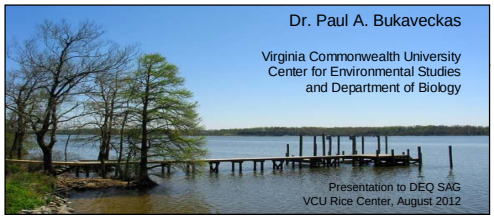
Science Advisory Panel for James River Chlorophyll Study: Activities 2011-12



Presentation Overview

Science Advisory Panel on Data and Modeling Needs for Assessing Numeric CHLa Criteria of the James River Estuary

- Objectives
- Approaches
- Progress to Date

Panel Members

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SAP Objectives

- Evaluating existing numeric CHLa criteria for the James. Are these scientifically defensible?
  - What are the approaches that may be used to develop CHLa criteria?
  - What do we mean by "scientifically defensible"?
- Assessment of the modeling framework for linking CHLa in the estuary with nutrient loads to the estuary.
  - What changes can be incorporated to the model for better fit with observed CHLa (hydrodynamics, grazing, etc.)?
  - How do these changes affect attainability (nutrient load-CHLa relationship)?

Approaches to Developing CHLa Criteria

- Balanced Community Approach
- Reference Condition Approach
- Water Quality Approach
- HAB Approach

1. What is the suitability of these approaches for developing James-specific CHLa criteria?
2. How do CHLa criteria differ when derived by various approaches?
3. Can we integrate results from multiple approaches to obtain a robust and scientifically-defensible CHLa threshold?

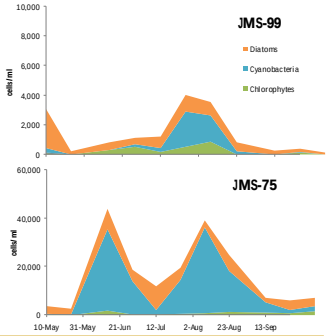
Approaches to Developing CHLa Criteria

Balanced Community Approach

- Eutrophication typically accompanied by simplification of algal communities and food-webs whereby a few species assume numerical dominance.
- DEQ developed seasonal and salinity-specific CHLa criteria intended to meet a statewide use designation calling for a "balanced, indigenous population of aquatic life in all waters" (DEQ 2004).
- Criteria to protect balanced communities were based on Bay-wide data that included historical CHLa concentrations and phytoplankton community composition characteristic of less nutrient-enriched conditions.

Balanced Communities

- Comparison of phytoplankton community composition at two sites in the tidal freshwater James River.
- JMS99 = low CHLa site; JMS75 = high CHLa site.
- Data from 2011.

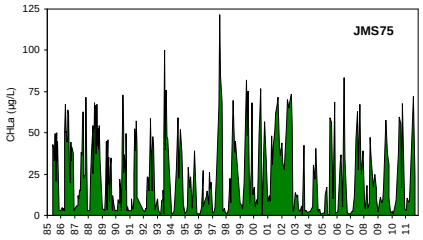


Approaches to Developing CHLa Criteria

Reference Approach

- The EPA (2007) reference-based assessment for CB used early historical data to characterize pre-impairment CHLa concentrations and define a desired threshold that would protect against excessive CHLa.
- CB data from the 1960's and 1970's were used to define historical reference conditions, though it was recognized that these do not represent pristine conditions.

James River CHLa Time Series

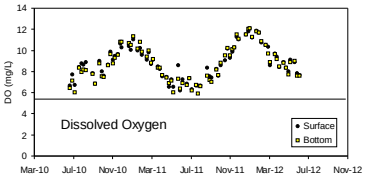


Long-term trends in CHLa (1985-2011) at station JMS75 based on monthly measurements by DEQ CBP.

Approaches to Developing CHLa Criteria

Water Quality Approach

- This approach seeks to establish CHLa criteria based on the contribution of algae to diminished water clarity and/or depletion of dissolved oxygen.
- Limited applicability to James – water clarity issues principally due to sediments, no dissolved oxygen issues (or pH).



Approaches to Developing CHLa Criteria

HAB Approach

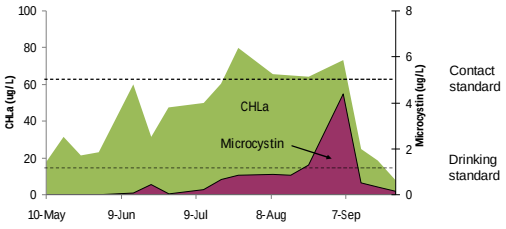
- HABs in the James: dinoflagellate blooms in saline segments and cyanobacteria blooms in tidal-freshwaters.
- Because HABs are often associated with high CHLa, a logical goal for numeric criteria is the prevention of these outbreaks.
- A key challenge to developing HAB-based criteria is that blooms of non-harmful species can also result in high CHLa thereby resulting in poor correlations between CHLa and cell densities of harmful taxa, or related parameters, such as toxin production. For harmful taxa which comprise a consistently large fraction of the phytoplankton community (e.g., cyanobacteria), correlations with CHLa will be stronger, thus providing a basis for CHLa-based criteria.

Deleterious Effects: Harmful Algal Blooms

Cyanobacteria blooms in the James.

- Algae produce chemical defense compounds (phytotoxins).
- In freshwaters, the most common are cyanotoxins produced by blue-green algae.
- Toxins are biomagnified in the food chain resulting in wildlife and human health concerns.
- In late summer, algal blooms in the James are dominated by cyanobacteria including known toxin-producing species (Microcystis).

Harmful Algal Blooms in the James



CHLa and cyanotoxins in the James River during 2011.

Summary: Approaches to Developing CHLa Criteria

- Balanced Community Approach
  - Basis for existing standard
- Reference Condition Approach
  - Potentially applicable if early historical data are available and demonstrate lower CHLa conditions.
- Water Quality Approach
  - Limited utility for James
- HAB Approach
  - Applicable but requires additional data on impairments from HAB events.

Getting Started

Key Questions

- Where/when/why do algal blooms occur?
- What are the deleterious effects of algal blooms?
- How do we model linkages between CHLa, impairments and nutrient loads?

Getting Started

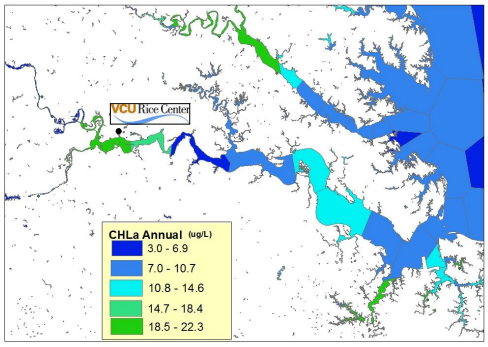
Key assets:

- DEQ-CBP Monitoring: long-term, continuous, high-level qa/qc sampling conducted at 12 stations in the JR Estuary (1985-present).
- University faculty (VCU, ODU, VIMS) engaged in James River research focusing on algal blooms, water quality, food webs and modeling.
- Research partners: VCU-City of Richmond Monitoring of Upper Estuary, HRSD Dataflow monitoring in Lower Estuary.

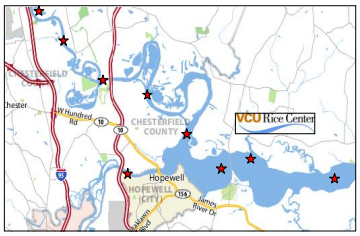
Getting Started: What we Know

- Upper JR Estuary
  - Chronic summertime algal blooms comprised of cyanobacteria
- Lower JR Estuary
  - Episodic blooms comprised of dinoflagellates unpredictable in time and space.

James River CHLa (Annual Average)



Algal Blooms in the Upper James

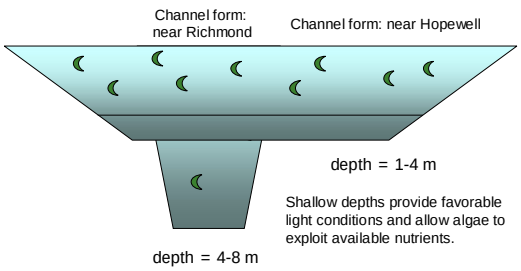


Sampling locations for VCU-City of Richmond James River Monitoring Program.

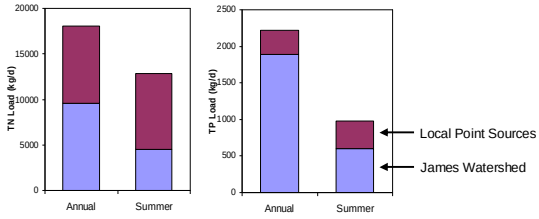
Persistent blooms occur in the region where the James transitions from a narrow, deep channel to a wide shallow channel.

The natural geomorphometry of the channel and proximal nutrient inputs foster persistent algal blooms that exceed current water quality standards.

Why Here? Depth effects on Algal Growth



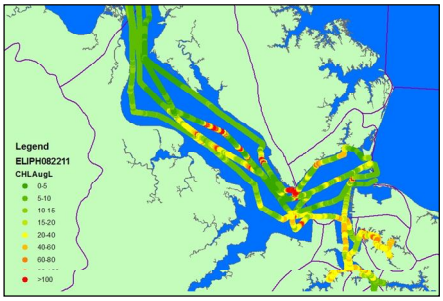
Why here? Nutrient Sources to James

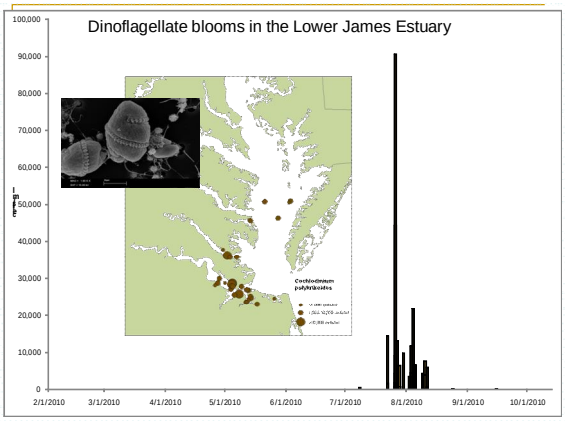


Data are average values for 2007-2010
Point Sources (PS) include WWTPs, Industry and Richmond CSOs.
Summer = May - September

Algal Blooms in Lower JR Estuary

Aug 2011





HABs in the Lower JR Estuary

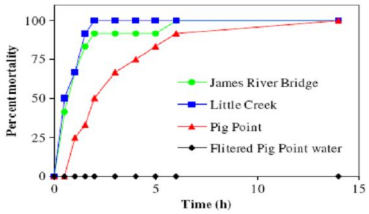


Fig. 12 Larval fish mortality after exposure to natural water samples collected from the lower Chesapeake Bay system containing bloom concentrations of *C. polykrikoides* on 6 Sept 2007

From: Gobler et al. 2008; Mulholland et al. 2009.

Progress To Date

SAP Proposed Workplan submitted to DEQ Nov-2011.

- SAP recommends that additional data are needed, and that further model evaluation is warranted, to assess existing CHLa standards for the tidal James River.
- Additional data needed to characterize the occurrence of blooms (e.g., intensity, duration, spatial extent) and to establish quantitative linkages between algal blooms and designated uses.
- Need to review and enhance modeling capabilities to allow accurate assessment of designated use attainment under various nutrient loading scenarios.
- 3-year data collection and model development phase (2012-14).

Data Collection Activities 2012

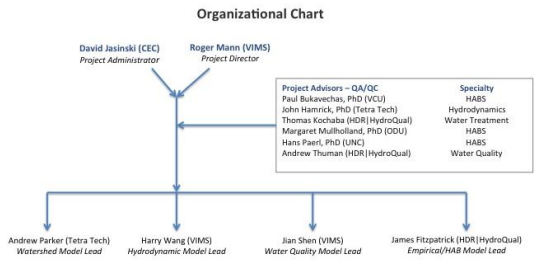
- Upper James Estuary (VCU)
  - Expanded monitoring of CHLa & phytoplankton.
  - Algal bioassay & grazing experiments
  - Monitoring Microcystin in water, sediments, biota.
- Lower James Estuary (VIMS, ODU, HRSD)
  - Expanded dataflow cruises including oligohaline
  - Continuous monitoring of CHLa & nutrients
  - Dinoflagellate toxicity tests

Modeling

Objective: a James River water quality model capable of predicting attainability of revised chlorophyll-*a* criteria and/or alternate criteria under various nutrient loading scenarios.

- What data are needed to support the preferred modeling approach?
- What is the sensitivity and uncertainty of the model?
- Is it possible to empirically model HABs?
- What is the feasibility of modeling top-down controls?
- What are the attainability/management implications of alternative criteria?

Modeling Project Team



Modeling Activities 2012

- Model review and selection
  - Watershed loading, hydrodynamics, water quality.
- Model Application
  - Data acquisition, empirical data analyses.

Upcoming SAP Activities

- Fall 2012 (4th Meeting)
  - Discussion of CHLa criteria & approaches
  - Results from 2012 data collection activities
- Spring 2013 (5th Meeting)
  - Planning for 2013 Data Collection Activities
  - Model Development