Sea Level Rise and Chesapeake Bay Hypoxia

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Recommendations from STAC Climate Change Workshop

1. Examine model parameterizations – temperature-dependence:

- Revise WQSTM temperature parameterizations
  - → Modify growth curve for phytoplankton (exponential rather than flattening; should not change calibration too much, because only changing impact of very higher temperatures)
  - → Also examine T-dependent mortality/grazing/remineralization terms

2. Examine forcing – wind:

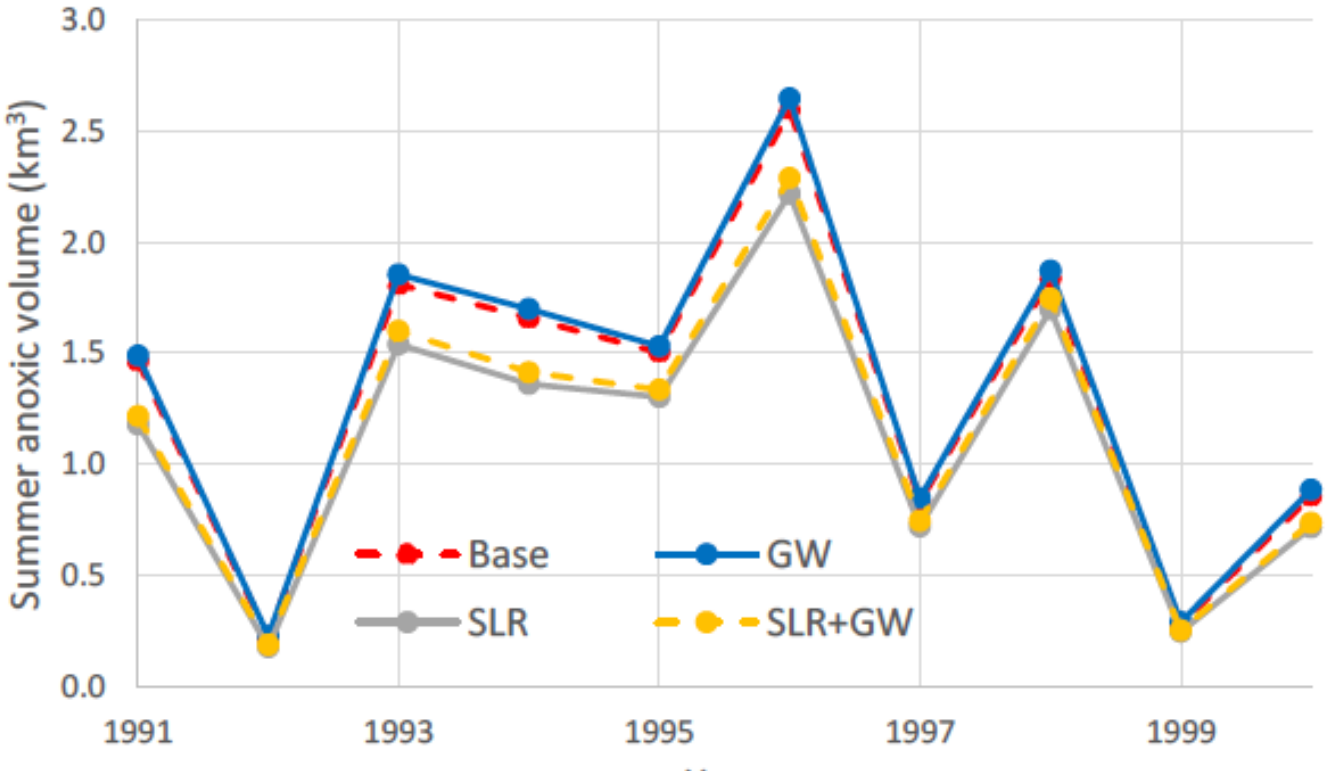
- M. Herrmann has provided the CBP MW with future winds (MACA); how do these (minor) changes in winds impact hypoxia in WQSTM?
  - → weaker winds? Small change in direction?
  - → run scenario with delta change in winds

3. Examine conflicting results for impact of sea level rise on hypoxia:

- Why are very similar models getting opposite SLR results?
  - → Same result with and without reduced nutrients
  - → Is this a water quality discrepancy or a hydrodynamic discrepancy?

Impacts of SLR on hypoxia: Differences between 2050 and 1995

3rd International Conference on Water Resource and Environment (WRE 2017) IOP Publishing
IOP Conf. Series: Earth and Environmental Science **82** (2017) 012001 doi:10.1088/1755-1315/82/1/012001

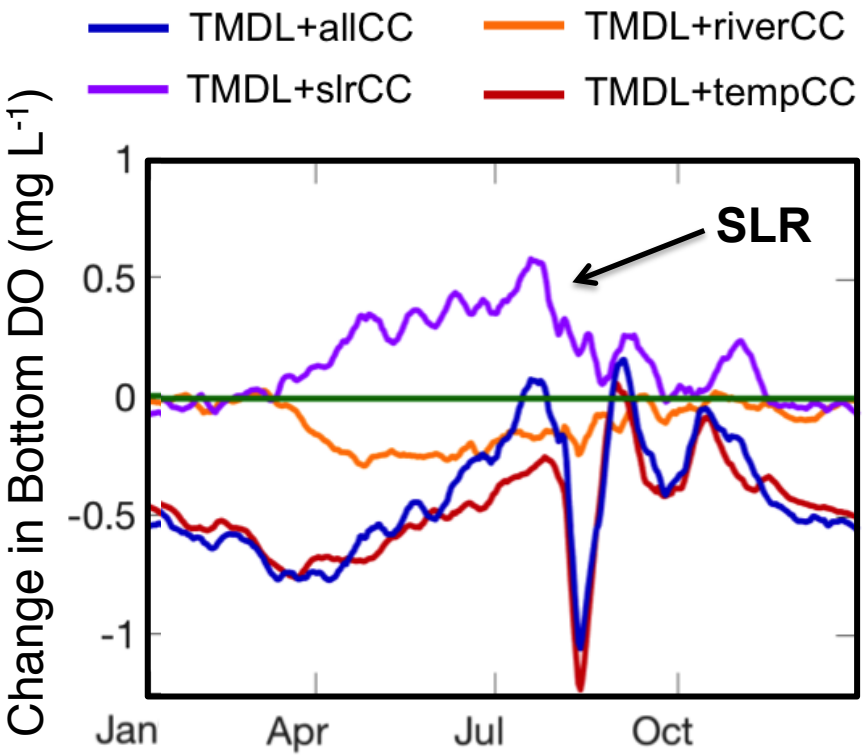


CH3D-WQSTM

Ping Wang et al., WRE2017

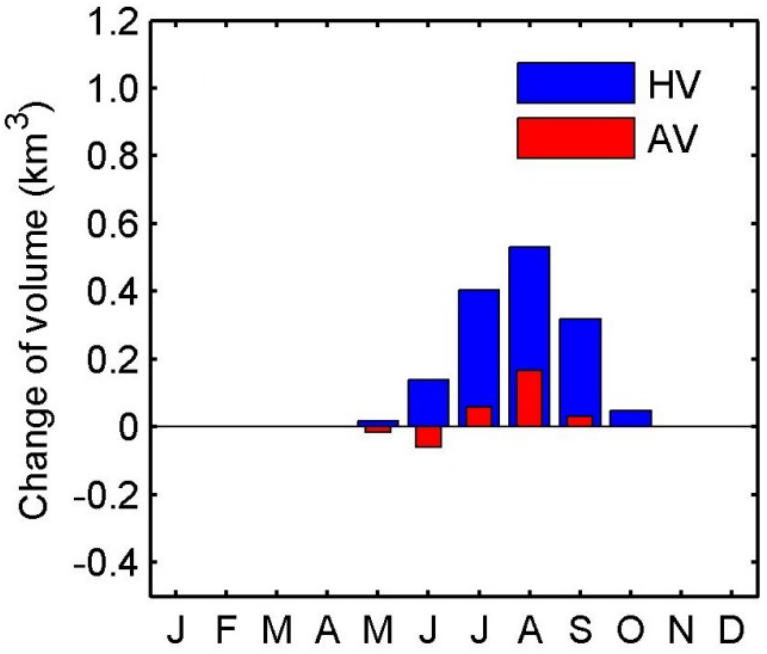
SLR improves hypoxia

Impacts of SLR on hypoxia: Differences between 2050 and 1995



_Ches_ROMS-ECB
Ike Irby, Marjy Friedrichs et al., 2018

SLR improves hypoxia



UMCES-ROMS-RCA
Wenfei Ni, Ming Li, et al., 2018

SLR exacerbates hypoxia

Why do we see opposite results in two similar ROMS-based models?

- Both models show increased estuarine circulation
- Working hypothesis:
  - One model shows ***SLR reducing hypoxia*** because high oxygen water is advected in from shelf
  - Other model shows ***SLR exacerbating hypoxia*** because high salinity water is advected in from shelf, increasing stratification and reducing mixing of high oxygen water from surface
- Why these differences? Possibilities include:
  - Different advection and diffusion schemes
  - One assumes nutrient reductions in place, one does not
  - Differences in outer boundary condition assumptions
  - One run is off-line; one run is coupled
- Which is correct? Different results in different environmental conditions?

Methods

Two ROMS models*:

- UMCES-ROMS-RCA
- *Ches*ROMS-ECB

Four model experiments with P6 WSM:

- Base Run for 1991-1995 (maybe also 1996-2000)
- Base Run + SLR_2025
- Base Run + SLR_2050
- Base Run + SLR_2100
  - \+ Possible additional simulations with P6 WSM-WIP

Analysis:

1. Compare hydrodynamics of two simulations (compare all physical terms in salt budget)
2. Compare biological results of two simulations (compare all terms in oxygen budget)
3. Compare to model outputs from additional models as time allows (SCHISM, EFDC, WQSTM)

* *Relative skill previously compared in Irby et al., 2016*

Milestones: Oct 15, 2018 – June 15, 2019

How will sea level rise impact hypoxia in the Chesapeake Bay? A multiple model intercomparison project								
	Months							
	1	2	3	4	5	6	7	8
Conduct consistent 1991-1995 base run for ChesROMS-ECB (VIMS) and ROMS-RCA (UMCES), both forced by Phase 6 Watershed Model output								
Compare hydrodynamics of two base runs (VIMS)								
Compare oxygen dynamics of two base runs (VIMS)								
Conduct consistent 1991-1995 SLR runs for ChesROMS-ECB (VIMS) and ROMS-RCA (UMCES) for 2025, 2050 and 2100								
Compare hydrodynamics of SLR simulations for ChesROMS-ECB and ROMS-RCA (VIMS)								
Compare oxygen dynamics of SLR simulations for ChesROMS-ECB and ROMS-RCA (VIMS)								
Conduct additional simulations to further investigate possible influence of outer boundary conditions, bathymetry, etc…. (VIMS & UMCES)								
Evaluate hydrodynamics and oxygen dynamics of additional simulations (VIMS)								
Write white paper describing results (VIMS & UMCES)								
Present results and submit white paper to STAC and MW meetings (VIMS)								

Chesapeake Ecological Forecasts:
www.vims.edu/hypoxia

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DEAD ZONE FORECASTS

Chesapeake Bay Daily

- Background
- Hypoxia Line Plots
- Salinity and Temperature
- Depth to Low Oxygen
- Striped Bass Habitat
- Dead Zone Size

Home > Research & Services > Topics > Dead Zones > Forecasts > Chesapeake Bay Daily

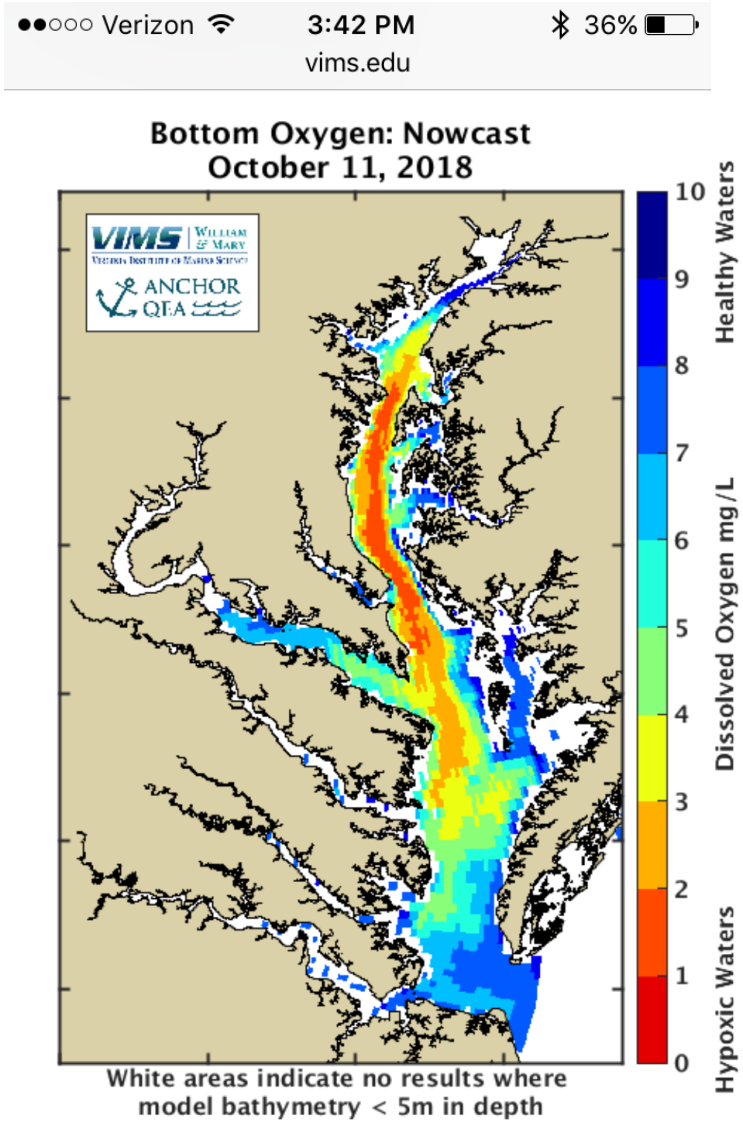
Chesapeake Bay Hypoxia Forecast

▶ Quick Introduction

Bottom Oxygen: Nowcast
October 15, 2018

Chesapeake Ecological Forecasts:

www.vims.edu/hypoxia



iPhone Screenshot from last Thursday

Blues → High bottom oxygen
= Good bottom water
= Bottom fish and crabs

yellow/green → Moderate to low oxygen
= Poor bottom water
= Fewer bottom fish and crabs

red/orange → Very low bottom oxygen
= Bad bottom water
= No bottom fish or crabs

Chesapeake Ecological Forecasts:

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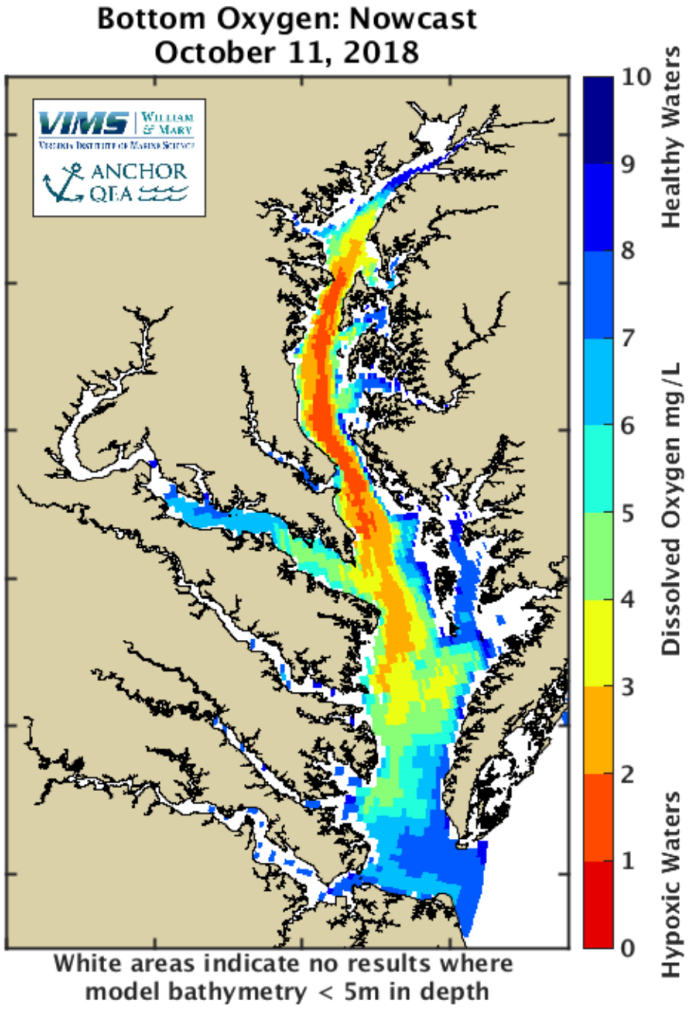
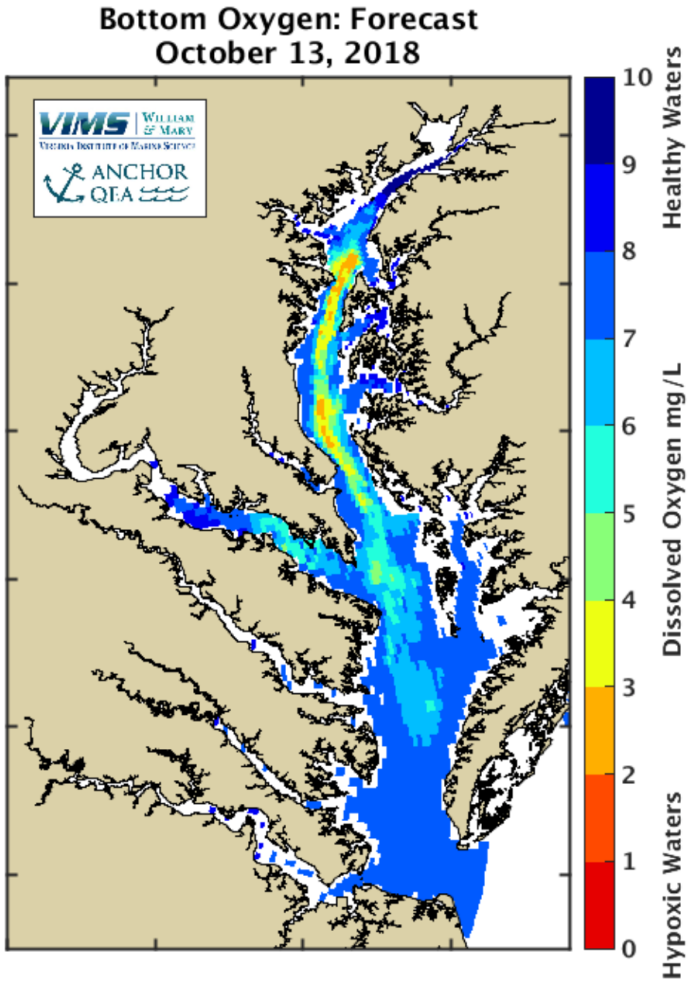
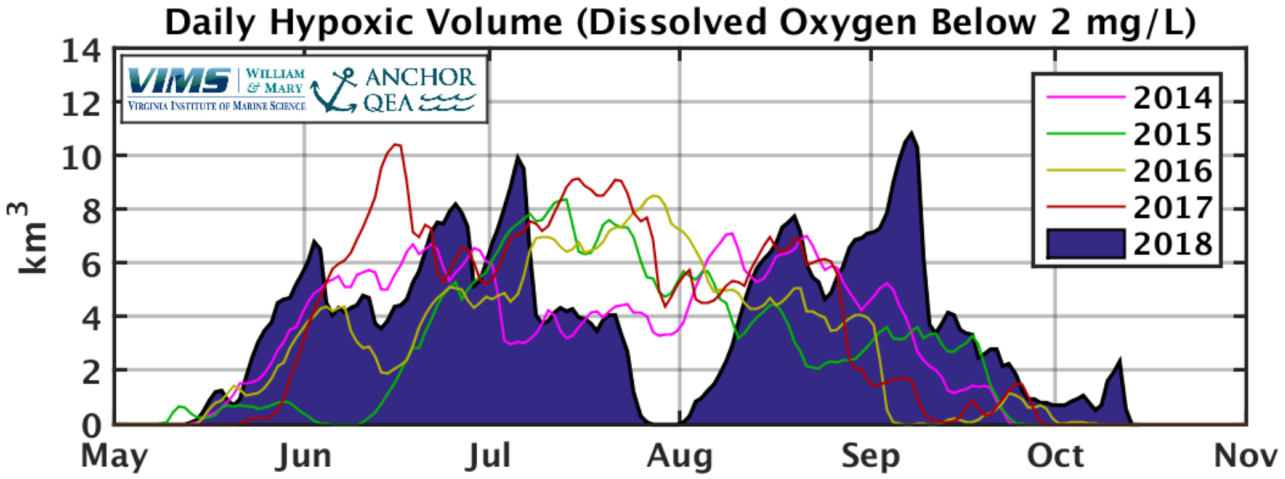


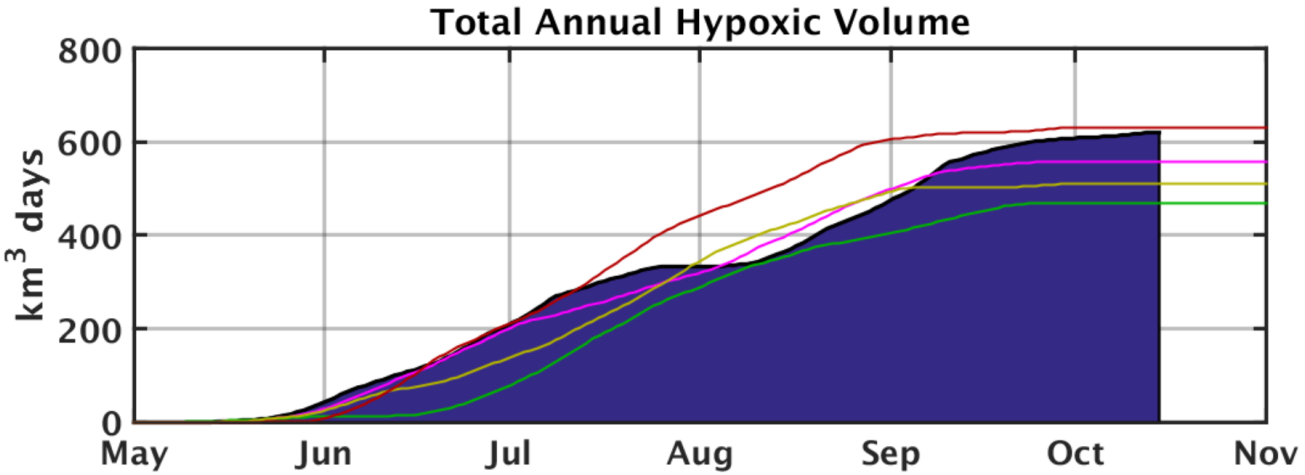


Before "Michael"

After "Michael"

Real-time hypoxia volume: www.vims.edu/hypoxia





Overall, the total amount of hypoxia in 2018 was estimated to be very similar to 2017, but the seasonal patterns in hypoxia were very different and hypoxia was estimated to start earlier and last longer in 2018 than in recent years.

Hypoxia Report Card (to be issued soon, with MD DNR)

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- Chesapeake Bay Daily
- Gulf of Mexico Seasonal
- Bay Hypoxia Report Card

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Hypoxia Report Card

Compare the annual severity of Chesapeake Bay hypoxia

During Fall 2017, the Virginia Institute of Marine Science joined with **Anchor QEA** to release their first retrospective seasonal analysis of the severity of hypoxia in Chesapeake Bay. The Annual Chesapeake Bay Hypoxia Report Card summarizes dissolved oxygen concentrations in the Bay as estimated by the team's 3-D, **real-time hypoxia forecast model**. The modeling team also generated the same dissolved oxygen statistics for 3 previous years for comparative purposes. Partial funding for this project comes from NOAA, in collaboration with researchers at the University of Maryland Center for Environmental Science and the Woods Hole Oceanographic Institution.

http://www.vims.edu/research/topics/dead_zones/forecasts/report_card/index.php

Hypoxia Report Card (to be issued soon, with MD DNR)

Year	Maximum Daily Hypoxic Volume (km^3)	Total Annual Hypoxic Volume (summed over each day; km^3 days)	Duration of Hypoxia (days)	Average Summer Hypoxic Volume (km^3)
2014	7.1	557	107	4.4
2015	8.4	468	94	3.7
2016	8.5	511	98	4
2017	10.4	630	92	5.1
*2018**	*10.8*	*~630*	*~125*	*4.6*

** Tentative, to be revised*

http://www.vims.edu/research/topics/dead_zones/forecasts/report_card/index.php

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Questions?

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