Scientific, Technical Assessment and Reporting Team (STAR) Meeting
Theme: Emerging Monitoring Technologies and Networks

Thursday, March 28, 2023
10:00AM – 12:00 PM
Meeting Materials: Link
This meeting was recorded for internal use only to assure the accuracy of meeting notes.

ACTIONS/NEXT STEPS

- ✓ Any monitoring agency representatives with feedback on the effort to gather nontidal water quality monitoring data for the Phase 7 watershed model should contact Isabella Bertani (ibertani@chesapeakebay.net); she is especially looking for feedback on the following questions:
    - Is the project missing any important stations? If it is missing data within a station; should they exclude any stations? Did they incorrectly identify constituents?
- ✓ Ken Hyer (USGS) will connect Lori Maloney (EBTJV), Jason Coombs (TU) and Greg Allen (EPA)/the Toxic Contaminants Workgroup with his USGS colleagues at the PA Water Science Center who are looking at monitoring 6PPD-Q in brook trout patches and targeting catchments.
- ✓ Keith Bollt (EPA) and Greg Allen (EPA) will connect regarding coordinating with EPA's Office of Pesticides and Chemicals (OPC) around 6PPD-Q and the Toxic Contaminants Workgroup.

MINUTES

10:00 AM **Welcome, Introductions & Announcements** – ***Ken Hyer*** *(USGS) and* ***Kimberly Van Meter*** *(Penn State) - STAR chair and vice chair,* ***Breck Sullivan*** *(USGS) STAR Coordinator,* ***Peter Tango*** *(USGS) CBP Monitoring Coordinator*

Announcements

- A recording from the Bay TMDL Indicator meeting can be found on the CBP YouTube channel here.

Upcoming Conferences, Meetings, Workshops and Webinars

- National Conference on Ecosystem Restoration – April 14-19, 2024, Albuquerque, New Mexico.
- Choose Clean Water Conference – May 20-22, 2024, Ellicott City, Maryland.
- Chesapeake Community Research Symposium – June 10-12, 2024, Annapolis, Maryland.

- American Planning Association (APA) Virginia 2024 Conference – July 21 – 24, 2024, Williamsburg, Virginia. Session Proposals due February 23rd.

Ken started the meeting by thanking everyone who worked on the Beyond 2025 climate small group efforts, and thanked Bo Williams and Breck Sullivan for their leadership.

10:05 **Non-tidal Water Quality Data Gathering Project** **– *Isabella Bertani (UMCES)***

Summary:

Isabella explained that as part of the phase 7 project to improve the watershed and estuarine models the modeling team worked to expand their calibration dataset for the watershed model. In the past, they've received water quality data for streams and rivers in the nontidal portion of the watershed that is curated by someone now retired. For this round of model revision, however, they needed to expand their calibration data set themselves, so they decided to develop automated workflow to reduce time spent on it in the future. They turned to the EPA water quality portal as the main data source, since it is the largest repository of water quality data in the country. This effort was also partly motivated by a STAC workshop which involved talking to local monitoring agencies about their needs, concerns, and feedback on how the modeling team should be using data in the watershed model. Local monitoring representatives said it is very important that their data are used as much as possible to calibrate the Bay Program model, and they wanted to have a transparent and streamlined process to submit their data to the modeling team for watershed model calibration. So, the modeling team set out to gather as much water quality data as possible for the nontidal portion of the Bay watershed. This data will be used for: dynamic watershed model calibration and verification, CalCAST calibration, and other applications such as machine learning.

They gathered data at over 13,000 stations across the watershed with Nitrogen, Phosphorous, and/or Suspended Sediment data. This data has gone through quality assurance/quality control checks, and is a standardized dataset that represents water quality across the nontidal portion of the Bay. As part of phase 7 efforts, they also have a page showing different spatial layers that relate to data or model characteristics with the phase 7 suite of models. Only a small subset of the stations passed the criteria to be used in dynamic model calibrations (about 3-400 stations depending on the parameter). The other purpose is they need to estimate loads so they can calibrate the statistical model CalCAST. They're using the statistical method called Weighted Regression on Time, Discharge and Season (WRTDS) to estimate loads. For a particular water quality record to pass basic model performance criteria to estimate WRTDS loads, certain criteria have to be met, and they have estimated 260 stations which meet these criteria. This is an improvement from the number used in the phase 6 model (only 77 stations). They not only estimated loads at those stations but also assessed model performance (WRTDS load estimation performance). Just because a certain water quality parameter passes load estimation doesn't mean it's statistically reliable enough to be used. They have a set of stations that passed and some that maybe pass and then others that did not pass and will most likely not be used in the calibration data set.

With the new stations included after this data gathering process, they are considering a broader spectrum of drainage area. They're including water quality stations representing smaller drainage areas which weren't represented previously. The project's next steps are to continue presenting and gathering feedback on this data set. Isabella said to feel free to get in touch with her and she'll be happy to share the data; the data is not yet posted publicly as it's still undergoing internal review. Isabella said she is looking for feedback from monitoring agencies who are looking to have their data represented. She is looking for answers to whether the project is missing any important stations; if it is missing data within a station; should they exclude any stations; and did they incorrectly identify constituents.

Isabella wrapped up the presentation by sharing that the team plans to re-do this data pull from the Water Quality portal in 2025, before the final stages of Phase 7 model development.

Discussion:

Ken said that Andrew Sekellick (USGS) is re-developing a SPARROW based nutrient-sediment load model centered around 2012; so essentially an updated SPARROW model. He is going through a similar process of identifying datasets that are available for load calibration. Ken asked if Isabella and Andy have connected since they are undertaking similar efforts.

Isabella said she is aware of Andy's efforts and he's aware of hers. She's taken similar steps as the SPARROW 2012 data gathering process. She is not using exactly the same criteria for station inclusion, however. Also, she is collecting data from 1985-present, whereas they are focusing on certain years. So, the efforts aren't completely overlapping but they are aware of each other, and Isabella took the SPARROW processing steps into consideration in her workflow.

Elgin Perry asked in the chat: When you find that data do not meet your criteria, is there a feedback loop to the originating agency to resolve the problem? Isabella responded that there is no formal process for that at this point, but this is why she is doing these presentations. She presented at the Water Quality Goal Implementation (WQGIT) meeting, and a representative from Pennsylvania (PA) said the data was excluding PA stations, so they got in touch with Isabella to add those.

Ken asked if Isabella could share what the criteria are for some of the stations. Isabella said the criteria is: a minimum representation of seasonality (a certain number of samples per season/quarter), a minimum number representative of different stream flow regimes (a certain number of samples taken at high flow percentiles), and a minimum number of samples (at least 30-40 per station). They aim to have coverage across seasons and flow regime.

Peter Tango (USGS) asked if there was a minimum number of years the team was relying on for those stations the team identified? And are they all current, or is the team using some with just a short period of data? Isabella said that they are retaining all stations that have at least 3 years of data. The data period does not necessarily overlap between stations. There could be one

station that has data from 1992-1995 and another station that has data from 2014-2017. The team might make it more restrictive in the future (at least 5 years of data).

10:25 **Web Application to Support the Compilation of Brook Trout Data** ***– Lori Maloney (Eastern Brook Trout Joint Venture), Jason Coombs (USFWS)***

Summary:

Lori introduced herself as the coordinator of the EBTJV, and Jason Coombs as a geneticist with the USFWS. Lori began the presentation by explaining that brook trout are a symbol for clean cold water, and love for this species motivates restoration for streams, rivers, and watersheds. To conserve a species, you need to know where it is. In Frederick, it's built into the city plan for protecting the city's water supply that brook trout needs to be protected. The city increased their forest buffer widths for their forest management plan. Lori emphasized that brook trout matter locally as much as they matter downstream.

The EBTJV is a member of the Fish Habitat National Partnership, and provides funding for conservation projects, serves as a hub for discussing brook trout science and management, and hosts the Eastern Salmonid assessment. The first assessment was completed in 2006 at the HUC 12 level. The initial analysis was with a lot of qualitative only data, and used classification and regression tree analyses to predict where brook trout were. Those showed that percent forest cover was very important for determining where brook trout were expected to appear. Around that time, Trout Unlimited was developing its own conservation success index that included other metrics like climate and land use vulnerability.

In 2015, EBTJV decided it would be more meaningful for management to look at the catchment scale level of data. EBTJV updated the assessment using data sources from state, federal and tribal sample data that had to include coordinates, dates, and species count or presence data for brook trout, brown trout, and rainbow trout. It used NHD Plus version 2 layers for the catchment delineations and also flow lines and direction. They used barrier data sets, and employed a ruleset based in ArcGIS which took a sample data point, identified the catchment, asked if it was already classified, and if not, it assessed whether it was possible to move upstream or if there was a barrier. If there was not a barrier, it moved upstream and repeated the process until it reached a barrier or the end of the stream. Then it classified all the catchments from their initial point from what the most recent sample said. Lori showed how this looks like in their portal, which is still available online.

EBTJV then moved from catchments to patches (a patch is a group of contiguous catchments that are occupied by wild brook trout). Patches are generally assumed to be genetically isolated. This is important because as brook trout populations become smaller and more isolated, especially at the southern end of their range, they lose advantages conferred by the larger metapopulation. With bigger patches, it can be considered a bigger metapopulation that has better genetic diversity and more resistance to local extirpations from demographic factors. In the 2015 analysis, there were just under 10,000 patches from Georgia (GA) to Maine (ME). However, this number is probably low because there's likely a lot of barriers missing, so there

are probably more patches. The mean patch size was 19 square kilometers. For the Chesapeake Bay region, there were 952 wild brook trout only patches, and 1552 patches with brook trout along with rainbow and/or brown trout. The mean wild only brook trout patch size was 14 square kilometers.

These data are used for EBTJV strategic planning and range wide objectives. Many partners, including states, use this data for their goal setting and assessments. Some states have used the range wide dataset to bring more resources into their state to argue for better sampling and more comprehensive brook trout data coverage. Trout Unlimited (TU) has multiple products that utilize these data as well; their conservation portfolio incorporates EBTJV catchment area as a layer and they will use the data release to update their products. The CBP Brook Trout goal is working on a method for tracking their goal, and they used EBTJV's data as the baseline. Groups like NFWF use the data to identify their focal watersheds. The Fish Passage program also uses the data.

Jason continued the presentation, sharing the Brook Trout explorer tool. Jason explained that there's been only two real analyses over the last 20 years. It's important to know that information on a much finer time scale, but it's a huge effort. EBTJV wanted to make an online application and train their partners how to use it, and then they would be responsible for uploading and maintaining their own data. Once this happens, EBTJV could reissue datasets on an annual timeframe. Once catchments are reclassified, they would then rerun the patch algorithm and assess metrics again. The first run was at the HUC 12 level, and the last was at the NHD plus version 2. Jason said this was not an apples to apples comparison, and due to that they decided to make the new online application with NHD plus version 2, in order to have a comparison, and they'll decide if they want to go to a higher resolution catchment layer for a later round.

Jason then went over the benefits of an online portal: Eliminating outsourcing (bringing in external partner to do the analysis); giving resource managers more control and ownership; not requiring any specialized software (just a web browser); and flexibility to allow resource managers to provide updates when they have the time to do so. Jason then went over the lessons they learned for the web support of the portal. They use open source software; and their server host is Amazon web services, using EC2 Instance. Finally, Jason showed what the tool looks like, and ended the presentation sharing what the future steps for the project are, including: Addressing the why/explaining changes seen; layering other habitat data such as land use or temperature; making comparisons in focal areas with abundance data; reflecting on multi-state collaboration and conservation efforts; seeing if they can assemble data on projects done for brook trout at the catchment scale; and highlight Chesapeake Bay region and work by TU/EBTJV for CBP in classifying projects done.

<u>Discussion:</u>

Peter Tango commented that this work has majorly shaped the CBP's Brook Trout Outcome.

Elgin Perry commented in the chat: How does your system identify the event that a species has been extirpated from a catchment? Jason responded that it will be a direct comparison of 2016

data with this data. If they see a catchment change class change from containing brook trout to not containing brook trout, that would be considered a local extirpation. Peter asked if that would be a change map, and Jason said yes, they will run analyses and put out a change map.

Ken said the web application was phenomenal, and asked what's the timeline on doing the next assessment? Lori said they've agreed on an annual timestamp; every year on March 1st Jason will go in to update it. Once they've completed the update for 2023 it will be a year timestamp after that.

Dan Goetz (MD DNR) expressed appreciation for the work and said that this was a huge lift to coordinate this information with all the states within the EBTJV range. This was strictly voluntary on the states' part. Dan stated this is probably the most comprehensive range wide assessment of brook trout in the US.

Greg Allen (EPA) commented in the chat: The Toxic Contaminants Workgroup is discussing monitoring for 6PPD-Q in brook trout patches and future habitat. Brook trout are highly sensitive to 6PPD-Q with an LC50 of 0.5 ppb. Let's coordinate!

Ken asked if the EBTJV is looking at that in any coordinated way? Lori said it's come up as a topic of interest, but EBTJV doesn't have any resources allocated to it. Ken said some USGS colleagues in PA were thinking of trying to do some of that work, particularly with presence/absence of brook trout and targeting catchments. Ken offered to connect these USGS colleagues with Jason and Lori.

Peter Tango commented that 6PPD-Q is the byproduct of tire wear and runoff, and that it is quite common but there is not a lot of data on it yet. It is recognized as impactful to salmonid populations. Keith Bollt (EPA) asked if it is regulated by the EPA. Greg Allen said he didn't think it was. It is readily allowed in the formulation of tire rubber; it keeps tire rubber from getting brittle. Greg said the tire industry is trying to find alternatives but as of this point it's still allowed. It's 6PPD when in the tire and when it comes off the tire and gets exposed to ground level ozone, it's converted to the quinone compound which is what some species are sensitive to. Greg said this started out in Puget Sound with Coho salmon that were heavily impacted but other salmonids were not as impacted. Recently, some thresholds were published with other species in that family. Brook trout has a low threshold, though not as low as Coho salmon, but it is still sensitive with brook trout's Lethal Concentration (LC) 50 at 0.5. Concentrations would need to be well below that to support brook trout habitat. Greg asked what other piece of data can be overlayed with the EBTJV's maps to make sure monitoring occurs in places where the probability is higher (maybe roadways, impervious surfaces).

Breck commented that the CBP produces a lot of tools in the hopes their partners will use them, and asked what was EBTJV's approach for working with their partners? Lori said they've had tremendous buy in from all of these partners since the start of the EBTJV. All of these partners with one exception are on their steering committee so they were part of the process developing the tool and it's important to them. Last year Jason had at least two training for data managers and devoted a lot of his time to troubleshooting with individuals to help them get their data into the database. They had many points of contact and reminders and a lot of

patience, providing whatever assistance they could and having follow-up conversations to make sure it's still working for them.

Keith said in the chat: Thanks Greg. EPA just completed its ban on asbestos. It's great that the tire industry is thinking about a voluntary response to the problems associated with 6PPD/6PPD-Q. However, do you know if EPA's Office of Pesticides and Chemicals (OPC) has this chemical on its radar? Has there been coordination between that EPA office and the CBP toxic contaminants workgroup?

Elgin said in the chat: This link shows EPA's concern: https://www.epa.gov/chemical-research/6ppd-quinone

Greg said in the chat: Thanks Elgin. @Keith very little interaction with OPC unfortunately.

Keith said in the chat: Thanks Elgin and Greg. Greg Allen, maybe an opportunity to explore moving forward? I have a connection at EPA OPC, and others in our office may too.

10:50 **Zooplankton Monitoring Using Deep Learning and Imaging Systems –** ***Hongsheng Bi (UMCES-CBL)***

Summary:

Hongsheng started his presentation by saying he will show not only the technology but also what can be learned from the new data collected. Plankton are the base for the marine food web; they are critical for ocean carbon pump and climate change; and many are excellent indicators for integrated ecosystem and climate assessment. Traditional plankton samples are done with a net and processed in the lab. Net sampling is discrete in time and integrative in space. In the coastal waters there are more disadvantages because coastal water tends to have high concentrations of particulates clogging the net, affecting the sampling efficiency. Advantages of using an in-situ imaging system instead include: No clogging or reduced filtering efficiency; it is nonintrusive, not causing damage to fragile organisms; can get high spatial and temporal resolution; can do simultaneous measurements on a suite of plankton groups; can better characterize size, behavior, bloom status etc. Traditional net sampling has a time lag for ecosystem assessment and processing can be laborious and time consuming.

Imaging in coastal waters, especially the Chesapeake Bay, is difficult. Legacy imaging systems can only take usable images when the turbidity is below a certain range, which excludes most of the Chesapeake Bay area. Underwater video profilers also have challenges with higher turbidity. Because of this challenge, research has been undertaken to develop underwater plankton imaging systems that are used in coastal waters. Work has been going on over the past 15 years to develop PlanktonScope, a high-density contrast system. Hongsheng showed example images that were taken in February of this year, including images of how the system functions in high turbidity water. The imaging processing still does a good job under high turbidity. He then showed images collected off the Chesapeake Biological Laboratory (CBL) research pier at the Patuxent River. He deployed the system in February 2023 and collected

over 1.5 million images. Hongsheng then downloaded and processed all of these images within two days, and plotted the data. It's a fast procedure allowing nearly real time data processing.

An important parameter for plankton data is size information. Traditionally this is measured by taking a picture under a microscope and using ImageJ. In the past two decades, there are machine learning and automated approaches for this that have been developed; however most procedures either use the bounding box as an approximation, or they use spherical shapes to approximate the organisms. Many of the organisms of interest for plankton research are not spherical but may be curly or some other shape. So Hongsheng and his team designed algorithms leveraged on the Facebook human key point detection. He demonstrated that this automated procedure had a very minimal error rate compared to manual measurements.

The PlanktonScope in-situ plankton monitoring system was deployed in February in the Patuxent River off the CBL pier. Images were taken at the rate of 3 pictures per minute, although it has the capability to take up to 10 pictures a second. A deep learning system processing the data was running in the background, separating the images into different major categories. All of the process data went into a database and was plotted. Hongsheng showed some results for copepod size and density change over time, over seasonal and hourly time periods. Copepod density increased a lot in the wintertime, and late winter and early spring had the largest copepods. The biomass was highest in late winter, early spring. That raises the question what does wintertime zooplankton productivity mean for the ecosystem? Does it provide evidence for top-down control for phytoplankton during the wintertime? What does it mean for fish liked striped bass when they are spawning in April and May? Episodic events could drive a mismatch between prey and predator.

Hongsheng then showed examples of the images and data he extracted from the PlanktonScope and some data of how zooplankton react to tides, salinity, and temperature. He said at this point there is not enough data to make conclusions. Then he showed an example of using the imaging technology in the Bering Canyon. He explained that the data is downloaded and processed quickly after pulling the instruments up, and showed the size and density distributions by sampling location. Hongsheng concluded the talk by sharing conclusions and next steps. Ocean observing systems are good for physical fields, but have more challenges for biology, so real time plankton monitoring fills in this gap. Additionally, the system can provide evidence for top-down control of phytoplankton, and the high resolution data can provide unprecedent information on plankton and their underlying processes.

Discussion:

Elgin Perry commented that it was very exciting work. Decades ago the CBP had a zooplankton monitoring program of the traditional type, and it was too expensive to maintain. It's left a big hole. The Bay tends to be managed based on a bottom-up model. Elgin said he always felt like the importance of top-down controls is not fully explored, and he thought the PlanktonScope technology would fill in that gap. Elgin asked about the deep learning models for identifying the images and whether Hongsheng is training neural networks to do image identification.

Hongsheng responded that yes, he uses two types of Convolutional Neural Network (CNN) models. The standard one used at the CBL pier is based on a Mask-RCNN procedure. Then the fast ID version is based on a different framework. It can process 2000-3000 images per minute. Deep learning has really helped. Before the deep learning was available, they could only overcome the hardware issues and couldn't solve imaging process issues.

Elgin asked if they have a series of images identified in the laboratory for building the training set for deep learning algorithms? Hongsheng responded that yes, they do. They are trying to minimize their working load. There are two types of models that use the same labeling procedure. They pull out the full frame images, look at which are copepods, and draw around the edge. For the recognition part, it's relatively easy. Before they ran the mass RCNN model they got a lot of false positives. Then they trained just a recognition model separately to segmented images. That model is easy to build so they just pull segmented images to the right category and build up libraries. The tedious part is labeling the original images. That's why Hongsheng said there isn't any information from the Chesapeake Bay incorporated in the model – because he doesn't have time to do the labeling work.

Elgin said it's exciting that this work is at the very beginning so there's room for improvement and these models will only get better. Hongsheng said that the accuracy and power of deep learning is already demonstrated elsewhere. Before they had this dataset, the accuracy was low. As the dataset gets up to 2000 individuals, it could jump to 70% or 80% accuracy.

Richard Tian (UMCES) asked, for the time series in the Patuxent River which is showing high variability in biomass, particularly higher in the winter, is this related to local growth or recruitment, or migration? Some of them [zooplankton] do vertical migration, so does depth of the camera affect time series numbers?

Hongsheng responded that's a good question and for this part of observations, the CBL research pier is located in Patuxent River mouth. Because the water mixing is strong, the depth is shallow. They have a camera around 3m underwater. If there are any clear migration patterns, they should be able to see it. Another paper Hongsheng did used data from the Hong Kong and Shen Zhen area and found there is migration - not necessarily vertical migration - but potentially horizontal migration associated with tides. Because most of the observations in the coastal water are shallow it tends to be well mixed. In this case looking at Eurytemora, a low salinity species, the bloom starts from the upper river and are transported down in that one week time. They will keep reproducing and increase their abundance. Overall, how does retention at maximum turbidity bloom contribute to those things? This year Hongsheng plans to deploy another unit in the upper Patuxent and hopefully see what synchronous changes occur in another location.

Bill Dennison (UMCES) said in the chat: Great presentation Hongsheng. I love the cutting edge technology to address an important component of the estuarine food web.

Tom Parham (MD DNR) said in the chat: DNR recently purchased a Flowcam and is in the early stages of building an algal species library for rapid assessment of phytoplankton bloom samples.

Peter Tango said regarding the change in size distribution relative to timing – white perch are spawning now which aligns with Hongsheng's research showing the March-April size distribution. Peter asked if they see larval fish as well as zooplankton and phytoplankton?

Hongsheng said that's a great question and that's what he is working on doing right now. He was funded by NCBO to do a survey on Eurytemora abundance distribution in relation to striped bass larval distribution. The first testing cruise was in the Patuxent River on Tuesday. Hongsheng hasn't looked at the data yet. The other unit is a fixed deployment in the upper Patuxent. They're trying to use that to capture both Eurytemora and striped bass eggs and larvae, coupled with biweekly surveys.

Ken said with continuous monitoring tools, fouling is always an issue. How great are fouling and maintenance issues? Hongsheng responded that he was able to do maintenance every 2-3 weeks in the winter. In the summer for last year's deployment, he was doing weekly maintenance, so the images are pretty good. Right now, he's looking at getting an automatic programmable winch, so he can program the winch to bring the system to the surface for half an hour in the morning and afternoon so they don't have to do the maintenance.

Amy Hamilton asked in the chat: Where in the upper Patuxent will the second IFCB be deployed? Hongsheng said it will be at the Pax River Keeper Camp.

12:00 Adjourn

Next meeting: April 25th, 2024

Participants:

Alex Gunnerson (CRC), August Goldfischer (CRC), R3-ANN CBPO Oyster 107, Jason Coombs (USFWS), Ken Hyer (USGS), Megan Thynge (EPA), Isabella Bertani (UMCES), Breck Sullivan (USGS), Lori Maloney (EBTJV), Mike Mallonee (ICPRB), Elgin Perry (independent statistician), George Doumit (DNREC), Ann Foo (UMCES), Doug Austin (EPA), Jacob Rash (EBTJV), Marisa Baldine (CRC), Amy Handen (EPA), Bill Dennison (UMCES), Emily Young (ICPRB), Hongsheng Bi (UMCES), Brian Burch (EPA), Karl Blankenship (Bay Journal), Daniel Wieferich (USGS), Dan Goetz (MD DNR), Kaylyn Gootman (EPA), Amy Hamilton (MD DNR), Katie Brownson (USFS), Chris Guy (USFWS), Katlyn Fuentes (CRC), Greg Allen (EPA), Richard Tian (UMCES), Matthew Mayfield (TU), Jason Olive (USFWS), Greg Barranco (EPA), Peter Claggett (USGS), Ashley Hullinger (PA DEP), Tom Parham (MD DNR), Meg Cole (CRC), Keith Bollt (EPA), Denice Heller Wardrop (CRC), Peter Tango (USGS)