



Criteria Assessment Protocol (CAP) Workgroup Meeting

December 8th, 2025
1:30 PM – 3:30 PM

[Visit the meeting webpage for meeting materials and additional information.](#)

Purpose: This monthly meeting of the Criteria Assessment Protocol (CAP) Workgroup included a presentation from Leah Ettema (EPA) about Dissolved Oxygen Assessment Methodologies. This will be a two-part presentation with the second part taking place at the February CAP WG Meeting. Then, Tish Robertson (VA DEQ) shared her presentation on *Communicating Bay Dissolved Oxygen*, which she presented at the Coastal and Estuarine Research Federation Conference. Lastly, David Parrish (VIMS) presented his methods of calculating water clarity, specifically in integrating remote sensing data.

Minutes

I. Welcome, Introductions & Announcements

Lead: Peter Tango (U.S. Geological Survey, USGS)

Comment: *Matt Stover:* A while ago, I mentioned putting some questions out to the Association of Clean Water Act Administrators, and I got a great response from a number of states. I asked 7 questions on how they handle their dissolved oxygen criteria, specifically at high frequencies. I am compiling responses on that to see what we can learn there. I am putting it in an Excel spreadsheet and hope to share it with the group in the near future.

- **Response:** *Peter Tango:* We have been working on revising the Chesapeake Bay Watershed Agreement. Last week, the Executive Council met in Baltimore. Kudos to the folks who put in time to formulate the expectations and language. With the Water Quality, Standards Attainment and Monitoring Outcome, the work you are doing to survey the states connects to the work that we have now committed to and have completed by 2030. That puts us on a timeline of expectation and production. Thank you for that research, Matt.

II. Background and Approaches to Dissolved Oxygen Assessment Methodologies, Part 1: Instantaneous Criteria Review

Lead: Leah Ettema (U.S. Environmental Protection Agency, EPA)

Leah presented the first part of her two-part series on how to determine instantaneous criteria impairment with high-frequency datasets, using her experience and the 2003 Chesapeake Bay dissolved oxygen criteria document. In this part, she dives into the criteria document to answer this question and more. In the next part, she plans to dive into alternative assessment methodology considerations.

Currently, allowable frequency of exceedance is not expressed in the EPA water quality standards documentation. Instead, Leah points to the 2003 criteria document to find this answer.

The first question Leah hoped to answer was “are exceedances of instantaneous minimum allowed?” There is an example from New York where continuous monitoring data was used and produced 98 and 99% compliance in two streams. These streams could not be delisted because the criteria must be met at all times. In the 2003 criteria document, Leah found that there are some dissolved oxygen (DO) exceedances allowed, and it includes instantaneous criteria by using reference curves.

Leah also found that for the Bay, space is an important component of criteria evaluation including pycnocline, volume, etc. The reference curve is based in area or space with time of exceedance. Based on the 2003 criteria document, the cumulative frequency diagram (CFD) method or reference curves are the recommended methodologies for instantaneous criteria, but there are alternative methodologies.

The 2017 Technical Addendum includes non-CFD methods for Open Water. When determining the methodology that should be used, Leah wants to find the best scientifically backed way to find the instantaneous minimum. This includes understanding the 10% exceedance rule.

Leah dove into the different durations of criteria assessment, which comes from the level of each parameter. In longer durations, those values impact the growth and other longer-term processes for fish, while in shorter durations, the values impact mortality of living organisms. Leah believes that this is more of a spectrum than it appears in the criteria. She also explains the importance of having both instantaneous minimum and daily mean.

Leah looks at each designated use and their instantaneous minimums. In a previous conversation with Jim Hagy, Leah notes that he mentioned how sometimes bottom DO isn’t monitored at the sediment but a meter or two above. With an instantaneous minimum of 1 mg/L at this depth, it would be likely that the sediment is seeing 0 mg/L which causes toxic fluxing of hydrogen sulfide. This could drive the rationale for using the biological reference curve, which is being used now.

For the migratory fish spawning criteria, the instantaneous minimum is 5 mg/L. This was set in the 1986 EPA Dissolved Oxygen Criteria. This was derived using production impairment rather than traditional EPA derivation protocols, and there was some confusion behind this in that 1986 document. This document also provides some helpful insight into the significance of exceedance in one continuous monitoring sample rather than one weekly grab sample.

After looking at these documents, Leah still doesn’t have a good idea of how many exceedances are allowed, so next she went into the EPA Integrated Reporting Guidance. In this document, she found that the technical rationale for using the 10% rule was missing, but it is the rule of thumb and intended to acknowledge measurement error. It was intended to be used with discrete data to make up for any error, which might not be necessary for the instantaneous minimum. Next, she looked at the open water and deep-water instantaneous minimum. Moving forward, Leah is wondering if sound rationale can be developed for allowable exceedances.

Actions:

1. At a later point, have a facilitated discussion on percent exceedance.

Discussion Notes (during presentation):

Comment: *Tish Robertson:* On the slides, you reference space being important to Bay assessment, which is true. However, the actual criteria were not developed with respect to space, correct? The criteria themselves were not developed using the CFD, but it is a tool for implementing the criteria.

- **Response:** *Leah Ettema:* That's a great nuance. Thank you. I wanted to highlight that we have to determine where the pycnocline is to determine where the designated uses apply.

Q: *Clifton Bell:* I'd like to get your input on the difference between frequency and assessment methodology. A lot of your presentation is treating them as two of the same, but I'm thinking of non-Bay criteria, like metals and toxics. In the Toxics Technical Support document, EPA recommends one in three frequency, yet the 10% rule is often applied to those criteria. Those two are treated independently, and EPA approves a lot of those listings. Should we be making some kind of distinction there?

- **A:** *Leah Ettema:* The one and three method applies to toxic criteria, which is not what DO is. DO is considered a conventional parameter and that one in three has some scientific basis. The Office of Research and Development (ORD) did a literature review 20 years ago and established that aquatic organisms can recover from a toxic event that occurs once every three years. There's an underlying ORD technical report which documents that and is the basis for that recommendation. I have a slide later in this presentation that talks about the 10% rule and an integrated report (IR) guidance. It is supposed to be applied to conventional parameters, but it is a rule of thumb. I have spent over 10 years trying to find a technical basis for that and have been unsuccessful.
- **Comment:** *Peter Tango:* One that was in our technical documentation was the use of the benthic invertebrate data, which was used as a justification for that specific application. It has not been reproduced for all of our designated uses, but it was linked as an approximate.
- **Response:** *Clifton Bell:* My point was that assessment methodology is not always directly tied to frequency. On the toxic side, that's a huge precedent on whether it's directly tied to the frequency of the criteria.
- **Response:** *Leah Ettema:* I'm not sure I agree with that.
- **Response:** *Tish Robertson:* For conventional pollutants, like DO, we tend to think about frequency as part of the assessment methodology. For toxics, you have the frequency baked into the criteria. That wouldn't be something that the assessors would come up with guidance for because it's already spelled out. For the conventional, we tend to reserve the frequency and how we handle that through the assessment program.
- **Response:** *Leah Ettema:* I've wrapped my head around this for a couple of weeks. It is nuanced and it is very important.

Comment (from chat): *Tish Robertson:* The 30-day Open Water criterion explicitly protects growth of aquatic life. But the 30-day Deep Water criterion protects survival of aquatic life.

Q (from chat): *Peter Tango:* Walt Boynton type question would ask you to hold your breath 6 seconds out of every minute of the day. Not so bad. But hold your breath for 9 days straight out of 90 days of a season... or 36.5 days out of 365, not so good. frequency of insult can be important.

Discussion Notes (after presentation):

Comment: *Tish Robertson:* That was the best presentation ever. I appreciate you going into those details that we don't normally talk about. Something I have been considering as an alternative for instantaneous minimum criteria is targeting the critical area of designated use, which would be

the bottom most part of the habitat. For open water, it would be the top of the pycnocline and for deep water, it would be the interface between the sediment and the water. We would look there for instantaneous minimum exceedances. If we decide 10% is what we want to go with, we wouldn't be considering 10% of the total habitat; it would be 10% within the space where we'd expect to find exceedances. If we key in on that part of the habitat and don't find excessive exceedances, then we can rest assured that the habitat is protected. I think that approach works best with the instantaneous minimum because it's the critical habitat and if you have organisms that aren't mobile, you are definitely protecting them. I would throw that out on the table as an assessment approach.

- **Response (from chat):** *Peter Tango:* The Maryland Fish Kill investigation unit maps show the shallow waters are prone to fish kills in low DO.
- **Response:** *Peter Tango:* In maps I've seen on fish kill investigations, a bulk of those are in small tributaries and near shore associated with diel scale activity for dissolved oxygen. That seems to be a place where we encounter fish kills. When we slice the habitats, it might be helpful to look at those maps.

Q: *Tish Robertson:* In your research, have you come across any other jurisdictions that use anything like the CFD for implementing DO criteria?

- **A:** *Leah Ettema:* I have not come across anything, but all of my research is focused on rivers and streams. I read that a CFD was being developed for somewhere else, maybe the Gulf of Mexico. I don't know if that was for an integrated report assessment or research. I also don't know of any other criteria that explicitly acknowledge the space-time component as much as this one does.
- **Response:** *Peter Tango:* I've been asked to help other states and programs, like San Francisco Bay and Massachusetts. A lot of folks are interested in knowing what we do and how we apply it, but I don't know anyone that has adopted the methods we use.
- **Comment:** *Matt Stover:* Of the five coastal states I've had survey responses to, which is Georgia, Oregon, Washington, Louisiana and Florida, none of them used the CFD like we do. I haven't gotten through all of the states yet.

Q: *Breck Sullivan:* This is tremendous and really helpful. When you showed some of the designated uses, like migratory fish spawning and nursery use, it showed a duration of two hours, but other criteria didn't have a time component for duration. Does that mean for instantaneous minimum we are looking at how frequently that data is available when there isn't a duration specified?

- **A:** *Leah Ettema:* In typical assessments outside of the Bay, most assessments are based on frequency of observation and allowing a certain number of those to exceed, i.e. 10%, regardless of monitoring duration. That's not universal. Some people will aggregate to one hour and then do 10% of that hour. Generally, the approach is comparing frequency of exceedances to frequency of measurements and determining impairment.

Q: *Leah Ettema:* What should part 2 discuss? We have to decide on the number in the percent exceedance. That's a big conversation but not one that I have specific insights to. Maybe that needs to be another facilitated discussion. Are there questions we have as a workgroup? What would be valuable to learn from other states, especially considering they don't have the spatial component? To me, it would be valuable to know how the combine data from different monitoring stations, but that's not something that I've looked into extensively. I can look, if that's the question, but it's not always well described in assessment methodologies, so I'm not sure how much insight we'll actually gain, unless that is a question Matt asked.

- **Response:** *Matt Stover:* No, I didn't ask the space question, which would have been a good one to include. Mine mostly had to do with how they assess different frequencies of DO with continuous and discrete sampling programs.
- **Comment:** *Leah Ettema:* They're very related too because we have some stations that have discrete data and other stations that have continuous.
- **Comment:** *Tish Robertson:* We also have stations that have different levels of monitoring efforts. Our long-term stations are full vertical profiles; some stations are only sampled at the top, and others are only sampled at the bottom. It's a motley of different densities of data over space and time. It varies based on where in the Bay you're talking about. That makes coming up with a one size fits all approach difficult.
- **Response:** *Leah Ettema:* I think the critical periods are fairly common in other continuous data assessment procedures. It's a recommended best practice to make sure to monitor in the critical periods, if you're using continuous monitoring.
- **Comment:** *Peter Tango:* I have seen a presentation about chronic repeated exposures to low DO versus single insult type of low DO and the impacts on life history, well-being and survivorship. Since the criteria came out, there is insight into repeated chronic low DO effects on fish. That may be something to read and think about to help inform allowable exceedances and the correct number. I'm thinking of the spatial components and places like High Lake in North Carolina where they do something like we do as far as segmenting areas, applying criteria to segments, and monitoring segments to distribute sampling to represent those segments. Sub-segmenting is what we did in 2017 which was supported by literature on sampling and frequency. Just thinking about the chronic impacts in allowable exceedances and the blending of effort through segmentation.

Comment (from chat): *Kaylyn Gootman:* Great presentation, Leah! And I do want to point out how unique the Chesapeake Bay is, especially in size, volume, and variety of designated uses.

- **Comment:** *Kaylyn Gootman:* I want to highlight how unique the Bay is. There is a lot of volume. It's quite different to how you would make an assessment of a river or stream. Like Tish was saying, we have a patchwork of data types and frequencies. It's complicated but I'm glad this group is digging into things.

Comment: *Peter Tango:* Some of the insights that haven't been accounted for have been what the space-time structure looks like relative to the fisheries and bug data conditions. It was somewhat done in Suisun Marsh with the fish data relative to DO. I know we have a lot of great fish data in the Bay. Looking to the future, some of these types of information might be valuable to the

researchers for tools and models that are under development. I haven't seen them synthesize the results in a structural way. We can use this to gain greater insights into how the Bay reacts and interacts with resources.

Q: Leah Ettema: Do you know where we are on developing biological reference curves for the other designated uses or criteria? Is that feasible or being talked about?

- **A: Peter Tango:** That's a topic for our criteria team here. We've used the benthic data in the habitat where it was most appropriate. We haven't said whether or not we could apply the information to the open water. The work on the James River was interesting to match biology to conditions, which was chlorophyll directed. There was lots of work to help justify or augment what is out there. We don't have a concerted effort underway just yet.
- **A: Tish Robertson:** We were using the benthos to understand the biological reference curve. For the open water and migratory fish spawning nurseries, those are swimming critters. How do you measure that? That's what we are struggling with. We don't have an index for fish or the other critters that rely in the open water or migratory fish spawning nurseries uses. In deep channel, Jenny Kiesman found that the 10% curve we use is a good one based on the benthos. The deep-water use is the one where we have the bio reference curve. We haven't found how to quantify reference when it comes to nekton.
- **Comment: Peter Tango:** Clarie Buchanan has worked to develop indices for phytoplankton and zooplankton. For zooplankton, there was a summer fish food index created by Versar folks. You all worked hard on the phytoplankton index, PIBI. I feel like those were more directed at the chlorophyll side, and I'm not sure we poked at them from the DO side. There is room for additional work that would benefit our ability to understand allowable exceedance relative to criteria. We had asked about how representative the BIBI was for near shore results. I think DEQ had done some studies on the shallow water relationships of the benthos. It makes me wonder if that data is leverageable to represent the open water side. We've never had that as a formal discussion.
- **Response: Tish Robertson:** I don't know. I was thinking about the tables Leah presented for open water uses, and it would be nice to look at those target species and understand what an appropriate use for open water would be rather than using the benthos. The benthos are great, but I don't know if the criteria are more calibrated to the benthos than the sturgeon. I think that's where the weakness is.

III. A new tool for communication dissolved oxygen concentrations in Virginia's portion of the Chesapeake Bay

Lead: Tish Robertson (Virginia Department of Environmental Quality, VA DEQ)

At the Coastal Estuarine Research Federation Conference, Tish gave this presentation, which she shared again for those who could not attend. This presentation focuses on a tool to increase communication of dissolved oxygen concentrations with the public. VA DEQ has a goal of increasing accessibility for the casual reader. They also want to be able to tell the full story and feel that they are currently limited by the few criteria they are required to present. To address these, VA DEQ is creating a tool with ArcGIS Experience Builder to communicate their integrated report findings and restoration efforts in a more casual and accessible way. This tool is called "Virginia's Chesapeake Bay Dissolved Oxygen Explorer." The tool includes an introduction to dissolved oxygen and descriptions of the DO critical habitats, which is a term they

use instead of designated uses. Then, they show the DO monitoring data for their focus areas and highlight the partners that collect that data. The tool also highlights areas with low DO and includes a high-level summary for the data interpretation approach. Lastly, they include resources that highlight community organizations and partners, provide links for further research, and list ways for readers to get involved in improving Bay health.

Actions:

1. As the tools mentioned are published, the creators should reach out to the Communications Team at the Chesapeake Bay Program to ensure they are shared with our network (bmartinezpenn@chesapeakebay.net and rfelver@chesapeakebay.net).

Discussion Notes:

Comment: *Peter Tango:* Seeing communication of our efforts is so important and this type of approach is super helpful.

Comment (from chat): *Mark Trice:* After Tish's talk, I wanted to mention some similar things we're working on at DNR.

<https://eyesonthebay.dnr.maryland.gov/eyesonthebay/CalibrationStationsInfo.cfm>

- **Comment:** *Mark Trice:* I included a link to a project we created recently. I was at the Bay Program Sentinel Site Meeting recently and it made me think about how we have no good visual tool for seeing the calibration data that is collected with ConMon and Dataflow. It would be hard to know if there is data nearby with all of the calibration data from Maryland and Virginia, so we put that together. You can download all of the calibration data for the site you click on at the link. It's a good supplement to the Bay Program Data Hub and links to it. On the hypoxia front, we are going to develop a Hypoxia Data Explorer over the winter. Over the last 15 years, we've created interpolated maps and other things that just reside in press reports and aren't very accessible. We're going to put that together to allow users to look at all these graphics and data in the same place.
- **Response:** *Peter Tango:* That'd be very timely, Mark. We have such strong information because of all of that work. After the new Agreement, it seems like people are asking for more from our data and you have preformed a lot of analysis over the years.
- **Response:** *Mark Trice:* It will also have a metric of data availability because sometimes sites are unavailable for various reasons which can impact the measurements and metadata.

Comment (from chat): *Dave Parrish:* In addition to all of the great work with public facing messaging, I think this may be the only place where you can publicly view all of these sampling locations collected across programs in Virginia in one place. Bravo!

Comment (from chat): *Jim Hagy:* I love how the Space Shuttle is still the symbol of a "launch." Gen X is still going strong!

Comment (from chat): *Breck Sullivan:* This is great!! When there is a release, please share the press release with Bianca Martinez Penn and Rachel Felver to share it on Bay Brief and other venues! We want to help make sure everyone knows about it! bmartinezpenn@chesapeakebay.net rfelver@chesapeakebay.net

IV. Water Clarity in the Lower York & James Estuaries: Data Flow Insights and Satellite Integration

Lead: David Parrish (Virginia Institute of Marine Science, VIMS)

This presentation focuses on the water clarity monitoring work that is happening at VIMS by integrating remote sensing. Dave explains the three monitoring platforms they are using at VIMS. This data is used to assess water clarity or light attenuation (Kd). Using an interpolation method called kriging, they can interpolate the entire segment from data cruises. This uses chlorophyll fluorescence, turbidity, and salinity to calculate light attenuation. A Kd threshold is used to calculate seagrass acreage. By bringing satellite information into this process, better calculations can be made to interpolate spatially.

Next, Dave dives into how they are acquiring and using satellite data. The satellite data is paired with fixed station and buoy data. Kd values are estimated by using different color bands from the satellite. Moving forward, they are planning to pair data from the James Polyhaline and Mesohaline with the satellite data. Dave explains some of the models they have been using and are planning on building out in stage 2.

Dave also let the group know that VIMS has a new version of the Virginia Estuarine & Coastal Observing System (VECOS). Here users can find quality control data by using interactive maps and queries. Lastly, Dave shared his next steps on this project with the team.

Discussion Notes:

Comment (from chat): *Peter Tango:* "Water clarity assessment" = Water clarity-acres evaluation. There has been work to translate submerged aquatic vegetation (SAV) habitat needs into water clarity acres relative to SAV goals. Like Dave said

Q (from chat): *Amanda Shaver:* Awesome talk, Dave! I did try to check the algal bloom app on VECOS and it wasn't loading. Is it only seasonally available?

Q: *Tish Robertson:* It seemed to me that the model you had for James Polyhaline and James Mesohaline weren't as good as the one you had for the York. Do you think that might be due to the bigness of James Mesohaline? It isn't homogeneous like York Mesohaline is.

- **A:** *Dave Parrish:* Good question. I think a couple of things are going on there. The model I presented in the James is an integrated Bayesian model. I think it is doing a better job at getting to the uncertainty in the data. The other model is a two-stage linear frequented approach. I'm taking the mean structure out of stage 1 and handling it as data in the second stage. I think a lot of the uncertainty you're seeing in the James model is real but it's also due to the fact that I'm not handling well with the joint models I was showing from the York. I haven't shown any results from the York Bayesian models. Those datasets will be in the same Bayesian framework and we will be able to handle it better in those systems. When we've looked at models in the past for those two segments, those coefficients, turbidity, chlorophyll and salinity, have been different in the two systems. That's part of it too.

Q: *Matt Stover:* Peter, I am curious if you have an update on the 2022-2024 stoplight chart? I don't know if Qian has mentioned anything.

- **A:** *Peter Tango:* Mike Mallonee has moved on from this work, and we have Mary Stack involved now. We had a call last week to help her with the transition and getting the data in place for the analysis. Richard and Qian were able to generate their results. Now, we're

working with Mary to have her pull the data with the format Mike was using. It's in action right now.

V. Adjourn

Next Meeting: February 8, 2026

Attendees:

- Allison Welch, CRC
- Amanda Shaver, VA DEQ
- Becky Monahan, MDE
- Bo Williams, EPA
- Breck Sullivan, USGS
- Clarie Buchanan, ICPRB
- Clifton Bell, Brown and Caldwell
- Cindy Johnson, VA DEQ
- Dave Parrish, VIMS
- Efeturi Oghenekaro, DOEE
- Elgin Perry, Independent Statistician
- Guido Yactayo, MDE
- Jillian Cudnik, EPA
- Jim Hagy, EPA
- Jon Harcum, TetraTech
- Juan Vicenty-Gonzalez, EPA
- Kaylyn Gootman, EPA
- Kelly Gable, EPA
- Leah Ettema, EPA
- Lee McDonnell, EPA
- Lew Linker, EPA
- Mark Trice, MDE
- Matthew Stover, MDE
- Melinda Cutler, MDE
- Michael Echevarria, HRSD
- Peter Tango, USGS
- Rebecca Murphy, UMCES
- Renee Karrh, MD DNR
- Richard Tian, UMCES
- Sophia Grossweiler, MDE
- Tom Parham, MDE
- Tish Roberston, VA DEQ