VCU

Virginia Commonwealth University

James River CHLa Study
First meeting of Science Advisory Panel
Monday Aug 22, 2011
VCU Rice Center

Meeting Notes by P. Bukaveckas and C. Viverette

Agenda

10:00 am	Welcome by Melanie Davenport (DEQ) and Paul Bukaveckas (VCU)
10:15	Background on JR CHLa Criteria (Alan Pollock)
10:40	Algal Blooms in the Upper James River (Paul Bukaveckas)
11:05	Algal Blooms in the Lower James River (Margie Mulholland)
11:30	Occurrence of Harmful Algae in the James (Harold Marshall)
12:00 pm	Lunch Break
12:30	Modeling Algal Blooms in the James (Clifton Bell)
1:00	Introduction to Breakout Session
1:15	Break-Out Groups
2:45	Summarize Discussion from Groups, Future Planning
3:30	Adjourn Meeting

Dr. Paul Bukaveckas (VCU) welcomed the members of the Science Advisory Panel and guests to the VCU Rice Center. Participants introduced themselves and Dr. Bukaveckas provided an overview of the meeting agenda. Melanie Davenport (DEQ) thanked the panel members for their willingness to serve on this important panel to help DEQ navigate a complex problem. DEQ appreciates the experience and commitment the panel will bring to this challenge.

A series of presentations described the current state of science with respect to algal blooms in the James River Estuary. Alan Pollock (DEQ) described the development of the current numeric CHLa standard and the need to ensure that this standard is based on the best available science. Dr. Bukaveckas described the occurrence of algal blooms in the upper (freshwater) segment of the tidal James where CHLa consistently exceeds the current standard. Dr. Bukaveckas described the combination of factors, including channel morphometry, water residence time and proximal nutrient sources, which give rise to chronic bloom conditions in the region near Hopewell (river miles 69-75). Dr. Mulholland (ODU) gave a presentation on the lower James where blooms are largely ephemeral in time and place. Dr. Mulholland outlined the challenges to studying the blooms and identifying the causative factors which include water quality conditions, circulation patterns and potential contribution from sediment sources. Dr. Harold Marshall (ODU) described the types of algae occurring in the James River Estuary. Harmful algae in the upper James were largely cyanobacteria (e.g., Microcystis) that bloomed in late summer, whereas the lower James exhibited a seasonal succession of various dinoflagellates. Lastly, Clifton Bell (MPI) provided an overview of existing models related to CHLa and nutrient loads in the James. The models accurately depict hydrologic loading and residence time but there is greater uncertainty in modeling CHLa. The use of statistical-empirical models may provide a useful approach for linking algal blooms with impairments (e.g., harmful algae).

After the presentations there followed a break-out session of work groups committed to specific tasks. These included assessment of monitoring needs in the Upper and Lower James as well as assessment of modeling needs. For the purposes of this activity, the Upper James was considered the tidal freshwater zone (river miles ~110-50) and the lower James included the oligo-, meso- and poly- haline zones (river miles ~50-0). The participants were tasked with identifying a group leader and assembling a preliminary list of recommendations. Group leaders were: Paul Bukaveckas (upper James), Ken Moore (lower James) and Clifton Bell (modeling). The meeting concluded with reports from the individual groups whose discussions are outlined below.

Next steps in this process are for each group to develop workplans which will be presented at the next SAP meeting (tentatively, mid-October).

Notes from Break-out Session on "Monitoring Needs for the Upper James River"
Group Members: Bukaveckas, Buchanan, Davenport, Garman, Whitehurst

The discussion focused on two aspects of monitoring needs in the Upper (tidal-freshwater) James River: (1) characterizing the spatial and temporal extent of algal blooms, and (2) identifying and quantifying impairments associated with algal blooms. With respect to the former, it was felt that spatial coverage provided by current monitoring programs carried out by VA DEQ and VCU were adequate to characterize the spatial extent of blooms. Relatively small surface area and strong mixing of the upper estuary minimize the potential for localized blooms in this segment of the James (unlike the lower James). Prior data collection efforts using "data-flow" technology could be used to further evaluate this assessment. Our understanding of temporal variation in algal abundance is limited to monthly and weekly sampling intervals. Thus, we have little understanding of variation in CHLa at finer scales (e.g., days). Continuous (15 min) monitoring of CHLa is available from a single site (Rice Pier) which is located within the zone of highest algal abundance. The group felt that an explicit comparison of the continuous data with the weekly-monthly data from the nearby monitoring station (JMS75) would be useful in assessing CHLa variability. In the Potomac, mean CHLa values were similar between continuous and discrete monitoring but greater variability in CHLa was observed in continuous data. It is important to note that continuous data for the James are from a near-shore location whereas weekly-monthly data are from the main channel. Therefore, some consideration of potential lateral variation should be included in this assessment. It was felt that an expansion of the continuous monitoring with 1-2 additional sites should be considered as part of this project. Additional sites should be located on buoys to capture main channel conditions. This would require greater consideration of how data from continuous monitoring networks should be incorporated in water quality assessments. Lastly, it was noted that the present algal monitoring program does not take into account benthic algal production. There was a concern that improvements in water quality could lead to a shift from pelagic to benthic algal production which would not be detected in current monitoring.

Consideration of impairments arising from algal blooms in the upper James focused largely on the issue or harmful algae and particularly those that produce toxins. The group felt that a key issue in assessing impairments was to identify and quantify loss of resources (or resource value) attributable to algal blooms. In this context, non-toxic effects on living resources (such as diminished food quality due to the presence of cyanobacteria) would be difficult to establish as a basis for numeric CHLa criteria due to their subtle effects. The focus on algal toxins (if present) would provide a stronger basis for linking algal blooms with diminishment of resources. This would require enhancing current monitoring efforts to include detection of likely algal toxins (e.g., Microcystin) in sources (phytoplankton) and in components of food webs, particularly "high value targets" such as anadromous fish and apex predators. The 3-year monitoring program should capture a range of environmental conditions (i.e., temperature, flow) to adequately assess the occurrence of harmful algal blooms in the James. Monitoring of Microcystin could be augmented by the use of genetic techniques to isolate the occurrence of toxin-forming strains even during periods when toxins are not being produced. In addition to monitoring, it was argued that an assessment of toxin effects would require experimental data to directly link exposure with effects on taxa that were important components of the James food web. This would provide an empirical basis for justifying standards either for toxin concentrations directly or for proxy indicators (e.g., CHLa, phytoplankton IBI, cyanobacterial abundance) that were shown to be related to toxin concentrations.

<u>Notes from Break-out Session on "Monitoring Needs for the Lower James River"</u>
Group Members: Pollock, Marshall, Moore, Mulholland, Barron, Hunley

There was general consensus that current monitoring activities in the Lower James River were insufficient to characterize the occurrence of algal blooms and their impact on water quality. Specific areas of concern were (1) identifying the appropriate metrics to characterize algal blooms, (2) lack of spatial resolution in the current (fixed-station) monitoring program, and (3) the need for additional monitoring within the oligohaline zone.

The initial discussion focused on the relative merits of various parameters that could be used to measure the occurrence and severity of algal blooms. The measurement of chlorophyll a (CHLa) is useful given the large amount of existing data and the opportunities for automated data collection to provide enhanced temporal and spatial resolution. However, CHLa is present in all algae, of which harmful algae may comprise only a small fraction. The group considered the possibility of taking a tiered, probability- based approach whereby CHLa is used as a first screening tool. Values exceeding a certain threshold trigger the use of other metrics which may be more directly linked to algae that cause impairments (e.g., cell counts and pigments specific to certain groups such as dinoflagellates). Alan Pollock mentioned that in 2005, EPA published a document for HAB whereby a threshold CHLa value would trigger measurement of microcystin. A key issue for the panel to discuss is whether CHLa should be the basis for the numeric criteria, and if so, is there a companion metric that needs to be included? Harold Marshall indicated that there are levels of cell abundance at which harmful effects have occurred. Exceeding that value could be associated with the probability of ecological impairment occurring. However, threshold cell concentrations are more difficult to establish for taxa that do not produce toxins. Experimental studies with cell cultures may be needed to establish dose-response relationships.

A second point of discussion was the occurrence of "hotspots" – areas where localized algal blooms result in impairment. These pose a challenge from both monitoring and regulatory perspectives. For monitoring purposes, hotspots could be targeted for additional effort to supplement the current fixed-station approach. However, linking the occurrence of hotspots to causal factors could be problematic given unknowns such as local contributing sources of N and P, the influence of wind- and tidal- mixing patterns and the role of benthic re-suspension. Margie Mulholland made the further point that if we focus where the blooms are, we focus on where the problems are, but these blooms can be transported from the site where they originate. Margie also emphasized the importance of legacies both with respect to understanding sources of nutrients and from a regulatory framework (the disconnect between management actions and onset of water quality improvements).

In conclusion, the group felt that dinoflagellates should be the appropriate focus for assessing water quality impacts of algal blooms in the lower James but that further work needed to be done to characterize spatial and temporal variability and to link their occurrence to impairments.

<u>Notes from Break-out Session on "Modeling Needs for Linking Blooms, Impairments and Nutrient Loads"</u>
Group Members: Bell, Hofman, Benham, Wang, Lung, Tango

The early discussion focused on attainment issues and particularly the role of food web ("top-down") effects on algal abundance in the James. It was concluded that it was unlikely that oyster populations would be sufficiently restored within the time period required for this planning effort that they would constitute an important removal mechanism for algae. Clifton Bell noted that Chesapeake Bay models have a mechanism to include menhaden and oysters in the lower bay but it is minor. Arthur Butt noted resent research suggesting that oysters have a local, but not widespread, effect on phytoplankton abundance. For the upper James, the impact of Blue Catfish on food web structure needed to be understood before any trophic controls could be included in modeling efforts.

Discussion then moved on to data needs. There is a need for data mining activities to determine what data exists and what data needs to be collected to fill in the gaps. Eileen Hofman noted that in order to determine relationships for probabilistic modeling a lot of data mining and simulations will be required. Because it is more difficult to simulate many variables in a large model like the Chesapeake Bay model, the model could be broken down into smaller domains to run simulations. Once functional dependencies are determined using smaller models, they can be included in the larger scale model.

In order to try and focus discussion, Clifton Bell suggested that the group come up with a list of goals – what are the outcomes of this process the group wishes to accomplish? These included:

1) improving the Chesapeake Bay Model to make it more predictive of HAB's
    a. by region (upper and lower)
    b. add new approach to modeling which includes breaking model into smaller components and running simulations
    c. modeling HABS and algal toxins (e.g., microcystins)
    d. mixing empirical and deterministic methods (e.g. utilize empirical models to characterize levels of CHLa that indicate conditions that promote HABs, then use deterministic model to link those levels back to loadings).

    e. develop functional groups (id species or functional groups indicative of HABS in upper and lower James).

2) Determine if current CHLa criteria are adequate
    a. Understand relationship between HAB measures (e.g. ChLa , functional groups) and impairment
    b. Bring the above back to loads (Loads >indictors>impairments)
3) Probability of attainment
    a. How does above relate back to health and designated use attainment
    b. Understand uncertainty or assigning probability of attainment

Workplan:

1) Upfront Data analysis to understand relationships and functional dependencies
2) Pick key indicators
3) Address trophic cascades (e.g. oysters, menhaden, blue catfish as top down controls) and their impact on attainability
4) Evaluate suitability of available models and recommend improvements or alternatives to Ches Bay model.