NC Nutrient Criteria Development Plan – Scientific Advisory Council (meeting #3) 8/18/2015

Attendees

SAC members in attendance:

- Marcelo Ardon
- Bill Hall
- Lauren Petter
- David Kimmel
- Martin Lebo
- Linda Ehrlich
- Clifton Bell
- Astrid Schnetzer
- Deanna Osmond
- Charles Humphrey (alternate for Michael O'Driscoll)
- Hans Pearl (and alternate Nathan Hall)
- James Bowen

SAC meeting facilitator:

- Andy Sachs

NCDENR NCDP Team members in attendance:

- Steve Kroeger
- Carrie Ruhlman
- Tammy Hill
- Mike Templeton
- Connie Brower
- Pam Behm
- Jing Lin
- Christopher Ventaloro
- Jeff Manning
- Jucilene Hoffman
- Rich Gannon
- Cyndi Karoly

CIC members in attendance:

In person:

- Andy McDaniel
- Anne Coan

Online:

- Doug Durbin

Meeting notes

All questions, comments and answers are paraphrased

1. **Welcome, Agenda Review & Housekeeping** (Andy Sachs, Facilitator)
    a. SAC members, DWR staff and audience attendees provide names and affiliations.
    b. Facilitator asks for approval on meeting notes from 2nd SAC meeting.
    c. Facilitator reminds SAC that current ground rules allow members to invite audience members to speak if they desire and, that SAC members should decide as a group to allow audience members to participate in discussions.
2. **NC Lakes Report Discussion** (Steve Kroeger)

a. Regarding the report entitled *Classification and Exploratory Analysis of North Carolina Lakes Data for the Nutrient Scientific Technical Exchange Partnership and Support (N-STEPS)*
b. The report is meant as a product for discussion. It does not represent any policy decisions.
c. The report serves as an overhead view (30,000 foot level) of lakes in North Carolina.
d. Questions from SAC:
    i. Is the data used in the report available? → Answer: *Yes*.
    ii. Was only DWR data used? → Answer: *Yes*.
    iii. How were lakes determined to be dystrophic? → Answer: See below. Based on communication between Steve Kroeger and other NC DWR staff.

Dystrophic lakes are so classified if they have (1) naturally occurring acidic water, (2) have heavily stained brown or dark water due to the presence of suspended plant colloids and larger plant fragments, and (3) have naturally occurring low phytoplankton productivity (although the littoral zone may have a well-developed plant community that can completely dominate the metabolism of these lakes as a source of dissolved and particulate organic matter). Exposed peat deposits, often found on the bottoms of Bay Lakes, also contribute to tannin-stained water and low pH. In this state, dystrophic lakes occur primarily in the Coastal Plains and Sandhills Regions. Generally, all Bay Lakes are dystrophic, with the exceptions of a few lakes such as Lake Waccamaw and White Lakes which lack one of the criteria to be considered dystrophic. Man-made lakes in the Sandhills and Coastal Plains may also be classified as dystrophic due to both low pH and highly stained water (generally due to the presence of pines and/or cypress trees along the lake shore and in the lake watershed).

Accurate measurements of light penetration within the photic zones of dystrophic lakes are greatly reduced by the presence of naturally occurring suspended plant particles and colloids. As a result, accurate measurements of the lake's trophic state via the NC Trophic State Index are difficult to make. Phytoplankton productivity is also suppressed by light limitation due to the dark coloration of the water along with its low pH, despite the availability of nutrients found in some lakes.

3. **High Rock Lake - Data** (Jing Lin, NCDENR Modeling & Assessment Branch)
    a. Overview of the data that is available for High Rock Lake. Key points:
        i. We have a large amount of data for High Rock Lake extending back to 1973
        ii. 2005-2010 is the period that is used with the current lake model.
        iii. Watershed
            1. Land cover, soil types, point sources, monitoring and groundwater influence related to HRL watershed discussed.

a. Over 150 permitted discharges in watershed. 21 are major discharges (permitted to discharge over 1 million gallons per day). Most HRL point sources release <100,000 gallons per day
b. Largest point source is up to 30 million gallons per day from Winston-Salem
c. We have no direct measurement of groundwater input to the lake, but it is expected to be low based on surrounding geology and watershed model calibration results

2. TP, TSS and flow
    a. When flow is higher, TP & TSS are higher
    b. TP and TKN (to a less degree TSS) are positively correlated to flow, indicating that non-point sources may be contributing
    c. Three major dischargers (to Abbotts Creek) have TP limits (0.5 mg/L summer, 1 mg/L winter)
3. Nitrogen and flow
    a. Higher nitrate-nitrite during low flow and in the summer, when less dilution is available, suggesting that major source of nitrate-nitrite is point source.
    b. Dischargers do not have TN limits

iv. Lake Physical Characteristics
1. Vertical and temporal distributions for temperature, DO, pH, and conductivity discussed for the following lake monitoring stations:
    a. HRL051 (upper lake)
    b. YAD152A (mid – lake)
    c. YAD169F (lower lake)
2. Residence time in HRL is relatively low
    a. HRL = 4 to 50 days
    b. For reference, Falls Lake = 4-7 months

v. Lake Biochemical Characteristics
1. Discussed relationship between Chlorophyll-a and other indicators
2. Discussed relationship between Chlorophyll-a and nutrients

vi. Summary:
1. Chlorophyll-a is an indicator for algal density and community
2. Chlorophyll-a concentrations are influenced by physical factors such as flow and turbidity
3. High pH is likely caused by high algal growth
4. Bottom hypoxia mainly controlled by physical parameters
5. Summer Chlorophyll-a is positively correlated with TN
6. HRL appears to be N abundant, but during summer phytoplankton growth tends to be N-limited or co-limited by both N and P.

vii. Questions/comments:

1. When talking about algae density, what do you mean by a species being "dominant"? → Answer: *If the density of an algal group is >40% of the total we consider that algal group to be dominant.*
2. How did you decide on algal population values that correspond to severe blooms? → Answer: *The values of 30,000 for Total Unit Density and 5,000 for Total Biovolume were recommended to us by our DWR phycologist, Mark Vander Borgh, as being possibly indicative of severe blooms. They are provided on the graphs as references.*

4. **High Rock Lake – Watershed Model** (Pam Behm, NCDENR Modeling & Assessment Branch)
   a. HSPF (Hydrologic Simulation Program – FORTRAN) chosen as model platform
   b. Watershed model estimates what is happening on land that results in nutrient export to High Rock Lake and provides relative loading by source.
   c. High Rock Lake watershed details
      i. 3974 acres in NC and VA
      ii. 145 subbasins
      iii. Land cover
         1. 47% Forest
         2. 30% Pasture/Cropland
         3. 18% Developed
      iv. Population of 850,000
      v. Discharges and withdrawals
         1. 22 major dischargers (>1 MGD)
         2. 18 minor dischargers
         3. 21 water withdrawals
   d. Watershed model results:
      i. Describes where loading to HRL is coming from spatially as well as by source
   e. Questions/comments:
      i. Data analysis showed point sources are likely a major source of nitrate loading to the lake, how was nitrate assigned to point sources in model? Was there a base flow analysis? → Answer: *The process for assigning nitrate concentrations to point sources that did not report nitrate was as follows: if only NH3 was reported, 10 mg-N/L was assumed for NO3 and 2 mg-N/L was assumed for organic N. If both total N and NH3 were reported, the balance was assumed to be 83 percent NO3-N and 17 percent organic N. The latter case applied to the majority of point sources in the model.*
      ii. For agriculture areas, are crop and pasture represented together? They are very different. → Answer: *They are represented separately in the model.*
      iii. The loading coming from developed lands does not seem to be that much higher than loading from forested lands. Is there much that can be done? → Answer: *The scale of the unit area loading graph is an issue there. Also, recall that point sources*

are not included in developed land unit area loading, but if they were, the resulting loading would be much higher.

5. **High Rock Lake – Nutrient Response Model** (Jing Lin, NCDENR Modeling & Assessment Branch)
    a. Nutrient Response Model development
        i. Two types of models:
            1. Environmental Fluid Dynamics Code (EFDC) model
                a. Developed by TetraTech
                b. Hydrodynamic model
                c. 3-dimensional (Flow, temperature, surface elevation)
            2. Water Quality Analysis Simulation Program (WASP) model
                a. Developed by TetraTech and modified by EPA based on TAC comments
                b. Variables include DO, phytoplankton, organic matter, inorganic nutrients and TSS
                c. Does not target turbidity, does not simulate pH
        ii. Calibration of models
            1. Used Time series plots for visual comparison and statistical measures which were compared with criteria suggested by EPA
            2. Challenges:
                a. Data errors
                b. Model simulates average conditions within each model cell, whose typical size is 16-19 acres
                c. Field data were collected at one point in the lake from lake surface to the depth of two times of secchi disk
        iii. Model results
            1. WASP model TSS results are not great.
            2. TP & TN both model results and observations did not show much of a seasonal signal
            3. Nitrate-Nitrite shows seasonal signal
            4. Surface DO looks good with seasonal signal
        iv. Questions/comments:
            1. Why not model pH in association with phytoplankton → Answer: *This relationship is already established. If chlorophyll-a decreases, pH decreases.* By targeting chlorophyll-a, pH impairment is expected to be resolved.
            2. Is nitrogen fixation included in this model? → Answer: *No and we are not sure how important it would be to include it.*
            3. This is not just about the relationship between N & P. The process is energy dependent and could be related to light limitations.
            4. Do we have an idea about the nitrogen fixing abilities of cyanobacteria? → Answer: *Mark, during last meeting, mentioned that he has found*

cyanobacteria species that can fix nitrogen in High Rock Lake, nitrogen fixation potentially exists in the lake.

5. Did the data match what you think is going on in the system? Does it reflect actual conditions? → Answer: *Yes, we saw good agreement in the general trend. The model predicts well on the average conditions and the ranges of data.*
6. There is some disconnect between bioassay results and model results.
7. List of variable to predict attainability:
    a. pH – not on list
    b. Turbidity – not on list
    c. Chlorophyll-a – on list
    d. TP – on list
8. Did the model consider different algal groups? → Answer: *The model simulates two algal groups but the calibration only considers the total and chlorophyll-a is the parameter we used for calibration. The model is not calibrated for different algal groups so it is good only for chlorophyll-a.*

6. **High Rock Lake – Classification, Designated Use and Impairment** (Pam Behm, NCDENR Modeling & Assessment Branch)
    a. Impairment of High Rock Lake for chlorophyll-a is associated with the federal 303(d) list
        i. Questions/comments:
            1. Is there data that shows that this level of chlorophyll-a is not supporting aquatic life in HRL? → Answer: *See the slide on evidence that aquatic life use has been impacted. The biggest indicator is dominance of blue-green algae in summer blooms.*
            2. How will we measure the impact of chlorophyll-a on aquatic life? → Answer: *This is why we are here. Tasks given to SAC during the first meeting include evaluation of the current standard.*
            3. Why is high dissolved oxygen not listed as an impairment? → Answer: *High dissolved oxygen was once listed on the 303(d) list under the total gases standard (and was later removed after it was decided that this was not a proper use of the total gases standard). The DO standard is not written to address* super-saturated DO conditions
            4. Is there a baseline for chlorophyll-a severity? Is there an indication that algal blooms are getting worse? → Answer: *Not sure. We have limited historical data so we can't draw definite conclusions on this. But there has been consistent documentation going back to the 1970's that blue-green algae blooms are common in High Rock Lake.*

7. **High Rock Lake Discussion and Brainstorming**
    a. Formulating and/or modifying the goal
        i. The following goal, as developed by the NCDENR NCDP team was presented to the SAC members to discuss and modify:

1. Goal: Reduce the severity of algal blooms in High Rock Lake to protect aquatic life.

ii. Group #1
   1. Asked: How do we get to a goal?
      a. Some concerns:
         i. Is the existing situation at HRL actually a problem?
         ii. Show us the impairment.
         iii. We have no data to illustrate the impairment.
      b. Conclusion:
         i. We have to get over this hurdle of not having sufficient data to look at. It may be useful to look at other freshwater systems in NC to use as a reference.

iii. Group #2
   1. Conversation was similar to group #1
      a. The goal, as stated, just reduces the level of chlorophyll-a, but we don't know if there actually is an impairment to aquatic life.

iv. Questions/comments:
   1. The concern over the potential for cyanotoxins provides motivation for us to move ahead. It would be useful for us to be able to measure for toxins.
   2. Discussion concerning whether to focus on the lake and deal with potential impacts to downstream uses vs. considering the lake and downstream uses from the start.
   3. Discussion concerning the goal provided by NCDENR staff.
      a. Thoughts:
         i. The goal, as stated, may be too specific. We list all uses.
         ii. Need to understand what is appropriate for this system.

v. Final High Rock Lake Water Quality Goal as agreed on by the SAC:

"To provide for the protection of designated uses in the HRL reservoir by defining and proposing the appropriate level of algal related indicators for each of the following uses:

- *Aquatic Life*
- *Fishing*
- *Fish Consumption*
- *Wildlife*
- *Secondary Recreation (e.g. wading, boating)*
- *Agricultural uses (e.g. irrigation)*
- *Water Supply*
- *Lower lake: Primary Recreation – full human body contact (e.g. swimming, water skiing)"*

b. Indicators and criteria

i. Group #1
    1. Talked about where to go from here?
        a. Using monitoring to provide more information on the current conditions
        b. Toxin monitoring
            1. There are methods that are cheap to do
            2. Astrid and Hans have info on these
        c. Establish a base line for current conditions so as not to make it worse
    2. What information do we have for High Rock Lake that can link the following together:
        a. Toxins
        b. Excessive biomass
        c. Impacts on indigenous populations
ii. Group #2
    1. Aquatic Life use
        a. pH
        b. DO
        c. Algal toxins
        d. Biovolume as a better indicator than unit density for aquatic life
    2. Fishing use
        a. Quality of fishery
    3. Recreational uses
        a. Algal toxins
        b. Cyanobacteria density
        c. Reported incidents of adverse impacts to recreation users.
    4. Water Supply use
        a. Algal toxins
        b. Taste & odor