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WATER QUALITY TOOL APPLICATIONS

Water Quality Tools

Applications to support growers and managers



Chesapeake Bay Environmental Forecast System
EcoOyster: a model for predicting oyster growth
Coastal acidification and oyster aquaculture
Shellfish Thresholds and Aquaculture Resilience



WATER QUALITY TOOL APPLICATIONS

Chesapeake Bay Environmental Forecasting System (CBEFS)



Real-time model forecast setup:

- Nowcast and 2-day forecast automatically produced nightly
- Forecasts displayed on the VIMS website

www.vims.edu/cbefs



WATER QUALITY TOOL APPLICATIONS

Background Contact Information Hypoxia (Dissolved Oxygen)

Dead Zone Size Depth to Low Oxygen Hypoxia Line Plots Bay-wide Salinity Bay-wide Temperature

Forecasts

Chesapeake Bay Daily Acidification Forecasts

Pathogens (Vibrio)

Focused Salinity and Temperature

vims.edi

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Chesapeake Bay Environmental Forecasting System (CBEFS)





WATER QUALITY TOOL APPLICATIONS

Chesapeake Bay Environmental Forecast System

- Background Contact Information
- Hypoxia (Dissolved Oxygen)
- Dead Zone Size
- Depth to Low Oxygen
- Hypoxia Line Plots
- Bay-wide Salinity
- Bay-wide Temperature
- Focused Salinity and
- Temperature Forecasts
- Chesapeake Bay Daily
- Acidification Forecasts
- Pathogens (Vibrio)
- Dead Zone Forecasts Sea-Level Report Cards Tidewatch

CBEFS

Chesapeake Bay Environmental Forecast System

Use our forecasts and "nowcasts" of temperature, salinity, dissolved oxygen, and other physical and chemical factors within the Chesapeake Bay to help monitor Bay health and plan your onthe-water activities. Based on observations and **computer models** developed by the Virginia Institute of Marine Science and partners, these tools accurately predict the current status of important environmental variables and how they are likely to change in the short-term.

Our Chesapeake Bay Environmental Forecast System simulates 3 conditions for each selected variable:

- 1. Nowcast: present-day status of selected variable in Chesapeake Bay
- 2. 2-Day Forecast: status of selected variable in the Bay 2 days from now, and
- 3. Forecast Trend: difference between nowcast and forecast (% change over 2 days)

Track "hypoxia" in the Bay, as

measured by the volume of waters

where DO levels are below 2 mg/L

Click a selection below to access the specified simulation.



DISSOLVED OXYGEN (DO) Discover when and where lowoxygen "dead zone" conditions may form.



DEPTH TO LOW OXYGEN Find the depth to fish-unfriendly waters where dissolved oxygen levels fall below 3 mg/L.

- Temperature
- Salinity
- Oxygen
- Acidification metrics
- Bacteria (Vibrio)
- Harmful Algal Blooms (HABs)
- Water clarity

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STITUTE OF MARINE SCIENCE

WATER QUALITY TOOL APPLICATIONS

screenshot of — bottom oxygen forecast

Blues → High bottom oxygen = Good bottom water

Yellow/green → Moderately low oxygen = Poor bottom water

Red → Very low bottom oxygen = Bad bottom water



WATER QUALITY TOOL APPLICATIONS



screenshot of Forecast for July

Blues → High bottom oxygen = Good bottom water

Yellow/green → Moderately low oxygen = Poor bottom water

Red → Very low bottom oxygen = Bad bottom water

WATER QUALITY TOOL APPLICATIONS

Bottom pH Nowcast *(Sept. 21)*

Sea Grant

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VIRGINIA INSTITUTE OF MARINE SCIENCE



Bottom pH Forecast *(Sept. 23)*





Sea Grant

VIRGINIA AQUACULTURE CONFERENCE

WATER QUALITY TOOL APPLICATIONS





Surface Ω_{arag} post-Ida (9/2)



WATER QUALITY TOOL APPLICATIONS



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water clarity





WATER QUALITY TOOL APPLICATIONS

Current products:

- Oxygen
- Salinity
- Temperature
- Acidification (pH, etc...)
- Harmful Algal Blooms
- Water clarity
- Vibrio
- Sea nettles





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WATER QUALITY TOOL APPLICATIONS

EcoOyster: A model for predicting oyster growth

Mark J. Brush | Virginia Institute of Marine Science









WATER QUALITY TOOL APPLICATIONS

EcoOyster

 Predicts daily, seasonal, annual, and interannual tissue and shell growth (weight and height)





WATER QUALITY TOOL APPLICATIONS

EcoOyster

- Calibrated to observed growth from around the Bay
- Operational at fixed sites around the Bay and in *Ches*ROMS-ECBO





WATER QUALITY TOOL APPLICATIONS

EcoOyster

- Relevant to growth in both aquaculture (e.g., triploids) and restoration (e.g., diploids) contexts
- Simulates effects of water quality on growth and tipping points related to acidification
- Metrics for aquaculture:
 - ➤ Growth rate
 - ➤ Time to harvest
 - Harvestable biomass



M. Kuschner, VIMS



WATER QUALITY TOOL APPLICATIONS

EcoOyster

- Computes ecosystem services associated with oysters:
 - Water filtration
 - > Water quality improvement
 - Particulate and nutrient removal
 - Economic value of nutrient removal





Introduction

The Harris Creek model simulates water quality, ecosystem dynamics, and function of restored cyster reets in five well-mixed boxes (Fig. 1). A

The model runs over an average annual cycle based on forced water temperature, satinity, and boundary conditions using Chesapeake Bay Program (CBP) data for 2000-16, additional water quality data for

2010-16 from the Maryland Department of Natural Resources. University

diagram of the model is given on the next page (Fig. 2).

The Harris Creek Oyster Restoration Model v.2 Drs. Mark J. Brush and M. Lisa Kellogg Virginia Institute of Marine Science June 2018

WATER QUALITY TOOL APPLICATIONS

EcoOyster

• Available online through a user interface

User-Defined Inputs:





WATER QUALITY TOOL APPLICATIONS

Coastal Acidification and Oyster Aquaculture



Using CBEFS and EcoOyster to predict the effects of acidification on Virginia oysters

Catherine Czajka and Emily Rivest | Virginia Institute of Marine Science



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WATER QUALITY TOOL APPLICATIONS

Coastal Acidification in the Bay affects oysters

- Coastal acidification: changes in chemistry of Bay waters due to rising atmospheric CO₂, freshwater input, and nutrient runoff
- Acidification reduces pH and calcite saturation state, which makes shell-building harder for oysters

WATER QUALITY TOOL APPLICATIONS

Predicting effects of acidification on oyster shell growth at aquaculture leases

- Using CBEFS and EcoOyster
- Lease sites provided by VMRC
- '<u>Acidification exposure</u>' is quantified as time when calcite saturation state is below 0.93 (Rivest et al., in prep)

Model Domain

WATER QUALITY TOOL APPLICATIONS

By 2067, oyster lease sites will experience ~1 month more of acidification exposure

86% of oyster leases will experience an increase in exposure

Mean shell thickness will be reduced by 33% at oyster lease sites due to acidification

Shell thickness = ratio of shell weight to shell height

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Conclusions & Implications

- Oyster leases in Virginia will be exposed to unfavorable calcification conditions more frequently in the future
- Reduced shell thickness may leave oysters more vulnerable to predation or more difficult to shuck
- Aquaculture and restoration practices in the upper tributaries may be at risk

WATER QUALITY TOOL APPLICATIONS

Shellfish Thresholds and Aquaculture Resilience (STAR) Map

Oregon State University College of Earth,Ocean, and Atmospheric Sciences

Brian Katz | Oregon State University

WATER QUALITY TOOL APPLICATIONS

Oyster production is most sensitive to what factors?

Candidates:

- Baseline environmental conditions?
- Extreme weather "highs" & "lows"?
- Acidification exposure?

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e.g. Freshwater discharge extreme event, 2018-2019

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WATER QUALITY TOOL APPLICATIONS

e.g. Acidification exposure

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WATER QUALITY TOOL APPLICATIONS

Conclusions & Implications

- Acidification exposure does matter
- Effects on production vary by location, season
- Local context can inform adaptation strategies

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STAR Map