Criteria Assessment Protocol Workgroup

August 19, 2020
1:00 p.m. – 3:15 p.m.

Webinar*:
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This meeting will be recorded for internal use to assure the accuracy of meeting notes.

Action Items

- ✓ Tish Robertson will present on the downstream boundary issue at the next meeting.
- ✓ Tish Robertson will follow up on the instantaneous minimum migratory fish spawning nursery criterion.
- ✓ Qian will present results on the 2017 – 2019 Water Quality Standards Attainment Indicator results at the next meeting.

AGENDA

1:00 **Welcome, introductions & announcements** – *Peter Tango, Chair Criteria Assessment Protocol workgroup, USGS@CBPO*

- National Monitoring Conference, Providence, R.I. April 20 – 22, 2021. Abstracts due September 24, 2020.
- DEQ is considering drafting a regulatory proposal to alter the downstream boundary of the mainstem Bay Deep Water use so that it includes more of CB6PH and CB7PH than what is currently designated. If this is a path they decide to go down, they will want the Partnership's assistance with buy-in on the new boundary. They would like to come to the next meeting to discuss this issue further and then go to STAR.
    - Peter agrees that this issue would need to be brought up in the CBP hierarchy.
- Tish discussed another issue that was brought up from their regional assessors regarding when the instantaneous minimum (IM) migratory fish

spawning nursery (MFSN) should be applied for the ConMon data in the two Pamunkey segments. It is her understanding the MFSN use only exists in low-salinity waters so the IM criterion should only apply when salinity levels are <=0.5ppt. However, that is not what is written in their regulation. The assessor posing the question wanted to know why there wasn't a MFSN use assessment result for YRKMH, since a portion of it is in the boundary of the MFSN use (as stipulated in the October 2004 EPA technical support document for designated uses). She wants to discuss with the workgroup about the regulation to see if it is correct the way it is written or if the salinity condition written for the 7 – day mean should also be written with the IM MFSN.

1:05 **Water Quality Standards Attainment Results, and, a first look into "Attainment Sensitivity" – Qian Zhang (UMCES) & Peter Tango (USGS)**

Qian will present the last Water Quality Standards Attainment results and show how dissolved oxygen results influence our need to look further at climate influence on criteria attainment for the future. We are also exploring the idea of understanding the buffer that might exist for segments in attainment of criteria and how resilient a segment may be in sustaining its attainment status.

Qian first showed the updated results for the 2016 – 2018 Water Quality Standards (WQS) Attainment Indicator. He recently completed the results for 2017 – 2019 so he can present these at the next meeting. The 2015 – 2017 result was 42.3% while the 2016 – 2018 result is 38.3%. The result is a little lower due to the high amount of flow in those years especially 2018. The decline here compared to the peak is not that dramatic. The score is still the fifth best result, and it is not as bad as expected. Qian then showed results for the WQS Attainment by designated use. In the 2016 – 2018 results, most of the uses are flat, but there is an increase for Deep Channel which is good news. There was a large decline in Open Water which influenced the overall decline in the indicator results. Out of the Open Water segments, three switched from not attaining in 2015 – 2017 to attaining in 2016 – 2018. The opposite occurred for the rest of the Open Water segments which is a lot of surface area and influenced the decline in the overall indicator results. Although multiple segments switched to not attaining, their attainment deficit is very small. The indicator calculation does not include attainment deficit only a yes or no for attainment which again explains the decline in the indicator.

Tish asked if those segments that attained in the 2015 – 2017 barely attained? Qian said that is a good question, but the calculation for the indicator does not put the magnitude of the attainment into consideration. He would need to look back into the raw data. Tish was curious if the segments close to attainment and nonattainment would vacillate because they are on the edge.

Mark Trice asked if the area of attainment was in square meters. Richard said he thinks it is in square meters.

The second part of the presentation was on the Attainment sensitivity analysis. The tools the CBP has now is an attainment indicator (binary pass/fail analysis), and the attainment deficit (any value from 0% to 100% deficit). The proposed attainment sensitivity analysis combines attainment deficit concept with the attainment buffer concept. This analysis is preliminary, and Qian welcomes suggestions.

The calculation for this tool is for each segment for each year (not a 3 – year period) and each individual month (June – September). It then computes the interpolated dissolved oxygen (DO) concentrations. He then assigns a criterion threshold and computes the % attainment. To combine the deficit and buffer concepts together, he proposes two potential new metrics 1) Maximum allowed concentration (Tmax - maximum allowed criterion that achieves an attainment of 100%) and 2) Area under the curve (AUC). In his presentation, he provided some examples on how these metrics could be used. The proposed metrics help expand from specific thresholds and binary results to explaining non-attainment and attainment with buffers/resilience. They also allow for quantification of segments over seasons or years and comparison among segments.

Richard Tian asked what Tmax was for the open water graphs he showed at the end of the presentation. Qian said that graph does not show magnitude but only direction of improvement.

1:25 **Climate Change and the Challenge of Meeting Open Water DO Water Quality Standards Attainment – Lew Linker (EPA)**

The Chesapeake Bay Open Water dissolved oxygen (DO) water quality standard of 5 mg/l (5.5 mg/l in tidal fresh waters) was established to protect the growth of larval, juvenile, and adult fish and shellfish. Under climate change conditions the average annual temperature is estimated to increase by 1 ^{o}C over the three decade period between the hydrology used for the Chesapeake TMDL (1991 - 2000) and the year 2025 and by 2 ^{o}C by 2055. Challenges in maintaining achievement of an Open Water DO water quality criteria of 5 mg/l in all open water designated uses at all times will inevitably increase throughout the next half century.

The new 2019 climate change assessment confirms the December 2017 climate change findings with a better model, providing better understanding of underlying processes, more specific findings on nutrient speciation, CSOs, wet deposition of nitrogen, etc.

The watershed key findings show increased precipitation volume, precipitation intensity, and evapotranspiration are major determinates of changes in loads due to climate change. Land use change beyond 2025 also increases nutrient and sediment loads. The long term mean precipitation increased 3.1% and temperature by 1 degree Celsius. The Total Nitrogen (TN) and Total Phosphorous (TP) loads are steadily increasing from 2025 to 2055 under climate change, but there is a greater proportion of organic N and P compared to Dissolved Inorganic N or P.

The Modeling Team looked at the marginal difference estimates of climate change only and climate and land use combined for multiple factors. For difference in freshwater delivery, sediment delivery, N delivery, and P delivery, the percentage of these factors increase over the years, and there is a higher percentage with the climate and land use scenarios combined.

The overall estimates of 2025 climate change impacts from the watershed to the estuary concludes an increase in flow by 2.4%, 2.6% nitrogen increase, 4.5% phosphorous load increase, and 3.8% increase for sediment load which will lead to consequences to the estuary. Keeping all other factors constant, sea level rise and increased watershed flow reduce hypoxia in the Bay, but the predominant influence are the negative impacts of increased water column temperature. This will make it harder for the Partnership to achieve their deep water DO water quality standard and even harder to reach the open water DO water quality standard. Lew showed a table of attainment and nonattainment for Deep Water, Deep Channel, Open Water, and shallow water segments which depicted nonattainment for CB6 and CB7 and shallow water areas in the different climate scenarios. This leads to the question of if Open Water will be more impacted then Deep Water and if shallow water will be more impacted by rising water temperatures than Open Water.

Lew commented their shallow water model needs improvement. The shallowest cell in the model is 2 meters deep, and with climate change, they do not have the relationship between depth and surface area to do a credible assessment. For the next generation Bay Model, the team is looking to use a fine scale unstructured grid. They are also considering a multiple model implementation based on the CMAQ (Airshed Model) multiple model approach.

All the jurisdictions have to complete their Watershed Implementation Plans (WIPs) to describe what amount, how, where, and when for all the implementation required to achieve water quality standards by 2025. There was A CBP Partnership Decision where the Modeling Workgroup recommended, and the Water Quality Goal Implementation Team agreed, that Open Water designated uses were not considered for the current climate change allocation decisions.

Key Points:

- The Chesapeake Bay Open Water DO WQS is based on protection of living resource habitats. The Chesapeake Bay TMDL is based on attainment of the summer Open Water monthly mean criteria of 5 mg/L, which was established to protect the growth of larval, juvenile, and adult fish and shellfish.
- Under climate change conditions the average annual temperature is estimated to increase by 1 degree Celsius. Climate change temperature increases in Chesapeake tidal waters are inevitable over the next half-century and are beyond CBP management and control.
- Challenges in maintaining achievement of an Open Water DO water quality criteria of 5 mg/l in all Open Water designated uses will increase especially in shallow water areas.

Claire asked Lew if they were assuming the same water transparency across all years? If transparency (clarity) improves, net phytoplankton DO production in OW might increase. Lew commented with the increase in intensity of flows they are putting more TSS in the model calculation, and there is also sea level rise that is increasing the depth of water clarity. Claire said she was more concerned about what is smaller than sediment (dissolved fraction) and not TSS. She is curious because as light improves, oxygen levels increase. Lew said that is another complexity between respiration and biomass, and something else they need to look into or need help from others to understand it.

Peter asked if these challenges raise a variance type question or suggesting a new criterion in the face of climate. Lew said the partnership needs to meet WQS so how can that be achieved with these complexities must be considered along with understanding how living resource habitats can survive.

1:50 **Exploratory Analysis of historical data: The influence of temperature on dissolved oxygen resources in the Open and Shallow waters of the Chesapeake Bay – Rebecca Murphy (UMCES) & Breck Sullivan (CRC)**

An update on progress with the ongoing investigation of climate risk on attainment of Open Water DO standards will be presented. The investigation centers on long-term observations of temperature, salinity, and DO in shallow Open-Water (generally less than 2 meters depth) and deeper Open-Water DO in main-Bay segments (extending in depth from the surface to the pycnocline). Ultimately the goal is to assess observed Open Water DO trends by CB-segment in order to understand the risk of increased temperature effects on meeting Open-Water DO criteria.

Rebecca began the presentation with stating these are exploratory analyses, and they would really like feedback from the workgroup on how to shape this work

to help with questions about water quality criteria. Both analyses were shaped from the results of the CBP climate change scenarios which showed more negative impacts on summer DO concentrations in Open and Shallow Water areas than in Deep Water, but it is still under investigation how well the estuarine model is capturing Open and Shallow response to rising air temperatures. They can gain insight into the estuarine model climate change predictions by analyzing the tidal long-term monitoring data and comparing patterns in temperature and DO over the last 30 years.

For the Open Water Analysis, Rebecca took two approaches to looking at the data. She looked at how well monitored temperature change throughout the water column since the mid-1980's compares to estuarine model climate change predictions, and the second approach investigated how well the past 30 years of DO saturation change throughout the water column compares to the estuarine model's clime change predictions.

To look at trends for water temperature at different depths for the long-term monitoring stations, Rebecca compiled and identified any depth and any station with >300 samples from the 1980's to 2018. She then fit a GAM to evaluate change over time to each unique station-depth-parameter data set. She then identified years from the beginning to end to compute change.

She showed a map with the maximum temperature change for each station over the 30 years at any depth. The Rappahannock has some of the largest maximum temperature changes in the Bay. She then showed a map for the location in the water column where the maximum summer difference in water temperature occurred. In the Rappahannock where the most changes occurred, most of it occurred in the surface of the water column. In general, some of the largest changes are occurring in the middle of the water column for the stations in the mainstem, and for the upper Bay, the largest change is at the bottom of the water column.

When they began this analysis, they thought the surface water temperature would be changing more dramatically than the lower depths. This is true for some stations, but especially for the eastern shore mainstem stations, there is a constant temperature change with depth so the surface increase is not universally the pattern throughout the Bay.

When comparing to the modeling results, the lower Bay where the monitoring change occurs the most at the surface was consistent with the modeling results. In the middle Bay where there were more diverse monitoring results, the modeling results do not capture this and show more change occurring at the surface.

Rebecca did the same analysis for DO saturation changes to see if decreases in DO saturation due to temperature increase impacted the ability to meet Open Water Criteria. The spatial patterns are very consistent with water temperature. The magnitude of the DO saturation changes varies from 0 – 0.33 mg/L. The largest changes occur mostly in the lower tidal waters, and Bay-wide the depth of the maximum change varies.

Claire asked Rebecca if the unit on her graph for DO saturation should be percent instead of mg/L. Rebecca answered that this has been a topic of discussion, but her results are computed in mg/L because this is how the model calculates it. She stated that she understands how percent could be more relatable to living resources.

Tish commented that she knows this analysis is focusing on temperature, but she was wondering if they considered stratification. Would Rebecca expect a similar pattern for stratification? Rebecca said there could be a similar pattern which influences the cut off for Open Water.

Lew asked Rebecca what she thinks is happening in the Rappahannock. Richard said to Lew that is why he asked Gopal whether ground water contribution differs across the Bay i.e. less ground water contribution in the Rappahannock. Lew said he is not sure why the Rappahannock temperature increase is larger than other places. He commented it is worth looking into, although there may be others who have good ideas about this.

Breck presented on shallow water areas and the potential larger climate change impacts on DO compared to Open Water shown by the model scenarios. She took three approaches to look at the effect:

1) Evaluate whether the frequency of DO criteria violation has increased at a select set of shallow water monitoring stations over the period of record.
2) Investigate how water temperature change relates to DO criteria violation in shallow waters.
    a. She did not present on this approach because after looking at the preliminary results, they found that more work needs to be done to look at the specific location and watershed characteristics of each station.
3) Compare temperature and DO trends in shallow water monitoring data to nearby long-term monitoring station

For the analysis, Breck chose 15 stations that varied across the Bay including stations in MD (western and eastern shore) and VA. Each of these stations had 11 or more years of data to use for finding trends. For approach number 1, Breck used the continuous data collected every 15 minutes for the parameters DO concentration (mg/L) and DO saturation (%). For approach number 3, Breck used

the shallow water calibration data which is collected once or twice a month and used the parameters DO concentration (mg/L) and water temperature (degree Celsius).

Breck showed graphs for approach #1 with DO concentration (mg/L) using a station in the Pamunkey as an example. The patterns seen at this site were shown at others in MD and VA. The criteria violation is shown to start earlier in the year such as March and April and end later such as October, but the largest amount of criteria violation is during the summer months. While it is not good for a station to be below 5 mg/L, most stations at least didn't show many occurrences of being below 3mg/L. For stations in VA during 2018, there was a large spike in criteria violation. Breck preformed the same analysis for DO saturation. They showed similar patterns as the DO graphs, but for some years at stations there were zero criteria violations. Also for both parameters, the eastern shore stations seemed to have more criteria violation than the western shore stations, but this was only identified for the stations she analyzed and may not be shown throughout all shallow water monitoring stations.

Breck then showed the results for approach #3 spatially, first showing the shallow water DO trends compared to the long-term monitoring DO trends. These results are the average model fit for the summer months for DO data. There are more possible increases in DO for MD long-term stations than shown for the shallow water stations. In VA, the long-term stations show unlikely trends while multiple VA shallow water stations have a significant decrease in DO and one has a significant increase. She showed an example of the GAMs analysis for a station in the Patuxent. The shallow water station in a 17-year time period had a 9.71% decrease. The beginning DO level was approximately 5.95 mg/L and the end period DO level was 5.37 mg/L. The long-term monitoring station during the same 17-year time period only had a 0.21% decrease. Overall, the shallow water station has a decreasing trend, but the magnitude of the change is not that large. Throughout the period of record the DO measurements are not very different. Also, the most change for the shallow water stations happen at the end of the period of record.

The next spatial graphs shown were the shallow water temperature trends compared to the long-term monitoring water temperature trends. For most stations, both shallow water and long-term were increasing, but a few more shallow water stations were significantly increasing for water temp. Again, the difference in the increase between the two stations are not drastic in both states, and they have similar current summer water temperature levels. Even at some MD stations, the shallow water temp is significantly increasing over the period of record by the current summer water temperature was still lower than long-term current summer water temperature.

To answer the original questions from the modeling team for this analysis of will shallow water be more impacted than open water, the answer is that the impact is not universal. It changes depends on the state and within the state. If a shallow water station is more impacted compared to long-term monitoring station, the difference is not drastic. The second question of if the shallow water monitoring stations are more impacted is it due to rising water temperatures, the answer is that it might be one factor. When looking at nearby shallow water stations within a state, both stations could have a significant increase in water temperature but opposing DO trends. Other factors could be nearshore watershed characteristics. Breck's approach #2 gets to this question more, but she did not show those results because they saw from the analysis it is different across the states. The results are really dependent on location. They need to get a better handle on understanding the watershed characteristics for each location so this will be a priority for their next steps.

Breck and Rebecca are open to suggestions from the workgroup to move forward with all three approaches and want to understand what is useful to the CAP WG. Breck provided three questions to start the discussion:

1) Is there a way to change the analysis on the high frequency data that would help answer specific questions the CAP WG has on criteria (Approach #1)?
2) Are there suggestions on how to gain general patterns on the shallow waters in comparison to long-term monitoring (Approach #3)?
3) Would it be more useful to look at DO saturation instead of DO concentration or both?

Lew suggested looking at both DO saturation and DO concentration.
Carl suggested when comparing the shallow water stations with the long-term monitoring stations to use the corresponding times for the continuous monitoring data and the long-term monitoring sample. There is so much short-term variability with temperature that unless the same time is compared it is hard to tell if there is a trend.

2:15 **Stresses, challenges and paths forward with the CBP Water Quality Monitoring Program to address assessment of all applicable criteria – Peter Tango (USGS)**
Peter will introduce at least six ways to close the loop on unassessed criteria attainment assessments. This introduction will provide a roadmap to discussions, decisions and commitments necessary for our program to fully address the criteria suite in the Water Quality standards for the Bay by adapting to limited opportunities to expand support for the traditional water quality monitoring program**.**

It is 2020, and the CBP is still nowhere near reporting on the full suite of Chesapeake Bay water quality criteria of the Total Maximum Daily Loads

(TMDLs). The program needs near-term commitment and implementation of updates to measure WQS attainment. There are new data collections through new technologies and citizen science and opportunities to think about different interpretations procedures which could help update data and analyses to cover more criteria. Peter provided different options of looking and approaching the data differently such as revising the rules for the application of data to close gaps because 1 – 2 measurements a month are currently accepted for the 30 – day mean but not for the 7-day mean or 1 day mean. Another option is to update the use of published tools for conditional probability, accepting uncertainty in estimates. This requires no longer talking about it but implementing it. Revising the language of the standards is one way to reduce the complexity of the criteria and rewriting the standards to match what matters such as particular seasons and matching with the TMDL.

The traditional water quality monitoring program is degrading in capacity under its present business model and assessment approaches. Adaptation is essential and critical to achieving success, and there are opportunities to adapt with new data streams, new tools of interpolation, and opportunities for revised data interpretation to address program issues. Peter will present this information at upcoming meetings especially as it pertains to updating the WQS Attainment and Monitoring Outcome Logic & Action Plan. He will also present this information at the next Modeling Team Meeting in September.

Matt Stover said MDE submitted an RFP to CBP to look at this very issue. They would like to use the State's ConMon network and Dataflow to start assessing these high frequency DO criteria. They are interested in finding methods to complete these assessments and would love to engage the CAP WG on how it will look. Peter commented there would seem to be a framework opportunity here to address short duration criteria over regions, in many segments and a hybrid evolution of assessing more and more segments for all available criteria. Matt stated yes, he thinks there are no shortage of options. They have given thought to a few of them and are leaning right now towards one that involves a cycling approach to collecting high frequency data.

2:35 **Coincident interests in criteria assessment with USEPAs Continuous Data WG**

- **2:35-2:50 Continuous Monitoring Analysis Questionnaire - Danielle Grunzke (EPA)**
  An EPA workgroup is compiling resources and writing a Q&A document focused on quality assurance of continuous data (post-collection) and its use in assessment purposes. This Q&A document is aimed to help states, tribes and EPA review and use continuous data in the context of 303(d) listing and other water quality decision-making.

At the Continuous Data Workgroup in 2014, they received a letter detailing some needs on how to deal with continuous data in the current framework of WQS and how they are not currently written to handle such large datasets. She organized the regional monitoring coordinators and regional assessment coordinators for a meeting to understand what they are struggling with, and continuous monitoring was a high interest topic for them all. Action items after this meeting was to have a representative from each EPA region on the workgroup, and the issues they wanted to address was Qualified Assurance (QA) of continuous data post collection and how that QA plays into the assessment abilities of the data. They also produced a list of ten questions which they sent out to their monitoring workgroups to get feedback on them. Currently they are still taking feedback and revising the questions and starting to outline answers for them.

Daniel stated CBP partnership is very interested in and concerned about data QA. The CBP has a Data Integrity Workgroup (DIWG) that is devoted to ensure high quality data integrity, along with the appropriate QAQC data documentation. The DIWG meets quarterly. They will be discussing assessment of continuous monitoring data at the next meeting in the fall. Daniel recommended Danielle and Leah participate in the meeting.

- **2:50-3:15 Exploratory Exercise: Dissolved Oxygen Assessment Methodologies in Rivers and Streams.- Leah Ettema (EPA-Wheeling, WV)** Leah has evaluated a diverse suite of potential assessment metrics for dissecting and summarizing criteria attainment and violations with continuous monitoring dissolved oxygen time series collected from the Catatonk River in NY. Leah will provide insights on the comparative analysis across the metrics for describing and visualizing the results.

  The main challenge in 305B assessments is that even though continuous monitoring is capable of better capturing true variability, the magnitude and duration of exposures that affect aquatic life are still largely unknown. States and tribes are still charged with having to use and evaluating continuous data with 305B assessments. To test out different methods of using continuous data, Leah applied the different assessment methodologies and results to a 9-year continuous DO dataset. She provided a summary of state DO standards that she used such as durations from instantaneous minimum DO value to 30 – day mean. She then had to base it off program goals and data requirements such as defining what a sample is for that program. The dataset she obtained was from the Susquehanna River Basin Commission from Cataonk Creek close to the Finger Lakes. Her calculations were done by

year, and she found the percent of all points (15 minutes) that were below 5 mg/L. She also found the percent of daily means and daily mins below threshold of 5.5 or 5 mg/L with a percent greater than 10% as impaired. For the first year in data (2011), there is a period in August where it is below the threshold of criteria violation, but it is meeting criteria in the other months. She then broke the results up for passing and failing to show each day with the metric used. When looking at 2011, all the assessment methodologies says passing, but when zooming into August data where the violations occur, a different story arises showing the water body impaired. For the 2013 data, August is passing, but impairments occur later in the year. Grab samples may have missed this impairment if they were only taken in August compared to the continuous capturing of monitoring data which showed it later in the year. Leah also created maps showing the DO events below the thresholds and the duration of them. She has the data and code available for anyone that would like to look at it.

3:15PM **Adjourn**

Participants: Breck Sullivan, Rebecca Murphy, Peter Tango, Qian Zhang, Lew Linker, Danielle Grunzke, Leah Ettema, Amanda Shaver, Doug Austin, Cuiyin Wu, Greg Busch, Tish Robertson, Claire Buchanan, Mark Trice, Becky Monahan, Bruce Michael, Matt Stover, Carl Friedrichs, Tom Parham, Richard Tian, Tish Robertson