

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

9/24/2018

Attendees

SAC members in attendance:

Lauren Petter
Bill Hall
Linda Ehrlich
James Bowen
Clifton Bell
Astrid Schnetzer
Marcelo Ardon

Michael O’Driscoll
Martin Lebo
Hans Paerl (via phone)
Nathan Hall (via phone)
Deanna Osmond

SAC meeting facilitator:

Andy Sachs

NCDEQ DWR staff in attendance:

Jim Hawhee
Connie Brower
Christopher Ventaloro
Bongghi Hong
Nora Deamer
Brian Wrenn
Mike Templeton

Raj Rajbhandari
David Huffman
Qaise Banihani
Pam Behm
Leigh Stevenson

Criteria Implementation Committee (CIC) members in attendance:

In person:
Andy McDaniel
Anne Coan

Guest speakers:

Stephen Parker (NC State University)

Meeting materials can be found on the Division of Water Resources Nutrient Criteria Development Plan Scientific Advisory Council webpage. Click [here](#) for a direct link.

Meeting notes

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All questions, comments and answers are paraphrased

1. **Convene** (Andy Sachs, Brian Wrenn)

- a. Desired outcomes for today's meeting:
 - i. Shared understanding of the comments and questions from the CIC on the pH Proposal.
 - ii. Shared understanding of fisheries data for HRL.
 - iii. Shared understanding of the workflow proposal for Chlorophyll-*a* criteria for HRL.
 - iv. Shared understanding of the continuing discussions on Chlorophyll-*a*.
- b. Administrative business (Brian Wrenn)
 - i. Request comments for meeting notes from the July 2018 SAC meeting.
 1. No comments from SAC members
 - ii. Request for academic schedules for planning future SAC meetings.
 - iii. Establishing a deadline for finalizing HRL recommendations:
 1. SAC has been discussing HRL for about four years. What time frame do SAC members feel is reasonable to finalize recommendations for HRL?
 2. DWR is concerned that the existing model for HRL is 10+ years old. Need to move forward before model becomes obsolete.
 3. Comments:
 - Lauren P. & Astrid S.: Agree that setting a deadline is a good idea.
 - Clifton B.: At least two more meetings required for chlorophyll-a to discuss temporal aspect, magnitude and extrapolation to other lakes/reservoirs.
 - Marcelo A.: What is the end product? We are still discussing pH and chlorophyll-a. We haven't even started to discuss TN and TP.
 - Brian W.: The deadline would be for all parameters. Does the SAC feel that this could be done in six months? A year? Should we meet more frequently to facilitate this?
 - Clifton B.: A year would be more realistic.
 - Deanna O.: Agrees.
 - Andy S.: How does DWR feel about another year of working on HRL?
 - Brian W.: Not sure. Will need to discuss with staff and management.
 - Lauren P.: Recommends holding multi-day meetings on consecutive days to focus efforts.
- i. Astrid S.: Two back to back meetings would be good.
- ii. Mike O.: One in-person meeting followed by a WebEx meeting is also an option.
 - Linda E.: Six months to one year reasonable. Multi-day meeting ok.

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- Clifton B.: The flow chart will help this process. Regarding TN and TP, there has been some mention in the literature of using bioconfirmation. The sticking point may be how to apply that to other lakes.
 - Marcelo A.: Another year sounds like a long time, but realistic. Multi-day meetings ok.
 - Lauren P.: We can aim for nine months. TN and TP may be easier once chlorophyll-a is established.
 - Martin L.: Six months to a year is good. Multi-day meetings are good.
 - Andy S.: I'm hearing that the SAC wants some structure and push from both the facilitator and staff. Can staff provide structure going forward?
 - James B.: Multi-day meetings in December sound good.
 - Nathan H.: TN and TP will be easier with chlorophyll-a established. Multi-day meetings would be good.
2. **Next Steps – Chowan River Update** (Leigh Stevenson)
- a. See “Blooms in the Chowan River” [presentation slides](#)
 - b. Blooms and surface scum were frequently being reported in the Chowan River and Albemarle Sound.
 - c. DWR got involved with monitoring in 2015 and monitoring continued through 2017.
 - d. 2018 has had the most citizen reported events to date (22 total)
 - 1. 8 from the DWR fish kill app
 - 2. 14 via email
 - e. DWR has made available an app to allow citizens to report blooms
 - i. First report was received on June 19, 2018
 - f. DWR microcystin sampling showed levels above the World Health Organization (WHO) and draft EPA criteria for protection of recreational uses.
 - i. See presentation slide # 8 for analysis results
 - g. Public notification via:
 - i. Direct communication (email)
 - ii. Public notices
 - iii. Communication with NC Department of Health and Human Services (DHHS) & local health departments
 - iv. DWR Algal Bloom online map updates
 - h. DWR plans to incorporate remote sensing technology in 2019.
 - i. Satellite imagery provided by NOAA
 - ii. There are some limits to the technology (cloud cover)
 - iii. Will be helpful in identifying cyanotoxin hotspots
 - i. Other actions:

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- i. Continue to work with DHHS and local health departments on communication
 - ii. Continue to work with local groups to identify bloom causes and manage the watershed
 - iii. Continue to develop bloom/cyanotoxin monitoring capabilities and investigate new technologies (remote sensing, drones)
 - j. Comments/questions:
 - i. Clifton B.: Do you have chlorophyll-a data to compare to the bloom information? Can that be collected in the same way that sampling is done for standards assessment?
 1. Leigh S.: There is routine monitoring that is ongoing in the Albemarle Sound. It may not be at the exact location of a bloom event. Hard to collect integrated sample when blooms are near shore because of the shallow depth. Estuarine monitoring team will collect cyanotoxin samples if there is a bloom occurring at the time of routine sampling.
 - ii. Deanna O.: Do you have enough data to show trends?
 1. Leigh S.: Not yet.
 2. Nathan H.: Chlorophyll-a concentrations have increased since 2014-2015. This has also corresponded with an increase in the appearance of surface scums.
 3. Brian W.: Most sampling has been in response to episodic events. Only three staff to do this and regular ambient monitoring.
 - iii. Deanna O.: Aphanizomenon algae was predominant in the 1980's but went away when the paper mill was closed.
 1. Elizabeth F.: There is a data gap regarding this as the Water Resources Research Institute (WRRRI) stopped monitoring following closure of the plant.
 - iv. Bill H.: What are the nutrient trends?
 1. Brian W.: TKN has increased, TP and TN are flat.
 2. Nathan H.: Organic nitrogen has increased.
 3. Jim H.: May want to look at the previous work done by APNEP for more information on this.
 4. Nora D.: DWR is also finalizing the Chowan Basin Plan which will provide additional information on this. Should be ready by the end of October.
 5. Pam B.: Part of the watershed is in Virginia. Has Virginia provided any data?
 - Brian W.: We are working with the Virginia Algal Network and can provide contact information.
 - Anne C.: About 75% of the watershed is north of the NC state line.
3. **Cyanotoxins** (Astrid Schnetzer, Christopher Ventaloro)
- a. HAB Cyanotoxin Draft Criteria Update (Christopher Ventaloro)

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- i. See: Brief Update of EPA’s Revised Cyanotoxin Criteria/Swimming Advisories”
[presentation slides](#)
 - ii. Overview of revisions:
 1. Children’s ingestion rate
 - Draft = 0.33 L/day (11 ounces/day), 97th percentile based on 2006 study with 53 participants
 - Revision = 0.21 L/day (7 ounces/day), based on 2017 study with 548 participants
 2. Relative Source Contribution
 - Draft = 0.8, presumed 80% of exposure through incidental ingestion and 20% exposure through other contact (dermal, inhalation)
 - Revision = no RSC, removed to maintain consistency with other recreation criteria (100% exposure through incidental ingestion)
 3. Criteria
 - Draft = microcystin 4 ug/L, cylindrospermopsin 8 ug/L
 - Revision = microcystin 8 ug/L, cylindrospermopsin 15 ug/L
 4. Duration & frequency
 - Draft = Swimming advisory not to be exceeded on any day, Recreational criteria not to be exceeded more than 10% of days/recreation season up to one calendar year
 - Revision = Swimming advisory stays the same, recreational criteria 1 in 10- day assessment period across recreation season with no more than 3 excursions per season occurring more than once in three years. (excursion defined as a 10-day period with any toxin concentration higher than the criteria magnitude)
 5. Estimated toxigenic cell density/toxin production
 - Draft = toxigenic cell density of 20,000 cells/mL (based on 4 ug/L microcystin)
 - Revision = toxigenic cell density of 40,000 cells/mL (based on 8 ug/L microcystin)
 - iii. Comments/questions:
 1. Deanna O.: What is the RSC?
 - Chris V.: A relative source contribution (RSC) is applied when calculating human health related criteria to modify the criteria magnitude based on the potential for exposure from varying sources.
- b. Update on Cyanotoxin Analyses (Astrid Schnetzer)
- i. Update on SPATTs data from HRL

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- ii. Looked back on data from the special study (summer 2016) to consider both dissolved and total fractions of cyanotoxins.
 1. 10% of toxin appeared in dissolved stage
 2. Majority was in particulate stage
 3. The fraction of dissolved vs. total can shift dependent on the cyanobacteria strains present and existing environmental conditions
 4. Will keep an eye on both dissolved and total toxins going forward
- iii. Comments/questions:
 1. Linda E.: What extraction method was used?
 - Astrid S.: methanol extraction and freeze/thaw extraction.
 2. Hans P.: Can *Cylindrospermopsis* species produce microcystin toxins?
 - Astrid S.: Possibly. Microcystin is not limited to only being produced by *Microcystis* species.
 - Deanna O.: There is some evidence for this.
 3. Bill H.: Does DWR sample for dissolved or total toxins? Is there an EPA method? Is there an established hold time?
 - Brian W.: DWR does total sampling.
 - Leigh S.: Yes, there is an EPA method. There is a hold time of 14 days. There is also a method for analyzing *cylindrospermopsin*, but we do not have the necessary technology to perform the analysis.
4. **Aggregation of Data for Criteria Development** (Clifton Bell)
 - a. See the document titled “*Slides on CHLa Assessment Units*” [here](#)
 - b. It is standard practice to pool data from multiple stations. Issue is whether to divide stations based on shared characteristics.
 - c. Recommend defining the assessment units based on the following:
 - i. Morphologic units
 - ii. Limnologic similarities
 - iii. Homogenous chlorophyll-a
 - d. EPA guidance on segmentation
 - i. Key word is “relatively homogenous”
 - ii. May use *a priori* knowledge. What is known about a water body is used to inform decisions about segmentation. Ex: the knowledge of the existing morphological separations in HRL can be used to establish relatively homogenous lake segments.
 - e. Examples:
 - i. Morphological features such as major confluences or pinch points can be used.
 - ii. Limnological features such as the standard river zones (riverine, transitional, lacustrine) can be used.
 - f. Other states commonly define assessment units a priori, use HUC 8 or limnological zones & major junctions as the basis for assessing chlorophyll-a. Often base assessments on limited data.

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- i. Some only use the lacustrine zone or the area near a dam. They use this to represent the entire lake and may also use each sampling station as an assessment unit
- g. NC currently:
 - i. Split assessment unit if two stations show different results
 - ii. Create small segments based on placement of sampling stations
 - iii. Station locations determine assessment units rather than the other way around.
 - iv. This leads to unstable assessments and increases implementation costs because worst station controls the assessment.
 - v. Clifton asks Pam Behm to comment on this:
 1. Pam B.:
 - The first bullet is correct
 - Regarding the second bullet: This can be true when additional information becomes available. Ex: Falls Lake began with two assessment units. As more information about the tributaries became available, and as water quality has changed, the assessment units were modified to accommodate the new information.
 - Regarding the third bullet: Assessment units are not based on sample station locations. However, station locations are usually established based on where we'd expect to see changes in water quality, such as the inflow of a tributary. If we see differences in assessment results between stations in an assessment unit, we will split the assessment unit to reflect the observed change in water quality. They are interactive.
 - Regarding the fourth bullet: Uncertain would be a more appropriate word than unstable.
 - Regarding the fifth bullet: Disagree with this statement. TMDLs are not related to the number of sampling stations. When the Falls Lake strategy was established, there were only 2 assessment units (AU's). There are now 10 AU's, but the strategy has not been changed to become more stringent.
 - i. Clifton B.: But the assessment unit with the highest chlorophyll-a level would be the toughest meet with the TMDL?
 - ii. Pam B.: Yes, but that depends on how the standard ends up being written. Currently it is written as "not to exceed" so all assessment units must meet the standard.
 - iii. Clifton B.: By defining the assessment units based on limnological features, each limnological zone would aggregate all sampling stations in that zone so that the

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zone itself would be required to meet the standard rather than the smaller units based on station location.

vi. Comments/questions:

1. Bill H.: Regarding the standard applying “anytime and anyplace”, if someone grabs a sampling in a cove would that be considered an exceedance?
 - Pam B.: They would need to use the DWR sampling protocols. This helps to avoid bad data.
2. Nathan H.: Agree with this in general. Riverine zone equates to high volume, high turbidity, low biology, and low residence time. Would the creek arms be riverine? The lake arms are about half of the lake area in HRL.
 - Clifton B.: An option would be to lump the arms in with the main stem at the confluence.
 - Martin L.: It would depend on the flow in the arms.
 - Michael O.: It’s tricky when considering a temporal variability as conditions in the lake change based on flow. Higher water levels would see more of the lake take on riverine characteristics.
3. Brian W.: Remember that the assessment units were not established for chlorophyll-a specifically. They apply for all parameters. Establishing separate assessment units for different parameters creates complexity when assessing data.
 - Clifton B.: That shouldn’t be a part of our discussion. There is good evidence to treat chlorophyll-a differently.
 - Marcelo A.: How likely would it be to have this many sampling stations in other reservoirs in the state?
 - Pam B.: Depends on the size of the lake and the ease of sampling.
4. Andy S.: Where are the SAC members on this issue?
 - Martin L.: Using limnology makes sense. Do you use each sampling station independently or do you need to integrate all to get a survey date summary?
 - Deanna O.: Not completely clear on the value either way.
 - Bill H.: Agree with separating mainstem from the tributaries. This provides the option to apply criteria based on different uses.
 - Michael O.: Agree with looking at morphology and zones. Need to understand however if there would be less or more protection.
 - Linda E.: Good to have more data so assessing by limnologic units makes sense.

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- Marcelo A.: Like the theory but have a problem with how it may be applied. Makes sense to stay with individual stations since transition zones may shrink or expand over time. Also, the current assessment units have been used for a long time. It makes sense to keep using them.
 - Lauren P.: Agree with Marcelo. Also concerned with over averaging data.
 - Astrid S.: There will always be an issue with the number of samples that are being collected. Lumping the stations will exacerbate this.
 - James B.: Agree with the EPA methodology.
 - Hans P.: Agree with Jim. Should be easy to model HRL to understand the different zones.
 - Nathan H.: The divide and pool option makes sense.
 - Clifton B.: There seems to be mixed opinions about this. I will write up a more formal proposal.
5. **Geomean vs. Arithmetic Mean for Chla** (Nora Deamer)
- a. See “Options Discussed for Calculating Chl a Criteria” presentation material [here](#).
 - b. Options include:
 - i. Geometric mean
 - ii. Arithmetic mean
 - iii. % exceedance of a standard
 - c. Geometric mean
 - i. Nth root of the product of the numbers
 - ii. Measures central tendency
 - iii. Is always less than or equal to the arithmetic mean
 - iv. In NC, only use for fecal coliform standards
 - v. Difficult to explain to the public
 - d. Arithmetic mean
 - i. Sum of all values divided by n
 - ii. Measures central tendency
 - iii. Influenced by outliers
 - iv. Easier to explain to public
 - e. % exceedance of a standard
 - i. Number of all values exceeding a critical value ($n > 40 \mu/L$) divided by the total number (n) of samples collected for the period of interest multiplied by 100.
 - ii. The percent of times (in a certain period) that a random process exceeds some critical value.
 - iii. Intended to allow for excursions of the standard (~10%).
 - iv. Useful when evaluating critical values “not to exceed” in order to protect a specific use.

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- v. Easily understood by public, easy to relate to blooms
 - f. Central tendency
 - i. Is it protective of uses?
 - ii. Does it protect downstream uses?
 - g. Other issues
 - i. Seasonality (summer vs. year-round)
 - ii. Depth integrated vs. grab sampling
 - iii. Toxic vs. non-toxic substances
 - h. Comments/questions:
 - i. Bill H.: Normally there would only be about 5 samples for a lake [based on typical DWR sampling efforts]. How does the amount of available data impact the use of no more than 10% exceedances with 90% confidence?
 - 1. Nora D.: We would need more samples to make the assessment.
6. **Population Dynamics Among NC Reservoir Striped Bass** (Stephen W. Parker)
- a. See presentation material [here](#)
 - b. Species specifics
 - i. Largest and longest live *Morone*
 - ii. Natural range St. Lawrence River to Florida and the Gulf Coast
 - iii. Kerr Lake, NC had one of the earliest self-reproducing introduced population (1950's)
 - c. Research objectives
 - i. Assess reservoir populations and assemblages
 - ii. Compare sampling methods and sampling protocols
 - iii. Assess population characteristics (growth, mortality)
 - d. NC research
 - i. ~12 reservoirs visited
 - ii. Stocking rate in HRL highly variable at first, but steady since the 2000's at about 5 fish per acre
 - iii. Used gill nets that specifically targeted bass species
 - iv. Employed systematic random sampling
 - v. Two field seasons 2018 (9 reservoirs, 800 net hours, 23,000 fish)
 - e. HRL specific results
 - i. Catch rate was lowest in HRL (only 25 fish caught)
 - ii. High degree of invasive species
 - iii. Required 80 net night (maximum effort of all reservoirs)
 - iv. 4th greatest abundance of all species
 - v. Lacked diversity (lowest number of species)
 - vi. Highest number of flathead catfish and carp
 - vii. Black crappie had highest catch rate
 - viii. Don't plan to sample HRL again

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f. Comments/questions:

- i. Clifton B.: This provides similar information as the earlier presentation we had from Wildlife Resource Commission. Comments: Bass are hard to catch as they tend to clump together, don't expect striped bass to reproduce in freshwater reservoirs so catch rates will vary by stocking rate. What might impact catch rates?
- ii. Stephen P.: Stocking is done at an arbitrary rate determined back in the 1970's & 1980's. Goal is to standardize stocking approach. Don't expect natural reproduction to occur. There is an abundance of prey organisms but competition with other species plays a role.
- iii. Clifton B.: There are few priority species in HRL. Species composition often depends on available habitat. Is there a difference between the amount of available creek habitat between reservoirs?
- iv. Stephen P.: Striped bass require thermal refuges in summer. Shallow water reservoirs contribute to die offs. HRL is wide but shallow
- v. James B.: Does this mean that there are fewer striped bass to catch in HRL or was it just that they were harder to catch?
- vi. Stephen P.: It would be hard to say with the amount of data available.
- vii. Astrid S.: Regarding the HRL assemblage slide, are any of those fish planktivorous? Did you do a gut content analysis?
- viii. Stephen P.: We did not do gut content analysis but gizzard shad and common carp are planktivorous.
- ix. James B.: Which of the fish in HRL are most adaptable to poor water quality?
- x. Stephen P.: Common carp are the most adaptive to poor conditions. The flathead catfish also persist everywhere.

7. **Continuation of chlorophyll-a flow chart discussion** (SAC members)

- a. James B.: Supports applying a confidence level of 90% and using a student's t-test. States that using arithmetic mean leads to greater number of failures and then using (log transformed) geometric mean reduces the number of failures.
 - i. Astrid S.: Should the group decide on a direction here?
 - ii. James B.: This illustrates the consequences of how we choose to go.
 - iii. Brian W.: What do you mean when you say pass or fail?
 - iv. James B.: Null hypothesis is that the average is greater than the criteria. Are we more than 90% confident that the mean is less than the 40 ug/L standard?
 - v. Marcel A.: For "results without confidence applied" is that comparing the mean to the standard?
 - vi. James B.: Yes, with no confidence level applied.
 - vii. Marcelo A.: How does this relate to the number of samples collected?
 - viii. James B.: There is greater confidence when there are more samples. For certain systems may want more samples.

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- ix. Lauren P.: During the last meeting we never talked about when in this process we decide on whether criteria under consideration are protective of the uses.
- x. Clifton B.: This is in the flow chart.
- b. Andy S.: What will move the group forward?
 - i. Clifton B.: Follow the flow chart.
 - ii. Andy S.: Does the group agree to follow the flow chart?
 - iii. There is general agreement to follow the flow the chart process.
 - iv. Andy S.: Does that start with part A-1? How do you proceed from there?
 - v. James B.: Provides a quick review of the flow chart. Process starts with section A-1 which requires deciding on whether to go with an exceedance-based criterion or an average-based criterion.
 - vi. Lauren P.: As we go forward it would be helpful to state what the basis is for any decisions that we make. (ex: was our choice based on best professional judgement?).
 - vii. Marcelo A.: Will we walk through this once or do it multiple times? Recommend we do this more than once.
- c. Andy S.: Starting with section A-1 “exceedance vs. average based criteria”
 - i. Linda E.: Average-based will reduce the impact of any anomalous spikes that are not significant. This helps avoid error.
 - ii. Marcelo A.: The spikes are important. Averaging ignores the extremes.
 - iii. James B.: I talked of the advantage of the existing standard because the existence of high values means something. If we go average-based we want variability to factor in hence the inclusion of statistical tests.
 - iv. Han P.: HRL is has consistent chlorophyll-a levels.
 - v. Astrid S.: Sampling is limited though.
 - vi. Clifton B.: We would have more success as a group establishing a seasonal average. Should shelve consideration of high-end values for now as we would need to demonstrate a relationship with a short-term effect. Eutrophic conditions can be better managed using an average approach. The literature is also more in line with using an average approach. Data availability also supports using an average. Models are also good at predicting averages as opposed to upper ends.
 - vii. Hans P.: Agrees.
 - viii. Nathan H.: Agree, upper end conditions often cannot be managed.
 - ix. Martin L.: Averaging considers upper end events whereas an exceedance frequency does not.
- d. Andy S.: Calls for vote on exceedance vs. average based criteria:
 - i. Results:
 1. 9 votes in favor of using average-based criteria
 2. Opposition:

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- Mike O., Marcelo A. (prefers incorporation of statistical tests if using averaging), Astrid S. (Need to be careful that the problem is not diluted out)
3. Other comments:
- Brian W.: There is a precedent for averaging along with a not-to-exceed value.
- e. Andy S.: Moving on the section A-3 “geometric mean vs. arithmetic mean”
- i. Nathan H.: Geomean. A geomean of 26 or 27 ug/L would be as protective as the current standard of 40 ug/L using the current assessment methodology. Arithmetic average may be impacted by management events.
 - ii. Marcelo A.: Average. The Chowan River is a great example. The rare extreme events that do occur cause real problems.
 - iii. Han P.: Geomean. Agrees with Nathan.
 - iv. James B.: Geomean. The geomean is always lower than the arithmetic average so is more protective. We need to know the answer to A-5 before we answer this. Without incorporating a statistical test, would prefer averaging.
 - v. Nathan H.: Agrees with James B.
 - vi. Deanna O. Agrees with James B.
- f. Andy S.: Jump to A-5. Would the result of the averaging be compared directly to the criteria or would a statistical test be used?
- i. Clifton B.: The not to exceed more than once in three years (1-in3) is an alternative to the statistical test.
 - ii. Lauren P.: Feel that A-7 and A-8 should be held off until we get to magnitude.
 - iii. Astrid S.: Does this work when only considering one year of data?
 - iv. Clifton B.: Won’t have the statistical power to list or de-list. Will force into an exceedance frequency area (1-in-3)
 - v. Andy S.: Sections A-3 through A-8 seem linked. Is there another question that needs to be asked?
 - vi. Marcel A.: We need to walk through various scenarios and come up with different proposals to vote on.
 - vii. Lauren P.: Agrees with Marcelo.

8. Wrap-up

- a. Next SAC meeting is on November 14, 2018.
- b. Final thoughts:
 - i. Clifton B.: Suggest we put together different proposals but leave magnitude for later.
 - ii. Bill H.: This is all academic. It can be expressed as an average or as a geomean. It’s the same.
 - iii. Marcelo A.: Should also consider data from multiple lakes.
 - iv. Lauren P. Offers to put together some proposals.

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- c. Discussion of holding back to back meetings to drill into this further without interruption. SAC members agree to this. Brian W. will come up with possible dates for this and poll SAC members. Considering doing this in early December.