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

03/31/2021

Attendees

SAC members in attendance:

Marcelo Ardon	Michael O'Driscoll	Wilson Laney
Jim Bowen	Hans Pearl	Rachel Gittman (not present)
Jud Kenworthy	Lauren Petter	Jessie Jarvis (not present)
Martin Lebo	Fritz Rohde	

NCDEQ staff in attendance:

Jim Hawhee	Forest Shepherd	Jing Lin
Peter Johnston	Pam Behm	Jeff Manning
Chris Ventaloro	Nora Deamer	John Heisman
Connie Brower	Susan Meadows	Mike Templeton

SAC meeting facilitator:

Jim Hawhee

Meeting notes

All questions, comments and answers are paraphrased

1) **Convene** (Jim Hawhee)
   a. SAC Rollcall and DWR Introductions
   b. Approval of October Minutes by Jim B. and Han P.

2) **Farewell to Connie Brower** who is retiring April 1, 2021 after 35 years.
3) **Linking nutrients, light, and SAV in Albemarle Sound** (Jud Kenworthy)
   a. Acknowledged APNEP partnership, the CHPP team and Dr. Joe Luczkovich at ECU for contributions to SAV work.
   b. Question for the day is can we use SAV to develop protective water quality criteria?
   c. 3 part presentation: SAV 101, Status of SAV in NC and Optical water quality.
   d. **SAV and Water Quality 101**: development of water quality criteria is ultimately based on concept of protecting designated use of a water body. Do we want to consider SAV as a designated use and how do we address that? Has been addressed by other states such as, Florida, Texas and Chesapeake Bay.
      A. History of interest in SAV goes back to 1970's. Over time saw changes in SAV.
      B. In 1991, there was a workshop held in Florida with Federal and State scientists and regulators to look at the state of the science and figure out if the water quality criteria that was in place was effective enough to protect SAV. Result was a general standard won't adequately protect seagrasses/SAV.

C. In 2009, EPA came out with "Seagrasses and Protective Criteria a Review and Assessment of Research Status" by Walter G. Nelson. Bringing science up to date. However, it's up to the states.
D. One thing that is taxonomically different between SAVs and micro- and macroalgae is the light requirements are much higher. If we're going to protect SAV, they need more light. Range of light requirements vary by species and by the level of impairment in the water. These plants can serve as an indicator of what the environmental quality actually is. We can look at their morphology and growth.
E. SAV are considered foundation species. They exert a degree of influence on their environment and other plants and animals, they interact with the water and slow currents and wave energy. They trap and stabilize sediment, assimilate and recycle nutrients, sequester nutrients and oxygenate the water and sediments. However, if we apply the right metrics, we can use the SAV as a tool to help manage the quality of our coastal waterbodies.

e. **Status of SAV in NC**: In NC there are 2 different types of SAV: High salinity seagrasses/SAV and low salinity SAV.
   A. **Low Salinity SAV**: 5-8 species, canopy meadow-forming species with light requirements of about 13% SI.
   B. **High Salinity Seagrasses**: 3 species, meadow-forming species with light requirements of about 22% SI.
   C. APNEP Indicator Report is currently being revised. Corrections to just a few errors.
   D. High salinity SAV trends from 2 studies 2006-2007 & 2013. Saw changes in seagrass in north zone (-5.9%), central zone (-2.6%) and south zone (-10.38%). Acoustic detection methods are being used since 2011.
   E. Low salinity SAV, did rapid assessment surveys (2014-2019)(Albemarle Sound, Pamlico River, Neuse River), did shore parallel transects, 1.0 meter ISOBATH, in-water verification and compared to historical data. We have SAV throughout the system but are becoming possibly impaired.
   F. Also set up 10 sentinel sites along those large estuaries: Albemarle, Pamlico, Neuse.
   G. We have baseline data to work with.
   H. What next? We need to link our SAV monitoring to our water quality monitoring by using a bio-optical water quality model.

f. **Optical Water Quality**:
   A. What next? We need to link our SAV monitoring to our water quality monitoring by using a bio-optical water quality model which will be covered in Nathan's talk.

g. **Path forward**: calibrate the low salinity optical model, support for water quality & SAV monitoring and monitoring programs need to be coordinated and integrated.

4) **Development of scientifically defensible chlorophyll a standards for protection of submerged aquatic vegetation in the Albemarle-Pamlico Estuarine System** (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. The goals for this Optical Modeling Project are to determine if current NC Chla standard protects high/low salinity clarity targets and recommend changes if necessary and to evaluate current water clarity in relation to high/low salinity clarity targets.
  - We already have a model calibrated for a NC estuary

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. We already have a model calibrated for the North River estuary (at the south end of APNEP). Project Objectives where to validate model for other high/low salinity areas and use the model to predict K_{PAR} and to figure out chl a thresholds that meet clarity targets.

f. Project Tasks: we already had a calibrated model, have data that goes into it (CDOM, turbidity, Chl a), we can predict K_{PAR}. Compare that the observed K_{PAR}. If they match well then, we can validate the model, then use it to assess current standards/water quality conditions.
  - Problems are data limitations: there is little data for CDOM (Neuse, Pamlico) and little data for observed K_{PAR}.

g. Settled on a model that predicted CDOM pretty well based on salinity and seasonality.
  - The model from the Neuse River and North River data sets can predict CDOM for Pamlico Sound. CDOM estimates are to some degree system specific. And the lack of CDOM data for NC waters is a real data gap that needs to be filled to do this right.

h. Developed a model for K_{PAR} based on Secchi depth and salinity.

i. Neuse River/SW Pamlico Sound Empirical model of K_{PAR} based on Secchi validated for Pamlico/ Pungo Rivers and North River. Provides confidence to estimate K_{PAR} for Pamlico & Pungo Rivers, data to validate bio-optical model & for other estuarine waters and to compare conditions against clarity targets for SAV.
  - Bio-optical model slightly underestimates K_{PAR} for high salinity waters.
  - Model also significantly underestimated K_{PAR} for low salinity waters.
  - Bias worsened as salinity decreased in the Neuse River.

j. Confident moving forward with the model for high salinity waters to predict thresholds for chlorophyll a. Looked at Chl a and turbidity. Turbidity was too high in some of the locations.

k. Low salinity (even through underpredicting light attenuation) ran the model, couldn't meet the water clarity target, with a couple of exceptions.

l. How does a median threshold Chla of 10 - 15 mg/L compare to the current do not exceed standard of 40 mg/L with a 10% exceedance allowance? Used all the States' estuarine monitoring data, ModMon data, Bogue Watch, SECN, USGS and DCERP data where a single station was sampled over and over. Looked at the median values and compared that to the 90% Quantile Chla, so the median threshold of 15 mg/L Chla is similar to the current States' standard. The way the standard is assessed is going to have an effect on how protective it is to SAV.

m. Current NC turbidity standard is not protective of SAV for high or low salinity waters.
n. How does current water clarity stack up against water clarity targets?
    - Data estimated using Secchi depth, data directly measured and data modeled for light attenuation.
o. Time series of K_{PAR} from western and eastern Bogue Sound. 20 year averages may not reflect current conditions. Patterns of change can vary within a single water body probably due to local processes and circulation patterns.
p. Conclusions:
    - Bio-optical model indicated a median Chla threshold for high salinity SAV of 10-15 mg/L similar in effect to NC Chla standard and agrees with Chesapeake Bay's high salinity threshold.
    - Bio-optical underestimates K_{PAR} and needs recalibrating for low salinity estuaries.
    - NC turbidity standard is not protective of SAV and should be 10 NTU or less, not 25 NTU.
    - Poor CDOM estimation is not the only cause of model bias but CDOM data is badly needed.
    - Direct K_{PAR} measurements needed for validating a recalibrated model for the low salinity zones.
    - Few data for turbidity, Chla, and CDOM from high salinity SAV zones behind Outer Banks.
    - Most NC estuarine waters do not meet SAV clarity targets.
q. **Jim H.** comments for DEQ looking to address some of those data gaps by getting samples, hopefully starting in May.

5) **Nutrient limitation of Chowan River phytoplankton, summer, 2020** (Hans Paerl)
    a. Acknowledge Malcolm Barnard.
    b. Resurgence of the cyanobacterial blooms in Chowan and Albemarle Sound.
    c. Objectives of research:
        - Determine nutrient limitation of the Chowan River Blooms.
        - What is the role of N2 fixation in supplying N to support blooms?
        - What are the salinity effects on the Chowan River Blooms?
    d. Two sampling points look at, bioassays were run and bottom-line, nitrogen limitation prevailed. Nitrogen inputs appear to be controlling the extent of the blooms. Phosphorus had no effect by itself.
    e. Need to look at the sources of nitrogen. In the Chowan we know we have external inputs and we also know that cyanobacteria can fix nitrogen. Also look at denitrification. Used acetylene reduction assay which is a surrogate at looking at nitrogen fixation. Found that during the bloom there was significant amounts of nitrogen fixation going on. Haven't quantified this yet for flux rates.

f. Initial Conclusions were finding the highest Nitrogen fixation rates during the Chowan River Cyano-blooms max in July 2020.
g. Ongoing research will investigate new nitrogen input estimates via N_2 fixation rates paired with drone imagery.
h. Salinity effects on CyanoHAB? It's not necessarily a barrier to cyanobacterial expansion. Ran further bioassays on this and they can handle higher salinities if there is enough nutrients.
i. Conclusions:
   - N limitation and some N and P co-limitation on phytoplankton (including CyanoHABs) in the lower Chowan R. This confirms earlier work (80's and 2000's).
   - Follow up with nutrient dilution bioassays to see what the thresholds are.
   - Cyanobacteria were stimulated by nutrient additions at salinities up to 6‰, which covers most of Albemarle Sound. Which CyanoHABs would be involved?
   - Will look at the potential roles of N2 fixation in supplying N needs for CyanoHABs.
   - Need to investigate salinity effects on cyanotoxin production.

6) **Question**:
   a. Wilson: Q for Nathan and Hans- from standpoint of turbidity, most of the data were one-shot samples, so how important or is it important for us to understand the daily cycle of turbidity in a system?
   b. Nathan: There are some stations that have continuous monitoring that are in that high salinity zones. Having continuous data is very valuable. Nobody goes out to sample when there is bad weather and high winds.
   c. Hans: When the winds are low there are more surface blooms and turbidity is actually going to be lower. When the wind is high the turbidity will dominate, and the bloom will be throughout the water column.
   d. Marcelo: Q. for Judd- you showed data for high salinity SAVs and talked about the changes that were between 2006 & 2013, but then later on showed data from 2019?
   e. Judd: We did fly in 2019, but conditions weren't great to get a full set of tier one extent data but did do the ground.
   f. Marcelo: You talked about the low salinity SAV as well. What was the baseline year for that?
   g. Judd: If you are referring to the table, the baseline is the historical maximum extent. That's an accumulation of observation and data for a period of decades.
   h. Marcelo: Q. for Hans. The satellite image for the Albemarle but not the Chowan.
   i. Hans: There have been times when the Chowan was in high flow, so you wouldn't see a surface bloom. Wanted to just show that you can see them.
   j. Marcelo: If you extrapolate your N-fixation rates, how does that compare to the amount of nitrogen coming down the Chowan?
   k. Hans: That's what we want to know.
   l. Nathan: I've done that for the estimates we have currently, and it was really low, like <2%. That's total nitrogen from tributary load.

7) **Evaluating options to establish clarity-related criteria** (Jim Hawhee)

a. **Underlying Assumptions for Clarity-Related Criteria**:
   - Submerged aquatic vegetation (SAV) provides habitat for hundreds of aquatic species.
   - Water quality standards should protect aquatic life and by extension, SAV.
   - SAV requires adequate light for growth.
   - Reduced clarity reduces potential SAV habitat.

b. **Criteria Options for Protecting Clarity**:
   - Direct clarity criteria: Secchi and photosynthetically active radiation (PAR).
   - Clarity-related criteria: Chlorophyll a and suspended sediment.

c. **Criteria Option: Secchi Depth**:
   - Criteria approach: establish clarity criteria expressed as Secchi depth to correspond to SAV protection goals.
   - Pros:
     • Secchi already collected at many sites in this region for integrated depth samples.
     • Historical record of Secchi depths may provide historical benchmarks.
   - Cons:
     • Relies on human judgment, imprecise.
     • Likely errors in the historical record.
     • Impractical for truck/bridge-based monitoring?

d. **Criteria Option: PAR**:
   - Criteria approach: establish clarity criteria expressed as PAR to correspond to SAV protection goals.
   - Pros:
     • Accurate measure of clarity.
     • Staff familiar with PAR meter use.
     • Secchi/PAR relationship can be modeled for historical data.
   - Cons:
     • Requires additional equipment and testing.
     • Bio-optical model required to identify cause/management response for clarity. impairments (algae, sedimentation, color).

e. **Criteria Option: Chlorophyll a**:
   - Criteria approach: use a clarity endpoint to inform a chlorophyll a criterion.
   - Pros:
     • Chlorophyll a standard in place and likely to remain.
   - Cons:
     • Requires bio-optical model (under development, 1 yr min).
     • Requires judgment for acceptable partitioning of acceptable shading by algae.
     • Chlorophyll used to protect other uses too; some are difficult to quantify.

f. **Criteria Option: Turbidity**:
   - Criteria approach: use a clarity endpoint to inform a turbidity criterion.
   - Pros:

• New SAV protections for sediment-related shading,

- Cons:
  • Requires bio-optical model (under development, 1 yr min),
  • Requires judgment for acceptable partitioning of acceptable turbidity shading,
  • Standards and management approaches for sediment TMDLs not well developed in NC.

g. **Questions/Comments**:

a. Hans: About the Chlorophyl standard, we have this issue with toxicity, which could become a problem within Albemarle because of the fisheries (crab fishing). Just wanted to throw that out there as another criteria. Another is CDOM, it should really be looked at as well because it is really a factor that could change with more intense storm activity and leaching from the watershed depending on land use. Just want to throw that out there too. Just from the modeling perspective.
b. Judd: CDOM is always a player. For the committee as a whole, we should walk through Jim's pros and cons.
c. Jim H: Very good idea. Open invitation for everyone to look at these to advance the discussion.
d. Jim B: Seems like water clarity is what's needed for SAV protection and why not start with a direct measurement? If it were PAR wouldn't you need to measure light extinction coefficient or something?
e. Wilson: I like Judd's idea to set aside time for a more thorough discussion.
f. Jim H: Hoping for the group to do that and chlorophyl a discussions are needed.
g. Judd: Quickest way forward with bio-optical model is your able to do more with other parameters.
h. Jim H: The model is a necessary step. We may be able to establish a clarity criterion without it, but we're not going to be able to establish a cause for impairment or establish a management strategy without some effort to partition responsibility between sedimentation versus algal, nutrient related issues. It's a critical tool we need to continue to develop.
i. Jim H: Do agree with Judd's suggestion to set-up a more discussion-based meeting next time?
j. Nathan: If we do look at Chla as a criteria, it might be useful to do what we did with HRL and have ranges of Chla that are protective of different uses. That seemed to be helpful for HRL. Narrowing ion on what we think might be acceptable. If we do that, we might see that SAV is one of the more sensitive uses and may be an umbrella for protecting other uses.
k. Judd: Point of one of his slides.

8) **Closing** (Jim Hawhee) – Ask the committee members to please reach out to at any time with comments, questions, suggestions. Think about pros and cons. **We can have a more discussion-based meeting next time**. **Comments by April 23, 2021**.
9) **Meeting Adjourned** (Jim Hawhee)