Nontidal Network Workgroup Monthly meeting

Wednesday, May 18th, 2022
1:00 PM – 2:00 PM

Meeting Materials:
https://www.chesapeakebay.net/what/event/nontidal_network_workgroup_may_2022_meeting

This meeting was recorded for internal use to assure the accuracy of meeting notes.

Actions:

- ✓ The Nontidal Network Workgroup will return to the identification of gaps and optimization of the NTN monitoring network at a future meeting with a focus on the questions of what is wanted out of the network and what are the goals and possibilities with the current funding allocations, with different scenarios looking at multiple objectives.

MINUTES

1:00 PM **Welcome and Announcements** – *Peter Tango (USGS)*

Meighan Wisswell was introduced as Virginia Department of Environmental Quality's (VA DEQ) new Nontidal coordinator.

Peter Tango announced that the Chesapeake Community Research Symposium (ChesCRS) is in Annapolis and virtual (hybrid) from June 6-8. The Scientific and Technical Advisory Committee (STAC) advanced monitoring workshop occurred in multiple events over the course of a year, looking at potential monitoring opportunities with new analysis and technology for Submerged Aquatic Vegetation (SAV), Dissolved Oxygen (DO), water clarity, and chlorophyll. The most recent one had connections to River Input Monitoring (RIM) site considerations and tidal monitoring with high frequency, high density infrastructure. The recommendations were targeted at management, policy and monitoring issues. There is another STAC workshop today on Per- and Polyfluoroalkyl Substances (PFAS).

Peter asked John Clune (USGS) about the temperature synthesis and whether he had an update on the database. John said the data release should be in review over the next month and published shortly afterwards. They're working in parallel for methods looking at trends and status on stream temperature using Generalized Additive Models (GAMs) method and other approaches.

1:10 PM **PSC Monitoring Review Update** – *Peter Tango (USGS)*

The monitoring review team has been working on a review since March 2021 responding to the PSC request on how to improve the networks and fill in gaps. These are coming out of needs assessments through the Strategy Review System (SRS) and the Strategic Science and Research Framework (SSRF) and many conversations with agencies and jurisdictions. The review team is working on finalizing the report and responding to comments from jurisdictions and agencies. The comments were mainly focused on better identification of priorities within the already prioritized items, provision of more details on activities aligned with monitoring such as analysis and reporting, and details on implementation. Maintaining the existing networks is of high priority. Addressing regulatory requirements is something

the states want to see as highest priority. All CBP workgroups are working on assessment of their progress for 2025 and helping those who are behind schedule on assessing progress is a priority. Details of activities aligned with monitoring, data analysis, collection and reporting was not emphasized in the review and was not requested by the PSC. However, on-going discussions are including those elements. A meeting will be organized with State and District of Columbia (DC) representatives to work with the investment menu. Program maintenance in tidal and nontidal is the first item on the list, and new monitoring dimensions come next. The Conowingo Continuous Monitoring (Con-Mon) and River Input Monitoring (RIM) Con-Mon sites have funding that is more tenuous.

Lee McDonnell of the Environmental Protection Agency (EPA) announced at the PSC Meeting they are prepared to invest 1.5 million dollars into monitoring maintenance, network development and enhancement. Details of the plan for distribution is not yet available but will be released soon. This is a major new investment that hasn't been seen since the last monitoring review in 2012, when EPA invested $2 million into NTN support. However, the total need is over $5 million. EPA alone doesn't have the capacity to address all the funding needs in the report. The monitoring groups might have to have challenging discussions unless there are other opportunities to fill gaps.

Implementing the recommendations and providing the funding is a multi-partner approach. National Oceanic and Atmospheric Administration (NOAA) and EPA are working together on the hypoxia collaborative to bring a multi-sensor network in the Bay providing information on unassessed criteria. Additional partners are anticipated to enhance this network. Submerged Aquatic Vegetation (SAV) Workgroup plus National Aeronautics and Space Administration (NASA) are looking to improve SAV assessment using satellite-based imagery. For the Conowingo Pool, a type of network is needed to pair outflow information and density of data with what goes on at upper end at Marietta. Pennsylvania Department of Environmental Protection (PA DEP) is stepping up to invest in sensors in the Marietta area.

The review team is awaiting additional comments on budget line items from Virginia and hopes to resolve these soon. New investments are already occurring, partnerships are already developing and more details on funding will be available soon. How EPA decides to roll out the $1.5 investment will affect whether or not investments have to be reduced for the RIM Con-Mon network.

Tom Parham asked if there are the same pathways for infrastructure funds rollouts for NOAA and USGS. MD DNR is talking with USGS about maintaining the RIM program and interested in knowing about these funding opportunities. Peter responded that EPA funds and opportunity to use them may be structured differently than USGS and NOAA, and there are not all identical pathways to receiving money and using it. Peter said he will come back next month with additional details.

1:30 PM **Identification of Monitoring Gaps in the Chesapeake Bay Nontidal Monitoring Network** – *Qian Zhang (UMCES/CBP) and Matt Cashman (USGS)*

Qian Zhang showed a slide from Joel Blomquist that shows the evolution of the streamgage network (across the US) in USGS. It started to decline in the 1970s. Then Qian showed the Nontidal Monitoring Network current sites (there are other historical sites not shown). The gaps are real, they can be identified – that's what this effort is aiming for. It is useful because the gaps should be understood and accounted for in models and analyses. A better understanding is needed of where there is more data and where there is less data. That representation effects confidence in modeling and analyses.

Monitoring can be optimized with an understanding of gaps. This is particularly true given there may be diminishing funding.

Before Qian started to work on this there was already a pilot study. Matt wrote code to do some analysis. The goals are to want to identify gaps in the current monitoring network in the Chesapeake Bay Watershed relative to geographic variables using cumulative distribution analysis. They aim to identify candidate sites to fill in those gaps, conduct field reconnaissance and establish new monitoring locations. The analysis will show where there is over and under monitoring. What is "over" and "under" monitoring depends on the specific goals or the why of the monitoring program. There has been a lot of code written to do this analysis and the analysis can be reproduced with different parameters such as nitrogen, phosphorous and temperature. Stations can be looked at by different categories (such small and large watershed) and different physiographic provinces. Joel and others have already done pilot applications on the Delaware River Basin; this is an adaptation of that work.

Matt Cashman explained that the fundamental question they're asking is, are the samples representative of the population? Are the stations and data they have going to explain what's going on through the whole? There are challenges in answering these questions. One challenge is dealing with large data sets coming from different sources. It takes a lot of time and effort to compile it, and there's a lot of GIS work that can be done to get it to the Area Of Interest (AOI). Figuring out the methods is another challenge. The key point is method reproducibility so that iteration can be done easily without having to go back to square one; instead, just altering the code a little. A key question is "representative of what?". These are sets of tools built to help answer this question and give some numbers of a network analysis, but those are just numbers and don't give an objective decision of whether something is good or bad. That's where the research question and the goal of the network comes in. Those are key features based on values, people, stakeholders etc.

The approach is looking at the representativeness of a monitoring network – sometimes this is represented as a sample or targets – vs the population the network is supposed to represent in this case the NTN. Matt built these tools out of predictive modeling work he's working on for habitat. Potential applications include identifying monitoring gaps and figuring out the impacts of various cuts would be.

The series of tools has been automated so with one line of code it will download all the National Hydrology Dataset (NHD) network onto a computer, pulling in thousands of different landscape variables. It's possible to enter any area of interest for the country, whether that's the Chesapeake Bay, the entire country, Delaware River Basin, James River, etc., and use that as the AOI. There are some wrappers around some other USGS functions to get any USGS data off the server. If all the habitat assessments are known, they can be used as assessment points rather than a gage. For the variety of different landscape variables, the variables the tools work off of come from 13 variables from a comprehensive data set. There are thousands of variables for every different category for every stream reach in the country. It leverages all this in a seamless way behind the scenes. For the example, Matt and Qian focused on a simplified version located on National Land Cover Database (NLCD) landscape data.

Qian said the example is for temperature to give people an idea what this analysis can provide but they've done it for other parameters like nitrogen or phosphorous. This package of code can be applied anywhere but they only focused on the Chesapeake. Qian showed the stations based on the criteria selected by the code. The color shows the starting year. The yellow stations are new and have only been

there for a couple months, installed by Greg Noe (USGS). It's possible to narrow down the criteria to remove those stations, and choose any parameter of interest. The analysis is based on cumulative distribution. Qian showed two distributions with one being the stream network (what they want to compare with) in all the reaches available, and the other based on monitoring stations. On the x axis they're only showing the results based on NLCD16 developed land. They can produce plots like this for each different land use and type and try to quantify whether it's over or underrepresented. They can superimpose the two distributions and see compared with the NHD network, the monitoring stations appear to be under-representing at the low end of the x axis which is NLCD developed land less than 10%. That's where the monitoring network is underrepresenting.

The next plot shows where the range of NLCD developed land is. This is only showing the bottom 25% of distribution on the y axis for illustration purposes. Those reaches have a stream order of 5 or lower. Blue is astream order of 3. The red are the ones identified on density plots in preceding slides. This is visually representing where the under monitoring is. They tried to quantify the differences using a metric called Earth Mover's Distance (EMD). It tries to quantify the distance between two distributions. It's a measure of the distance between two probability distributions over a region D. In other words, the EMD is "how much work is needed to bulldoze the distribution to be the same?" The more work needed, the more different the two distributions are. If there are two identical distributions that means the monitoring is at a perfect level.

Qian showed a plot using that metric and produced from Matt's code which gives an idea of how much work is needed or how large that metric is – how different the two distributions are. On the x axis is the EMD score, on the y axis is different parameters or land use variables. The parameters with the highest bias score or EMD score are forested and developed. In other words, the forested streams tend to be under-gaged. However, the stream reaches in the urban settings tend to be over-gaged. There could be a specific purpose for designing the network for that (such as collecting data from urban streams for a specific reason). They did an experiment where they moved the gage from the network iteratively and recalculated the bias score and saw how that effects the EMD score. They'll do this for each individual station separately and see the influence of each station on the bias score if they remove the station.

Matt said that this is all of those original temperature locations across the watershed. These are all colored based on if the gage is lost, how will it change the network bias. They found that in developed areas there are many temperature gages so a gage is lost in the Baltimore/DC urban area, there is an over representation so it wouldn't create a gap and would reduce bias. Agriculture is in the middle; neither over nor under represented. For forested areas, there are a lack of gages for the amount of stream miles of that type in the watershed, so any of those are lost, particularly in the north and west of watershed, it would have a big and worsening impact on the ability to understand temperature effects in forested areas. This is just bias. It's a statistical number. It doesn't have an objective good or bad; it's all dependent on the goal. For something like developed areas, maybe a bias is desired because there is a need to explain anthropogenic effects on stream temperature. But for trying to understand the impact of climate change on headwaters and brook trout, there isn't enough data. The gages that are present there are key and should be preserved.

Matt showed a figure where gages aren't plotted on a map, just in terms of scale and direction. Every one of those points is a gage and what happens if that gage is lost. For some developed areas, losing them would reduce bias. For forested areas, losing them would increase bias. Agriculture could go both ways, averaging out around zero.

That was just one example with temperature. Future work can look at nutrients, sediment, bacteria or anything else. A lot of this code Matt developed for doing rapid habitat assessments and BIBI samples. IT can be done on anything with a location, and using both discrete and continuous samples, real time gages like temperature, conductivity and turbidity. These tools are only tools – they help make an analysis easier. They handle big data behind the scenes, help avoid GIS processing, clipping, linking, increase the reproducibility and shareability, and have built-in analysis methods which can be tweaked dependent on the goal and aid in decision making. Ultimately, it's a tool that doesn't answer the fundamental questions of is the network representative, is it representative of what? Based on those principles the tool can be used to get quantitative data to inform management decisions that might happen to a network about adding a location, or what impacts to certain goals would be certain stations are lost.

Peter Tango commented that the group can go back to what it is that folks will want for this network looking forward, and part of it may be temperature. The STAC rising water temperature workshop was looking at that question.

Joel Blomquist thanked Qian and Matt and said it's good to move forward with the type of tools they use in the Delaware and across the country. Joel wanted to emphasize some ways of applying this that weren't specifically noted. The idea of bias and representing the sampling network in a distribution that is identical to the population of interest is somewhat of an inefficient fallacy, if they're using advanced monitoring tools to interpret the results. If they just wanted to get a standalone snapshot it would be efficient, that's something that could be gotten out of a probability network. Joel recommended doing a design that covers the breadth of the distribution that exists in order to have the characteristics that are important to cover. It's important to match the range but not necessarily match the distribution. That's the principles they're using when they're applying it. Additional principles to come into play is to increase the density where the impacts are either the most important for nitrogen and phosphorous or have greatest variability of response of interest in nitrogen and phosphorous. If forests have the least impact on fluxes to the bay, then increasing the density of sampling for nitrogen and phosphorous in forests is not the desired metric.

Matt responded that these tools are intended to be a little more objective, agnostic. In a case where nitrogen and phosphorous are the explicit goals, there can be a justified way where the resources would be allocated where there is high loading. It's easy to adapt what Matt and Qian have to have a weighted type approach where those areas with high loads based on previous science can be weighted differently than just a pure distribution analysis. The way they have it now doesn't make that assumption. Not everything will have as much prior knowledge or depending on the question could be completely one way or other. Matt knows some of the other work going on and focusing on smaller headwaters with unique variability and combination of different landscape types they want to look at those in combination. Another next step is rather than looking at development in isolation look at a whole suite of variables together. In multi variant approach look at combination of variables like in principal component analysis for watershed and look at how combination of variables is being represented across the network.

Qian commented that depends on the goal that they're aiming towards. If the goal is fluxes of nutrient and sediment loads, a similar analysis just using some output from Spatially Referenced Regression on Watershed attributes (SPARROW), some representation of flux yield across network, using that instead of land use. See whether the stations well represent that. On the other hand, for this kind of work it

really depends what the partnership or a particular workgroup or manager wants. Matt and Qian wouldn't make those decisions. Maybe there's a specific scenario or goals that the analysis can provide some support on for those goals. It depends on the needs of the specific people.

Tom Parham commented that it would be interesting to look at different ways the questions could be nested so it wouldn't just be agriculture or forested, for example, looking just at forested areas on eastern shows. Peter said that the group will revisit this discussion and talk about how to apply it based on what funding updates.

Breck Sullivan commented that thinking about the PSC monitoring report, they're hoping to grow the network as well as sustaining the current network. Would this be helpful if there is a need to implement a new station? Is it bad to increase bias in a certain area putting in a new station? Qian responded that this method also shows where if a station is added the bias is reduced. In other words, it will show whether adding or decreasing a station increases or decreases bias. Matt added that they have the cumulative distribution plot which shows the gages on that plot and one can find where there's gaps and not dots. This can answer the question of if you want to fill in this gap what stream reaches will do this, and it will show that on the map. Joel has tackled this question and filled in the gaps that way. There's an iteration for change of bias which is a separate track. There's gage loss and gage addition (adding a gage and it looks at every stream reach possible and it gives a ranking for every stream reach if a gage was added there). So there are two different packs: one is bias and one is gap and manually choosing that gap to fill in.

Mark Nardi asked what does the group want out of the network? There are 123 stations. The group knows what's done with it now, but what do they want to be able to do with it and what's important and how do they answer that question because it will probably be different for all of the different constituencies. How do they begin to get at that so they can start looking at analyses? Matt responded that he has no way to answer that first part. Acknowledging multiple objectives, one could identify a short list and look at multiple tradeoffs all at once which would explain if a certain gage happened to go, this might impact monitoring for x but not for y or this objective could be useful but detrimental for this one. Mark said that they could use tools to build a set of scenarios and look at those scenarios. The question is what are the scenarios and how to build a consensus around what those scenarios should be. Qian agreed and said he could imagine some kind of documentation around scenario analysis. He reiterated that the decision is not something that Matt and Qian can make but they can provide supporting information to help inform the decisions, as well as a reproduceable way to look at different scenarios.

2:00 PM Adjourn

Participants: Peter Tango (USGS), Amy Goldfischer (CRC), Cindy Johnson (VA DEQ), Mark Nardi (USGS), Joel Blomquist (USGS), Mike Mallonee (ICPRB), James Colgin (USGS), Matt Cashman (USGS), Meighan Wisswell (VA DEQ), John Clune (USGS), Jon Dillow (USGS), Curtis Schreffler (USGS), Qian Zhang (UMCES), Mark Brickner (PA DEP), Ellyn Campbell (SRBC), Alexander Gunnerson (CRC), Tom Parham (MD DNR), Tyler Shenk (SRBC), Jamie Shallenberger (SRBC), Alex Soroka (USGS), Breck Sullivan (USGS), Kristen Heyer (MD DNR)