NC Nutrient Criteria Development Plan – Scientific Advisory Council (meeting #2) 7/21/2015

Attendees

SAC members in attendance:

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

SAC meeting facilitator:

- Andy Sachs

NCDENR NCDP Team members in attendance:

- Steve Kroeger
- Carrie Ruhlman
- Tammy Hill
- Mike Templeton
- Jim Hawhee (+ colleague)
- Connie Brower
- Pam Behm
- Jing Lin
- Christopher Ventaloro

CIC members in attendance:

In person:

- Andy McDaniel

Online:

- Anne Coan
- Doug Durbin
- Bill Kreutzberger
- T.J. Lynch

Other NCDENR staff in attendance:

- Mark Vander Borgh
- Rich Gannon (online)

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. Andy review ground rules.

c. Bill Hall comments that he feels it might be useful for audience members to be allowed to participate during SAC meetings.
    i. Andy reminds SAC that current ground rules allow members to invite audience members to speak if they desire and,
    ii. That it is up to the SAC members to decide if they want to allow audience members to participate and to what degree.

2. **DWR Division Update** (Steve Kroeger)
    a. Request that SAC members submit the names of any alternates in advance.
    b. Informs SAC that High Rock Lake data will be made available on the NCDP webpage.
    c. Discusses CIC.
        i. Announces the names of the CIC members and states that they are attending this meeting via webinar.
        ii. Announces CIC meeting date (August 5, 2015)
    d. Discusses N-STEPS program
        i. DWR is discussing the N-STEPS Program with EPA region 4
        ii. NC DWR lakes report (Analysis Report for Classification and Exploratory Analysis of North Carolina Lakes Data for the Nutrient Scientific Technical Exchange Partnership and Support (N-STEPS)) is currently under review.
        iii. Albemarle Sound information and data review is being conducted by Tetratech.

3. **DWR Monitoring Programs** (Steve Kroeger, NCDENR)
    a. Steve gives a brief overview of the different DWR monitoring programs. He discusses:
        i. An overview of DWR physical & biological monitoring
        ii. The purpose of DWR monitoring programs
        iii. The frequency of monitoring
        iv. The 5-year rotating basin sampling regime
        v. Physical-Chemical monitoring
        vi. Biological community assessment
        vii. Monitoring in lakes & reservoirs
        viii. DWR resources for monitoring
    b. Questions and comments:
        i. Clifton Bell asks: Does DWR do routine visual observations?
            1. Steve answers: No.
        ii. Martin Lebo asks: Has the assessment of macroinvertebrates been extended to estuaries?
            1. Steve answers: No.
        iii. Michael O'Driscoll asks: Does physical sampling include sampling for stormwater events?
            1. Steve answers: No. Sampling is prescheduled. It would be difficult to do routine stormwater event sampling. Stormwater events can be sampled for special studies.
        iv. Bill Hall asks: Does DWR do periphyton sampling?

1. Steve answers: No.

4. **High Rock Lake - Chlorophyll a** (Pam Behm, NCDENR)
    a. Pam describes the history of the HRL watershed.
        i. HRL is an impounded reservoir that was created in 1928.
        ii. Owned and operated by Alco Power Generating, Inc.
    b. Mentions that the NCDP team has gathered some fish health data for HRL and that it is posted on the NCDP website.
    c. Goes over the impairments that exist in HRL
        i. Chlorophyll-a in arms
        ii. Chlorophyll-a and turbidity in upper portion of lake
        iii. Chlorophyll-a, turbidity, and high pH mid-lake
        iv. Chlorophyll-a and high pH in the lower portion of the lake
        v. Nathan Hall questions the "no impairments" label for the section of the Yadkin River leading into HRL. He asks if there really is no impairment and finds it unlikely that it would not be impaired for turbidity.
            1. Pam answers: a drop in turbidity impairment was seen here, but not sure why. We will need to review the listing history.
        vi. Bill Hall asks: is there impairment for dissolved oxygen in HRL?
            1. Pam answers: No DO impairment was observed, but stresses to keep in mind that our sampling is typically done at one point in time during the day, where surface DO is typically super-saturated. For lakes/reservoirs impairment assessment, the NC DO standard is only applied to surface layer and would only result in DO impairment for measurements below 4.0 mg/L. There is no diurnal information available.
            2. Discuss DO further at the next SAC meeting
    d. Pam specifies question for the SAC concerning HRL
        i. Is the current chlorophyll-a standard, as applied, appropriate to maintain biological integrity?
        ii. How to best determine appropriate numerical N & P criteria?
        iii. Also,
            1. What can be considered a "natural" frequency of occurrence for cyanobacteria blooms?
            2. How much is too much?
    e. Tasks for SAC
        i. What concentration/frequency/duration of chlorophyll-a is appropriate to protect aquatic life?
        ii. How to express N & P?
        iii. Is the chlorophyll-a water quality standard enough as a response indicator?
        iv. Are other response indicators appropriate?
        v. Would resulting criteria translate to other lakes?
    f. For next SAC meeting:

i. Review existing HRL data
ii. Review existing tools
    1. Watershed model
    2. Nutrient response model

5. **High Rock Lake Algae** (Mark Vander Borgh, NCDENR)
    a. Mark discusses the available algal data for HRL. He covers how and when samples have been collected, how they were processed and examined and what species have been identified.
        i. Sampling conducted: 2002, 2004, 2005, 2006, 2008-2010 plus 2011 (never analyzed).
        ii. Describes sampling and analysis methods including the different algal density and biovolume determination methods.
        iii. Michael O'Driscoll asks: Is there any data available that precedes Mark's data so to make historical comparisons?
            1. Mark answers: yes, but he does not have it. Can we find this data?
        iv. What was found in HRL:
            1. 140 alga taxa. ID'd to genus.
            2. Most common were: cryptomonads, diatoms and pseudanabaena (blue-green).
            3. Pseudanabaena:
                a. Present in 83% of assessments.
                b. Blooms throughout water column.
                c. Recent science shows that it is a toxin producer.
            4. Cylindrospermopsis of particular concern.
                a. Present in 44% of samples.
                b. Produces cylindrospermopsin cyanotoxin.
                c. We have no data for this organism
                d. Can be stratified in water column.
        v. Nathan Hall asks: Are cyanobacteria displacing other species or are they occurring together?
            1. Mark answers: It is hard to tell definitively, but he thinks they are not displacing other species.
        vi. How does HRL compare to other lake/reservoirs?
            1. HRL is very similar to other lakes/reservoirs that occupy similar ecoregions.
            2. HRL is unlike mountain lakes.
    b. Questions/comments:
        i. Clifton Bell asks: Does DWR count hetercytes (nitrogen-fixing)?
            1. Mark answers: No, and they aren't required for nitrogen fixation to occur.
        ii. Astrid Schnetzer asks: How far down in size do you count?
            1. Mark answers: Down to 2 microns for colonial species, but counts get fuzzy at that point.

iii. Astrid Schnetzer asks: How do you count organisms that leave the field of view?
    1. Mark answers: We follow the procedure laid out in our SOP.
iv. Linda Erhlich asks: Is there a high measure of chlorophyll-a when blue-greens are dominant?
    1. Mark answers: Chlorophyll-a is not the dominant pigment in blue-greens. If you see a high chlorophyll-a count and a high density of blue-greens you would be underestimating the level of blue-greens if you were to rely on the chlorophyll-a count alone.
v. Bill Hall asks: What changes in HRL between March and July?
    1. Mark answers: Temp, pH, light, geology are all changing.
vi. David Kimmel asks: Do we use biovolume?
    1. Mark answers: We use cell/ml, biovolume and units/ml together.
vii. David Kimmel asks: Do we use convert to biomass (carbon:chlorophyll-a)?
    1. Mark answers: No, this can get complicated.
viii. Michael O'Driscoll asks: Have we noticed any patterns related to the added nutrient inputs/flows due to stormwater?
    1. Mark answers: I would expect it to.
ix. Nathan Hall asks: When cyanobacteria are at 80% at the end of summer what fraction of the biovolume are they?
    1. Mark answers: They are completely dominant.
x. Astrid Schnetzer asks: What type of sampling are we doing?
    1. Mark answers: We sample at 2x the secchi depth. It is an integrated sample.
xi. Marcelo Ardon asks: Has there been changes in the Secchi depth over time?
    1. Mark answers: It changes with seasonal variation.
xii. Astrid Schnetzer asks: Is the chlorophyll-a size fractionated?
    1. Mark answers: No.

6. **Overview of Approaches for Numeric Nutrient Criteria Development** (Tiffany Crawford, EPA)
    a. Tiffany provides an overview on approaches that can be used to derive numeric nutrient criteria. Topics discussed:
        i. Assessment endpoints
            1. Can use EPA's ecological risk assessment framework in assessment of endpoints.
            2. Lake case study:
                a. Management goal
                b. Lake conceptual model
                c. Linking endpoints to criteria derivation
                d. Refining the conceptual model
                e. Deanna Osmond asks: Do you not set endpoints or make a statement identifying uncertainty?
                    i. Tiffany answers: If you don't have quantitative measurements you don't use it.

f. David Kimmel asks: How do you implement a management goal?
    i. Tiffany answers: States must be able to justify what they come up with.
g. Some questions about the conceptual model example.
    i. Answer: Basically, must take care when defining goals, uses and narrative statements.
h. Michael O'Driscoll asks: Does the final goal have to be a concentration?
    i. Tiffany answers: No.
i. Lessons learned:
    i. Ecological risk assessment framework is a valuable tool to derive criteria
    ii. Assessment endpoints clarify what is being protected
    iii. The most sensitive endpoints should be used.
    iv. Possible to identify many endpoints, but may not have enough data to derive criteria for each one.

ii. Tools for numeric nutrient criteria development
1. Reference condition approach.
    a. Protecting the best of what's left.
    b. Select sites that reflect management goals.
    c. Deanna Osmond asks: How do you choose reference conditions for man-made lakes?
        i. Tiffany answers: Use Reference Period Approach (see below)
    d. Classification of reference sites.
    e. Data quality and quantity including selection of defensible percentiles.
    f. Reference period approach.
    g. Case study: Reference Period Approach in Estuaries
2. Stressor response approach.
    a. Most states rely on this to derive criteria.
    b. EPA has a 2010 guidance document
    c. Data requirements:
        i. Data must be nominally matched in space & time.
        ii. For estimating a simple linear regression must have minimum of 10 independent samples per degree of freedom.
    d. Thresholds for response.
        i. Should link directly to an assessment endpoint.
    e. Unexplained variability

i. Minimize when possible (ex: use annual average or geometric mean, not both).
ii. Account for unmodeled factors. These may need to be considered in the big picture, but create noise.

f. Approaches for addressing variability.
i. Classification
1. TREED models
2. Astrid Schnetzer asks: What is a TREED model?
a. Tiffany and David Kimmel answers: It's a classification and data tree. Does not rely on normalized data and is non-parametric.
ii. Hierarchal models.

g. Precision of stressor-response models.
h. Clifton Bell asks: has EPA addressed staying from making cause-effect relationships based on stressor-response approach?
i. Tiffany answers: Don't get wrapped up in causality. That can be found in the literature. Defining a good threshold and the data in the same way can help avoid this.

3. Mechanistic modelling.
a. What is a mechanistic model
b. Types of mechanistic models
c. Why model?
d. How to use water quality models.

iii. Questions/comments:
1. Clifton Bell states: For HRL we have a mechanistic model. Rather than setting a target upfront we may need to assess past data to see what is doable and appropriate.
2. Pam Behm asks: How do we use the model to determine if the chlorophyll-a standard is appropriate and how do we do this for N & P?
a. Tiffany answers: You can run the model for a background reference period. You can consider using data from when the lake was created. Also look at existing levels and remove impairment conditions to help define background.
b. Lauren Petter adds: You can turn off certain loadings to help establish background. Use a feasibility analysis to bound it.
c. Clifton Bell adds: Concerned that this would not be appropriate to screen out loadings.
d. Lauren Petter responds: It's just a way to estimate background.
3. Bill Hall comments: Reservoirs have a design life. Conditions are expected to change so comparing historical conditions to current conditions may not be appropriate.

a. Nathan Hall responds: Some analysis has been done comparing older and newer reservoirs. See Brant Touchette (NCSU).

4. Michael O'Driscoll to Pam Behm: Is a nutrient budget available for HRL?
5. Bill Hall to Pam Behm: Can an empirical analysis be done for chlorophyll-a and nutrients for HRL?
6. David Kimmel interjects: Statistical warning. Percentiles are based on variability of data. Mechanistic understanding usually linear, but most environmental data is not. TREED models may not produce appropriate natural breaks.
7. Bill Hall comments: Lake impairment needs to be defined. What is use? Why is use impaired? How do we link impairment to assessment goal.
8. Linda Erhlich comments: We may need data on unmodeled factors.
9. Martin Lebo comments: A set of uses must be defined. It is possible that we end up impairing for one use while protecting other uses.

7. **NNC Methodologies and Criteria in R4 States** (Lauren Petter, EPA)
   a. Lauren provides an overview of how other EPA region IV states have implemented nutrient criteria.
      i. Alabama
         1. Chlorophyll-a only for 40 lakes and reservoirs.
      ii. Florida
         1. Chlorophyll-a, TP, and TN for most waters, nitrate-nitrite for springs.
            a. Deanna Osmond asks: Does Florida have a lot more data than other states?
               i. Lauren responds: Yes.
            b. Astrid Schnetzer asks: Is seasonality accounted for in this approach?
               i. Lauren responds: Yes, there are summer and winter bounds.
            c. Clifton Bell asks: Is this a stressor-response approach?
               i. Lauren responds: No, this is a combined criteria approach.
            d. Pam Behm asks: Do they record the frequency of sampling for geometric means and how does the single sampling location protect the entire lake?
               i. Lauren responds: Alabama feels that the sampling sites are representative, but they can add sites if necessary.
      iii. Georgia
         1. Chlorophyll-a, TP, TN for 6 lakes.
      iv. Kentucky
         1. Nutrient narrative provisions only.
      v. Mississippi
         1. Nutrient narrative provisions only.
      vi. North Carolina

1. Chlorophyll-a for trout and non-trout waters state-wide.

vii. South Carolina
1. Chlorophyll-a, TP, TN for lakes/reservoirs > 40 acres.

viii. Tennessee
1. Chlorophyll-a for 1 lake, translator for TP and nitrate-nitrite for wadeable streams.

b. Questions/comments
i. Connie Brower asks: Alabama only has one point where standards are applicable. Would this approach be approved now?
1. Lauren responds: EPA is still working to get them to fully address their water bodies.
ii. Michael O'Driscoll asks: Regarding water body classifications, has anyone done anything with regard to urban vs. rural streams?
1. Lauren responds: Not aware of anyone doing this.

8. **A Critical Examination of Nutrient Criteria Development using Weight of Evidence/Stressor-Response Methods** (Bill Hall, Hall & Associates)
a. Bill provides a brief definition of what criteria are. He then presents a number of case studies that used weight of evidence/stressor-response evaluation to develop numeric nutrient criteria and discusses where, in each case, things were done well or problems arose.
i. Case studies included:
1. Streams
a. Southeast Pennsylvania
b. Jackson River, Virginia
c. Colorado WQS
d. Alternative approaches
2. Lakes
a. Florida
b. Minnesota
3. Estuaries
a. Great Bay
ii. Things to look out for based on case studies:
1. Cannot assume a cause and effect relationship, must demonstrate it.
2. Other controls besides limiting nutrients may be needed to control algal growth. Ex: periphyton control is nearly impossible using only nutrient controls.
3. Must take into account all evidence not just that which supports a desired result.
4. Is it appropriate to use literature references from studies in different ecoregions?

5. Relationships between nutrient concentrations and macroinvertebrate health are difficult to establish. Does biological assessment relate to nutrient criteria?

9. **Case Studies on Water-Body Specific Numeric Nutrient Criteria** (Clifton Bell, Brown & Caldwell)
    a. Clifton discusses the drivers behind the establishment of water-body specific nutrient criteria, some major variations in approaches to establish criteria, and three case studies involving lake/reservoir, river/stream and estuary systems.
    b. Tension exists when establishing nutrient criteria between the need for regulatory simplicity vs. accuracy. Regulatory simplicity leads to the development of default concentration-based numeric nutrient criteria while technical accuracy provides a more predictive approach that is water-body specific.
    c. Major drivers of water-body specific approaches
        i. Variability between water bodies
        ii. Attainability vs. diminishing returns
        iii. High costs of nutrient control
    d. Nutrient criteria can be based on:
        i. Concentrations (nutrients and response variables), or
        ii. Loads, or
        iii. Translator mechanisms.
    e. Common elements of successful water-body specific approaches:
        i. Response variables that indicate use attainment for the water body
            1. Human health
            2. Ecological
            3. Aesthetic
        ii. A means to relate those nutrients to those response variables.
    f. Case studies:
        i. Case study #1 - Integrated Criteria for Arizona Lakes/Reservoirs:
            1. Arizona sought to revise nutrient criteria for lakes/reservoirs.
            2. Determined target ranges more scientifically defensible than single values.
            3. Characterized lakes/reservoirs (shallow, deep, sedimentary, urban, ingneous).
            4. Established criteria using thresholds.
            5. End result:
                a. Includes numeric and narrative components.
                b. Requires further guidance for mid-range variables.
        ii. Case study #2 – Using a Model to Set Nutrient Goals for Wadeable Streams.
            1. Colorado wadeable streams affected by urban runoff, wastewater and agriculture.
            2. Developed a model to determine if current end-of-pipe limits and in-stream targets were attainable.
            3. Challenges:

a. High pH
b. Current chlorophyll-a target shown to be unattainable even with the elimination of all anthropogenic sources.
c. Easier to control algae with phosphorous controls

4. Questions/comments:
   a. Michael O'Driscoll comments: This is more challenging in the high plains where there is more flow.
   b. Nathan Hall asks: What was driving the high pH?
      i. Clifton answers: Partly algal respiration, partly geography.

iii. Case study #3 – Brief History of James River Estuary Chlorophyll-a Standards.
1. James River estuary stretches from Richmond to Hampton Roads, Virginia.
2. Nutrient-related issues such as chlorophyll-a peaks with cyanobacteria, including *Mycrocystis aeruginosa,* in the tidal freshwaters and periodic blooms of potentially harmful dinoflagellates in the lower estuary.
3. Timeline:
   a. 2004-2005 – VA adopts subjective chlorophyll-a criteria.
   b. 2010 – USEPA model predicts ~$1 billion needed for addition nutrient controls.
   c. 2011-2015 – VA conducts the James River Chlorophyll-a study.
      i. Results of study:
         1. Focus on Mycrocystin in tidal freshwaters with the primary impairment of concern being the behavioral effects of microcystin on aquatic life.
            a. Used a combined probability approach for determining risk.
         2. Potential linkages between chlorophyll-a and uses.
            a. Bioassays used to establish a link between the risk of aquatic organism mortality associated with *Cochlodinium polykrikoides* and Chlorophyll-a concentrations.
            b. Defensible chlorophyll-a criteria ranges defined.

iv. Conclusion:
1. Due to the large costs involved in nutrient control, the effect of nutrients on designated uses must be understood before developing criteria.
2. Water-body specific approaches result in better management of nutrients.
3. Methods and tools already exist.

v. Questions/comments:
1. Lauren Petter asks: What is the water body type with the most concerns?
   a. Clifton answers: Streams. For most states periphyton is of major concern. Data suggest that this cannot really be controlled with

nutrient controls unless nutrient levels are extremely low. Probably need to look at other variables (pH, DO, etc…) in these cases.

2. Astrid Schnetzer asks: For estuaries, do other states go into frequency and duration?
    a. Lauren Petter answers: Don't think Florida got into that. They focused on SAV and water clarity.
3. Astrid Schnetzer asks: How do we resolve ephemeral instances of algal blooms?
    a. Tiffany Crawford answers: Florida had a range of criteria based on a lot of data.
4. Clifton Bell comments: Regarding bioassays vs. field studies, bioassays tend to be more conservative.
5. Nathan Hall asks: Are their suitable reference sites for HRL that are not impaired?
    a. Linda Erhlich asks: Is Lake McIntosh in Burlington a suitable reference site?
        i. Pam Behm answers: It is not similar to HRL.

10. **Wrap-up** (Steve Kroeger)
    a. Logistics:
        i. We will submit travel forms for last meeting.
        ii. Need to think of meeting schedule for after August.
        iii. We will set up a doodle poll with suggested dates for SAC to choose from.
    b. Water-body classification:
        i. How will we approach this?
    c. N-steps:
        i. We will send out deliverables as they become available.
    d. Next meeting (August 18, 2015):
        i. Will focus on High Rock Lake.
11. **Last thoughts**:
    a. Bill Hall: Define impairments for HRL.
    b. Martin Lebo: What are we protecting?
    c. Linda Erhlich: Appreciated hearing about other states.
    d. Clifton Bell: Define impairments for HRL. Our desire to limit algae may not be reasonable.
    e. Nathan Hall: Curious if any reference sites for HRL exist.
    f. Michael O'Driscoll: Want to understand more about the hydrogeology of HRL and how we may compare it to other lakes to find a suitable reference site.