Spatio-Temporal Evolution of Hypoxia in Sub-Estuaries of the Chesapeake Bay

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Spatial Variability vs. Temporal Variability

• In any monitoring program or research Endeavour to understand the bio-physical process that dominate ecological systems we must sacrifice either the spatial or temporal components.

• Spatial intensive – lower temporal resolution
• Temporal intensive – lower horiz. spatial resolution
  • May lose vertical dimension
Resolving the Spatio-Temporal dilemma

South and Severn River stations
Resolving the Spatio-Temporal dilemma

- REMUS 100
- HydroLab DS 5
- NOAA Annapolis Buoy
Severn River 6-15-2011

D.O. mg/l

Depth (m)

Round Bay

USNA
South River 7-22-11
Severn River D.O.
June Average DO over Distance
Severn River, 2009

y = -0.1126x + 5.8064
R² = 0.4904

July Average DO over Distance
Severn River, 2009

y = -0.1111x + 5.0732
R² = 0.4296

August Average DO over Distance
Severn River, 2009

y = -0.3291x + 7.0363
R² = 0.9699
Feeling the Hypoxic Squeeze in 3-D

Habitat squeeze

Vertical Hypoxic squeezing

Lateral hypoxic squeezing

Temporal Hypoxic squeezing

D.O. (mg/l)

-0.029

-1.7

-3.4

-5.1

-6.8

-8.5

-10

-12
Hypoxic Squeeze Index

• How do we calculate how much squeezing has occurred and what is the threshold for fish kills?

\[
\left( \frac{\left| DO_{surface} - DO_{Bottom} \right|}{DepthAvg.DO} \right)
\]
Cause of Severn River Fish Kill
26 July 2010

Annapolis Buoy From July 25th to 29th 2010
Time vs Wind Speed

Annapolis Buoy From July 25th to 29th 2010
Time vs Wind Direction

NOAA/NOS/CO-OPS
Preliminary Water Level (A1) vs. Predicted Plot
8575512 Annapolis, MD
from 2010/07/25 - 2010/07/27

Date/Time (LST)

Predicted WL  Observed WL

(Obs-Pred)
Conclusions

• It is possible to map bio-physical process in the spatio-temporal domain by intensive multiplatform monitoring
• Fleet of REMUS 100’s may be the future
• The South and Severn Rivers have similarities and differences related to timing and strength of stratification leading to different emergent D.O structures

• Hypoxic squeezing is realized in both spatial and temporal domains-leading to a better understanding of fish kill prediction
• Combining buoy data at the mouth with weekly intensive monitoring and REMUS runs may allow us to hindcast environmental conditions throughout the sub-estuary from just the buoy alone!