Eighth Science Advisory Panel Meeting for James River CHLa Study
Nov. 20, 2014

James River CHLa Study
Progress to Date and Upcoming Deliverables
- 2011: Workplan developed to guide data collection efforts
- 2012-14: Data Collection Activities, Model Development & Calibration
- 2015: Data Analysis and Panel Recommendations
  1. Are current CHLa criteria protective of designated uses?
  2. Does the new model provide more precise and scientifically defensible basis for setting load allocations?

Q1. Are current CHLa criteria protective of designated uses?
- Approaches to data analysis discussed at Data Workgroup Meeting (July 2014)
- Report on Data Analysis & Panel Discussion of Results (Nov. 2014)
  - Next: revision of report based on Panel review
  - Submission to DEQ for Review
  - STAC Review

Q2. Does the new model provide a more precise and scientifically defensible basis for setting load allocations?
- First presentation of model calibration results (Nov. 2014)
- Planned Model Workgroup Meeting (Jan-Feb 2015)
  - Present results for Panel review (April 2015)
  - Report due to DEQ (June 2015)
  - STAC Review

Today’s Meeting
10:00 am  Presentation of Empirical Relationships Report (Bukaveckas)
10:45  Break-out groups to discuss results from data analysis
11:15  Reporting of results from break-out groups
12:00  Lunch
12:30  Further discussion (as needed)
1:00 pm  Presentation on Model Calibration (Jian Shen & Jim Fitzpatrick)
2:00  Presentation of Modeling Results (Harry Wang)
2:30  Panel Discussion of Modeling Progress and Plans for Integration
3:00  End Meeting

Q1. Are current CHLa criteria protective of designated uses?
- What are the threats to designated uses?
  - Objective 1: Identify metrics (e.g., DO, pH, water clarity, phytoplankton IBI, HABs).
- Does the risk vary with CHLa?
  - Objective 2: Relate probability of exceeding thresholds to CHLa.
- What is the risk if CHLa standard is attained?
  - Objective 3: Assess risk based on expected distribution of CHLa at attainment.
General Approach

- Define metrics and thresholds of interest (e.g., DO < 5 mg/L; pH > 9).
- Calculate the probability of exceeding thresholds for observations pooled within CHLa ranges (e.g., 0-10, 10-20 µg/L).
- Derive combined probability of exceeding threshold at a given CHLa, and probability of occurrence for that CHLa for a range of mean CHLa values.
- Assess risk to designated uses for range of CHLa relative to current criteria.

Metrics Tested vs. CHLa

- Water quality
  - Daily minimum DO < 5 mg/L
  - Daily maximum pH > 9
- Water clarity
  - TF: algal contributions to TSS
  - OH, MH & PH: Percent Light through Water
- Phytoplankton community metrics
  - diversity, evenness, IBI scores
- HAB metrics
  - TF: Microcystin
  - OH, MH & PH: densities of harmful taxa (Cochlodinium)

HAB Metrics: Tidal Fresh

- Recent studies (Harding et al. 2014; Yuan et al. 2014) used human health end points (e.g., drinking and recreational contact standards) to assess risk to designated uses from Microcystin.
  - MC levels in the James have rarely (drinking) or never (contact) exceeded these standards (risk of impairment too low to assess with available data).
- For aquatic life, LC50’s for aquatic invertebrates are ~ 100’s – 1000’ µg/L (Smith et al. 2008); mortality effects unlikely in this system.
- Our focus: effects on ecosystem services provided by benthic filter-feeders (Rangia).

HAB Metrics: OH, MH and PH

- Toxicity assays for the dinoflagellate Cochlodinium. Data are cell densities causing >20% mortality. Red symbols are James-specific studies.

Data Used for this Analysis

- Data for various metrics and years:
  - DO, pH (ConMon)
  - CHLa, MC, TSS (weekly)
  - DO, pH (ConMon)
  - CHLa, NTU (Dataflow)
  - Phytoplankton (Dataflow)
  - P-IBI (monthly)
Results: Tidal Fresh – DO and pH

Tidal Fresh - all 5 metrics

Tidal Fresh

All metrics show relationships with CHLa and therefore support the view that CHLa criteria can be used to protect designated uses.

The risk to designated uses is a function of the probability of threshold exceedence in a given CHLa range, and the frequency of occurrence of CHLa values in that range.

<table>
<thead>
<tr>
<th>CHLa (µg/L)</th>
<th>p (DO&lt;5)</th>
<th>p (pH&gt;8.5)</th>
<th>p (Combined)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-30</td>
<td>1%</td>
<td>50%</td>
<td>0.5%</td>
</tr>
<tr>
<td>31-60</td>
<td>10%</td>
<td>35%</td>
<td>3.5%</td>
</tr>
<tr>
<td>61-90</td>
<td>50%</td>
<td>15%</td>
<td>7.5%</td>
</tr>
</tbody>
</table>

Assessing Risk

Current CHLa criterion for tidal fresh = 23 µg/L (Jul-Sep mean)

Lower James: DO & pH vs. CHLa

Increasing likelihood of elevated pH (>8) in CH and low DO (<5 mg/L) in pH with higher CHLa. Results from 2006-2008 Summer ConMon data.
**Water Clarity**

No observable effect of CHLa on water clarity (as % Light through Water). Results from dataflow mapping of Turbidity and CHLa. Thresholds based on SAV light requirements for MH/PH (23%) and OH (13%).

**Phytoplankton IBI**

Frequency of occurrence of phytoplankton communities rated as Poor condition based on IBI analyses of monthly CBP samples for 1986-2011.

**Phytoplankton Metrics**

Dinoflagellate contributions to phytoplankton biomass and community evenness in relation to CHLa. MH and PH samples collected during July-September 2011-2013. Lines denote mean values for observations binned by CHLa.

**HABs: Lower James**

Frequency of exceeding specified cell density thresholds of Cochlodinium in relation to CHLa. MH and PH samples collected in conjunction with dataflow cruises during July-September 2011-2013. Fluorescence-based CHLa converted to extracted equivalents.

**CHLa Distribution in Lower James Segments**

Proportional distribution of CHLa by year based on dataflow mapping of OH, MH and PH segments during July-Sept. CHLa <20 µg/L account for ~95% of measurements in all three segments.

**Assessing Risk**

Likelihood of exceeding specified thresholds for daily minimum dissolved oxygen (> 5mg/L) and abundance of Cochlodinium (>1,000 cells/ml) as a function of mean CHLa. Vertical dashed line denotes current CHLa criteria for MH and PH (10 µg L⁻¹).
Q1. Are current CHLa Criteria Protective of Designated Uses?

<table>
<thead>
<tr>
<th>Segment</th>
<th>Metric</th>
<th>Support needed for CHLa criteria?</th>
<th>Current criteria protective?</th>
</tr>
</thead>
<tbody>
<tr>
<td>TF</td>
<td>DO, pH</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Clarity</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>HAB</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>P-IIB</td>
<td>Yes</td>
<td>???</td>
</tr>
<tr>
<td>OI, ML, PH</td>
<td>DO, pH</td>
<td>Inconsistent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Clarity</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HAB</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P-IIB</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

*P-IIB results suggest that attaining CHLa criteria would not be sufficient to improve phytoplankton community condition.

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