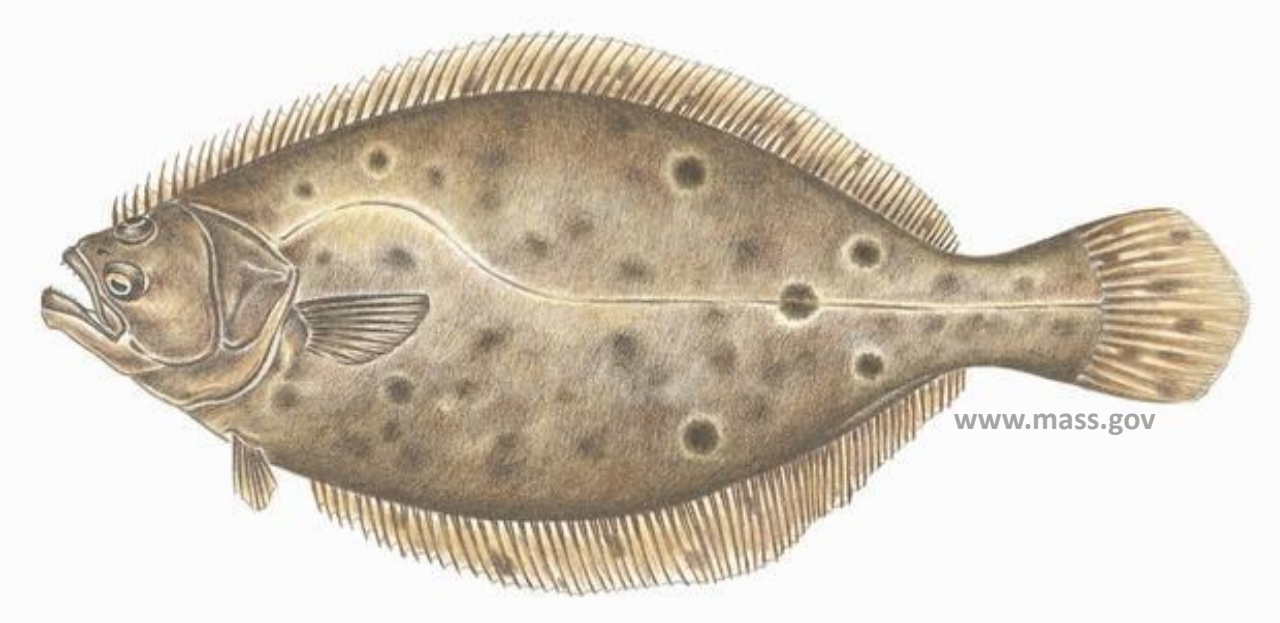
Summer Flounder Habitat Suitability in Chesapeake Bay & the Impacts of Hypoxia



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VIMS Department of Fisheries Science

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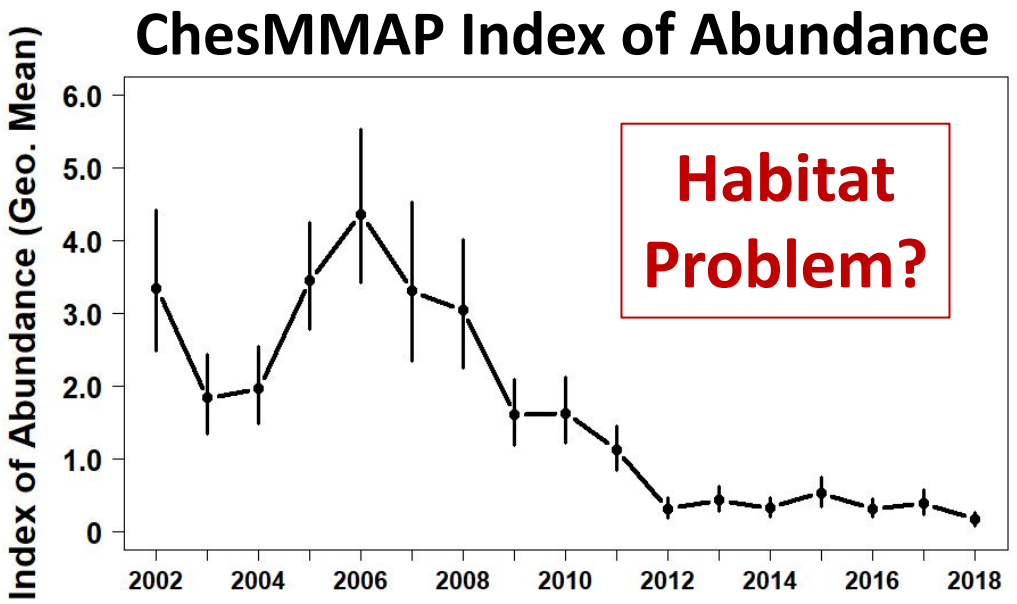
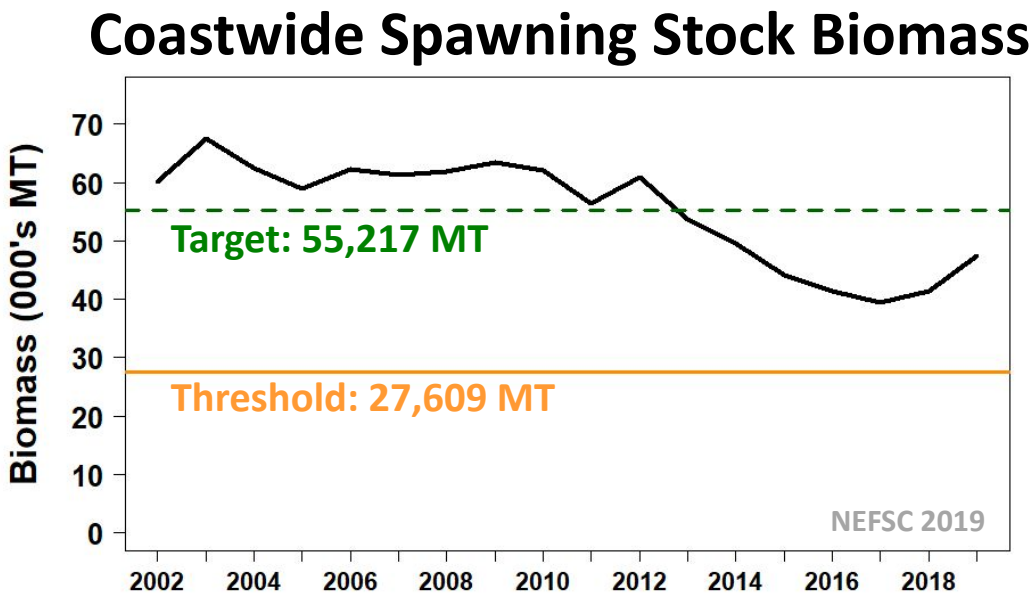
Summer Flounder in Chesapeake Bay

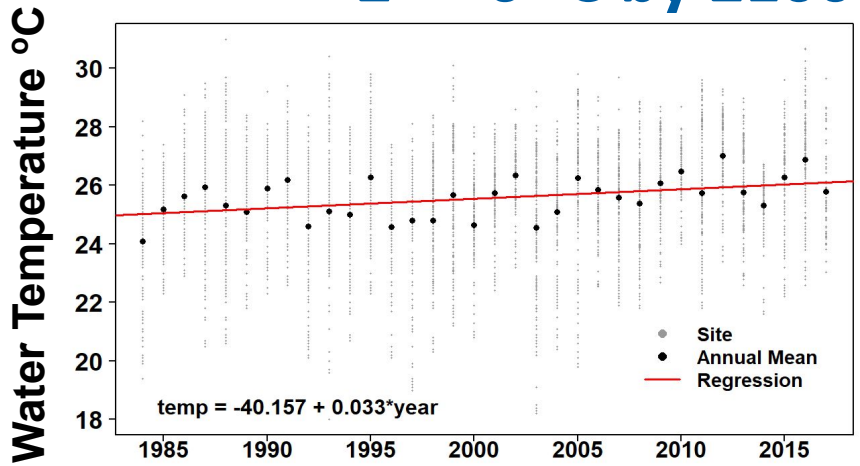
- Seasonal Residents: late spring – fall
- HAPC: foraging, refuge, & nursery habitat
- Historically supported valuable commercial & recreational fisheries



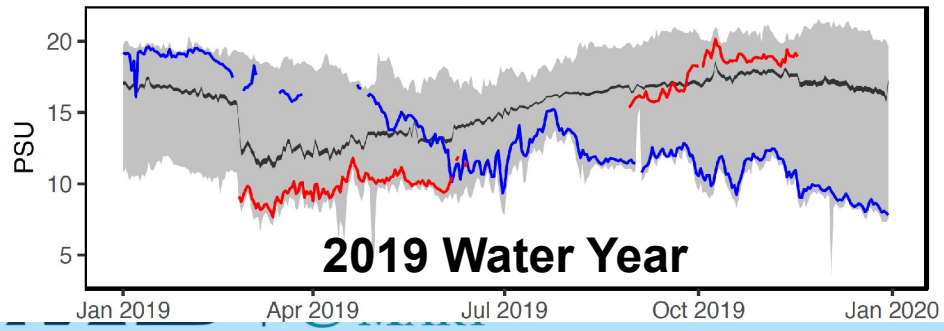


A Changing Bay…

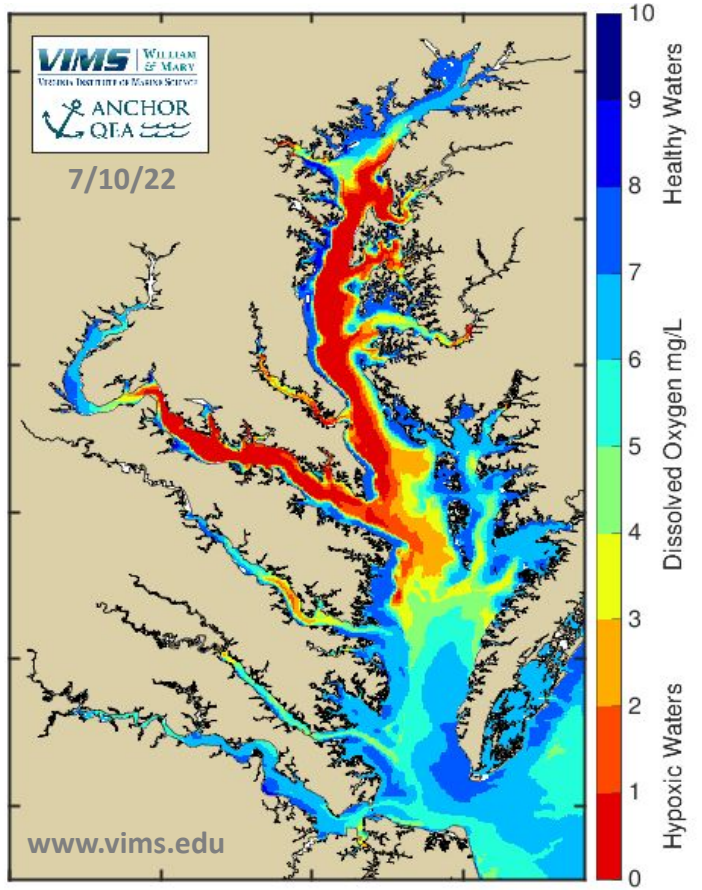
- **Water Temp**: expected increase of 2° – 6° C by 2100



- **Salinity**: storm frequency & intensity likely to increase



- **Dissolved Oxygen**: increase in severity & extent of *hypoxia*



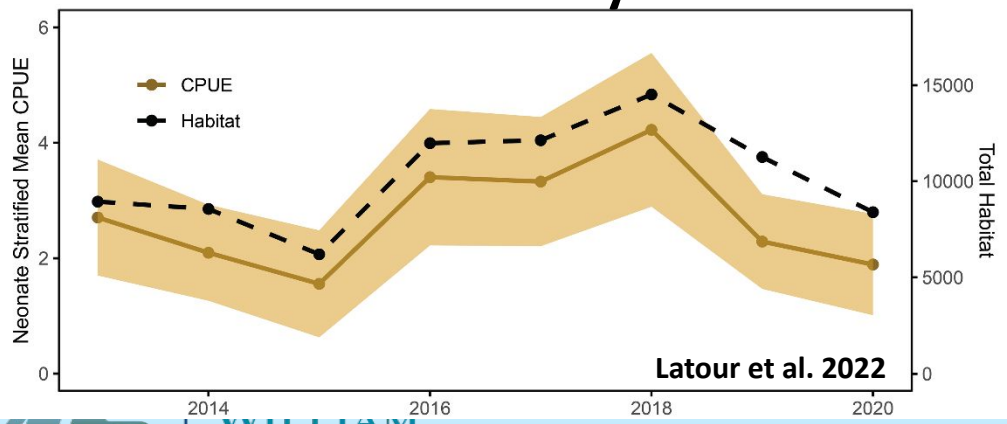
Evaluating Habitat Suitability

Combine Ecological Niche Model (ENM) & Regional Ocean Modelling System (ROMS)

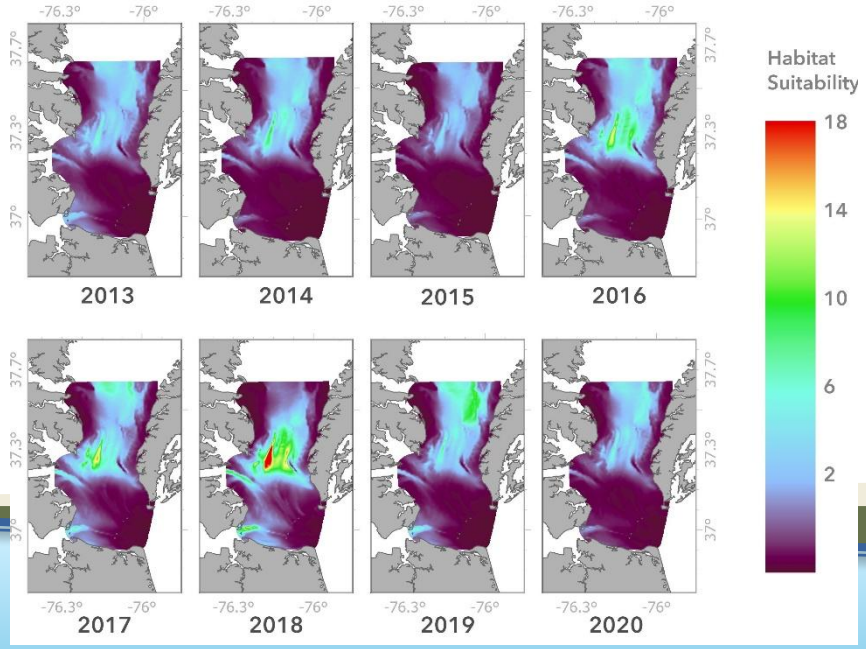
- **Generate habitat suitability index (HSI) time-series (ecosystem indicator)**
- **Evaluate spatial patterns (expected 'prime' locations)**
- **Quantify influence of environmental phenomena (e.g., hypoxia)**

Example: Neonate sandbar shark in Ches. Bay

Habitat Suitability Index



Spatial Distribution of Suitable Habitat



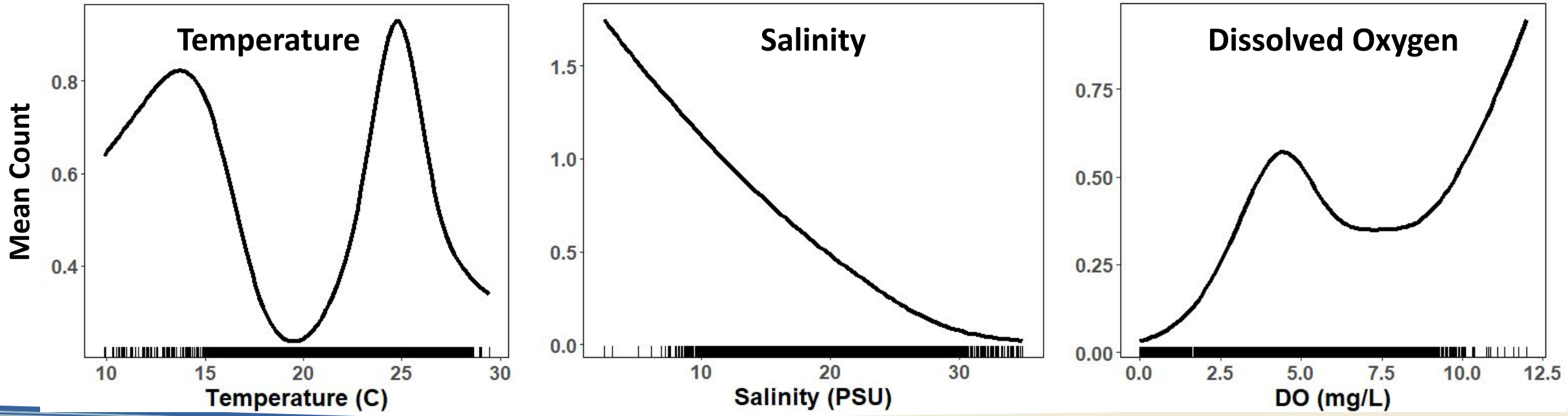
Objectives

I. Develop an Annual Habitat Suitability Index (HSI) for summer flounder in Chesapeake Bay by coupling a bay-specific ENM for this species with a ROMS model of hydrographic conditions.

II. Evaluate the influence of the summer hypoxic zone in the mainstem of the bay on suitable habitat for summer flounder in this estuary.

Summer Flounder ENM

- Previously developed by VIMS, funded by NCBO
- Based on SF CPUE & hydrographic data from ChesMMAP; 2008 – 2018
- Negative binomial GAMM w/spatial autocorrel. in sdmTMB
- *Mean Count (CPUE) as a proxy for habitat suitability*



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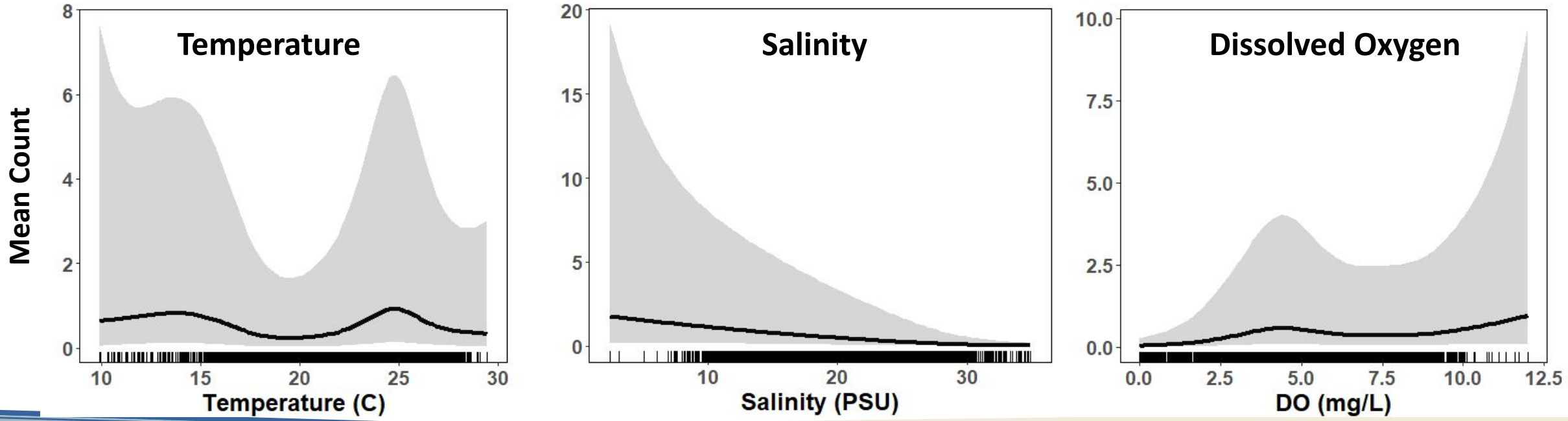
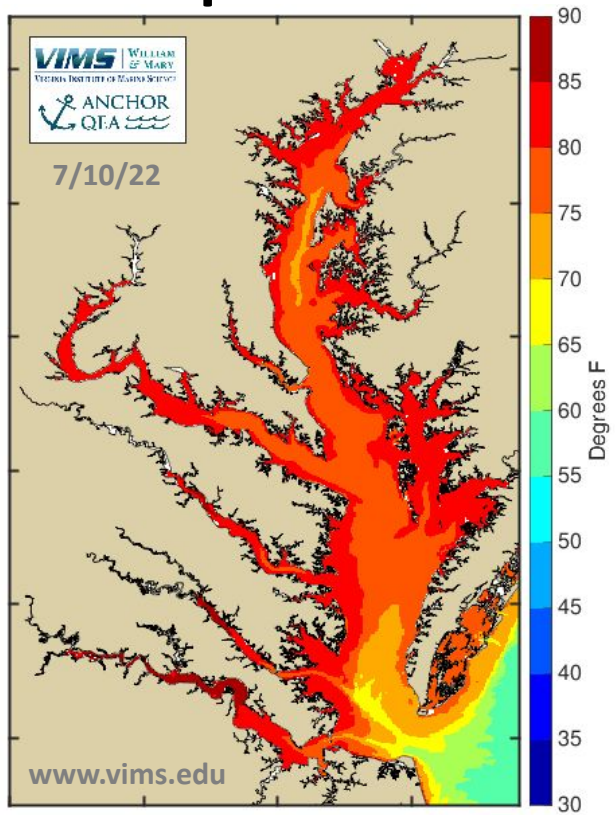


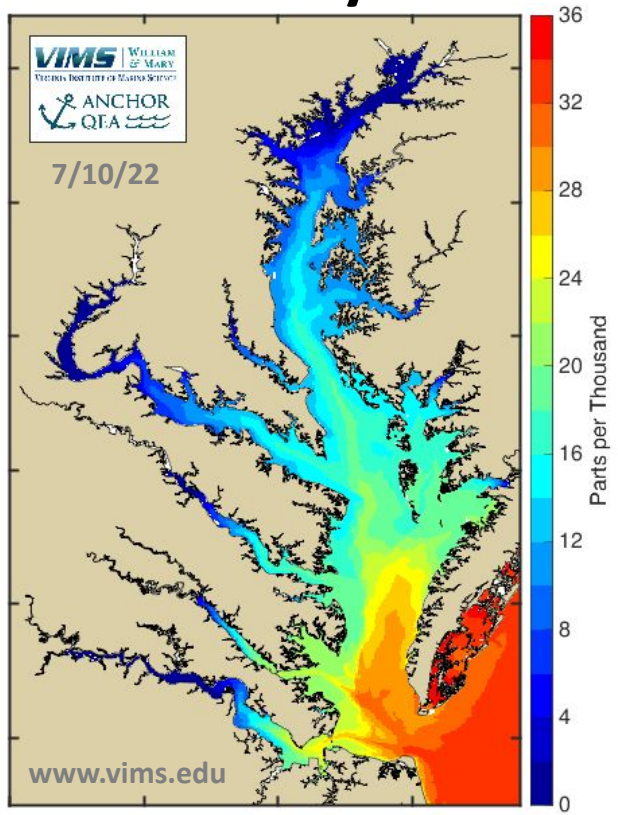
Chesapeake Bay ROMS (*Ches*ROMS)

- Estuarine-Carbon-Biogeochem (ECB) model w/20 vertical layers
- Hindcast bottom WT, SA, DO at 600 m resolution in ChesMMAP Frame
- Daily Values: Mar 1 – Nov 30, 2002 – 2018

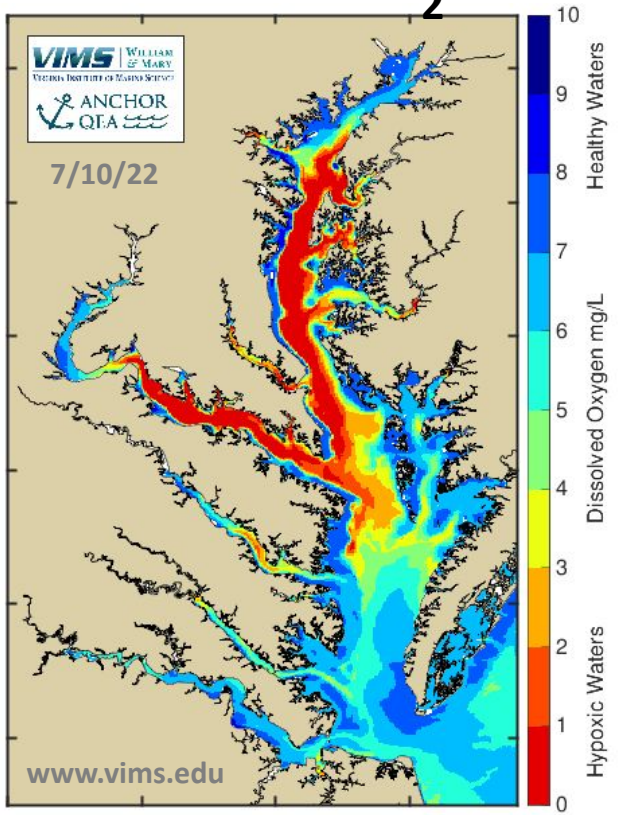
Temperature



Salinity



Dissolved O_2



VIRGINIA

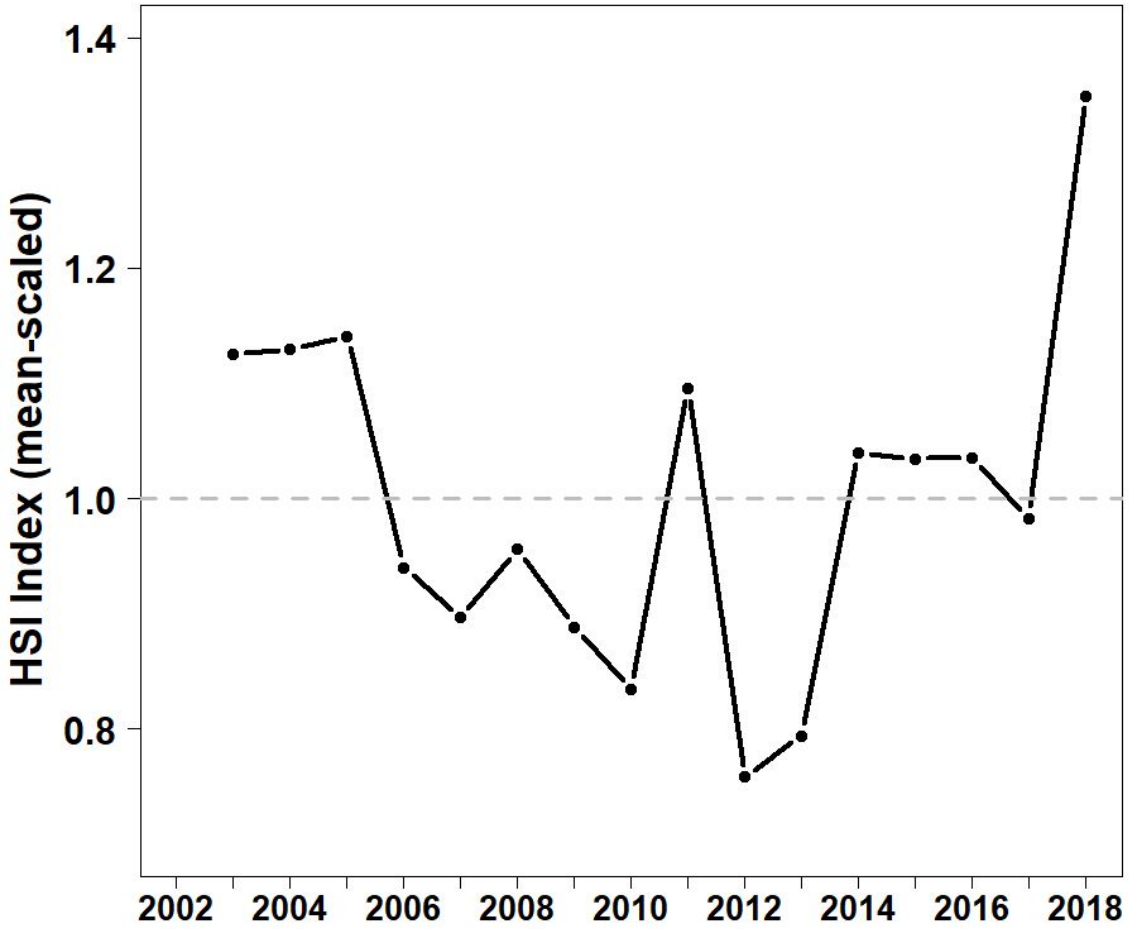
Methods

Objective 1: Develop summer flounder annual HSI for Chesapeake Bay

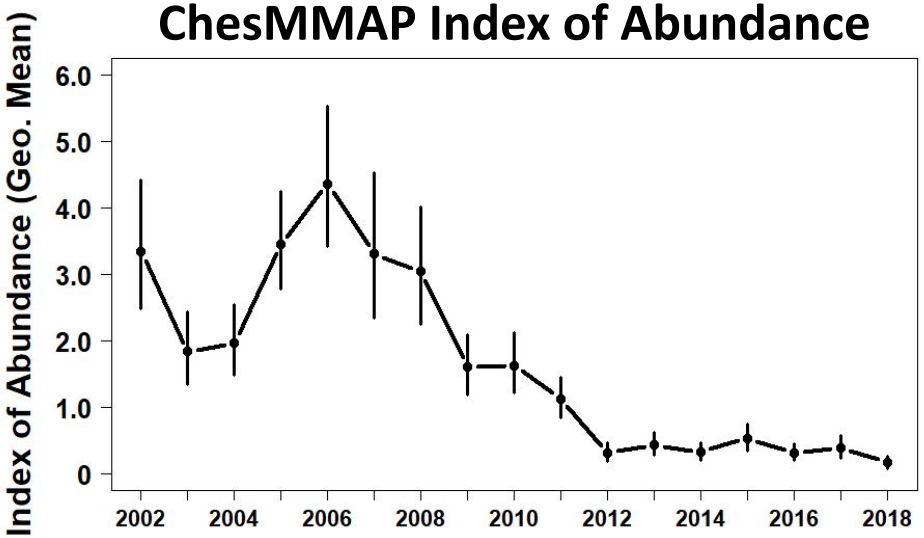
- Couple summer flounder ENM & *Ches*ROMS hindcasts
- Predict summer flounder count at each grid cell daily for May, Jul, Sep, 2002 – 2018
  - Recall: *Predicted count as a proxy for habitat suitability*
- Calculate mean count/cell across days for each month within each year
- Annual index = sum of all mean cell counts throughout bay & across months

Summer Flounder HSI in Chesapeake Bay

Summer Flounder Habitat Suitability Index (HSI)



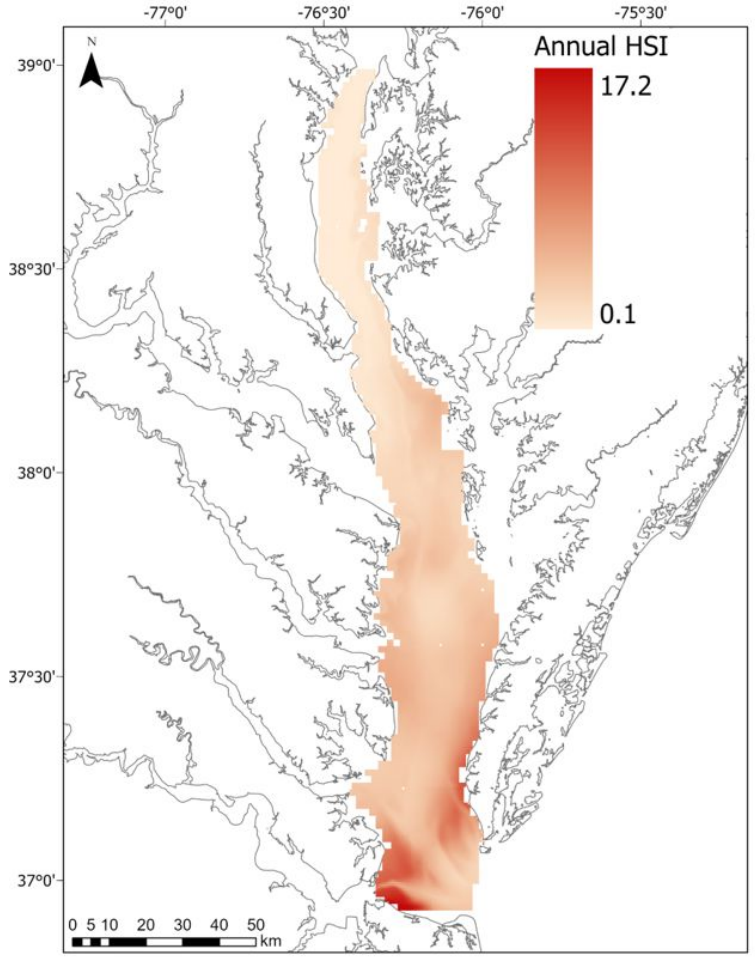
ChesMMAP Index of Abundance



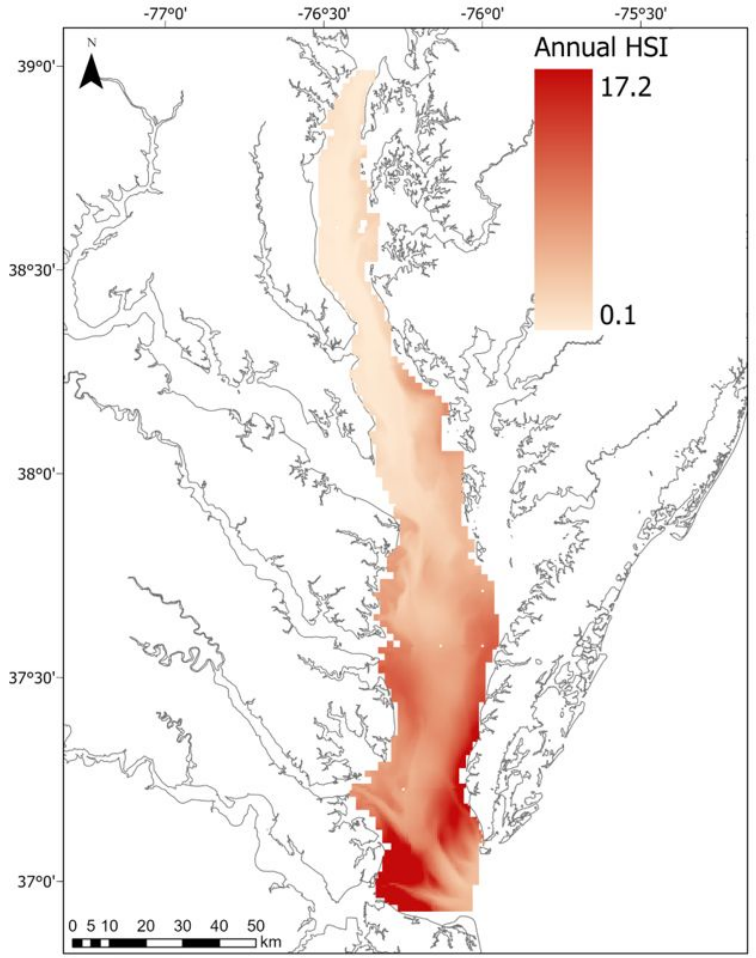
** Trends in quantity of suitable habitat (~ btm WT, SA, DO) ***do not*** appear to reflect trends in relative abundance

Spatial Distribution of Suitable Habitat

2012 (lowest HSI)



2018 (highest HSI)

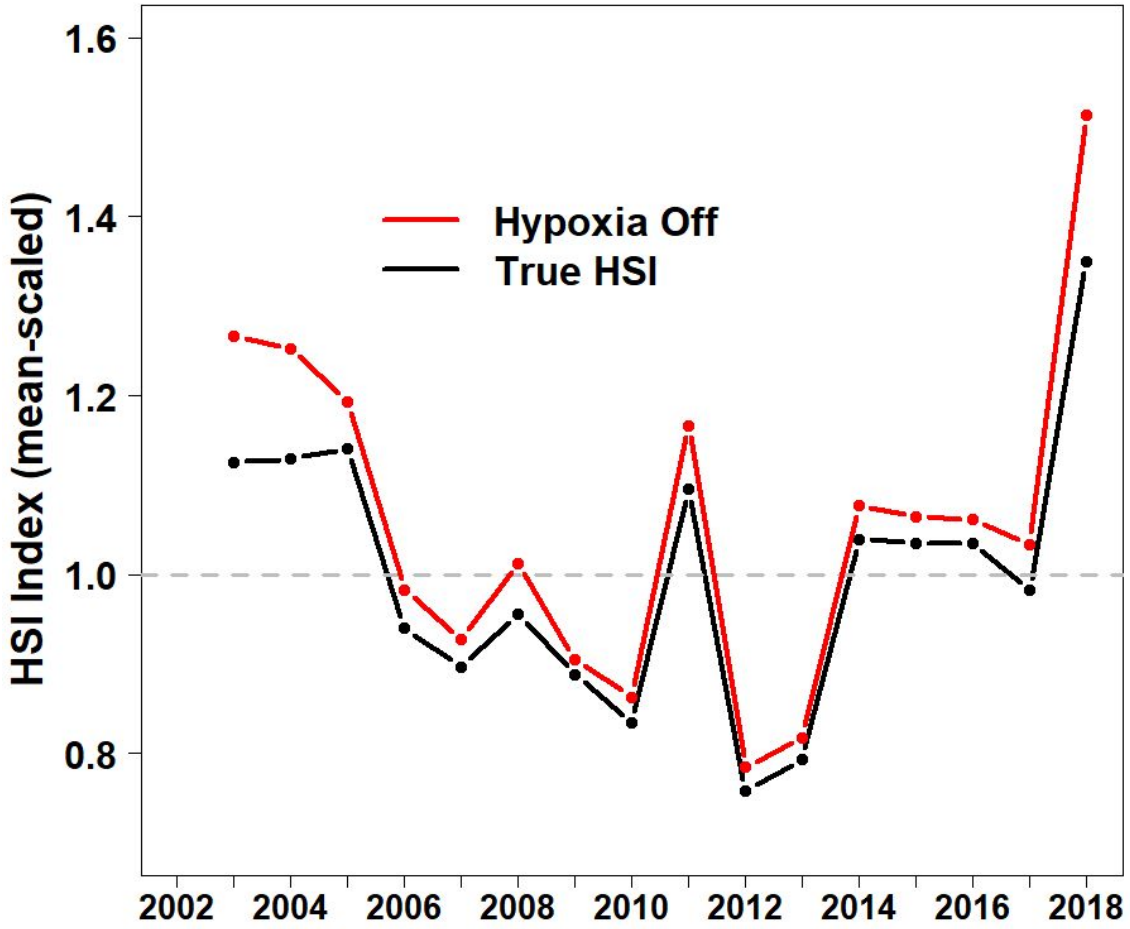


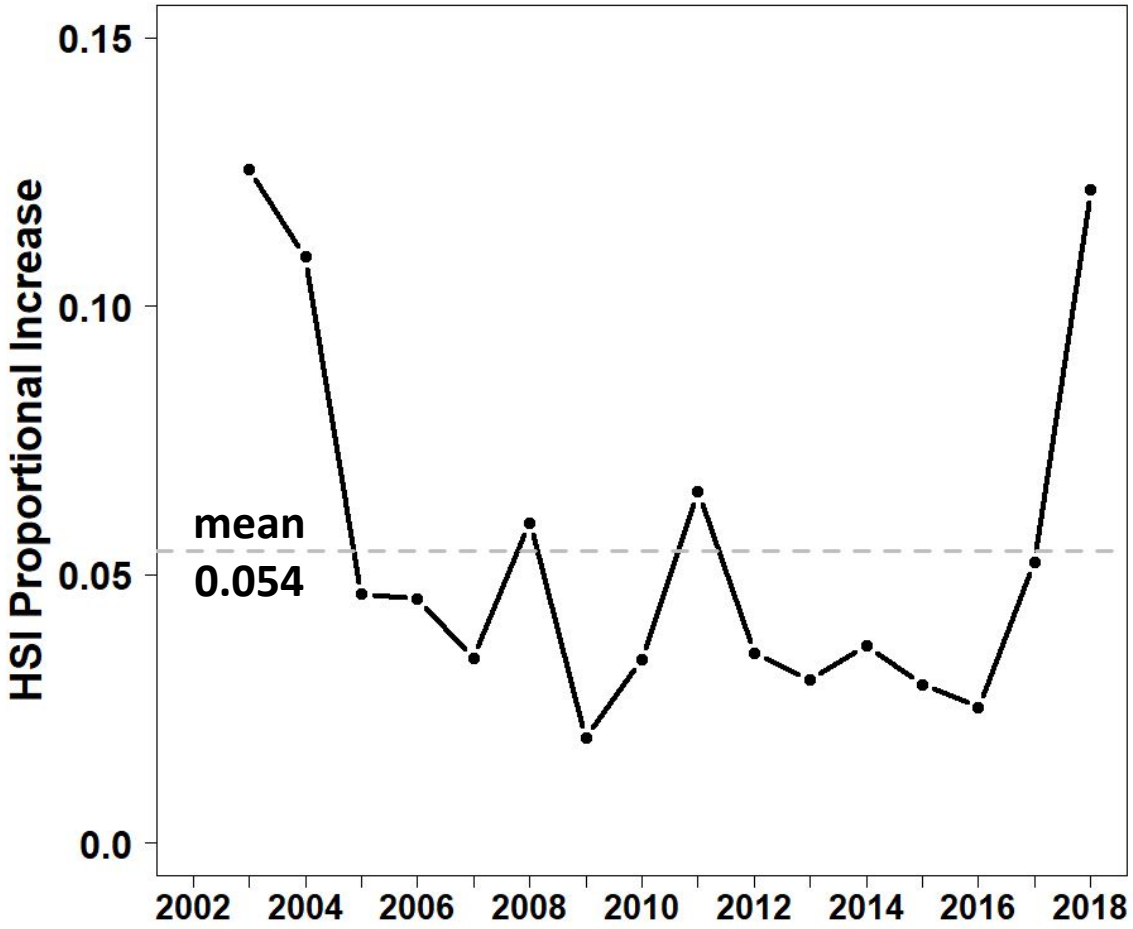
Methods

Objective 2: Evaluate influence of hypoxia on HSI

- "Turn off" hypoxia
  - *Ches*ROMS cells where DO ≤ 2.5 mg L^{-1} changed to 4.7 mg L^{-1} (*subjective* - peak of Count ~ DO curve)
- Repeat calculation of annual HSI
  - Couple ENM & *Ches*ROMS "hypoxia off" data
  - Calculate mean count/cell across days by month & year
- Compare with "true" annual HSI

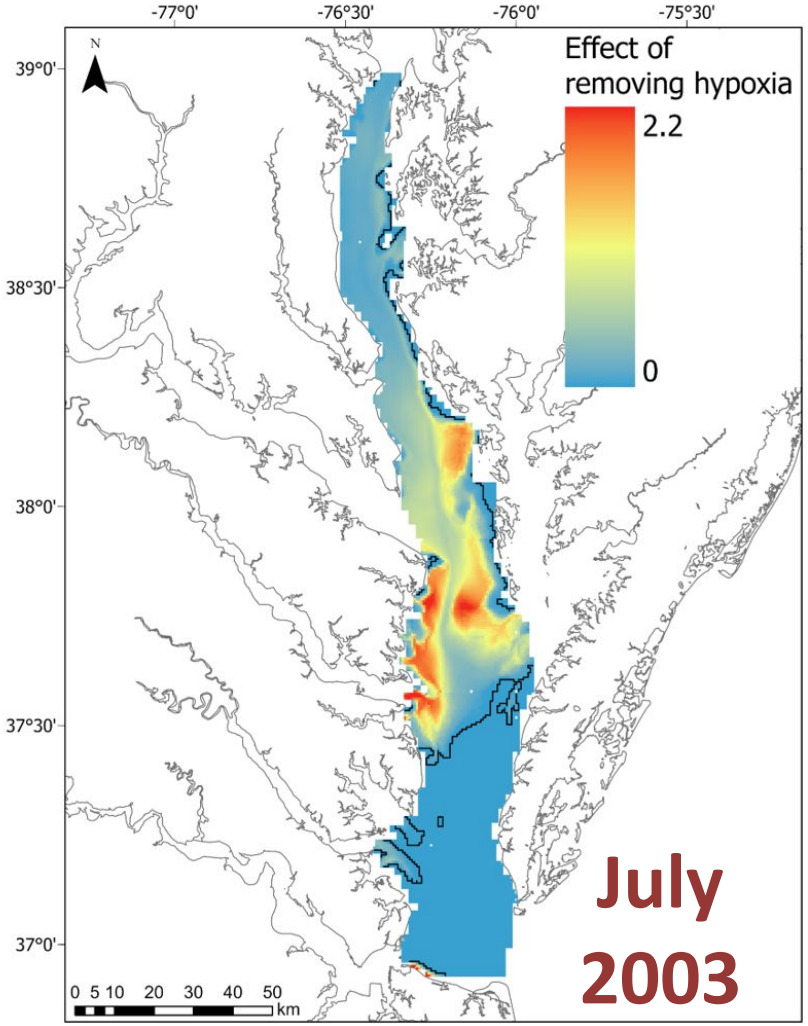
Influence of Hypoxia on HSI



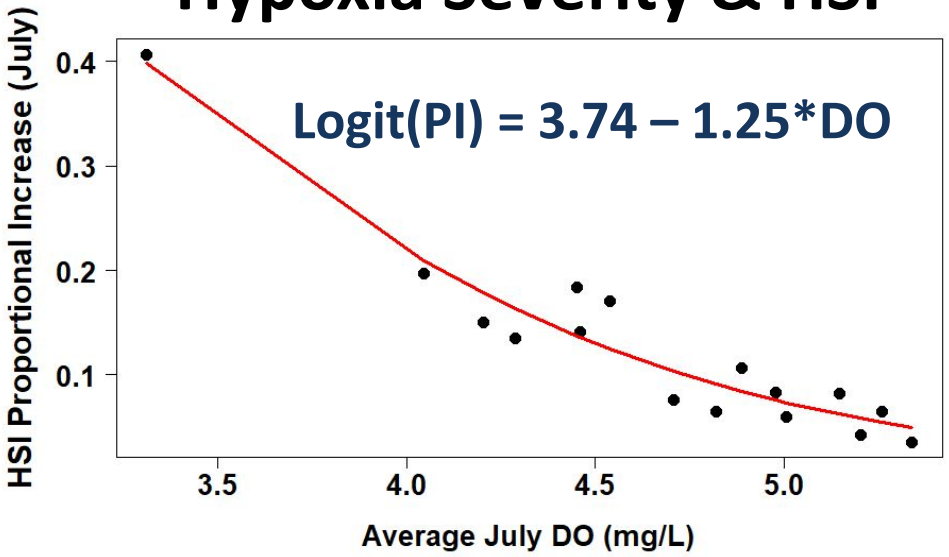


Focus on July

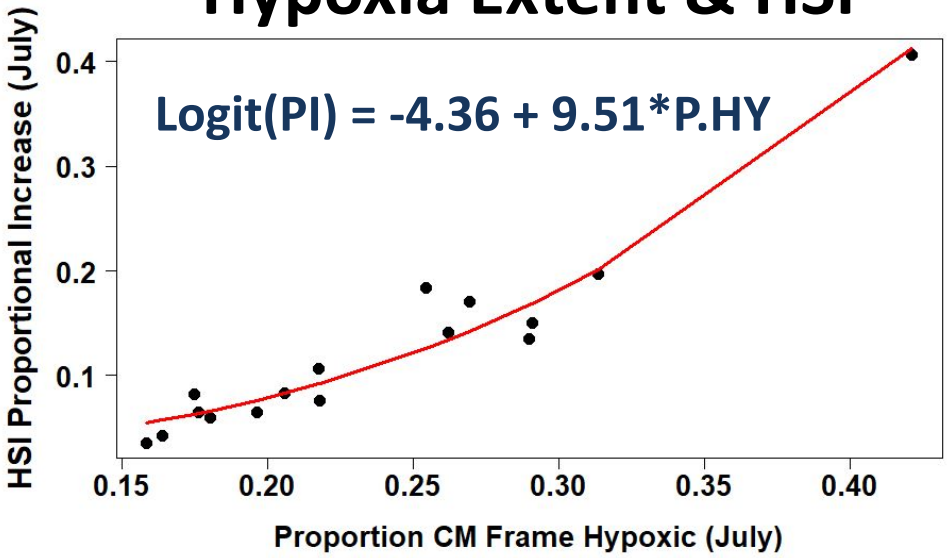
Distribution of Increased Suitability



Hypoxia Severity & HSI



Hypoxia Extent & HSI



Conclusions & Future Directions

Objective 1: Develop summer flounder annual HSI for Chesapeake Bay

- Declines in relative abundance *do not* appear to be related to habitat as measured by bottom temperature, salinity & dissolved oxygen
- Propagate uncertainty from ENM for
- Provide to Mid-Atlantic SOE & Risk
- Apply methods to additional species

Conclusions & Future Directions

***Objective 2*: Evaluate influence of hypoxia on HSI**

- **Hypoxia impacts summer flounder suitable habitat in Chesapeake Bay**
  - **Consider more objective approach to "turn-off" hypoxia**
  - **Refine analysis of relationship between severity & extent of hypoxia and change in suitable habitat**
  - **Evaluate "edge-effects": possible aggregation at the boundaries of hypoxic zones (e.g., Craig 2012 in GOM)**

Thank You