NC Nutrient Criteria Development Plan – Scientific Advisory Council (meeting #11) 1/25/2017

Attendees

SAC members in attendance:

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

SAC members online:

Bill Hall

SAC meeting facilitator:

Andy Sachs

NCDEQ DWR staff in attendance:

Jim Hawhee
Tammy Hill
Mike Templeton
Connie Brower
Pam Behm
Jing Lin
Christopher Ventaloro
Jeff Manning
Jucilene Hoffman
Cyndi Karoly
Bonghi Hong
Nora Deamer
Brian Wrenn
Rich Gannon
Joseph Smith
Raj Rjbhandari
Elizabeth Fensin

CIC members in attendance:

In person:

Andy McDaniel

Meeting notes

All questions, comments and answers are paraphrased

1. **Convene** (Andy Sachs)
    a. SAC members, DWR staff and audience attendees provide names and affiliations.
    b. Facilitator asks for approval on meeting notes from October 19th, 2016 SAC meeting (meeting #10)
        i. Comments:
            1. Martin: Army Corps. of Engineers Is incorrectly recorded as Army Core.
2. **Synopsis and discussion: High Rock Lake special study** (Jason Green)

a. See slides here
b. Study review
    i. The 2016 special study of HRL was conducted from July-September.
    ii. Sampling was conducted at four locations:
        1. In the upper, middle & lower portions of HRL and
        2. In a major tributary
    iii. Two floating platforms were used to collect diurnal data at the following stations:
        1. Static station – data collected here throughout the study)
            - YAD 152C
        2. Roaming stations – floating platform was moved at 2-week intervals
            - YAD HRL051, YAD069AS, YAD169B
    iv. Data was collected near surface (photic zone) and near bottom. Platforms secured with multiple anchors. No vandalism occurred.
    v. Platforms and instrumentation were inspected and serviced at 2-3 week intervals.
c. Data collected
    i. The following data was collected at 24-hour intervals at each platform:
        1. Depth
        2. pH
        3. Temp
        4. Conductivity
        5. Total Dissolved Solids
        6. Total Algal RFU
d. Data accuracy
    i. Biofouling was a concern
        1. Growths of bryozoans and rotifers, detritus
    ii. Site visits included the following actions:
        1. Locating the equipment/meters
        2. Gathering “dirty” data
        3. Cleaning and inspecting equipment
        4. Calibrating instruments
            - Calibration for chlorophyll-a was done using a Rhodamine WT dye.
        5. Collecting current ambient water quality data
e. Data products
    i. Diurnal data
        1. Jason reviews some examples of the diurnal data
        2. Correction factors were used for:
            - DO (concentration - mg/L)
            - DO (% saturation)
            - Total algal (RFU)

3. Excel spreadsheets of the raw and corrected data will be made available to SAC members

ii. Caveats concerning chlorophyll-a data
   1. YSI documentation discusses the value of this data
   2. Variability in data
   3. Comparison to lab analysis

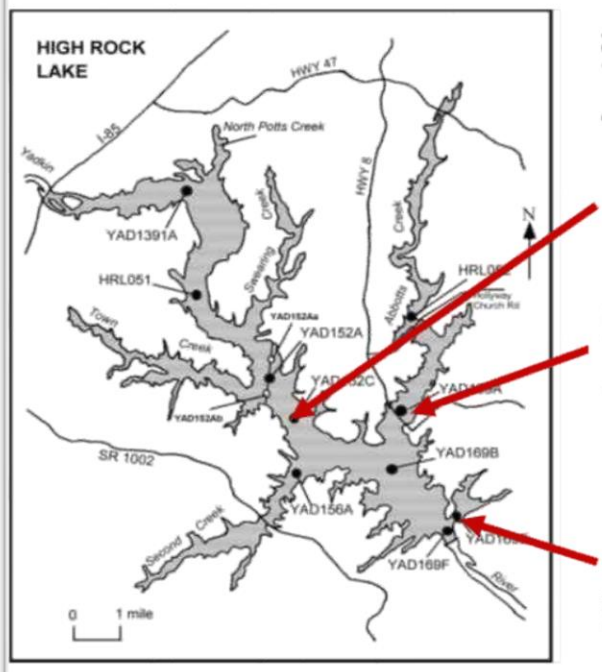
iii. pH data looks good
   1. pH ranged from 7.5 to 10+ S.U.
   2. Diurnal expression was apparent
   3. Data was consistent with typical characteristics associated with hypereutrophic lakes

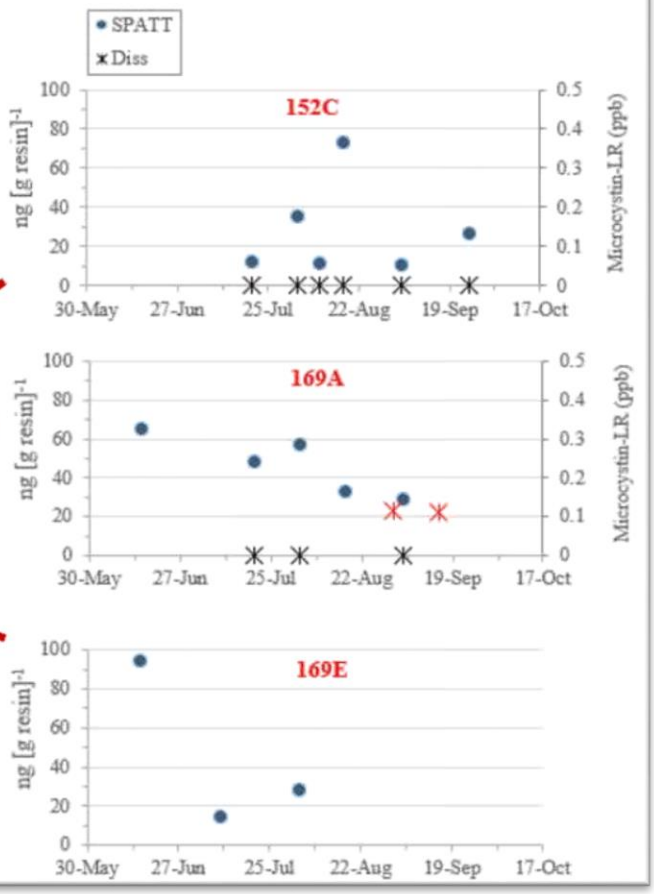
iv. pH vs. DO
   1. Good correlation between DO increases and pH increases

v. High Rock lake – 2016 Ambient Monitoring Summary May-October
   1. See Ambient Monitoring Summary here
      - This data is from the ambient monitoring stations located in HRL. These are typically sampled once per month.
      - For this study, we were able to get at least ten site visits for most of these ambient monitoring stations. Data was typically collected around mid-day.
      - Table on first page shows summary for each station for:
         i. Chlorophyll-a, turbidity, pH and DO
      - Second page shows data from upstream to downstream.
      - Third page compares data:
         i. Chlorophyll-a vs DO (surface saturation) and chlorophyll-a vs. surface pH
         ii. Surface pH vs. DO (surface saturation) and surface pH vs. DO (concentration [mg/L])

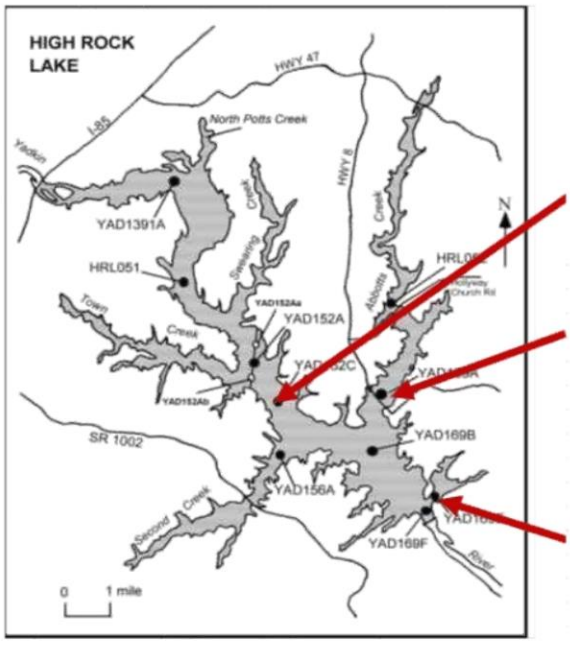
vi. High Rock Lake – Summer 2016 Cyanotoxin Results (Astrid)
   1. Preliminary SPATS results are in. Will have more thorough analysis ready for the March SAC meeting.
   2. Looked at three stations from those parts of HRL that are on the 3030(d) list as impaired for chlorophyll-a.
      - YAD152C, YAD169A, YAD169E (results below)

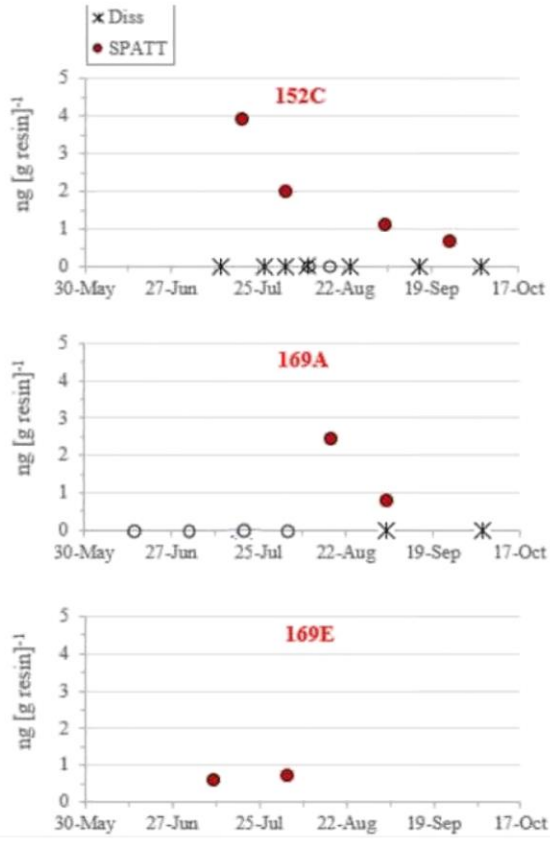
Microcystin-LR





Cylindrospermopsin





3. Have not had time to compare this to what we typically see in other lakes.
4. Microcystin
    - Each station had positive SPATS results for microcystin.
    - SPATS results are for toxin that has accumulated over a few weeks and was washed off the SPATS bags
    - Dissolved toxins results are from single sampling events on specific days and represent toxin levels at that point in time.
    - Data was analyzed for interference and compared against toxin calibration curves.
    - Two of the dissolved toxin samples showed positive results (~0.1 ppb) at station YAD169A
    - Take away: microcystins seem to be in most of the samples in concentration that cannot be confirmed with grab sampling.
5. Cylindrospermopsin
    - There were positives at each station, though not for each sampling event.
    - No dissolved samples tested positive for cylindrospermopsin
6. Comparison to existing advisory levels
    - Drinking water (10-day)
        i. Microcystin → 0.3 ug/L (infants/pre-school), 1.6 ug/L (school-age/adults)
        ii. Cylindrospermopsisn → 0.7 ug/L (infants/pre-school), 3 ug/L (school-age/adults)
    - EPA draft recreation criteria
        i. Either swimming advisory (not to be exceeded) of criteria (not exceeded more than 10% of days in recreation season)
        ii. Microcystin → 4 ug/L
        iii. Cylindrospermopsin → 8 ug/L

f. Questions/comments:
    i. Connie: How longs were the SPATS in the water?
        1. Astrid: between 2 and 4 weeks. The results are an average for the exposure time. The amount of toxin on the filter is divided by the total number of days the filter was out in the water to provide this average.
    ii. Nathan: These are nanograms/gram resin per day?
        1. Astrid: Yes. Also, these are semi-quantitative results. That's why we are taking grab samples along with it. And it is difficult to make direct comparisons with other indicators such as chlorophyll.
    iii. James B.: Do the SPATs equilibrate to ambient conditions quickly? Do they have a saturation point?

1. Astrid: studies have shown that toxins can be detected within hours of exposure. There is possibly a concern that the filters can reach saturation over time. As far as semi-quantitative goes, they are reliable! Several of these samples had results that were close to the lower threshold of detection. These values can't be trusted quantitatively, but they do indicate that toxin was present. Toxins below the detection threshold would not appear in the analysis.

iv. Nathan: So what is the ratio between the dissolved vs. total portion of toxin?
    1. Astrid: That is the question! We might be able to shed some light on this as we look further at the data from this summer.
v. Clifton: Was turbidity sampled?
    1. Jason: No.
    2. Jim H.: There is no turbidity data here, but we hope to discuss this later today. We plan to provide you this data prior to the next meeting (March). We will discuss it more then.
vi. Linda: Do we know what algal species were present during the study?
    1. Elizabeth: Pseudanabaena and cylindrospermopsis were co-dominant.
vii. Deanna: Did you do comparisons to the static site?
    1. Jason: We did not do comparisons.
viii. Clifton: What was the time frame from sample collection to report? Is the data available now? What about the cyanotoxins data?
    1. Jason: It took about two months from collection to developing a report. The ambient data is ready and the diurnal data is close to being ready. The cyanotoxins data is being handled by Astrid's lab.
ix. James B.: For the data report that is not ready yet, can you incorporate histograms and time history analysis for each of the stations?
    1. Pam: We will provide you the data first and then go back and work on some analyses.
    2. SAC members agree with this. They would like the raw data sooner, but would like to have the summaries at least two weeks prior to the next SAC meeting in march, 2017.
x. Linda: (refers to the HRL chlorophyll-a conc./distribution map) The concentrations and distributions that you see in the ambient data appear to match well with the map.
xi. Michael O.: Is the data affected by flow? Are the stations fixed to one spatial level in the lake? Will the platforms conform to changes in water flow/volume?
    1. Jason: The sampling platforms were anchored to the bottom, but they were not completely fixed in one position. They would have risen/fallen with rising/receding lake levels. Measurements near the surface would have remained at a relatively consistent depth, but bottom measurement depth would have varied with lake level.

2. James B.: What were the depth goals?
3. Jason: About half a meter from the surface and one meter from the bottom.

xii. Nathan: Will the water quality profile data that you did during each visit be available to us?

1. Jason: We can provide that data.

3. **Discussion: Are the uses of High Rock Lake presently impacted, and what are the implications for criteria development?** (Andy Sachs, SAC members, DWR staff)
   a. Jim H.: This issue has come up several times throughout this process and it is something that we need to discuss a bit further as a group. When considering whether a use is impaired, we look at the criteria to make that determination. In the criteria development process, however, there are a number of ways in which we can determine if a use is being impaired (literature reviews, experimental data, etc.). We are looking to protect the uses of HRL per the Clean Water Act and want everyone to have a good idea of the implications of what we are trying to do here.
   b. Clifton: Are there real problems other than the default criteria? When we go parameter-by-parameter there are two approaches:
      i. Are there any existing problems in the lake?
         1. If not, the existing criteria may be fine
      ii. Literature based approach
         1. Coming up with values and then comparing then to the lake
      iii. Suggest looking at both of these sources of information side-by-side and then seeing if one of the sources better fits the situation in HRL.
      iv. Example #1: Dissolved Oxygen
         1. Instead of looking at the existing fishery in HRL and saying that they are doing well so DO is ok, it would be more appropriate to consider the scientific literature which has many dose-response analyses that would suggest what DO is appropriate to protect aquatic life
      v. Example #2: Perception of recreational uses
         1. This is much more subjective. Much less likely to find relevant studies for this specific water body.
      vi. Andy: So we would go forward looking parameter-by-parameter, but we would have discussions based on what the literature says vs. what other information may be relevant.
   c. Lauren: What Clifton said goes well with what EPA would like to see. Discussions and reasoning behind any decisions that are made (regarding information sources and criteria development) need to be clearly articulated.
   d. Jim H.: We just want to be careful in that we don't want to assume that there needs to be a problem before we can set criteria. Criteria are meant to protect the uses before problems develop.

    i. It would be good for us to assimilate all relative information prior to deciding on criteria for all of the uses.

e. Nathan: From previous discussions it does appear that the Denton Water Treatment Plant has been incurring some expenses in the treatment of the water from HRL. This would suggest that there is some level of impairment there for this use.
    i. Clifton: Eliminating taste & odor issues may not be an achievable goal. Even if we bring chlorophyll-a levels down to a point that would minimally support the fishery there would likely still be taste & odor issues for the WTP. It would be more useful to look at the degree of reduction of taste & odor issues associated with different chlorophyll levels.

f. Andy: One thing that we should clarify is the difference between the terms "impact" and "impairment". An "impairment" is a definitive situation. A water body is considered impaired based on the water quality standards in rule. An "impact' is based on some change to a system, in this case, due to nutrients.

g. Martin: When you to about some parameters (DO, pH, etc.) there is a stressor or toxic effect. It is different when you talk about nutrients, productivity and chlorophyll. These require optimization so that each of the uses can be met.

h. Jim H.: There's also the legal language that says that the most sensitive use has to be protected. We have to be careful that we are not sacrifices a less "valuable" use for the greater good.

i. Bill (commented via the web): When the SAC makes recommendations on nutrient criteria, we will need to defend those recommendations, particularly, the criteria that indicate that HRL is currently impaired. The public will want to know what uses are impaired.
    i. Nathan: Is there other data regarding reference reservoirs that we might look at, especially with regard to aquatic life?
    ii. Pam: Going back to the 1970's, HRL has been one of the most eutrophic lakes in the state.

j. Marcelo: I agree with a lot of what Clifton said, but the question is: do we need to wait until there is a big identifiable problem before we enact controls? Or, can we use our experience and scientific knowledge to anticipate what problem may arise given the current conditions in HRL?
    i. Andy: So you would want to make use of scientific knowledge and literature from other areas to help extrapolate what may occur in HRL in the future?
    ii. Marcelo: Yes, we can use literature that raises concern in other places and tie it to HRL data that makes us concerned.

k. Deanna: Have these metrics been getting worse over time or have they been static? And has anyone looked at nutrient cycling?
    i. Pam: We have not done a trend analysis, but there is some anecdotal evidence that chlorophyll levels have been increasing.

l. Bill: Water quality criteria are set to protect designated uses. With regard to drinking water there is an assumption that that since the Safe Drinking Water Act requires treatment of

source waters to produce potable water, the need for additional treatment would not indicate an impairment of the source water.

m. Andy: If everyone is willing, as we go forward we will:
    i. Go parameter-by-parameter for each use,
    ii. We will have a discussion following the two line of argument (literature vs. existing problems)
    iii. We build the best argument on either side
    iv. Then make a decision via consensus or vote
    v. Responses to this proposal:
        1. Linda: I give more weight to current apparent meeting of the designated use. There doesn't seem to be great urgency to the water supply use. I would be willing to hear the other side, though.
        2. Clifton: I agree with using both kinds of information to attain whether a use is being attained and also to allow ourselves the opportunity to examine if maybe a use can be attained to a better degree.
        3. Martin: I agree with what Clifton just said. Looking at the full information that we have will help us to make better decisions.
        4. Jim: I think it's a sensible approach as we move forward. I'm troubled by making decision regarding aquatic life in a man-made lake where we have little scientific literature to help guide our decision.
        5. Michael: regarding recreation, we have some evidence for other areas, but for HRL we do not have any information useful for decision making. Regarding other data, HRL does not seem to be doing as well compared to other Piedmont lakes. Looking at the lake right now, it is impaired based on the current standards. If we disagree with that then we are disagreeing with how those standards were developed.
        6. Marcelo: I think it's sensible to take all of the available information. It will be hard to make decisions for uses that we have no data for. Would caution lack of action when we have imperfect data. A lot of the data we have paints a consistent picture of HRL that implies there are problems.
        7. Nathan: I like the idea of using literature and specific HRL data. We don't know what will happen in the future, but we know that there is potential for the biomass situation to cause drastic changes relatively quickly.
        8. Deanna: My biggest concern for the future condition of HRL is that even if we do develop protections for the lake, will they be enough given that we don't know what future conditions may be, especially with regard to temperature increases.
        9. Astrid: High temperatures will definitely be of concern related to algal blooms and toxin productions. There are a lot of factors that will play into algal mass and toxin production.

Criteria evaluation and resolution: High Rock Lake clarity and/or turbidity (Andy Sachs, SAC members, DWR staff)

n. See discussion materials here.

o. Turbidity discussion

i. We currently have a water quality standard for turbidity in rule for Class C (15A NCAC 02b .0211) waters. The standard is:

1. Class C - 15A NCAC 02b .0211 (21) Turbidity: the turbidity in the receiving water shall not exceed 50 Nephelometric Turbidity Units (NTU) in streams not designated as trout waters and 10 NTU in streams, lakes, or reservoirs designated as trout waters; for lakes and reservoirs not designated as trout waters, the turbidity shall not exceed 25 NTU; if turbidity exceeds these levels due to natural background conditions, the existing turbidity level shall not be increased. Compliance with this turbidity standard can be met when land management activities employ Best Management Practices (BMPs) [as defined by Rule .0202 of this Section] recommended by the Designated Nonpoint Source Agency [as defined by Rule .0202 of this Section]. BMPs shall be in full compliance with all specifications governing the proper design, installation, operation, and maintenance of such BMPs;
2. Of note: 25 NTU is about equal to 0.5 meters Secchi depth.

ii. Clifton: This a "not to exceed" value, correct? Is there averaging that occurs for assessment?

1. Pam: There is no averaging for assessment. We use a >10% with 90% confidence limits based on a minimum of 10 samples for determining impairment of surface waters.

iii. Clifton: According to the turbidity standard language, the Yadkin River standard for turbidity would be 50 NTU. Is there consideration for where sampling occurs to account for the transition from the 50 NTU to 25 NTU standard?

1. Jason: Yes. Sampling stations are generally located to account for this.

iv. Jim H.: Do we need to consider both turbidity and water clarity? Will one account for the other? Do we need to clarify any differences between the two indicators?

1. Linda: Sometimes they correlate well, other times they do not.
2. Nathan: Water clarity has several components. This includes turbidity, but can also include such things as color. For example: a blackwater stream may have limited clarity due to dark coloration (tannins), but practically no turbidity.
3. Michael O.: Also need to account for different types of turbidity. Turbidity can be the result of high algal biomass, but it may also be due to sediment entering the lake.
4. Clifton: Marcelo, can you look at the relationship between chlorophyll-a and turbidity based on the supplied data?
5. Marcelo: Looking at the April data there is a weak correlation.

6. Jing: We have seen this in HRL. There is a strong correlation between turbidity and nitrogen and phosphorous.
7. Lauren: If we decide to move forward with turbidity now, can we revisit water clarity at a later time after we've discussed how it relates to chlorophyll-a?
    - Andy/Jim H.: Yes, we can vote now and revisit if later discussions warrant a revote.

v. Andy: Should the current water quality standard for turbidity remain or would you like to see it modified for HRL?
1. Martin: Turbidity due to algal mass is better controlled by the chlorophyll-a indicator.
2. Marcelo: Did the HRL model provide any information on this?
    - Jing: Yes, there was a strong correlation between total suspended solids and chlorophyll-a, but not turbidity. Turbidity acts as a limiting factor for algal growth.
3. Michael O.: There is some basis in the recreation use literature to suggest that 25 NTU is acceptable for recreational uses.
4. Linda: Turbidity is indirectly related to nutrient criteria. May need to consider what can be done to limit it through management practices.
5. Martin: Turbidity and Water Clarity are not good indicators for nutrients.
6. James B.: Stick with the current turbidity standard.
7. Michael O.: It would be good to tease out organic vs. inorganic composition, but the current turbidity standard seems appropriate.
8. Marcelo: Stay with the current turbidity standard.
9. Nathan: I don't think turbidity is associated with nutrient.
10. Astrid: Do Colloidal Dissolved Organic Materials influence nutrient?
    - Nathan: That mostly related with wetlands. There are no major wetlands in HRL so it shouldn't be a significant contributor.
11. Bill: Keep current turbidity standard.

vi. Andy: SAC members vote on turbidity
1. Consensus reached. SAC members voted to maintain the current water quality standard for turbidity for HRL.

p. Water clarity discussion:
i. Andy: There is presently not water quality standard for water clarity. Should there be one as an indicator of nutrient pollution for HRL?
ii. Nathan: Adopting a statewide standard for water clarity would not work as the factors contributing to clarity vary greatly from water body to water body.
iii. Martin: Water clarity is better discussed in relation to chlorophyll-a.
iv. Diana: Establishing a standard for water clarity using Secchi depth would be difficult to assess as measurement of depth is subjective based on user perception.

v. Clifton: Water clarity is relevant to nutrient control, but it would be better discussed in relation to chlorophyll-a. Also, the HRL model does not account for clarity.
vi. Martin: Clarity will be more appropriate when we discuss estuaries (SAVs). It's not appropriate for HRL.
vii. James B., Marcelo, Nathan, Deanna, and Astrid: Agree with above.
viii. Andy: Consensus is to discuss water clarity further when the SAC looks at chlorophyll-a.

q. Next indicators up for discussion: pH and DO
   i. Jim H./Connie: What information further information will help you discuss upcoming indicators?
      1. Clifton: The HRL ambient monitoring data and the HRL summer study data.
      2. Jim H.: We will send you background data on the existing water quality standards for pH and DO and the HRL data.
      3. Deanna: What will be after pH and DO?
      4. Jim H.: The timeline we are looking at is pH and DO in March, Chlorophyll-a and cyanotoxins in May, and causal indicators in July.

4. **EPA cyanotoxins guidance update** (Connie Brower)
   a. Connie is part of an Association of Clean Water Administrators (ACWA) workgroup that is working with EPA to discuss implementation concerns related to the recently released draft Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermopsin (EPA 822-P-16-002, December 2016).
   b. The draft criteria are:
      i. Microcystin = 4 ug/L
      ii. Cilindrospermopsin = 8
      iii. Both criteria are based on a child's body weight and exposure risk (children typically spend more time recreating in and around surface waters than adults and they also tend to accidentally ingest more water while recreating).
   c. The draft criteria present two options for states and tribes to consider regarding regulatory limits for the mycrocystin and cylindrospermopsin cyanotoxins.
      i. The first option is to use the recommended criteria as swimming advisory action levels. These are not to be exceeded on any given day during the swimming season.
      ii. The second option is to adopt the criteria as standards to satisfy all purposes of the Clean Water Act. The criteria are not to be exceeded on more than 10% of the total days of the swimming season.
   d. EPA's goal is to publish the recreational criteria for cyanotoxins in its final form prior to the beginning of the next swimming season (2017). Ultimately, criteria related to cyanotoxins will be available for the following uses:
      i. Drinking Water (Published 2015)
      ii. Recreation (Draft 2016)

iii. Aquatic Life (TBD)

e. The DWR does not currently analyze cyanotoxins when it receives algal samples. This work is done in conjunction with the NC Department of Health and Human Services. The DWR Water Sciences Section is currently working to procure the ability to test for cyanotoxins in its laboratory.

f. Connie attended a meeting of the recreation water quality criteria for cyanotoxins workgroup in December of 2016. Some of the concerns brought up by various states included:

   i. The draft criteria for recreation are about 5x lower than those produced by the World Health Organization (WHO)
      1. WHO's values are based on older cell count data and considers exposure to adults
      2. EPA's data is based on microcystin testing and considers exposure to children
   ii. States are divided on how they want/need to adopt these recommendations
      1. Most states don't routinely monitor for cyanotoxins and will face challenges adopting the recommended criteria as either water quality standards or swimming advisories
      2. In many states, water quality standards and swimming advisories are handled by different agencies
      3. Some states, such as Utah, have experienced catastrophic events related to harmful algal blooms (HABs) and cyanotoxins that have resulted in illnesses in people and pets and have shut down water supplies. Other states have experienced HABs irregularly in surface waters and have little or no information regarding cyanotoxin levels.

g. Questions/comments:

   i. Deanna: Did Utah say what organisms they had seen during the HAB they recently experienced?
      1. Elizabeth: I have this information and will email it.

5. **Scoping riverine nutrient criteria parameters and relating them to Central Cape Fear special study** (Nora Deamer, Connie Brower)

   a. See presentation slides here.

   b. Nutrient related issues in the Central Cape Fear (CCF) river:

      i. Nutrient over enrichment
      ii. 2009 – Algal blooms began occurring
         1. Cyanotoxins were present
         2. Taste & odor issues
      iii. Agriculture input – Swine and poultry CAFOs, cropland
      iv. Limited nutrient limitations on NPDES permits and limited buffer requirements
      v. Low DO, increasing BOD, high turbidity
      vi. Increased water draw and decreasing 7Q10 flows

vii. Flow obstruction due to locks & dams

c. Review of uses:
   i. Aquatic life (federal & state threatened/endangered species), recreation (primary/secondary), agriculture, water supply
d. Criteria development considerations:
   i. Criteria needed for wadeable and non-wadeable streams
   ii. Potential indicators of nutrient over enrichment for both:
      1. Animals – fish, invertebrates, crustaceans, worms, mollusks
      2. Algae & plants – chlorophyll-a, periphyton, pheophytin, assemblage, cyanotoxins
      3. Chemical stressors – N, P, turbidity, TSS
      4. Physical stressor – DO, pH, temperature, flow
      5. Trophic status
      6. Stream Nutrient Assessment Procedure (SNAP) – Ohio/EPA matrix for assessing nutrient over enrichment in wadeable streams. http://www.epa.ohio.gov/Portals/35/wqs/nutrient_tag/SNAP_Subgroup_Rpt_8-14-2014.pdf
   iii. Ambient monitoring system station summaries (see slide 22)
   iv. WSS Cape Fear Special Study – 2010 Algal study results (see slides 24 & 25)
   v. CCF Instream Nutrient Concentrations (see slide 28)
e. Central Cape Fear special study is being planned
   i. Study will gather ambient data to support development of CCF modeling efforts
   ii. What data would SAC members like to see as part of this study? (open question)
f. Questions/comments:
   i. Jim H.: Just want to clarify that this presentation is meant to provide a starting place for us to choose indictors for CCF.
   ii. Pam: We are trying to start monitoring for this study during the summer (2017). SAC member input regarding the type of information you would like to see will help us design the study to be of best use to you.
   iii. Bill: Are the lock & dam blooms due to advection (movement of the bloom from point of origin)?
      1. Nathan: We looked at this during the summer and found that flow was low and that stratification occurs behind the locks & dams. After the lock & dam, mixing occurred and chlorophyll-a concentrations dropped.
      2. Nora: We have modified our sampling procedure to account for stratification. We now sample down to 0.5 meters.
   iv. Andy: What data would you like to see from the study?
      1. Marcelo: Residence times behind the dam
      2. Deanna: Periphyton
      3. Nathan: Transit time may be better than residence time.

4. Michael O.: Nitrogen 15, Isotropic Nitrogen, particulate nitrogen, total nitrogen and total dissolved nitrogen
5. James B.: Secchi depth (photic zone 2x Secchi depth)
6. (?): Have models incorporating periphyton been developed?
    - Clifton: Yes, but there are problems with calibration
7. Astrid: There are some major concerns with this system:
    - Microcystin has been identified up and down stream even when algal growth doesn't trip the current chlorophyll-a standard.
    - Chlorophyll-a standard will not be useful for regulating periphyton
    - This river system lacks some of the regulatory protections that other systems have (buffers, permit requirements)
8. Marcelo: Dissolved organic carbon (DOC) and dissolved organic matter (DOM)
9. Lauren: data on SPATS
10. Astrid: Urea
11. Martin: Dissolved TKN will get at particulates
12. Clifton: Bottom substrate assessment helps with developing model that includes periphyton. Would like to see taxonomy. Hardness.
13. Bill: Multiple forms of phosphorous (dissolved organic, dissolved inorganic, particulate), silica, carbonate.

Attachments

- Synopsis and discussion: HRL special study

High Rock Lake Diurnal study 2016.p

2016 High Rock Lake Ambient Data S

- Turbidity/Water Clarity discussion background information

High Rock Lake Turbidity Criteria an

Ranges-DO-pH-clarity_SAC20170125.pd

- Indicator scoping for Central Cape Fear River special study

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