NC Nutrient Criteria Development Plan – Scientific Advisory Council (SAC)

10/30/2020

Attendees

SAC members in attendance:

Jessie Jarvis	Fritz Rohde	Michael O'Driscoll
Lauren Petter	Rachel Gittman	Wilson Laney
Jud Kenworthy	Marcelo Ardon	Jim Bowen (attended late)
Martin Lebo	Hans Pearl	

NCDEQ staff in attendance:

Jim Hawhee	Bongghi Hong	Jing Lin
Nick Coco	Karen Higgins	Ian McMillan
Connie Brower	Forest Shepherd	Rich Gannon
Pam Behm	Peter Johnston	Elizabeth Fensin
Nora Deamer	Susan Meadows	Casey Knight

SAC meeting facilitator

Maya Cough Schulze

Criteria Implementation Committee members in attendance:

Andy McDaniel
Anne Coan

Meeting notes

All questions, comments and answers are paraphrased

1) **Convene** (Maya Cough Schulze)
    a. SAC Rollcall and DWR Introductions
    b. February minutes approved.
    c. June minutes approved.

2) **2020 Chowan River Basin Water Resource Plan** (Forest Shepherd, PowerPoint presentation)
    a. This plan is currently out for public comment which ends today.
    b. General overview of basin plan including water quality and nutrient monitoring results and recommendations for protecting water resources.
        a. The entire plan consists of 8 chapters:
            - Chapter 1: Basin Characteristics (Geography, Population and land cover, non-point source pollution)
            - Chapter 2: Monitoring Data and Water Quality Assessment
            - Chapters 3 and 4: Watershed (HUC 10)

- Chapter 5: Nutrient Sensitive Water Summary
- Chapter 6: Water Quality Initiatives and Funding
- Chapter 7: Permitted and Registered Activities
- Chapter 8: Water Use and Availability

c. Nutrient loading is a continual water quality issue throughout the basin. Topics to cover are nitrate, total Kjeldahl nitrogen (TKN), ammonia, phosphorus, chlorophyll a and algal blooms.

d. There are two impaired waters in the Chowan River Basin:
   1. Wiccacon River with an exceedance for Benthos.
      - Currently on the 303d list.
   2. Cricket Swamp with an exceedance for pH. Source not determined.
      - Currently on the Impaired Waters List.

e. In 1982 DENR developed a Chowan-Albemarle Action Plan and Chowan River Water Quality Management Plan to address the water quality problems in the area by constructing a strategic plan with specific management goals focused on the Chowan River. These goals included: reducing phosphorus inputs by 30-40%, reduce nitrogen inputs by 15-25%, chlorophyll a peak levels not to exceed 40 ug/L and summer mean chlorophyll a concentrations below the 25-30 ug/L. Implementation measures put in place mainly included converting point-source dischargers to land application where possible and installation of agricultural best management practices throughout the basin.

f. In 2002 and 2007 the Chowan River Basinwide Water Quality Management Plans indicated a reduction in nutrient inputs which led to a steady decline in the frequency and the intensity of algal blooms, along with few reported chlorophyll a readings over 40 ug/L.

g. The nutrient load declined over the last 30-40 years. In 2019 the % reduction of nitrogen was reduced by 98.99% from 1982 and a reduction of 95.82% of phosphorus.

h. Nutrients:
   - Nitrate: Two stations in the last 5 years that have the highest 75th Percentile of Nitrate concentrations in the Chowan River basin are Blackwater River and Meherrin River.
     - Meherrin -Flow normalized loading trend. As of 2016 the total nitrogen load had increased about 24% mainly due to an increase in TKN.
     - Blackwater river watershed showed in 2016 total nitrogen load had decrease about 29%.
     - Due to tidal influences there are no flow gauges on the Chowan River.
     - In early to late 2000's the sampling changed from surface grabs to photic zone sampling.
     - Nitrate concentrations along the mainstem of the Chowan river generally decreased until 2005-2009-time frame followed by a generally increasing nitrate concentrations through the 2015-2018-time frame.
     - Notably the Meherrin river has consistently relatively high nitrate concentrations as identified by the 75th Percentile. Can also see the

impact from the Meherrin river on the Chowan river. On the map (shown on presentation) the station at Winton appears to be elevated possibly due to the influence of the Meherrin river.

- Ammonia: Over the last 5 years the two stations with the highest 75th Percentile of Ammonia concentrations are the Meherrin River and the Gatesville station.
- TKN:
    - The ammonia component is a very small fraction of the overall TKN concentrations.
    - Organic nitrogen is the dominant form of nitrogen in the TKN concentrations.
    - Over the last 5 years the two stations with the highest 75th Percentile concentrations of TKN are the Potecasi creek and the Colerain station.
    - TKN decreased until 1990's then increased.
    - Increased instream concentrations TKN to 2015-2018 timeframe. Source of increase is unknown, but not likely linked to increased algal concentrations.
    - Flow normalized loading trends in the Potecasi; TKN loading increased slowly after 1999 & began increasing dramatically after 2003 until 2012. The estimated load registering at 100% increase from the 1981-1985 base-line load. Estimated load in 2016 was ~80% higher than the 1981-1985 base-line load. Source unknown.
- Total Phosphorus:
    - The 1982 Management Strategy put in place a total phosphorus reduction goal of 30-40%. To achieve a reduction in chlorophyll a concentrations with peak levels not to exceed 40 µg/L and summer mean Chl-a concentration below 25-30 µg/L.
    - Over the last 5 years the 3 segments with the highest 75th Percentile are Potecasi Creek, Colerain station and Gatesville station.
    - Nottoway River looking at flow normalized loading trends shows phosphorus loading has declined. Blackwater river watershed also showed declined.
    - Between 1981-2016, the instream total phosphorus concentrations throughout the Chowan River mainstem have remained stable. Exceptions are the Blackwater River station and Chowan River at Riddicksville.
- Chlorophyll a:
    - Over the last 5 years the 3 segments of the Chowan with the highest 75th percentile conc. of Chl-a and percent exceedance of the 40 µg/L are the 3 downstream stations: Gatesville, Colerain and Edenhouse. (see pp)
    - The 5 year mean Chl-a concentration shows decreasing Chl-a concentrations until 2010-2014.

    - Algal blooms formed since 2010 have shifted to the pHAB category of blooms with potential human health concerns and these have been increasing over the past several years.
    - During the years with increased blooms, there were times when high microcystin toxins were detected above the WHO guideline of 10 µg/L.
- Location of large algal blooms in Chowan are dependent on many environmental factors such as: N & P availability, stream flow, climate (temp., light intensity, precipitation, wind driven tides and storm events).
- **10 recommendations**: Agriculture BMPs and Waste Management, developed areas, Nutrients in Chowan Basin and Albemarle Sound, streamflow research, Administrative, Communications & Public relations, climate change, Forestry & Water Quality, NCDEQ and Water use and demand.
    - Nutrients in Chowan Basin and Albemarle Sound - DWR continue to work with NCDP &SAC to develop appropriate protective criteria. Develop/expand capacity for monitoring, support research & use of new monitoring techniques, expand local education, expand/initiate groundwater quality monitoring.
    - Research in determining if the Chowan river system in nitrogen or phosphorus limited - conduct bioassays throughout Chowan & Albemarle to understand response of algae to N & P, preliminary assessment of nutrient modeling, external nutrient models and establish need to modify current NSW strategy.
    - Research into nutrient source identification – conduct research into role of nitrogen-fixation as a source, there is a need to understand sources & bioreactivity of organic nitrogen, critical need for technology that can distinguish a specific nitrogen signature (to identify specific source, like, animal types, domestic waste, forest, sediment, etc.) and research to understand relationship between groundwater & surface water.

i. Comments/questions:
    a. Marcelo: Are there trends in the long-term pH at these stations?
    b. Forest: (In chapter 2 of the Chowan River Basin Plan) See increase in pH going downstream (Nottoway & Blackwater).
    c. Marcelo: We're seeing increases in dissolved organic matter in other areas and theories it might have to do with acidification.
    Have you looked at dissolved organic carbon or dissolved organic matter?
    d. Forest: Not in the Chowan.
    e. Hans: May be useful to look at the variability in pH to see how the blooms might contribute to an increase in pH. The priorities listed seem to revolve around the nitrogen question. Nitrogen fixation is a very important question.
    f. Elizabeth – not a lot of blooms this year and didn't see microcystis blooms.

g. Marcelo: Could there be a role from legacy nitrogen in these systems; from sediment? And need to figure out where this nitrogen is coming from.
h. Nora: Do you think we should add to the research needs to address the recycling of nitrogen from sediment?
i. Hans: It's probably an important part but need to come to figure out this nitrogen fixation problem because if that's occurring than nitrogen recycling is likely low. I'd look at new sources of nitrogen first.
j. Nathan H.: Another reason to look at nitrogen fixation is the biomass of potential nitrogen fixing species (the ones containing heterocysts) has gone up about 100-fold in the last 20 years. So, the phytoplankton cell density data is telling us that we should be looking at nitrogen fixation too.
k. Wilson L.: Do you see anything in the records to indicate that when we have tropical storm events legacy chemicals might get flushed out?
l. Hans: There's a lot that comes back in. Could potentially see an increase because of organic matter coming back in.
m. Michael O.: Can you try to get more discharge monitoring in the areas? Maybe talk with USGS. And get concentration data as well.
n. Nathan: Probably better to go for concentration data.
o. Rich G.: Appeared to be an overall decrease in flow over the years of data Forest presented. Is there a known consumptive use that has increased over the years?
p. Hans: We've had episodic storms and dry periods, so the trade-off between them may play a role in the lower flows that we're seeing as well as consumptive use. Lower flows could benefit the bloom organisms.

3) **2021 Coastal Habitat Protection Plan (CHPP): Priority Habitat Issue – Submerged Aquatic Vegetation Protection and Restoration with a Focus on Water Quality** (Casey Knight)
   a. Overview of the NC Coastal Habitat Protection Plan: origin and purpose, goals and priority issues.
   b. Timeline: Got **SAV, Rule Compliance and the I&I Papers** mostly done and presented that background information to the CHPP Steering Committee, EMC, CRC and MFC.
   c. **SAV** in NC:
      - Importance: provides habitat for animals, stabilizes sediment and shoreline, reduces wave energy, improves water quality and clarity, sequesters carbon and increases coastal community and ecosystem resilience.
      - In NC there are 2 different types of SAV: High salinity (>10 ppt) seagrasses and low salinity (≤10 ppt) freshwater grasses.
      - History of SAV in NC (shows map of low and high salinity grasses).
      - APNEP Indicator Report: extent of submerged aquatic vegetation, high salinity estuarine waters mapped out showing changes over several years. Showing the southern zone at over a 10% loss in sav.
      - What's happening? Water quality! Increased nutrients = agal blooms and a decrease in water clarity. SAV need clear water. Other issues like direct physical

disturbances, climate change, chemical controls and pathogens. However, the main focus of this issue paper is the water quality issues.

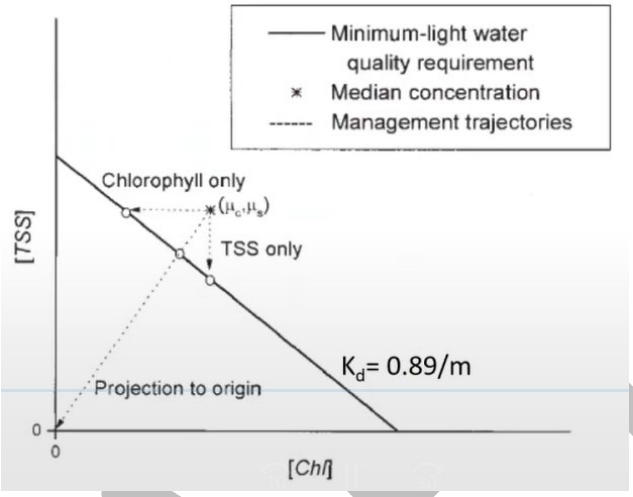
d. Case Study: **Chesapeake Bay**. Their strategy was to develop the SAV restoration goal and then the water quality criteria based on the needs of the SAV. Initial goals were based on historic data of SAVs 1950-2000's. Came up with an acreage goal of **185,000 acres** and an interim goal of **92,000 acres**. Found minimal light requirements in high salinity were 22% light availability and in low salinity it was 13% availability.
e. Case Study: **Tampa Bay**. They also looked at a mapping event from the 1950's that was their best-known mapping event. Came up with **38,000 acres**. Nutrient management strategy: chlorophyll a targets and nitrogen loading targets.
f. What should **NC's goals** be? Looked back at 1981-2215 and came up with **191,155 acres**.
g. How do we get there? Support water quality improvement efforts, enhance SAV research and monitoring, improve collaboration, protect and restore.
    - Set SAV acreage goal at 191,155 acres.
    - Determine % light needed (PAR attenuation)
    - Set chlorophyll a concentration target (optical model)
    - Set nutrient load concentration targets (interim nutrient criteria)
    - Determine contributions by source/location in watershed.
h. **Recommended actions**: protection and restoration of SAV through water quality improvements.
    - By 2022, NCDP SAC evaluate, recommending the EMC establish water quality standard for light penetration. Target value of 22% to the deep edge (1.7m) of SAV for all high salinity SAV regions and light penetration target of 13% to the deep edge (1.5m) for low salinity SAV regions.
    - By 2022, NCDP SAC evaluate and recommend the chlorophyll a water quality standard be revised if needed by the EMC to ensure protection of SAV in high and low salinity regions, beginning with the Albemarle Sound and Chowan River.
    - By 2024, EMC adopts nitrogen and/or phosphorus criteria to help protect and restore ~12,900 acres of low salinity SAV habitat in Albemarle Sound SAV reg.
    - By 2021, DEQ will commit to protecting and restoring SAV to reach interim goal of 191,155 acres coastwide.
    - By 2021, DEQ will form workgroup with NGOs and local governments to inform and guide development of watershed restoration plans that protect, restore or replicate natural habitats.
    - By 2022, DEQ will form workgroup with DWR, Soil and Water Conservation, local governments and other partners to develop a plan to increase the use of best management practices related to water quality within SAV regions.
    - By 2022, DEQ will facilitate development of specific policies through local, state and federal pathways that encourage and incentivize the protection of coastal habitats as recommended in NC Risk and Resiliency Plan.
    - Monitoring: By 2023, DEQ fund, develop and implement assessment program to conduct coastwide SAV mapping and monitoring at regular intervals.

- Monitoring: By 2023, DWR evaluates and prioritizes the incorporation of shallow water sites.
- R and D: By 2023, DWR and academics will determine loading and sources of nutrients and sediments and links to chlorophyll a.
- R and D: By 2022, state of NC and DEQ, through the Secretary of Emergency Management will request more accurate estuarine bathymetry data from NOAA.
- R and D: By 2022, DWR will request the NC Policy Collaboratory to investigate the impacts of agriculture practices and land use changes on water quality.
- Education and Outreach: By 2021, DEQ Off. Of Education and Public Affairs will work with local gov. and NGOs to develop public educ. And stewardship programs with social marketing and public awareness.
- Education and Outreach: By 2022, DEQ through funding of NCSU by APNEP will provide economic evaluations of the co-benefits SAV provides to coastal economy in terms of fish habitat, waterfowl and wildlife, recreation, shoreline stabilization, water purification and carbon sequestration.
- Funding: DEQ will obtain funding adequate to meet goals.

i. Comments/questions:
   a. Jim H.: FYI: Karen Higgins and I have been named to be DWRs representatives the CHPP process.
   b. Judd: Regarding the monitoring issue paper, is this paper going to tie into the recommendations coming out of the SAV paper?
   c. Casey: Yes, the SAV and Wetlands papers are doing it on their own but this paper will summarize the status and trends of all 6 of the coastal habitats.

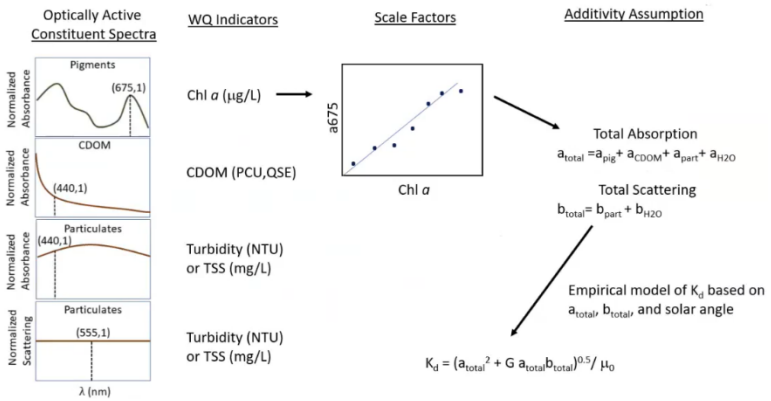
4) **Update on the Optical Water Quality Monitoring** (Nathan Hall)
   a. Funded by APNEP.
   b. There are 2 different water clarity targets based on salinity: High and Low SAV Zones.
      - High Salinity needs 22% PAR to target depth of 1.7 m. From a water clarity perspective, you have a light attenuation coefficient of 0.89/m.
      - Low Salinity needs 13% PAR to depth of 1.5 m, light attenuation coeff of 1.36/m.
   c. How do you get to those targets? What combinations of the things that attenuate light are permissible to still have those light levels at those target depths? L
      - Light attenuation substances like colored dissolved organic matter (CDOM), suspended particles, phytoplankton. Has a model that can figure out these combinations.
   d. The goals for this project are to use this model to figure out (based on water quality data we have) what the current clarity situation is, how much of the benthic area is currently meeting those targets to support SAV. Need to determine if our water quality standards are protective of having clarity to meet those targets. If not, how can we change our water quality standards to achieve that.
   e. This project was focused mainly on chlorophyll because of the concerns around increasing blooms, in particular in the Albemarle Sound region.

f. The figure below shows what we'd hope to accomplish. The diagonal line is a line of constant attenuation, based on a background average of CDOM concentration (held constant), then ask the 2 things we can manage: chlorophyll with nutrients and turbidity through erosion control. Goal is to get to the target level of attenuation.



g. How the bio-optical model works: We know the things that attenuate light. They absorb and also scatter he light.
Model starts off by measuring the absorption and scattering spectrum of these things. Then need to come up with a water quality indicator that's a measure of the things that are absorbing and scattering light.
So, we have optically active constituent spectra (pigments, CDOM, particulates), WQ Indicators (such as, chl a, CDOM, Turbidity), scale factors and additivity assumptions. See figure below.

How the Bio-Optical Model Works



Measure absorption and scattering, then need to relate the indicator back to the spectra through a regression of the indicator against one of the peaks in the spectra. Get a scale factor that allows you to go out, measure your indicator and then calculate exactly how

much absorption there was across the whole spectrum. Add up everything and get light attenuation.

h. Project objectives were to validate the model for other high/low salinity areas and use the model to predict light attenuation, and to figure out chl a and turbidity thresholds that meet clarity targets.
i. Project tasks were to gather chl a, CDOM and Turbidity data, plug them into the calibrated model, get a predicted light attenuation, validate those values by comparing it to observed light attenuation data. Once validated the model can be used.
j. Challenges: CDOM is not a regularly measured water quality parameter, so not much data available (some from Neuse R and Pamlico S). Very little observe light attenuation data (some from Neuse R, Pamlico S, Bogue S and Albemarle S).
k. Approach was to estimate CDOM based on salinity. High scatter at low salinity. Relationships are river specific (for example, between the North R and Neuse R the relationships aren't the same and no reason to think they will across all the estuaries). Don't think I can estimate CDOM from Albemarle S based on this relationship.
l. Validated the model and got same result as Biber et al. 2008, so the model was coded correctly.
m. Tested: In Bogue S (close to where it was calibrated) - there's lots of scatter but with minimal bias, so the model isn't over- or under-predicting light attenuation. In the Neuse R – there is a strong relationship, but the model was really bias and underestimating the light attenuation. Same in the Pamlico S, underestimating light attenuation. The Albemarle S ha a weak relationship and underestimated light attenuation.
n. For high salinity zones, CDOM is not as important there as turbidity and chl a. Clarity is near the threshold and **turbidity dominates attenuation**.
o. Conclusions: model works well for high salinity waters near where it was calibrated, model will require recalibration for low salinity waters, poor CDOM estimation is not the only cause of bias but CDOM data is needed, high salinity areas examined were near clarity thresholds but chl a was a minor component of attenuation and current chl a levels and WQ standard (40 ug/L) are protective of clarity targets for high salinity SAV.
p. Comments/questions:
    - Judd: The bias might have something to do with the nature of the particles that are suspended in the water. Have you thought more about that?
    - Nathan: Yes, it comes back to the calibration and concern of recalibrating the model without all the proper data.
    - Judd: For the purpose of this committee, what's the potential of using this model in Albemarle Sound? Can you write up a couple of pages of what we can do?
    - Nathan: Yes.
    - James Brown: Not all these factors that result in attenuation of light have an equal importance. It would be interesting to see them mapped and what fraction of the attenuation comes from chl and does that vary from each location.
    - Nathan: good idea.

- Jim H.: Will be helpful to know what sort of data density you might need and what locations. If you have ideas, we can discuss it informally and talk about the ambient monitoring program.
- Nathan: If it can be done in conjunction with the ambient monitoring program, we may be able to keep costs low.

5) **Project Updates** (Jim Hawhee)
   a. **Albemarle Sound and Chowan River algal related criteria**: Staff went through and did a preliminary vetting of algal-related criteria.
   b. **Remote Sensing Project**: funded by NSTEPS. The project is ongoing. Using our algal and chl a data and are trying to correlate that with satellite imagery, hoping to provide more predictive capability. Hopefully, done with project by the end of the year.
   c. **HRL**: we met with the CIC, bringing the SACs recommendation to them. Gave feedback and we are taking it into consideration and trying to develop standards language and assessment language currently.
   d. **Another SAC Meeting**: Should be in December, however, we'd like to substitute it for a CIC Meeting. Intended target is to get the HRL package coupled into the Triennial Review package and to the EMC/WQC by January.
   e. **Moving forward for the next meeting for this group**. Light penetration target is something that was discussed during phase I of the Albemarle Sound Study. Bioassays were recommended and development of a light attenuation model.
   f. **To open it up to discussion** with this group, I propose we continue looking at this issue of light penetration over then next meeting and see how we want to move forward with this topic. Do you want to meet back in January and what direction?
      - Judd: We have a data-rich environment for SAV in the Albemarle Sound. Our gap is what Nathan explained, solving the issue of calibration of the model. That model has been used in 5 different estuaries along the Atlantic seaboard and when it's correctly calibrated it works quite well. We should move forward with discussions.
      - Hans: Is there enough data for the ambient monitoring program to look at changes in turbidity in context of whether the turbidity is driven by external inputs in parallel with an increase in organic matter loading or a climatic input like wind mixing? Is there something in the database that can tell us if there has been changes in turbidity over the decades?
      - Nathan: Turbidity has increased in Albemarle Sound and the 3 main stations. Two of the stations, the turbidity has gone in parallel to chl a.
      - Hans: Might be something to bring up at next meeting.
      - Jim: There's the question of differentiating the different components of clarity and being able to tie that back to management actions. I don't want to proceed down a road if we don't have enough to discuss or hit a dead-end. We can start discussing at next meetings, while working internally on algal parameters.
      - Judd: Keep in mind, chl is increasing the last 2 decades and the nice thing about the model is you can parse out those 2 parameters. Can't deny the increasing

rates of nitrogen and chl that are occurring. Thinking about Albemarle Sound. There's a tool to sort that out and then decide if you even need to worry about a chlorophyll standard. Should not ignore those current trends.

6) **Closing** (Jim Hawhee) – please reach out to at any time with comments, questions, suggestions.
7) **Meeting Adjourned** (Maya S)