Using Chesapeake Bay Program Model Scenarios to Predict Restoration Impacts on *Vibrio vulnificus*

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STAC Panel, March 15, 2023

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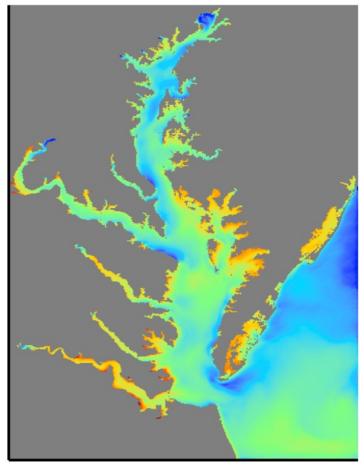
HORN POINT LABORATORY

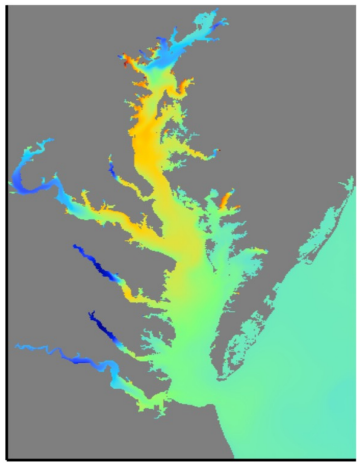
Ecological Forecasts of Sea Nettles, Pathogens and HABs

Existing model forecasts using a mechanistic model (ChesROMS-ECB)



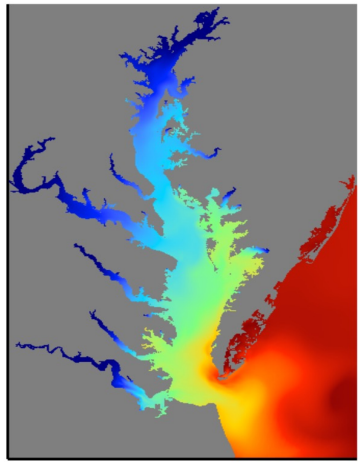
Temperature (°C)

25
20
15



pH

10
9
8
7



30
20
10
0

Salinity (ppt)

www.vims.edu/cbefs

Long-term in situ observations

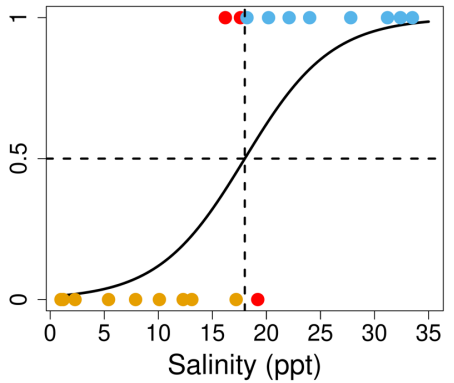
Chesapeake Bay Program
Science. Restoration. Partnership.

Train model using observation

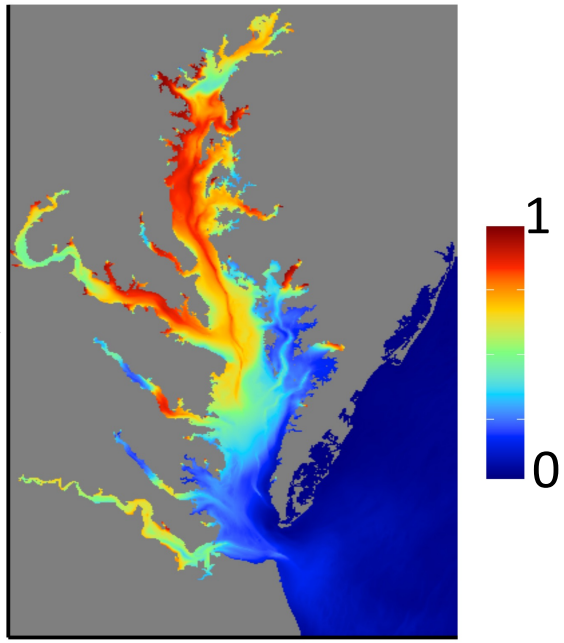
in

Empirical habitat model

out



Forecast probability of Sea Nettles, Pathogens and HABS

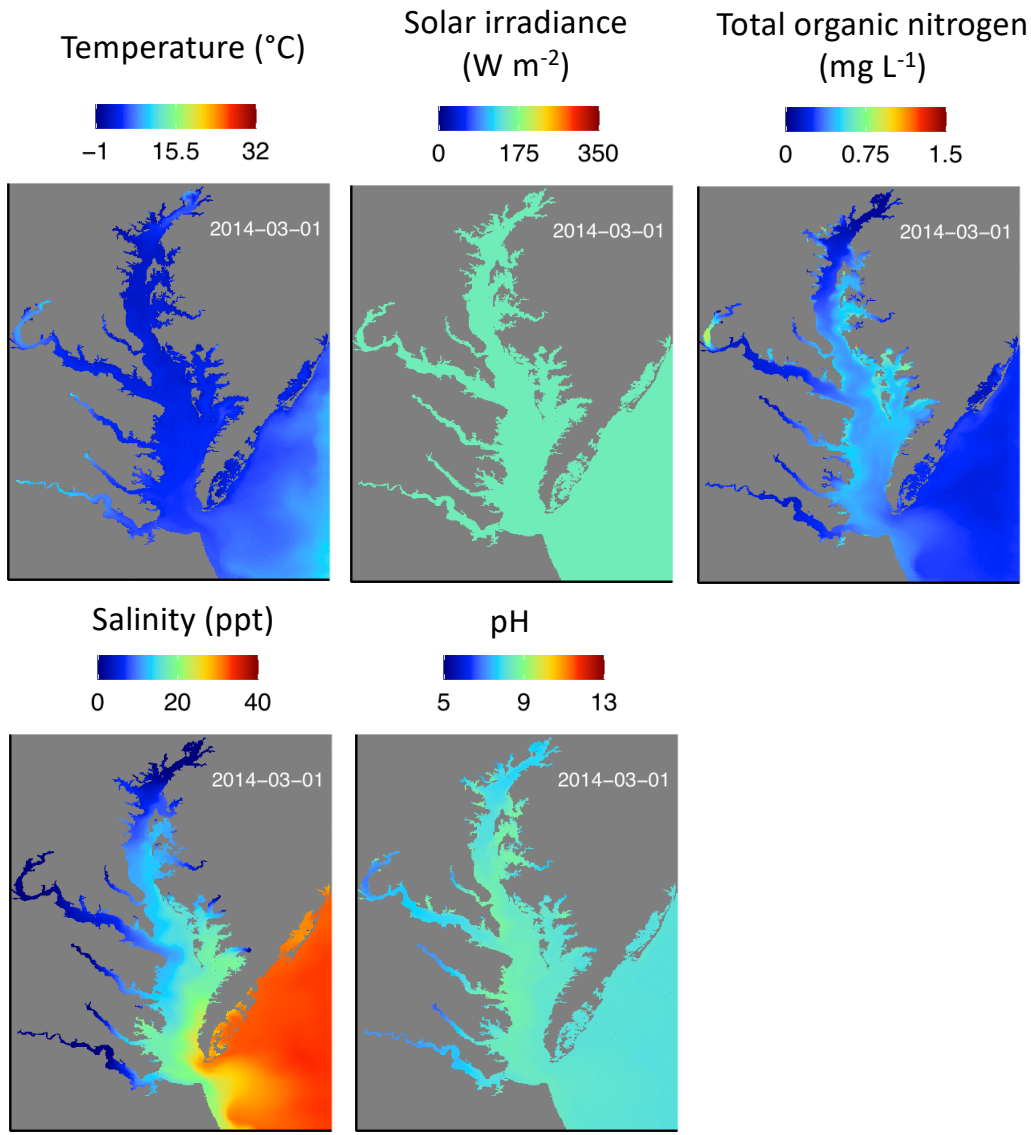


1
0

Most of our current focus is on operational nowcasts and short term (2-3 day) forecasts (CBEFS).

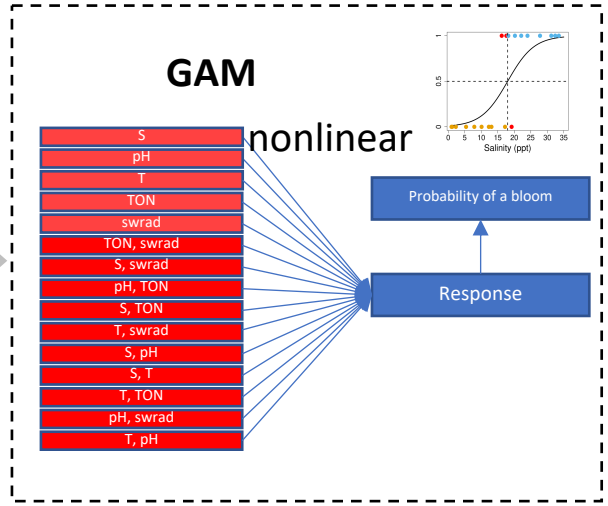
Forecasting *Prorocentrum minimum*

Existing model forecasts



Dante Horemans' postdoc work in collaboration with Dr. Marjorie Friedrichs, VIMS and UMCES

Empirical habitat model



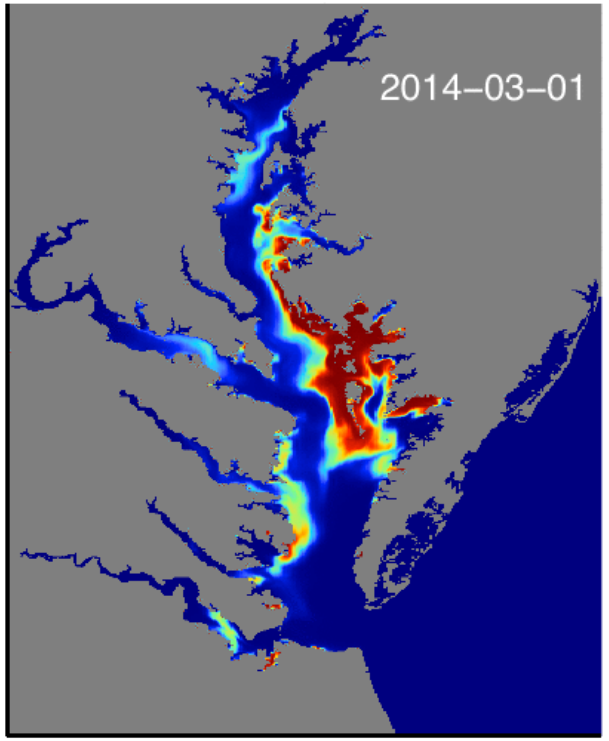
in

out

Probability of a *Prorocentrum minimum* bloom

low high

0 0.5 1



GAM = Generalized Additive Model
"Machine Learning Techniques"

Very high skill levels r^2 = .86

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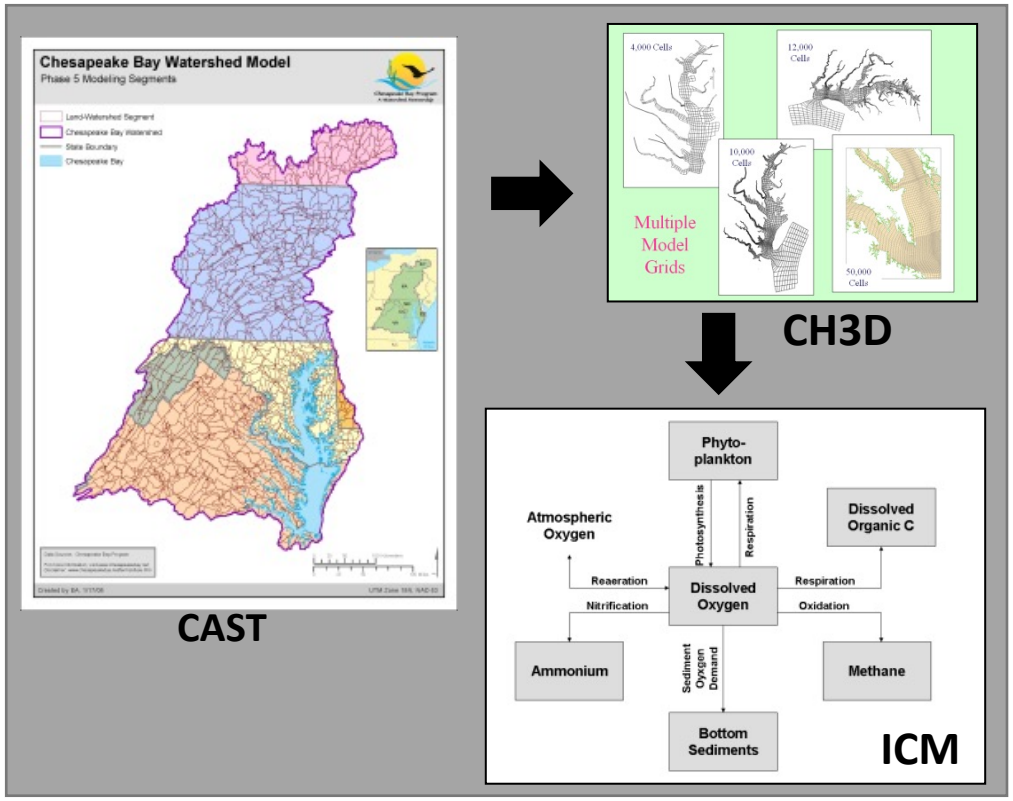
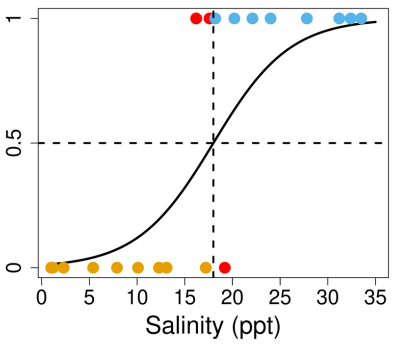
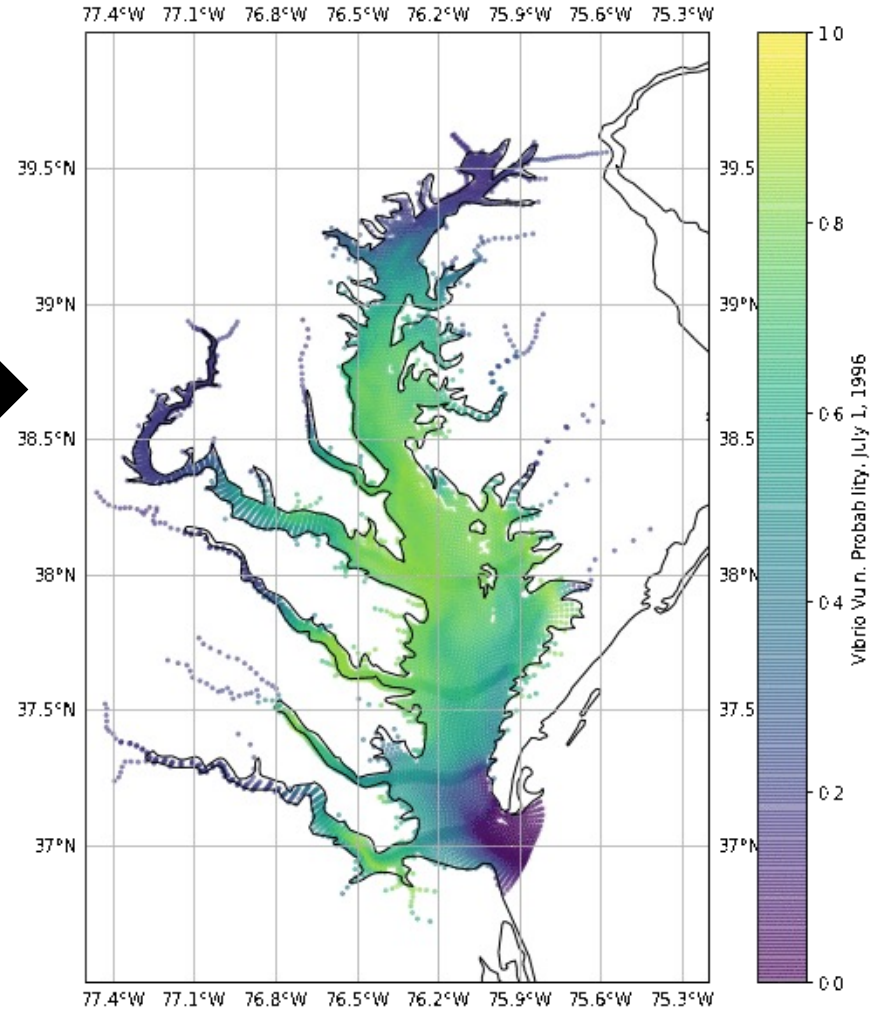
Chesapeake Bay Program Management Model



Empirical Vibrio models (Jacobs et al. 2010, 2014)



V. Vulnificus probability Summer 1996



Predicts spatial and temporal variability in *Vibrios*

Marshall Grossman's thesis work

In collaboration with Dr. Victoria Coles

University of Maryland Center for Environmental Science

Coupled Natural and Human Systems (CNH2)

We are Focusing on *Vibrio vulnificus* Because People Care (NSF CNH2)

- *Vibrio vulnificus* is a halophilic bacteria that poses worldwide economic and human health risks
  - Responsible for 80,000 illnesses annually in the U.S. alone (Scallan *et al.* 2011)
    - 85% require hospitalization with a fatality rate over 30% (Newton et al. 2012)
  - Exposure occurs both in:
    - Recreational activities
    - Consumption of contaminated seafood (Na Ra Yum et al. 2018)
- Associates with water quality and physical parameters such as:
  - Temperature and salinity
  - Chlorophyll, DO, turbidity, zooplankton, & nutrients

Photo illustration

Oysters recalled amid Washington's largest ever Vibrio outbreak

By Cookson Beecher on July 21, 2021

NATIONAL

A rare but dangerous flesh-eating bacteria is infecting Florida residents

October 19, 2022 · 9:13 AM ET

EMILY OLSON

2 people in Florida have died after eating raw oysters: What to know about eating the shellfish

Staff and wire reports

Published 6:21 a.m. ET Aug. 19, 2022 | **Updated 11:27 a.m. ET Aug. 19, 2022**

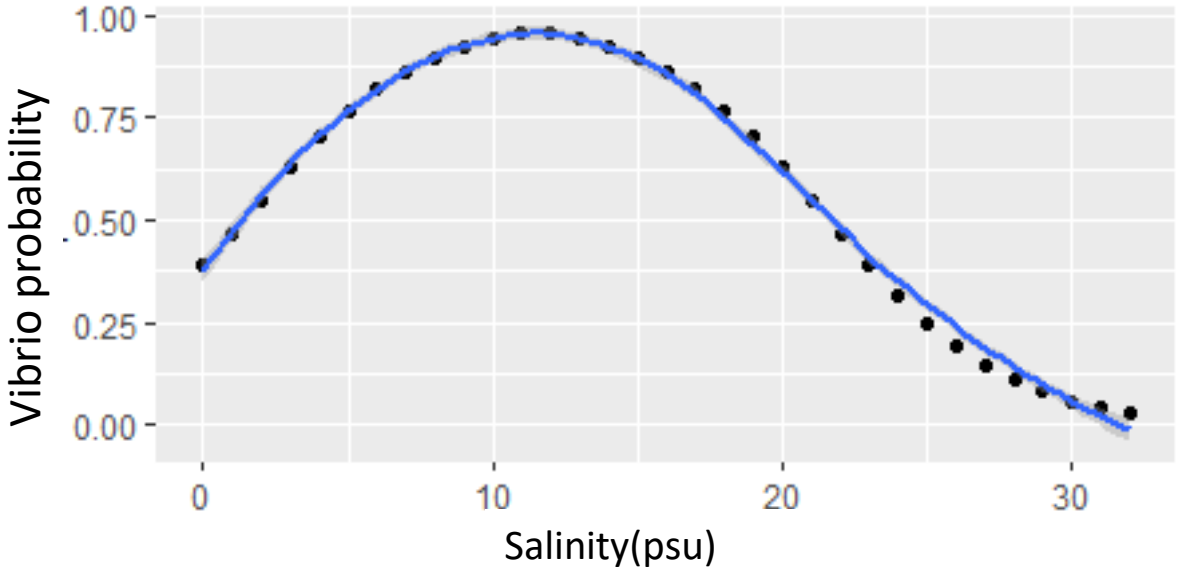
Empirical Modeling of *Vibrio vulnificus* Can Include Water Quality Parameters

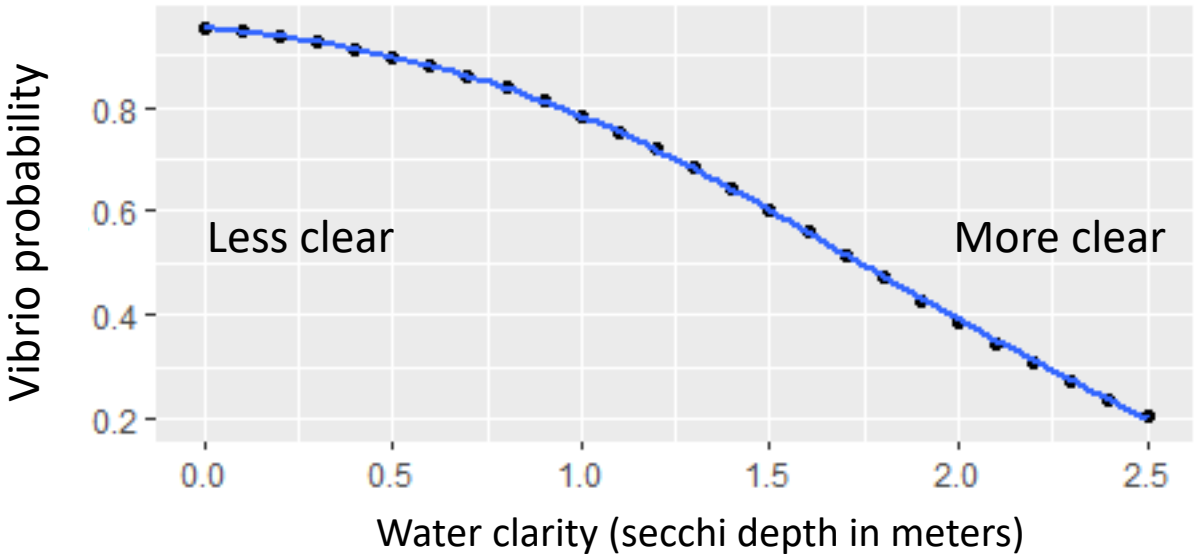
- Jacobs et al. 2014 developed empirical models to predict *Vibrio Vulnificus*
  - Multiple models that include:
    - A model that uses only temperature and salinity (which is being exercised operationally today)
    - A model that includes Secchi depth as a proxy for water clarity
  - The model that includes water clarity has not been used to forecast *Vibrio vulnificus.*

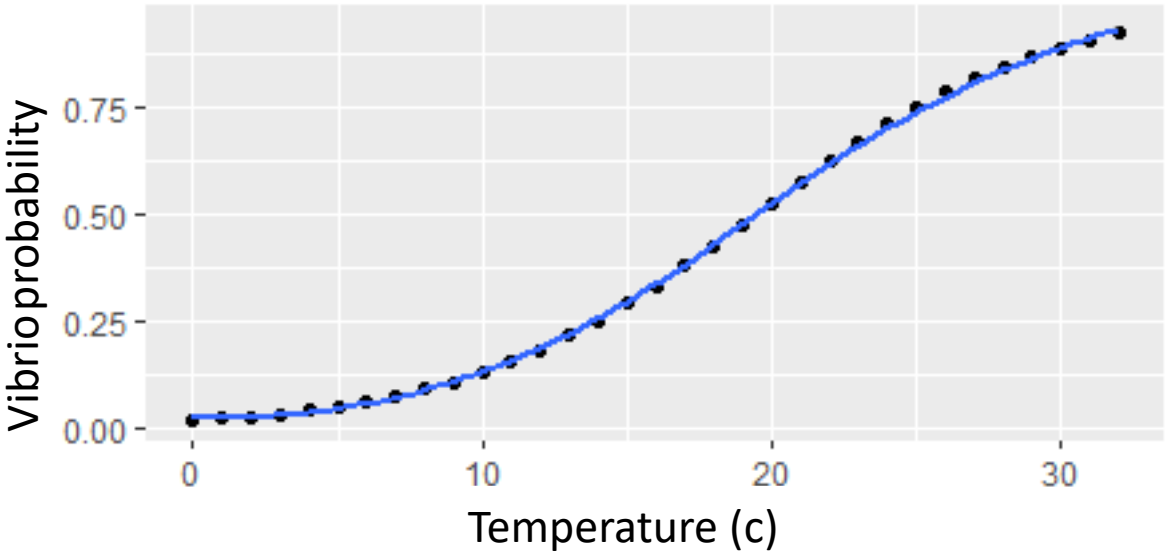
- We are applying the *Vibrio vulnificus* model with water clarity to Chesapeake Bay Program (CBP) model output in order to:
  - Current Focus: Understand how water clarity influences *the spatial and temporal variability Vibrio vulnificus.*
  - Future Work: Use this model to test CBP future water quality and climate change scenario impacts on *Vibrio vulnificus*: "business as usual" - "If TMDL is met" - "E3s"

Less "stuff" in the water means less Vibrio!

Jacobs et al. 2014





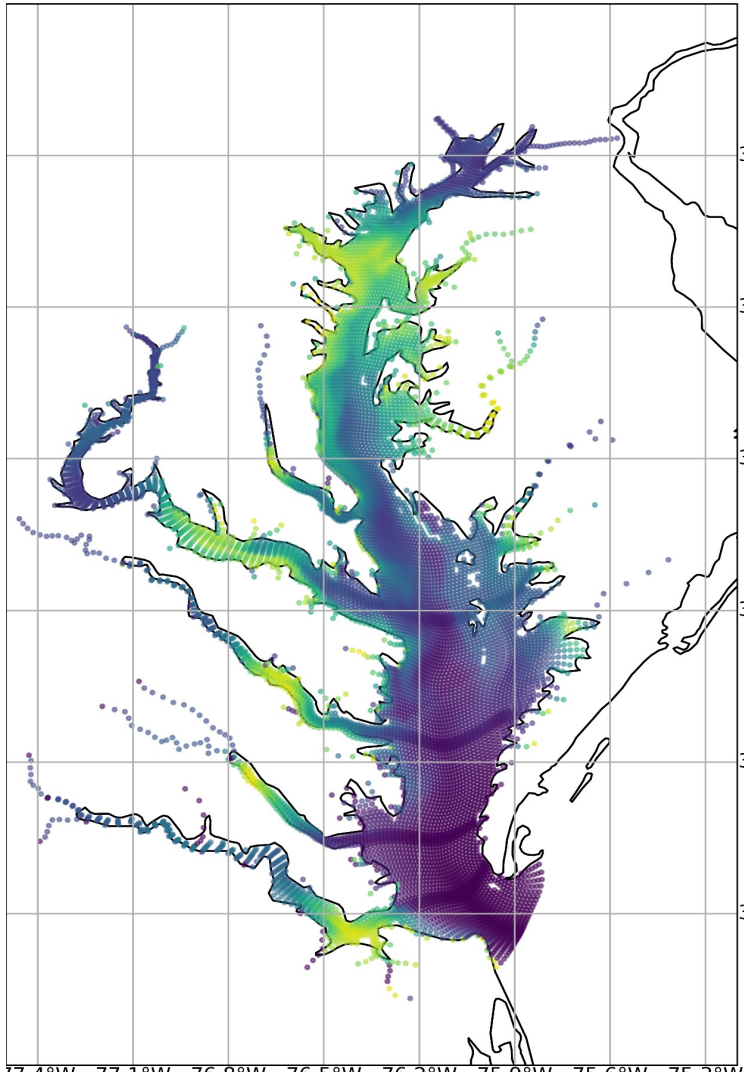


Vibrio Vulnificus sensitivity:

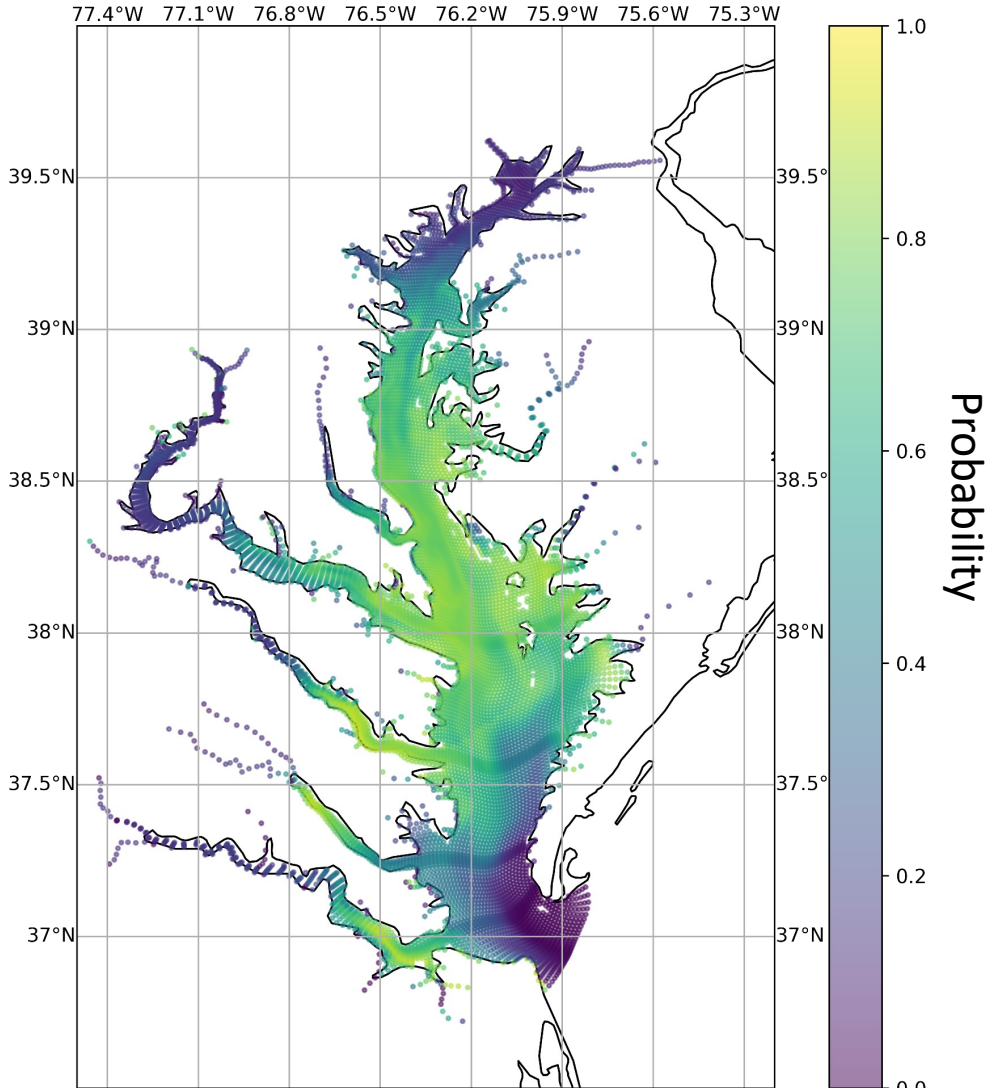
- A mesohaline, warm water organism
- Probability decreases when water clarity increases
- Model is very sensitive to water clarity
- Suggest restoration leading to increased water clarity will reduce *V. vulnificus* probability

V. Vulnificus Probability in a Dry (1995) vs. Wet (1996) Year

V. vuln. Probability- Day 185, 1995



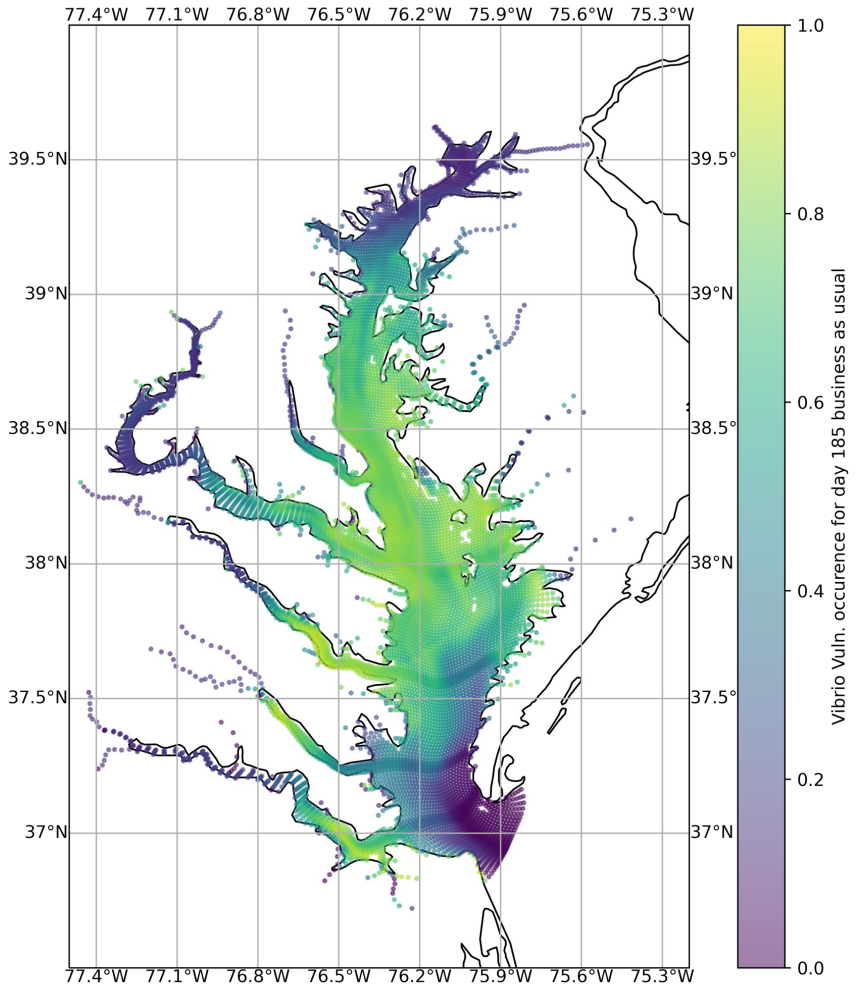
V. vuln. Probability- Day 185, 1996



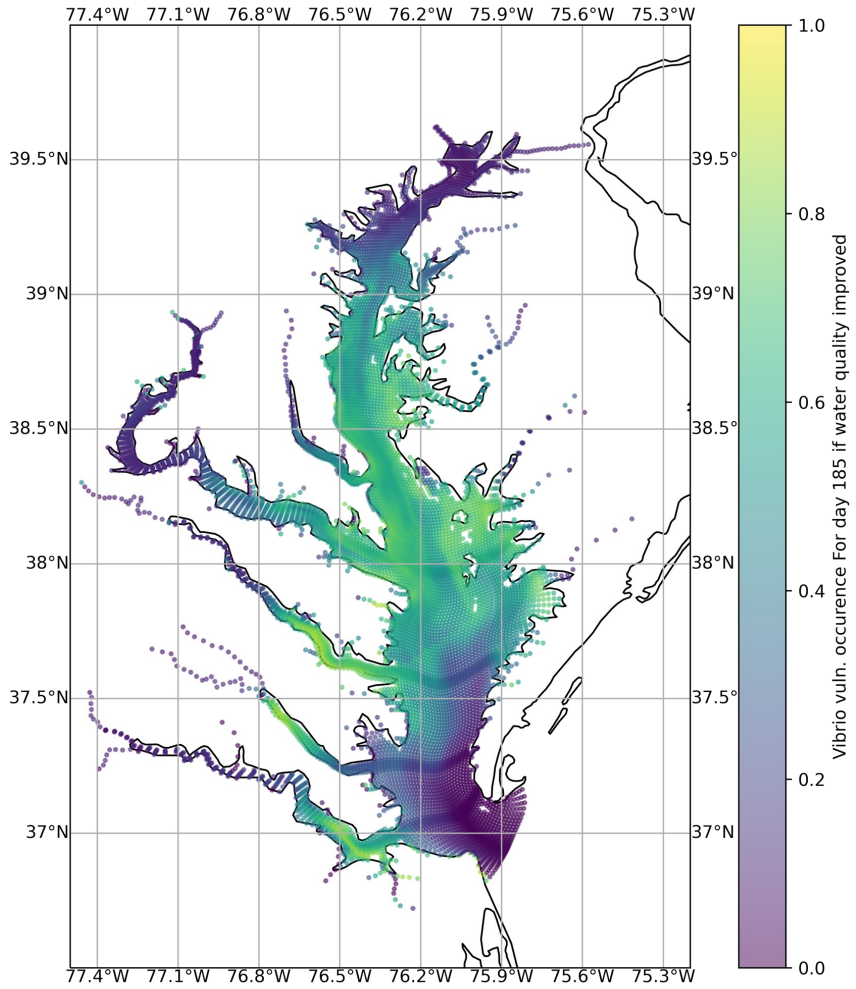
Differences are due to salinity and water clarity. Average difference in secchi depth= 0.43m

V. Vulnificus Probability in Response to 50% Increase in Secchi Depth

V. vuln. Probability- Day 185, 1996



V. vuln. Probability- Day 185, 1996 with SDx1.5



Probability

Difference in secchi depth = 1.5x

Conclusions

- We are applying the *Vibrio vulnificus* model with water clarity to Chesapeake Bay Program (CBP) model output in order to:

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  - *Future Work:* Use this model to test CBP future water quality and climate change scenario impacts on *Vibrio vulnificus*:

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