Bay Oxygen Research Group (BORG) Meeting

January 26th, 2026
12:00 PM – 1:00 PM
Visit the meeting webpage for meeting materials and additional information.

Purpose: In this meeting, participants heard a draft presentation, *4-Dimensional Interpolator 101*, by Kaylyn Gootman (EPA) and provided feedback. Then, Rebecca Murphy (UMCES) and Elgin Perry shared an analysis of class imbalances and how those findings can be applied to the 4-d interpolator. That agenda item will be covered in more depth at our next meeting on February 23rd.

Minutes

I. Welcome, Introductions & Announcements

Lead: ***Breck Sullivan*** *(U.S. Geological Survey, USGS)*

Follow up from November and December BORG Meeting

Items from past meetings we will bring to future BORG meetings:

- Proposed thinning for remainder 50m resolution segments
- Discuss the schedule and feasibility of updating the correlation computations using new data as available going forward in operational mode
- Discuss with the group how Tier 2 data can be used to support the tool even if it is not used for criteria assessment

Action Item from December BORG Meeting:

- Confirm if there is continuous dissolved oxygen in Teir 2 Chesapeake Monitoring Cooperative (CMC) Data to support correlation computations.
  - Completed: CMC confirmed there is none.

Upcoming Conferences, Meetings, Workshops and Webinars

- Choose Clean Water Conference – May 18-20, 2026. Lancaster, Pennsylvania.
- Chesapeake Community Research Symposium – June 1-3, 2026. Annapolis, Maryland. Abstracts due February 13, 2026.

Breck Sullivan (USGS) reviewed the agenda with the group. She noted that with the tighter timeline for this meeting, there may not be time to take all questions and discussions. If you have any thoughts or questions you were unable to share, feel free to email them to Breck Sullivan (bsullivan@chesapeakebay.net) for response and review.

II. 4-Dimensional (4-D) Interpolator 101

Lead: ***Kaylyn Gootman*** *(U.S. Environmental Protection Agency, EPA)*

Kaylyn Gootman (EPA) shared a draft presentation with participants that will be used when communicating with Chesapeake Bay Program management about the 4-d interpolator. She would like feedback from participants. While this is still a draft, Kaylyn would be happy to share the final communication piece with members of BORG to use for educating their management or leadership.

Within this presentation, Kaylyn explains how the 3-d interpolator was used and where it is used in the water quality standards criterion assessment process. Next, she explored why developing a new method is necessary. The next slide, which is a history of the interpolator at the Chesapeake Bay Program, is still under construction and explores publications related to the interpolator. Then, Kaylyn explained the 4-d interpolator itself, including its goals, processes, and data used.

Discussion Notes:

Comment (from chat): *Mark Trice:* 3d interpolator use – our hypoxia volume reporting

- ***Response (from chat):*** *Rebecca Murphy:* Thanks, Mark. That's a good one to add.
- ***Comment (from chat):*** *Mark Trice:* We also use it for spatial habitat assessments.

Comment: *Matt Stover:* On the slide "Dissolved Oxygen data sets", I want to mention that Maryland Department of Environment (MDE) monitors over 50 fixed station sites at multiple depths on a monthly basis.

- ***Q:*** *Kaylyn Gootman:* We can add that. Would that be better represented in its own box?
- ***Response:*** *Matt Stover:* Perhaps in its own box because it doesn't seem to fit with the others. Also, I think we have deeper water continuous monitoring (ConMon) with the Chesapeake Bay Interpretive Buoy System (CBIBS) buoys, especially in Fishing Bay.
- ***Response:*** *Kaylyn Gootman:* I will make sure that those are added to the slides. Thank you.
- ***Response (from chat):*** *Rebecca Murphy:* Yes, state monitoring that includes the Virginia Department of Environmental Quality (DEQ) and MDE vertical arrays can be added.
- ***Q (from chat):*** *Breck Sullivan:* Want to confirm that we have this data or do we need them to help direct us to it?
- ***A (from chat):*** *Rebecca Murphy:* We have the data, Breck.

Q: *Mark Trice:* In the development timeline, did that include this other effort to develop a new tool that never got off the ground maybe 15 years ago?

- ***Response:*** *Kaylyn Gootman:* This morning I was looking over the 3-d interpolator user guide from 2006, and it was talking about DART. Was it DART?
- ***Comment:*** *Mark Trice:* It was a group of statisticians, possibly from Johns Hopkins. They hired a consultant and there were a lot of meetings. I think there was a tool, but it never got used from what I know.
- ***Q:*** *Kaylyn Gootman:* Was that an effort to add in time?
- ***Response:*** *Mark Trice:* I wasn't a main member of that group. It was either a better 3-d interpolator or maybe adding some elements of 4-d.
- ***Response:*** *Rebecca Murphy:* There was definitely a publication by a consulting company that used kriging. From talking to Gary, that kind of died away because it wasn't well automated. I think it was just snapshots in time, so it was 3-d. It was the idea of using a more sophisticated technique, kriging.
- ***Response:*** *Mark Trice:* I remember having some discussions where we presented ideas and they wrote those up.

- ***Response:*** *Elgin Perry:* The group that Mark is talking about included Frank Curriero from Johns Hopkins and Mary Christman at University of Florida. My recollection is that they were looking at kriging but felt that it didn't offer much of an advantage over inverse distance weighting, which is what the 3-d interpolator was doing. They looked into 4-d interpolation and decided it wasn't computationally feasible at the time.
- ***Response:*** *Kaylyn Gootman:* This has been so helpful. In this process, I've been learning that we have been using interpolation software in the partnership for a very long time. The groundwork was there. We've had the groundwork placed and have advanced towards needing a new tool now that we have the data and software.

Comment (from chat): *Amanda Shaver:* On the data slide, the dissolved oxygen (DO) that is collected through the Old Dominion University (ODU) benthic probabilistic monitoring is pretty impressive over three years.

- ***Response:*** *Kaylyn Gootman:* I see your comment in the chat, Amanda. Thank you.

Q: *Matt Stover:* In terms of using all the data in the interpolator, we've talked about using the ConMon data to characterize dial and seasonal cycles to develop the patterns that would inform the interpolation. Then, we'd talk about wanting to use that data for the assessment itself and I think that's where we ended up. We say we're using all of the data. Are we using it for understanding the patterns and model development but not using those measured DO values for comparison to criteria? I am trying to clarify exactly what we're doing for that.

- ***Response:*** *Kaylyn Gootman:* Maybe in the slides, we can be clearer in what all data actually means.
- ***A:*** *Breck Sullivan:* Hopefully we can clarify that in our next presentation. There are four key components in the tool and how the ConMon is used in each component is different. The next presentation will focus on the mean mid-day results. As you are saying, we are trying to use the ConMon for the dial cycles too.
- ***Response:*** *Kaylyn Gootman:* Maybe it's "to inform assessments for criteria." We will have to do some word smithing.
- ***Response:*** *Matt Stover:* At that part, I want it to be super clear because that's a concern of ours. We are going out there to collect that data and its labor intensive. We want to get the most out of it. It seems like we're using a derivative of it to create the model, which is valuable. Our opinion is that it is valuable for direct assessment.
- ***Response:*** *Kaylyn Gootman:* That makes sense. These data are labor, time and cost intensive. From a jurisdiction, we're using them directly, but they're also informing a surrogate model to better inform the interpolator.
- ***A:*** *Rebecca Murphy:* We are using the high frequency data in the base level of the interpolation. We are putting it in and making sure the interpolator performs well with that data. It is also being used to inform the cycles. The high frequency data is being used in many parts of the tool. It wouldn't function without it, and we wouldn't have been able to build this without it.
- ***Q:*** *Matt Stover:* My interpretation of what you said is that the data is being used for pattern development or recognition. Is that accurate?
- ***A:*** *Rebecca Murphy:* Yes, but it is also being put into the interpolation. On the diagram of the 4-d tool, Matt is talking about using the high frequency data in the last three parts or green circles of the interpolation. However, we are feeding it into the first one too. We get an hourly estimate everywhere in the Bay from the interpolation. In a meeting or two ago, Melinda asked whether we should replace the interpolation output with the raw data when it exists. That is something we can continue to discuss. We've been working to see what impact that

could have because the quantity of hourly interpolations is high. Potentially, we could replace the interpolation output with data, if it is there, but there would be some concerns with that.

- ***Response:*** *Matt Stover:* Thanks for bringing that up, Rebecca. That is one of the things we are thinking about. Should we be using modeled data in places where there is monitored data? Coming from a monitoring background, I trust what I can measure. If we decide to not go in that direction, I will have to better understand the issues.
- ***Response:*** *Jim Hagy:* We have the continuous data that Matt pointed out which we can use where we have them. As soon as you're not at that location anymore, you are making an inference based on the continuous data elsewhere. It seems we're all grappling with how to do that in the most defensible way possible.

II. Class Imbalance and Proposed Experimental Units

Lead: ***Rebecca Murphy*** *(University of Maryland Center for Environmental Sciences, UMCES) and* ***Elgin Perry***

This agenda item is a continuation and further analysis of the November BORG presentation, "Subsample High Frequency." In the first presentation, there was an imbalance triggered by adding the 10/15 minute continuous monitoring data. In the November meeting, it was recommended that the data be subsampled to hourly to mitigate this. However, there was still so much ConMon data that the results were being skewed, so the team has been working on weighing the data and will cover that in today's presentation.

Rebecca's Presentation: *Class Imbalance and Proposed Experimental Units* (up to slide 5)

Data sets of different spatial and temporal scales are being used together in the 4-d interpolator. The high frequency data far exceeds the amount of the boat collected data and is in shallow water. The high frequency shallow water data used to create the interpolator can over represent shallow water patterns. The generalized additive model (GAM) approach can limit this issue; however, the frequency of the data is too high to be mitigated by the GAM. The development team has been exploring this issue and potential solutions, including hourly subsampling and weighting. This presentation explores the weighting method, which could allow the hourly data to be used by being weighed less than the other data sources.

Elgin's Presentation: *Class Imbalance Problems with 4-D Interpolator*

Elgin defined the problem described in Rebecca's presentation as class imbalance, which is an imbalance between data used for training and prediction. Elgin shows a graph to help describe the issue, where the majority data is a high frequency dataset and the minority data is a non-high frequency dataset. This shows that when the high frequency data is used without a mitigation method, that data influences the results at a deeper depth. The root mean square improves for the minority data in the sub-sampled and weighted methods. Elgin used the inverse of the ratio of the sampling densities of the majority and minority class as the ratio used to weigh the data.

The next slide shows graphs of predictor variables used in the interpolator. The lines show the density of training and target data. In this example, ConMon data is creating the imbalance and certain regions are over-represented. Elgin also showed examples of how this impacts other fields. From his research, Elgin recommends the development team focus on implementing experimental units, under sampling or subsampling, and class weights.

The rest of Rebecca's presentation will use subsampling and weighting on the 4-d interpolator data, but there was not enough time to cover this. This presentation will be given at the next BORG meeting. Feel free to email Rebecca (rmurphy@chesapeakebay.net) with any questions that were not covered in today's meeting or bring them to the next meeting.

Discussion Notes:

Discussion will be taking place at the next BORG meeting, along with the rest of the presentation material.

III. Adjourn

Next Meeting: ***February 23, 2026***

Attendees:

- Allison Welch, CRC
- Amanda Shaver, VA DEQ
- Andrew Keppel, MD DNR
- Angie Wei, UMCES
- Becky Monahan, MDE
- Breck Sullivan, USGS
- Cindy Johnson, VA DEQ
- Efeturi Oghenekaro, DOEE
- Elgin Perry, Independent Statistician
- Jay Lazar, NOAA
- Jim Hagy, EPA
- Jon Harcum, TetraTech
- Joseph Morina, VA DEQ
- Kaylyn Gootman, EPA
- Kelly Gable, EPA
- Leah Ettema, EPA
- Mark Trice, MD DNR
- Matt Stover, MDE
- Melinda Cutler, MDE
- Patrick Woolford, EPA
- Rebecca Murphy, UMCES
- Tish Robertson, VA DEQ
- Zhengui Wang, VIMS