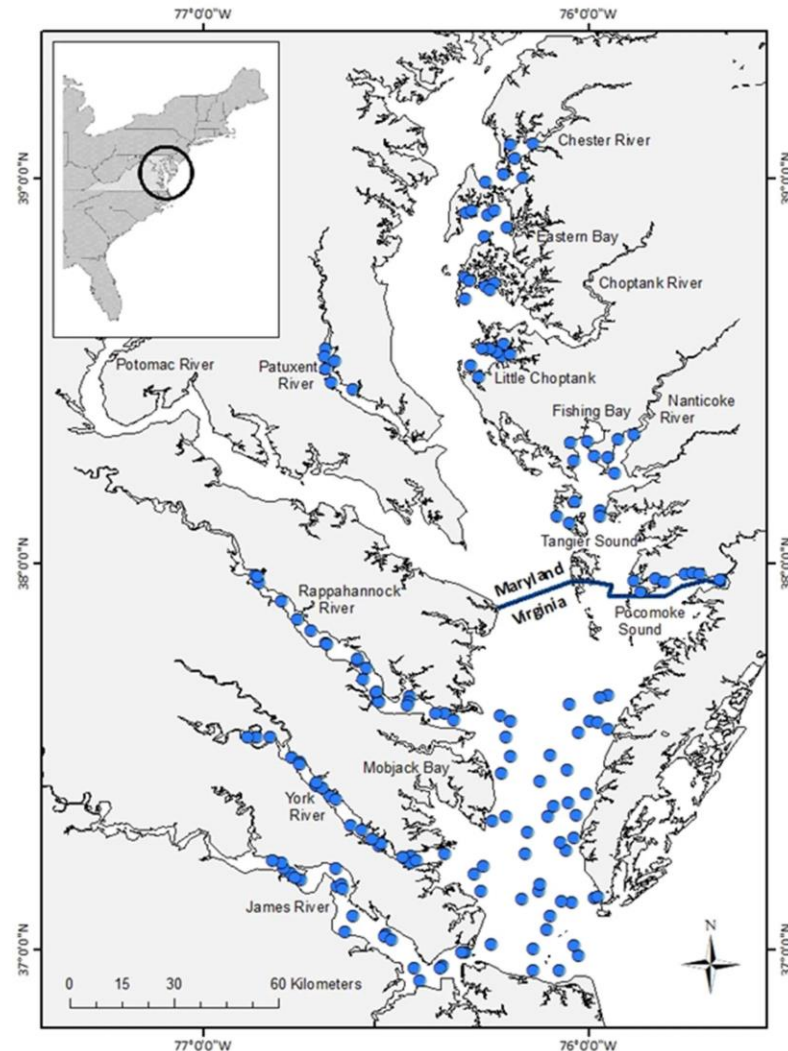


How Did We Select Habitat Suitability?



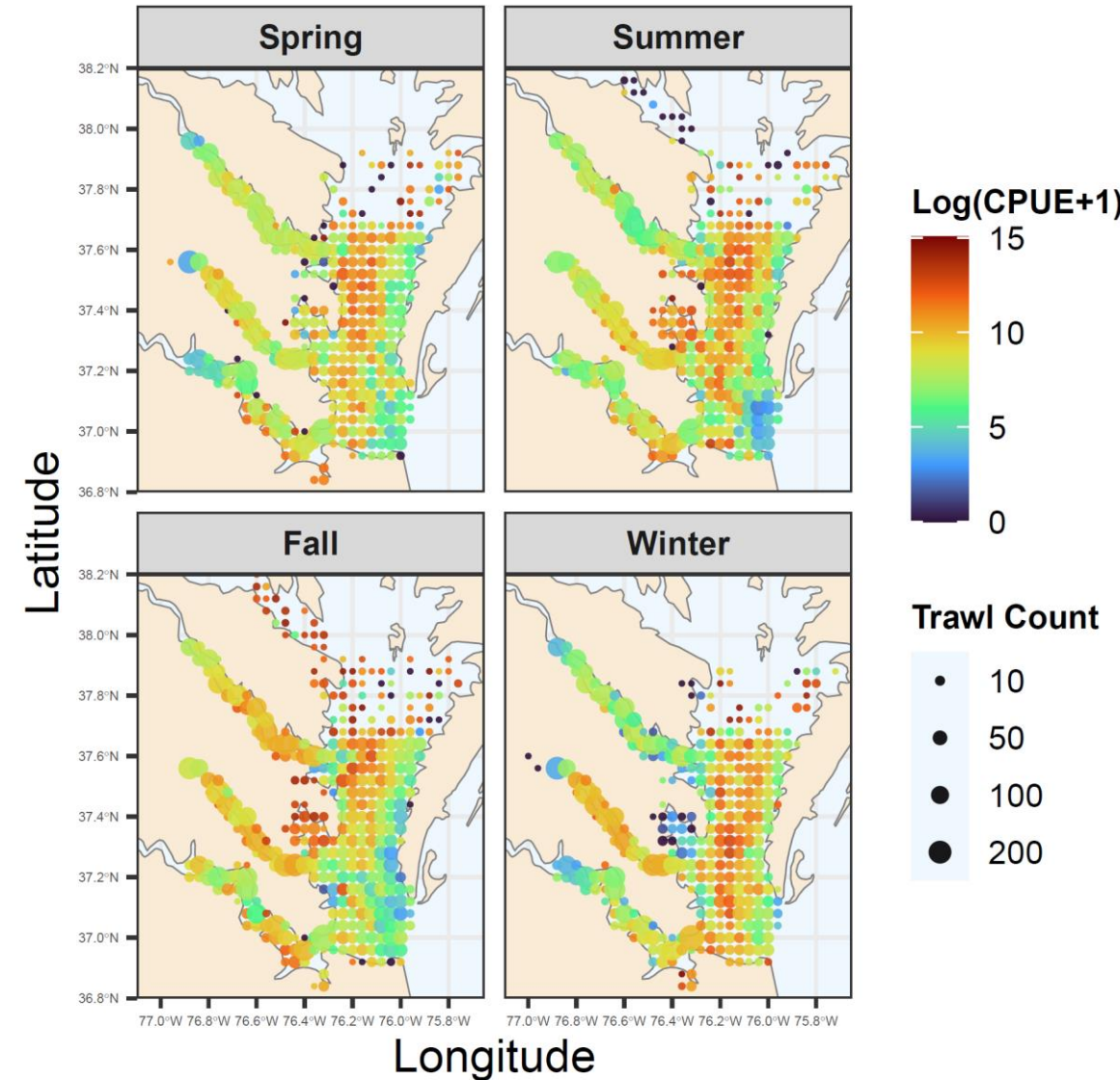


Habitat Suitability Response Variable

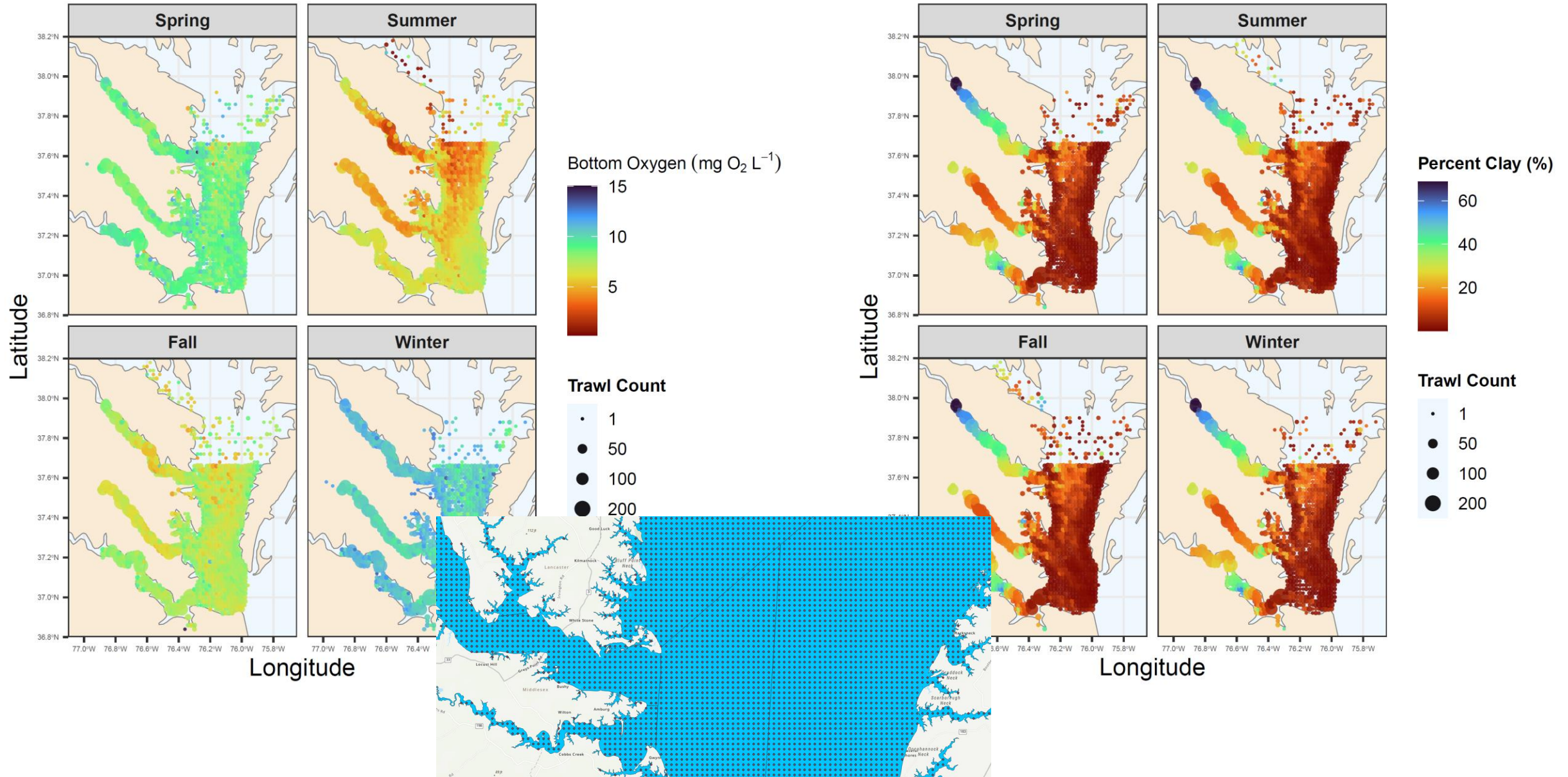


Maryland Department of Natural Resources Blue Crab Summer Trawl Survey
Virginia Institute of Marine Science Juvenile Fish Trawl Survey

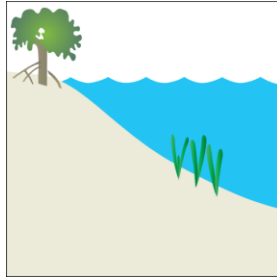
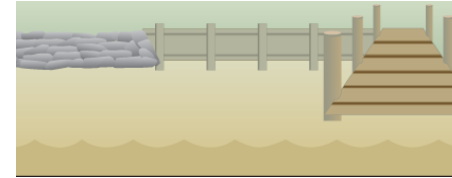
Seasonal Distribution of Bay Anchovy



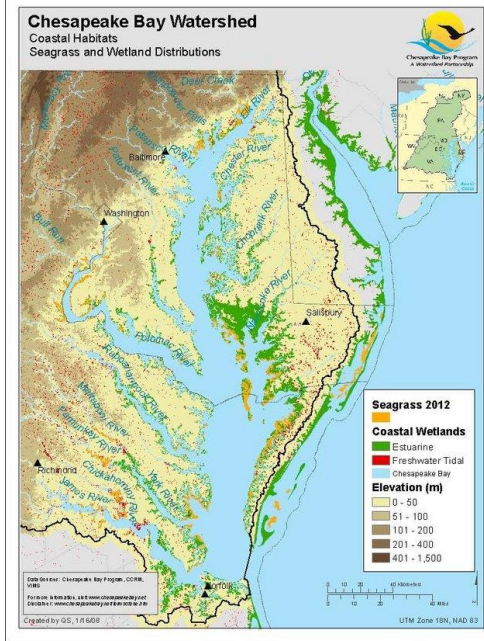
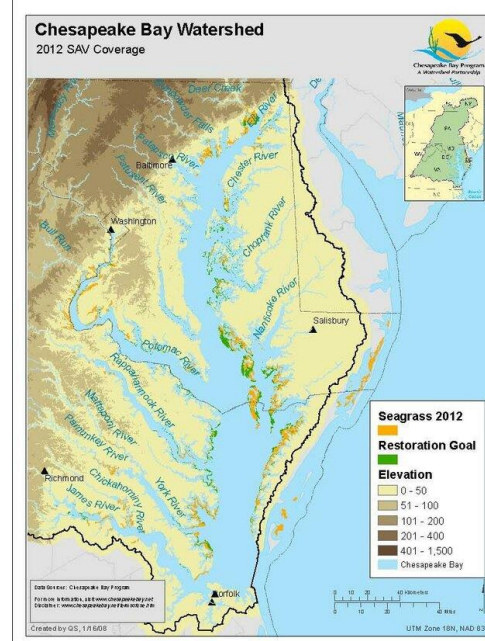
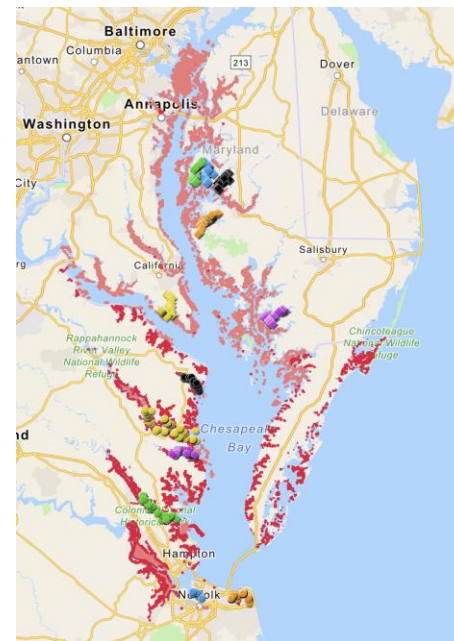
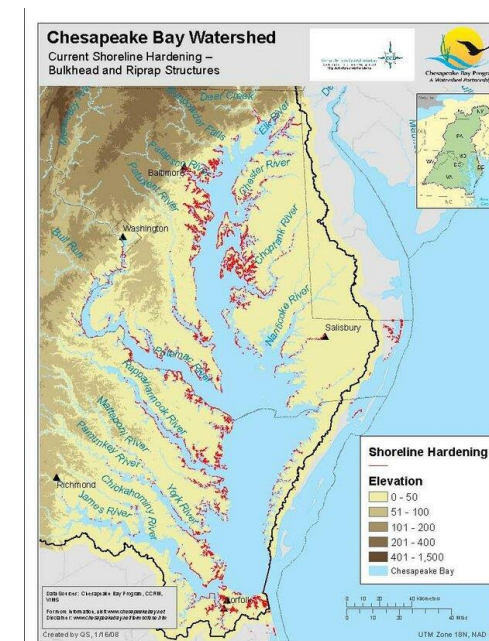
Water Quality Covariates



Structural Habitat Covariates



Shoreline
LULC



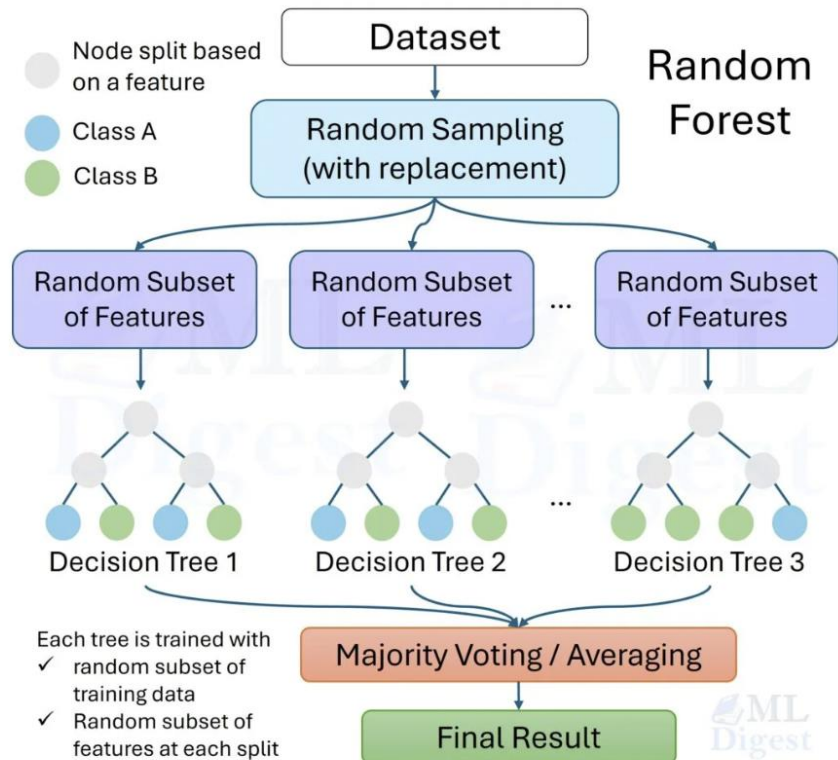
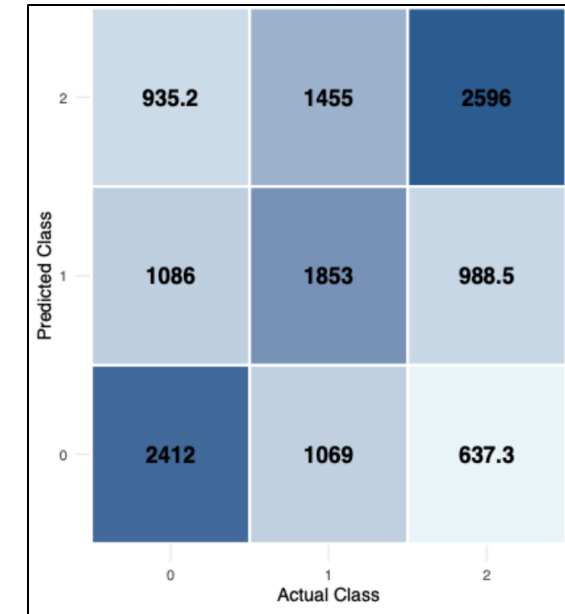
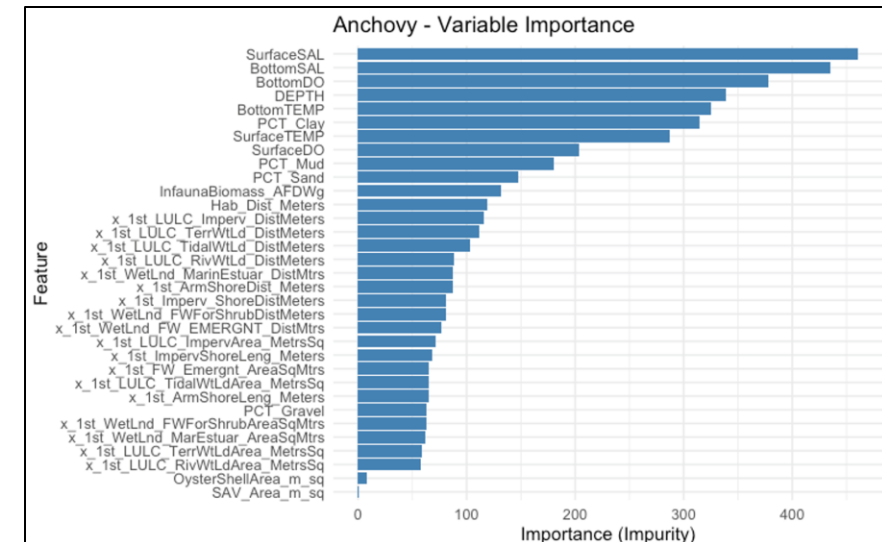
<https://storymaps.arcgis.com/stories/>

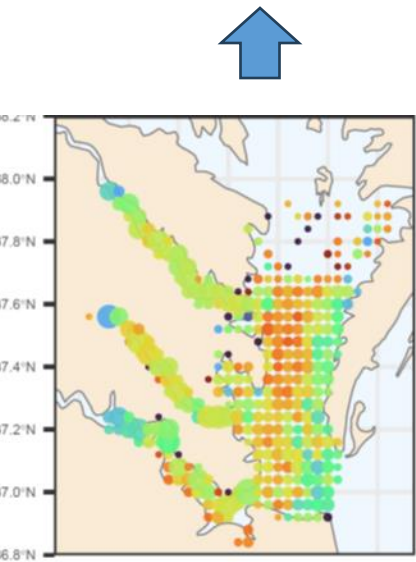
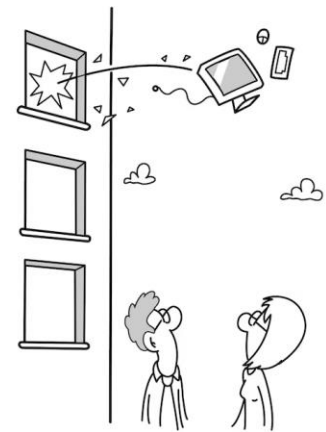
Bilkovic et al. 2014. Designing Sustainable Coastal Habitats. STAC Publ. No. 14-003.

<https://planetarycomputer.microsoft.com/dataset/group/chesapeake-lulc>

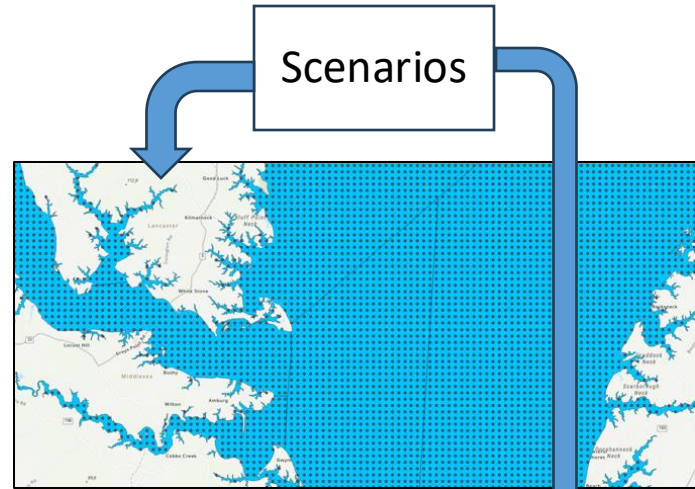
Very Preliminary Results

Class	Bay Anchovy
0	0% - 33% (CPUE <2,765)
1	33% - 66% (CPUE 2,765 – 56,629)
2	66% - 100% (CPUE >56,629)

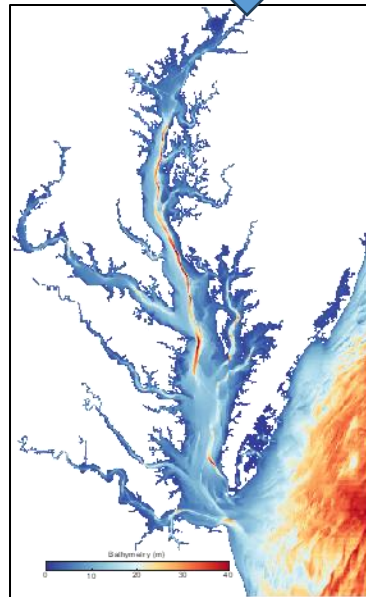




Estimate Covariates Bay-wide

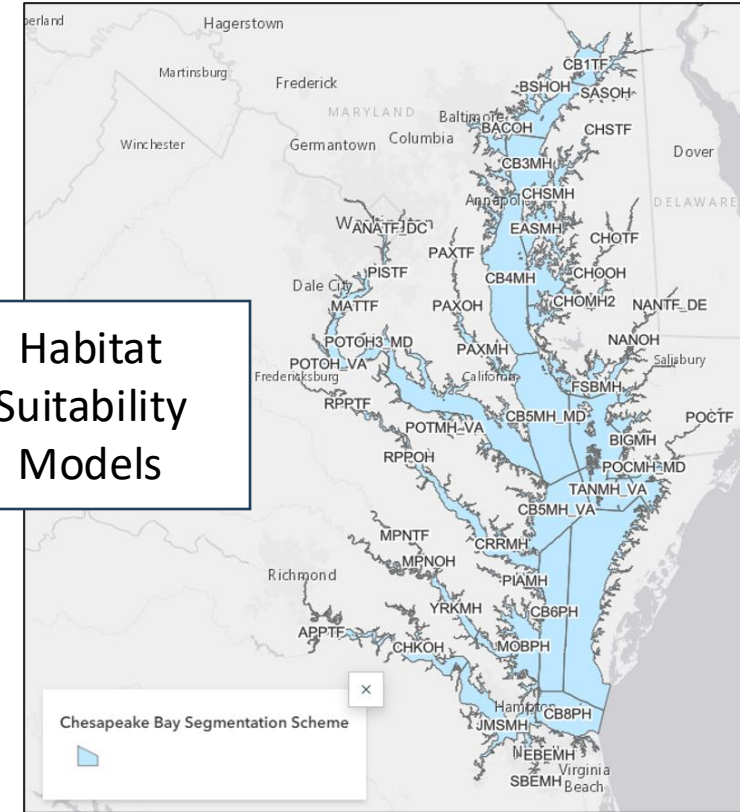


**ROMS
-ECB**

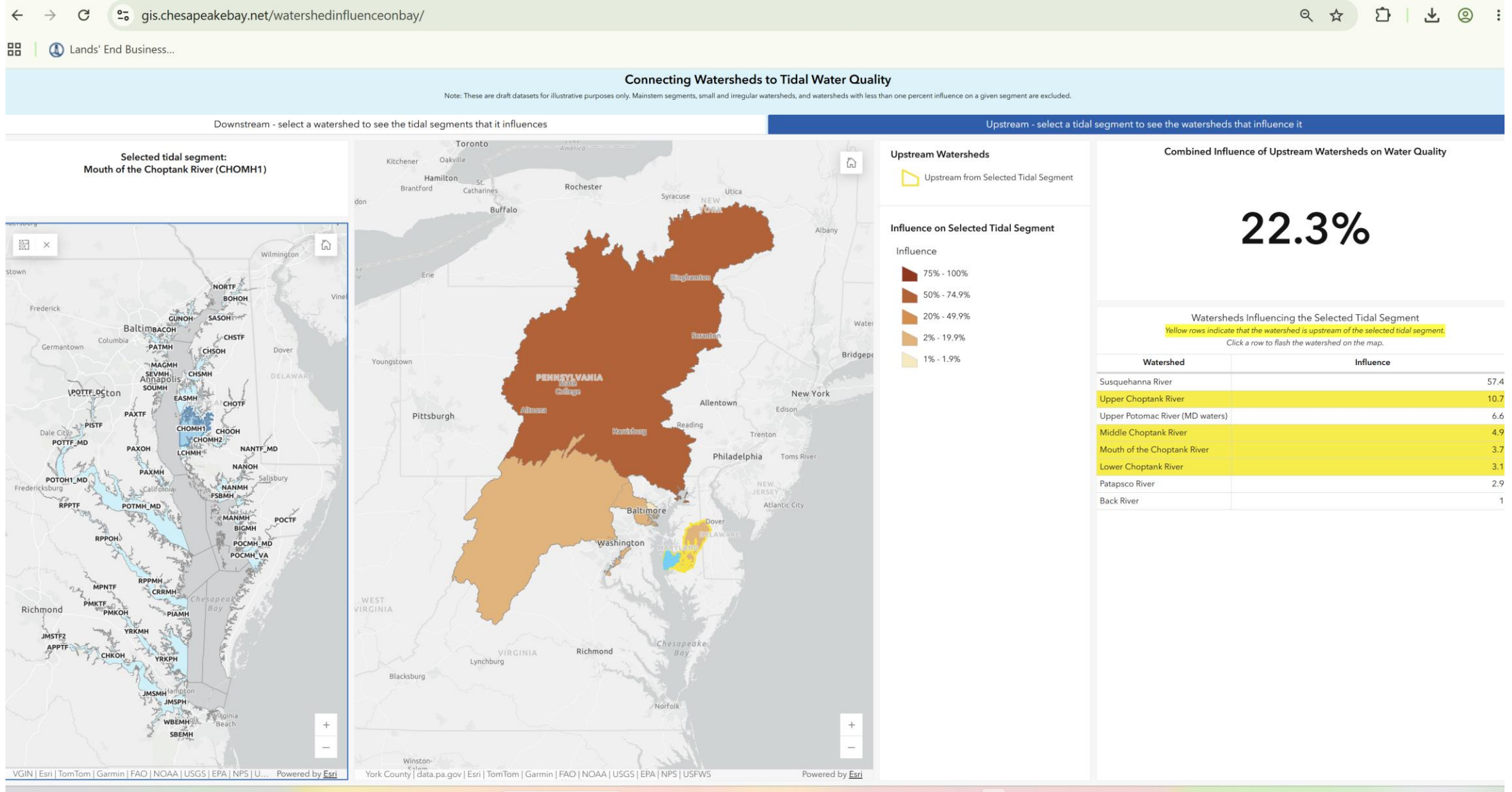


Predictions on Segment-like Scale

**Habitat
Suitability
Models**



Example: Traceback



Product: Handoff

- Method & some results
 - Colin's chapters
 - Colin's papers
- Strengths & weaknesses
- Some guidance
 - Elevating analyses from Demonstration-level
 - Suggestions for next steps (species, data)
 - Interpretation

Conceptual Link to Management

After
upgrades

Sensitivity to Mgt Covariates
 ΔWQ
Structural

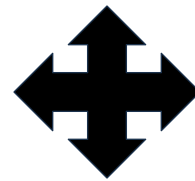
Habitat Suitability
"segment-scale"
Species/Stage/Season

Score spatial areas
Bay-wide

Traceback to WQ
actions in watershed(s)

Evaluate structural
habitat opportunities

Many other factors
and information



Next Steps

- Ready to get much needed input and critique
- Back-up plan(s)
- Demonstration
 - Illustrates the methodology
 - Someone else will need to upgrade the data used and maybe the analysis
 - May be possible to inform management
 - Pilot Study is a higher bar
- Reminders
 - Unfunded
 - 1-2 chapters in a student's dissertation

