An aerial photograph of the Chesapeake Bay area, overlaid with a color-coded map showing seasonal hypoxia and anoxia forecasts. The map uses a color scale where blue represents lower levels of hypoxia/anoxia, and yellow, orange, and red represent increasing severity. The most intense areas (red/orange) are concentrated in the main stem of the bay and its tributaries, particularly in the upper reaches. The surrounding land is green, and the ocean to the right is a deep blue.

# Seasonal Hypoxia and Anoxia Forecasts in Chesapeake Bay

Jeremy Testa, William Dennison,  
Caroline Donovan, Rebecca Murphy, Donald Scavia  
and team members at the University of Michigan,  
Slava Lyubchich, Joel Blomquist and USGS partners

# A Multi-Institutional Effort

Jeremy Testa, Slava Lyubchich, William Dennison,  
Caroline Donovan, Rebecca Murphy  
***University of Maryland Center for Environmental Science***



Donald Scavia and his team  
***Graham Sustainability Institute, University of Michigan***



***Joel Blomquist, Bruce Michael, and many others at  
Maryland DNR, USEPA Chesapeake Bay Program  
USGS, NOAA, many past forecasters***

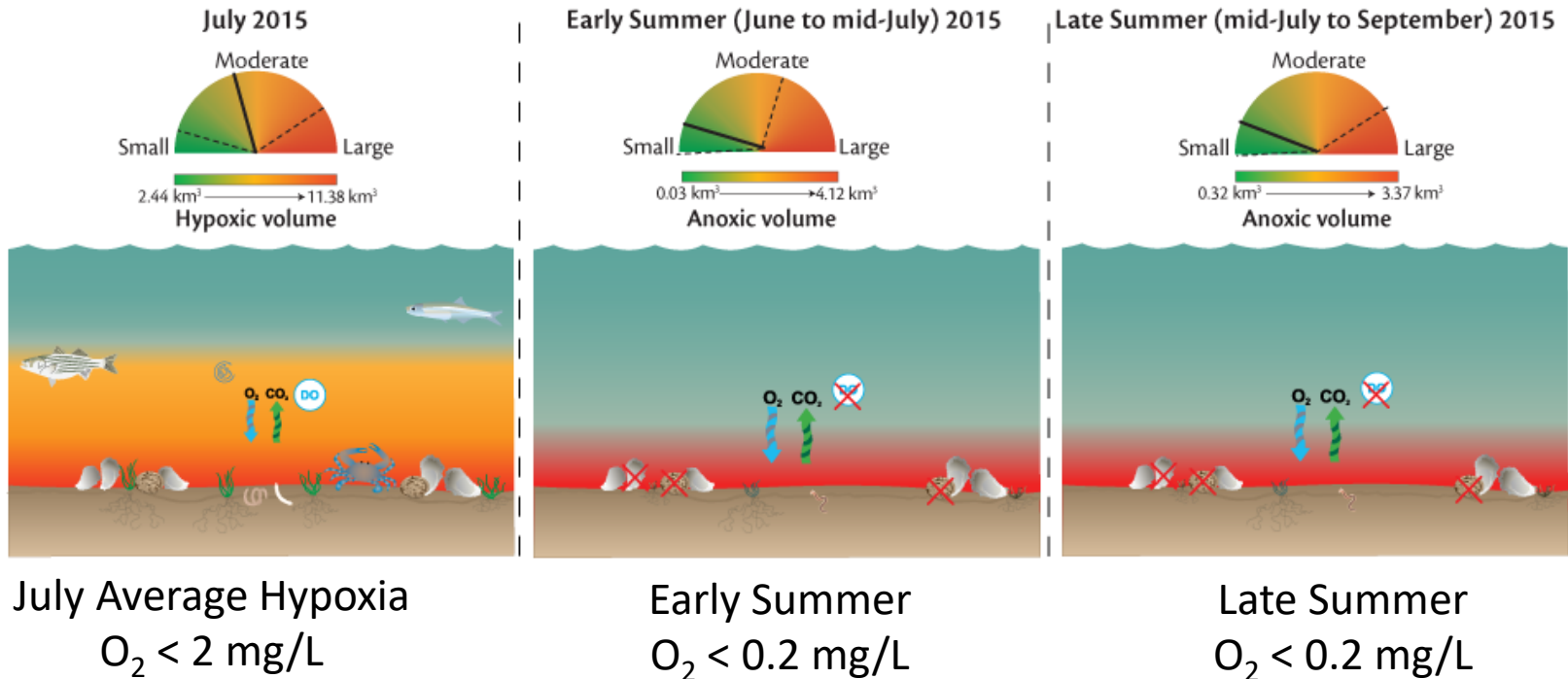


# Forecast Models

Three models have been used to forecast summer hypoxia and anoxia in Chesapeake Bay

**Chesapeake Bay Summer Forecast:** 2015 ▼

Click on the items below for the 2015 summer forecast indicators:

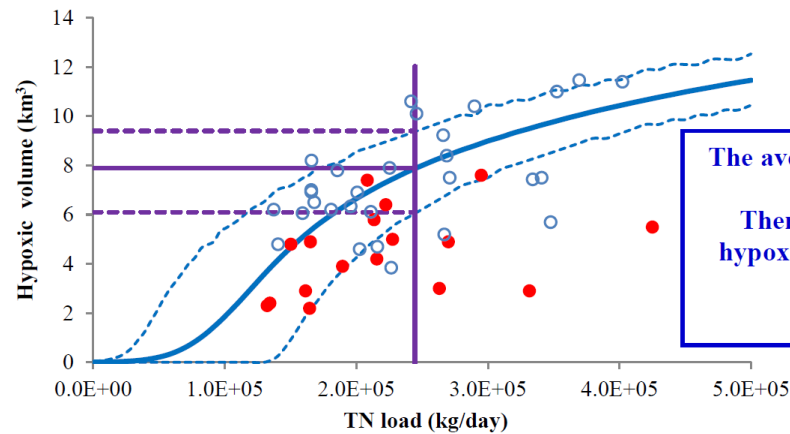


- All models forecast hypoxia and or anoxia based on winter-spring nutrient inputs
- <http://ian.umces.edu/ecocheck/forecast/chesapeake-bay/2017/>
- Anoxia models are regression based, hypoxia model is a modified oxygen sag model
- Each fall, forecast is evaluated with a *Summer Review*

# Two Models

## Hypoxia

$$DO = DO_s - \frac{k_1 BOD_u(F)}{K * k_2 - k_1} \left( e^{-k_1 \frac{x}{v}} - e^{-K * k_2 \frac{x}{v}} \right) - D_i e^{-K * k_2 \frac{x}{v}}$$



The average 2017 forecast is 7.9 km³.

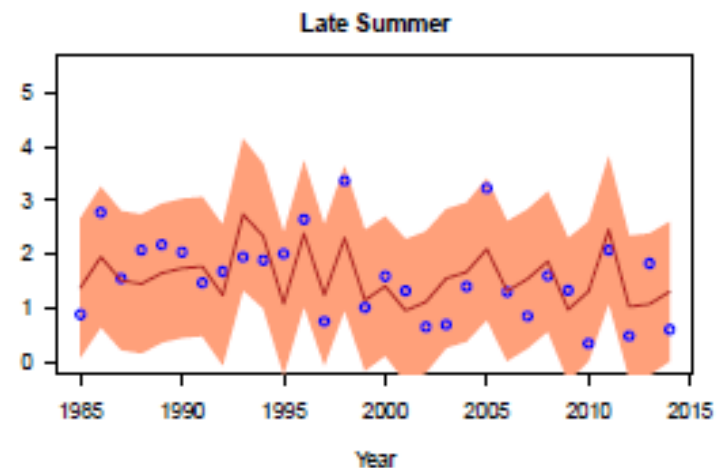
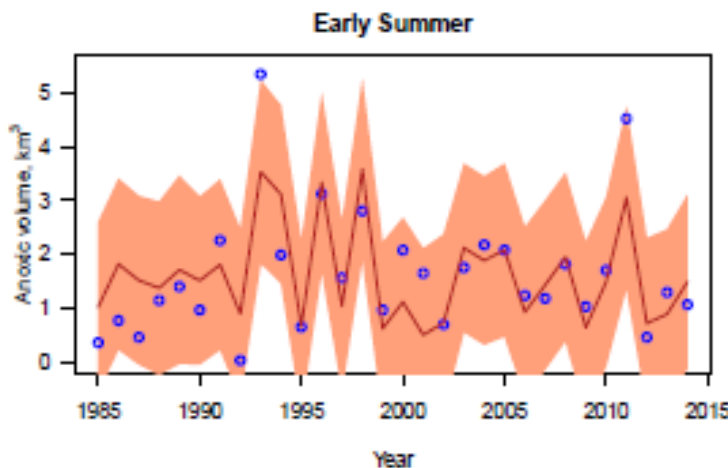
There is a 95% probability that hypoxic volume will be between 6.1 and 9.4 km³.

(Scavia et al.)

## Anoxia

$$\text{Anoxic Volume}_{\text{early summer}} = b_0 + b_1(\text{TN Load}_{\text{JA}}) + b_2(\text{RFlow}) + b_3(\text{MSL}) - b_4(\% \text{SE wind})$$

$$\text{Anoxic Volume}_{\text{late summer}} = b_0 + b_1(\text{TN Load}_{\text{JM}})$$

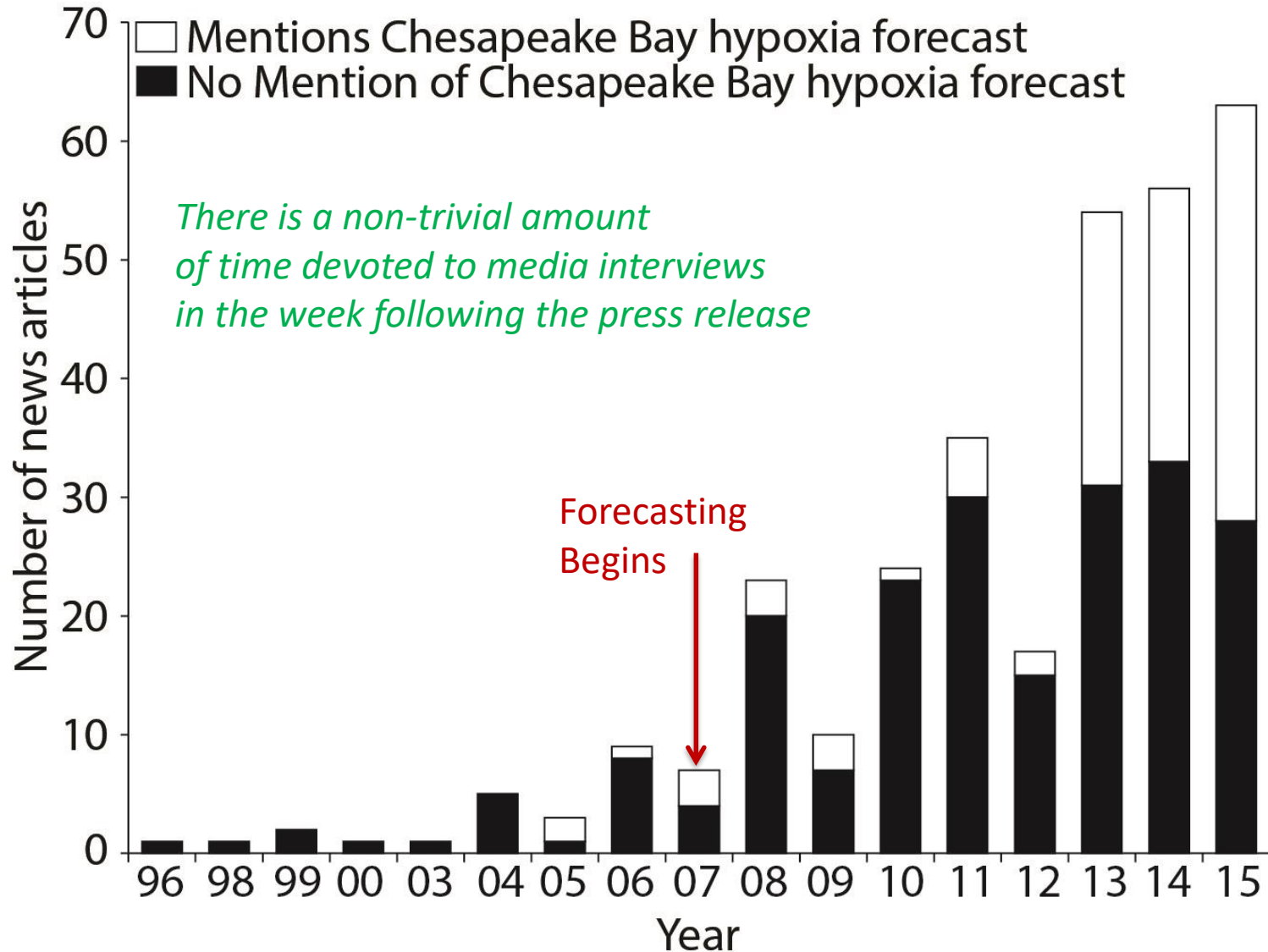




# Forecast Timeline

- Early June: USGS Provides Loads
- 1-5 days later, UMCES and UM generate forecasts
- Press release written, edited, and approved by participating agencies within ~7 days
- UMCES and UM Press Team develop release, solicit quotes and input from agencies
- Website Launched, Press Release Made:
  - 2015: June 23
  - 2016: June 13
  - 2017: June 14
  - 2018: June ~18
  - 2019: June 12

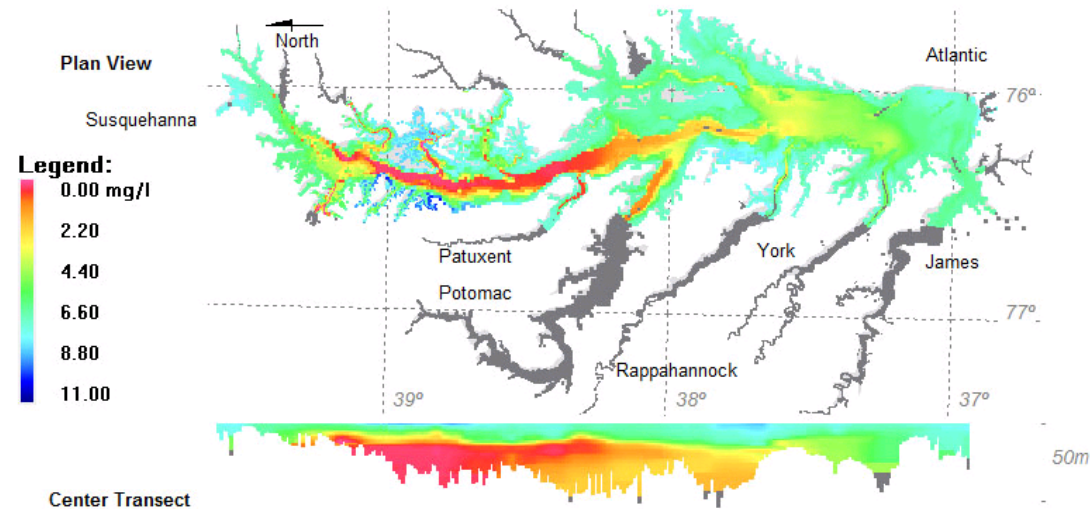
# Increased Media Interest in Hypoxia and Forecasting



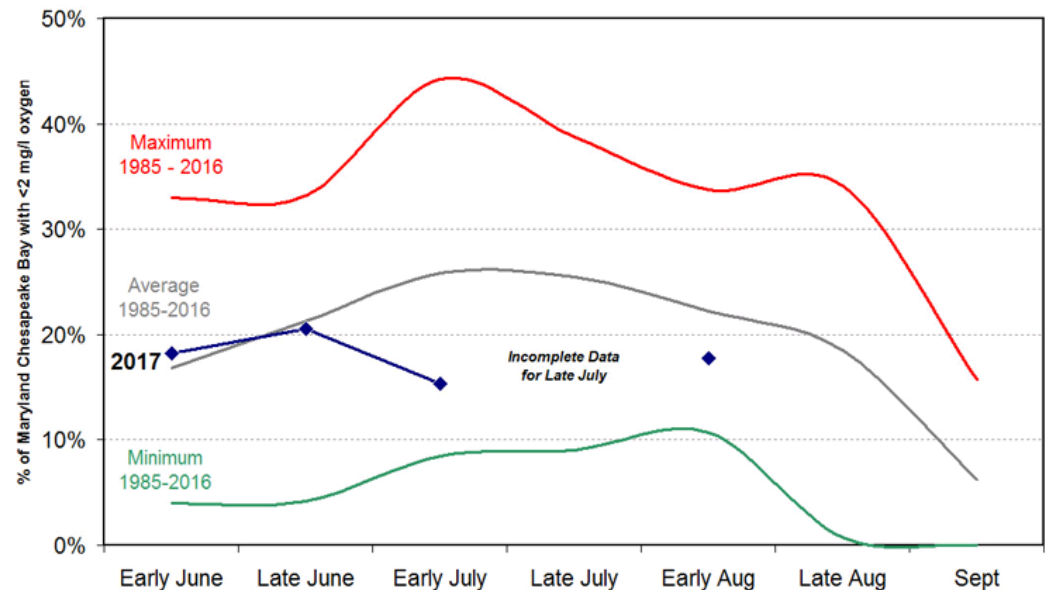
# Assessment of Realized Hypoxia Throughout the Summer Refers to Forecast

- DNR Hypoxia Reports
- Should this effort be expanded?

## Chesapeake Bay Minimum Dissolved Oxygen Conditions Early August (Aug. 8-14)



## Percentage of Water in Maryland's Mainstem Chesapeake Bay Below 2 mg/l Oxygen



# A few quick thoughts:

- A single seasonal forecast may be better than multiple forecasts. Perhaps an ensemble of forecasts for the same metric?
- Past seasonal forecasts were not linked to habitat. They could be, but habitat is dynamic.
- We used to do a “Summer Review” of how the forecasts played out. We saw this as a teaching and learning moment. It received far less attention than the forecast.



Thank You

