Modeling Workgroup Quarterly Review

July 6, 2021

Event webpage:

https://www.chesapeakebay.net/what/event/july_2021_modeling_workgroup_quarterly_review_meeting_day_1

For Remote Access - WebEx Link:
https://umces.webex.com/umces/j.php?MTID=mf136d8221a185f8ebc7a62a1802f8937

Meeting number: 120 471 9812 **Password:** u2bh7M8x

Phone number: +1-408-418-9388 **Access code**: 120 471 9812

To enter the webinar, please open the webinar link first.

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

==========

9:00 Announcements and Amendments to the Agenda – Mark Bennett, USGS and Dave Montali, Tetra Tech

The August Modeling Workgroup Meeting is canceled.

9:05 Overall Review of Phase 7 WSM – Gary Shenk, USGS

The tasks, sequence, timing, and critical paths for the various tasks of Phase 7 CAST, CalCAST, and Dynamic Model for a fully operational model by December 2023 will be presented.

9:30 Discussion of Phase 7

- Olivia Devereux asked if they do two calibrations, one the regular way and another using the annual average hydrology, then will they have two sets of delivery factors? If so, which will they use?
    - Gary Shenk said in the end they will have one delivery factor. It will be an iterative process to set this. They will stick with the delivery factors calibrated from CalCAST, but if they needed to move off of those delivery factors to get a reasonable calibration they can look into why and where the initial CalCAST didn't work. They can then perhaps make a global adjustment that would allow them to iterate back and make a calculation within CalCAST and make a calibration with a dynamic model.
- Lew Linker commented the presentation helped show a clear path forward for the model development. He stated literature says as the temperature increase the public water supply increases, and there would be a loss of water in the stream. He asked if there is an element in the Phase 7 development flow for this. This is something we might want to track under climate change scenarios.

    - Gary Shenk said they don't. It is good to consider, and they might consider it when they're putting together the climate change application.
- James Martin asked how does this schedule align with the Chesapeake Conservancy delivery of updated Land Use as well as "hyper-resolution" hydro.
    - Gary Shenk said he doesn't know about the schedule, and he thinks they can use whatever land use they have as they go in. As for his view on the hyper-resolution, it is really important. They just now seeing this type of information for the first time so they will not be able to develop a perfect model. The Modeling Team will use the hyper-resolution information available, but they will not get their best stuff until closer to 2025. Even if they had it all, the Modeling Team wouldn't know what to do with it all. Gary thinks it is going to be a long iterative process of improving our information based on this new type of information.
    - James Martin commented that is not how the contract and work from Chesapeake Conservancy was sold to the partnership. He recognizes that Gary is right that they might have some useful deliverables.
    - Norm Goulet commented he agrees with James Martin because the final resolution scale for the model was sold on the fact that they would be using the hyper resolution of the stream work. He is also concerned about the two choices from the model Chesapeake Conservancy chose. SWIMM is a hydraulic model, and it requires a lot of piping and continuity for it to work efficiently. SWAT is limited with urban areas. Maybe someone should sit down to figure out a more appropriate model.
    - Gary stated they don't intend to use SWAT or SWIMM at the moment. He was saying those are the only things that are on the science needs database that would pertain to the development of the new model that come from the Water Quality Goal Implementation Team (WQGIT). They don't have anything in terms of direction from the Water Quality GIT, and they plan to get it in October.
    - Lew Linker said they can bring to issue back to the Modeling Workgroup Chairs and other key participants offline to see if it's something the Modeling WG should take up.
- James Martin said he thinks the Modeling WG is making a mistake with being deadline driven with a science-based program.
    - Lew Linker said they take direction from the PSC, and the PSC has stated they want a fully operation model suite by 2025 for examining 2035 climate change
    - Dave Montali said if they are told to take more time to build a better model, they will take it. However, the directive from above is to deliver a model by 2025. There is more time to better understand what they can do in that timeline.
    - James Martin said he doesn't disagree that the PSC said they want a reevaluation of climate in 2025. He thinks the Modeling Team has interpretated that to mean a brand new model. The PSC said to reassess climate.

    - Dave Montali said he is right, but one of the shortfalls with the existing model especially with the estuary model is that they don't have a good tool to look at shallow Open Water. When they do the 2035 assessment, they will have a better tool to look at climate change on Open Water.
    - James thinks the focus should more be with the estuary model and shallow water.
    - Dave Montali said maybe in October with the WQGIT is to ask if they need a new watershed model.
    - Lew Linker said the Modeling Workgroup makes the CBP tools to solve the problem and the MB, PSC, and WQGIT state what the problem is that needs to be solved.
- Dave Montali said he participated on the technical workgroup meeting last week, and a topic that came up was why they are having a finer scale model where the outputs are back at the county level, particularly for agriculture. In addition to the question of if they should have new watershed model, there is the issue of what scale can they have or need to use to help with management decisions. He thinks they can things at a fine scale and roll them up to a management scale.
    - Gary Shenk said if the Partnership wants to stick with Phase 6, the Modeling Team has other projects they could focus on. From a finer scale model, they don't know the true scale for BMPs unless they are incentivizing them for being placed in certain areas.
    - James Martin also commented they don't know which crops are on which slope or which soil type. How determine fine scale leaking when there is only county scale crop information?
        - Gary Shenk said it's the combination of what is happening on the land and the runoff/natural runoff characteristic of the land. They would know one of those on the fine scale, but they would only know the other one on the county scale. People could get credit potentially for the natural characteristics, but not necessarily the man made characteristics.
- Norm Goulet has concerns on the urban side. Not having the correct position of BMPs is problematic if they are going to a finer scale model. A lot is still at the county level.
- Karl Berger stated they don't even have urban fertilizer data correct ar the state scale.
- Norm also shared urban phosphorous sensitivity was limited in Phase 6 to just sparrow due to lack of urban P data.
- Bill said he agrees with Norm. Also, they have a dearth of phosphorous information right now. How does that help facilitate targeting at a better scale when that is going to arbitrarily distributed to a finer segmentation.
    - Gary Shenk agrees that they do not have fine scale information on phosphorous soil. In the model, it is the combination of the propensity of landscape to generate sediment over land flow and phosphorus in the soil. If they can get one of those characteristics really well, they can still give

differential credits for a BMP that is correctly situated on the landscape to deal with runoff and sediment.

- Bill said the model is going to be governed by the calibration points… There are not going to be enough calibration points to know what is going on at the finer scale. Even if they expand the networks some, there are still going to be large areas going to one calibration point along with many assumptions.
- Gary said they are not just using the calibration points as the only information. They are using a lot of statistical studies that states phosphorous is delivered by sediment runoff and overland flow. They are using the understanding of what causes overland flow and what parts of the landscape experience it.
- Dave Montali said this conversation is something they should continue in October with the WQGIT.

9:45 Phase 7 WSM Development – Gopal Bhatt (Penn State)

In April, a presentation was made that provided an overview of an initial prototype of the CalCAST, a time-averaged spatially distributed hydrology model of medium resolution NHDplus scale. Over the last quarter the primary focus for the watershed model development has been on a time-varying, dynamic spatially distributed hydrology model with hourly simulation of NHDplus scale streamflow. The presentation will provide an overview, structural details, initial results, and validation of the dynamic hydrology model prototype.

10:15 Discussion of Phase 7 WSM Development

- Dave Montali asked what is the methodology for grouping model segment that have a generalize routing approach.
  - Gopal Bhatt said potentially yes, they could be losing monitoring stations at the small scale. Currently they focus on aligning them to Phase 6 river, but it does not need to stay that way.
  - Dave said there are still opportunities to adjust for smaller water monitoring stations.
  - Gopal said this exercise was mostly technical, but they would need input from everyone on how they should be grouped together.
- Lew Linker said if they look at the simple routing model, change in storage would include groundwater. How is groundwater passed from the simple routing to the HFPF or is there another system for groundwater representation in the simple routing model?
  - Gopal said the simple model for now is only for the river route. They are still using HFPF in this prototype for the land simulation where they are simulating all the pathways. The land simulation has not changed. So far they have only replaced river simulation with simple routing. Gopal said Gary Shenk also pointed out that there are other flow characteristics that are important in CalCAST, and they will have those simulated. Lew Linker said in previous models they were able to with the observed data

show what changed with the improvements. He asked if they would be getting to that point with the hydrology model.
    - Gopal said yes. Their intentions now was that as they move from river segment to NHD everything was wired properly so they just compared it to Phase 6.
- Norm Goulet asked what the ratio of calibration states with load data vs flow data. Gopal said for flow data there is 450 stations, but he doesn't know for water quality.

11:00 Comparison of Modeled and Monitored Nutrient Trends and Other Watershed Analyses – Isabella Bertani, UMCES and Gary Shenk, USGS-CBPO

The presentation will provide an update on analyses aimed at obtaining an appropriate comparison between the output of the Phase 6 Dynamic Watershed Model and flow normalized loads from WRTDS. In addition, discussion of work on testing watershed properties as predictors of long-term average streamflow will provide an overview of tests performed to assess the ability of different watershed properties to improve calibration of CalCAST. CalCAST is the Phase 7 time-averaged model of streamflow at the NHDplus 1:100K scale.

11:30 Discussion of Modeled and Monitored Nutrient Trend Comparisons and Other Watershed Analyses.

- Norm Goulet said people on the land use workgroup have said that turf grass is being overestimated. What is the effect of the overestimation in this study?
    - Isabella Bertani thinks it is not easy to say because they have turf grass as a land use term in the model and plus they added the additional percent of turf grass to further capture overprediction. She thinks it would have a less of a nonlinear response and become more of a linear response, but she also wonders if the turf grass is overestimated than something else must be underestimated. What would be the land use when they are overestimating turf grass?
    - Norm said it would end up as mixed open.
    - Dave Montali said that she made turf an indicator of impervious. Dave said he can understand there is too much turf grass in the land use, but is there a way to sum up impervious and use it directly?
    - Isabella said she has done that and receives a better result when she uses turf grass than the sum of impervious. She wonders if it is because turf grass is overestimated. She will show later that some of the stations where they still do worse is where there is a lot of impervious surface.
- Karl said turfgrass estimates are a lot more accurate in highly urban areas, and a lot less accurate in rural areas.
    - Norm said this would help explain why Isabella is seeing the difference in latitudes.
    - Olivia Devereux asked Karl if that implies turfgrass could be misclassified pasture/hay in agricultural areas instead of mixed open as it is in urban areas?

- James Martin asked if she is using all flow in a stream. Is the groundwater contribution streamflow factored in the calculations? Isabella said she is using all stream flow that is observed at the monitoring station. They are not differentiating between baseflow.
    - James asked is the missing component groundwater.
    - Isabella said this is a simple model so it is something they could do as a next step. This is more to look at watershed properties and how much they can explain.
    - James asked if she could look at extreme low flow and use that flow as an estimate of groundwater driven base flow.
    - Isabella said she can try it, and they are going to explore how hydrographs can be explained.
    - Lew said the clear purpose is to try and explain the landscape factors and what they contribute to flow so they can improve the flow.
    - James said if they are missing the groundwater entirely, they are explaining away the mismatch.
    - Isabella said they looked into baseflow index pattern. When considering baseflow, they could not get rid of the pattern in the residuals. The strongest predictors were groundwater recharge and temperature.
    - Gary Shenk said total flow includes groundwater contribution.
    - James said streamflow is all sources, but he thought they were looking at it as a function of precipitation and evapotranspiration and not the groundwater.
    - Gary said they are assuming what comes in the watershed thought precipitation leaves in different exists including groundwater so the stream flow includes it.
- Bill Kealing asked about groundwater lag times the impact to the study
- Isabella said they have groundwater lag times among the variables, but they have not seen a strong correlation.
- Karl Berger asked if the SPARROW model have relationships between land use and flow and maybe there is insight from SPARROW and Scott Ator's paper for this topic.
    - Isabella said they get similar coefficients because Scott also finds that temperature is also an important predictor on top of precipitation and evapotranspiration. He also finds the perception of impervious land use has a positive effect. She compared her results to what Scott found, and they had similar findings. The one variable that he found was important in predicting stream flow was the enhanced vegetation index. She did not get any model improvement with it.
- Dave Montali said an area of improvement in Gopal's work is reservoirs. He asked in her work, is that something that might change it.
    - Isabella said it might in some cases. In this model, they are using water withdrawals from Phase 6, but they know there is better a product coming from NHD+. This is an area where they might see improvements once that product is available.

- Dave also stated the set up the model is by land use. He asked if there is a definition of breakdown of precipitation and how much goes to run off. Is the issue of turf grass and impervious due to how they have land use described?
    - Gary Shenk said the way they differentiate land uses hydrologically is by a recommended parametrization. it gathered parameters from a number of different applications but primarily from the Phase 2 and 3 models. one land use versus another land use. They didn't calibrate those land uses specifically to say on should have more runoff than another land use. This work done by Isabella combined by Gopal's work is to take another look at those parametrizations and results of runoff by land uses and see if they are calibrating the correct change in hydrology.
    - Dave is asking if they should go back and look at how they are hydrologically differentiating the flow by land use.
    - Gary said yes and that is why they are doing these tasks. In the past, they have differentiated by land use and let the calibration determine the physical characteristics by county. They want to now take a look at it and see if the characteristics of the land use really hold and how best can they do it.

Discussion from Isabella's second presentation:

- Norm Goulet asked if Isabella's work is telling them that they should not be segmenting even further. It seems with the conclusion that it gets worse when they go smaller.
    - Gary Shenk said they have seen in the models that when they get on a finer scale the make good predictions. If they are able to understand what is happening on a finer scale, they are able to do better at the aggregated scale. However, they don't have any proof that going to a finer scale will make it automatically any better.
    - Norm said the finer they go the more they need to make assumptions of the data and combine more data.
    - Gary said if the partnership decides that they don't want a finer scale then they do not need to work on it. He does see benefits in going to a finer scale. What Isabella is working on they have been asked multiple times to do and haven't been able to give an answer because they didn't have the tools or capacity. They are at a point where they make validations of their predictions. It is not a complete story yet, but they are starting to see that some of the most important predictors are what they think should be predictors.
    - Lew Linker said this is a fair question, but this analysis may not be the one to answer it. Gopal is going to do an analysis of finer spatial scale and show some of the results at the next meeting.
    - George Onyullo said they should not use this one analysis to decide if they do a fine scale model or not.

- Isabella said WRTDS is not the truth. There is uncertainty to it too that they need to consider. She hopes it a tool that informs the way they precede and not the deciding the factor.

11:40 Quantifying Co-Benefits of Ecosystem Services Associated with BMPs –Ryann Rossi, ORISE-EPA ORD

This project is focused on quantifying ecosystem services associated with BMPs relevant to upstream communities. Results will be used to communicate co-benefits associated with BMPs via CAST and other materials.

12:00 Discussion of Quantifying Co-Benefits of Ecosystem Services

- Lew Linker asked if she is working with Olivia Devereux and Jeremy Henson and if they would be able to monetize the results. Ryann said she has been working with both people. She said for monetizing it is out of her expertise, but for some factors there are already monetized information for example iTree. There has been a conversation that they carry one parameter all the way to monetization.
  - Olivia Devereux said that Bo Williams is in charge of coordinating all of the co-benefit and ecosystem services work at the CBP. In terms of monetization, they do have all the costs of BMP.
  - Lew said there is the costs of all the BMPs but then there are the costs of the co-benefit which is more of a return on investment.
- James Martin asked for the air pollutant if she did it for all of the BMPs. Ryann said no, it is not for all of the inventory. It is only for ones that involves trees.
  - Olivia said there are BMPs they could add to CAST that have no effect on nitrogen but would have an effect on the ecosystem services. They have gotten to that point in the study. They do know if the BMP has a true value of zero or if the BMP was not evaluated. She thinks the next priority is to look at the BMPs not evaluated.
- Jesse Bash asked if there would be more scatter in a rural area versus urban due to the removal multiplier.
  - Ryann said yes there will be difference between rural versus urban, but it is an average multiplier that is used. She will need to look back at the iTree methods to see if it accounts for seasonality.
  - Lew Linker asked if she could share documentation for iTree. It is available here.
- James Martin asked Olivia how this could be incorporated into CAST. It is more a function in the reporting or tabular data. Olivia said they will do it in stages. The next step would be with CAST23.
- Karl Berger said costing out the co-benefits seems like very subtle calculations. Are they looking at similarly subtle environmental costs, such as embedded carbon for installing BMPs or servicing them. It costs money and carbon to maintain BMPs. Even trees.
  - Olivia said the costs account for life-cycle costs.
- Bill Keeling asked if the ecosystems benefits happen immediately.

    - Vanessa Van Note said they would receive the full ecosystem benefit once they report the trees. Olivia said it is consistent with the hydrology
- Dave Montali said relative to these ecosystem services and co-benefits he thought co-benefits were associated with other CBP outcomes.
    - Jeremy Hanson said he tries to only use the terms co-benefits when referring to cross-GIT benefits. Ryann's work is ecosystem services driven and based on the literature definition of ecosystem services. It might be able to help with co-benefits for the CBP.
    - Dave Montali would say that some parameters are both ecosystem services and co-benefits so if time is limited, they should focus on ones that are both.
    - James Martin stated the work that was done a couple of years ago on co-benefits initially focused on CBP Outcomes, but it also considered co-benefits identified by local governments such as real-estate values and bacteria reduction.
- Bill said in terms of soil health he didn't see tilling practices. There are certain BMPs that support Brook Trout but is there limitation to streams that only support Brook Trout? Olivia said they do have a map where Brook Trout are, and they could restrict it to those areas. The soil health one is in flux, and they are not done making a definition for it.
- Action item to bring Ryann Rossi back for a presentation in October of January.

12:10 BREAK

1:00 Optimization Update: Integration with CAST – Kalyan Deb, Pouyan Nejadhashemi, Gregorio Toscano, Sebastian Hernandez-Suarez, and Julian Blank

The initial integration of the optimization framework with CAST will be presented. The approach uses CAST to validate the initial settings and evaluate the proposed solution. The initial results show that the proposed methods can reduce the BMP implementation cost while satisfying the load threshold.

1:20 Optimization Discussion

- Lew Linker said they have a call for folks to nominate a county - particularly for areas that they don't have right now, such as VA counties, a segment on the Eastern shore, an urban segment, etc - and provide insight on what they need to fix or change.
    - Gregorio Toscano said they don't want to restrict the user to certain locations. Every county they have a different requirement, and they want to understand what kind of decision making ideas that users may have. They haven't spent much time on this development yet but it's coming.
    - Pouyan Nejadhashemi said they would like to have an advisory group with not only regional representatives but also through the agencies. If anyone is interested, please contact them or Lew. They want to get as much feedback as possible. They're welcome to any party that wants to be a part of this development.
    - Lew Linker commented the optimization they do in New York would be different than what they would do in VA so it would be great if they could get folks from all across the watershed.

- Dave Montali stated they won't be able to determine the validity of the results because they don't have all of the BMPs in yet. Is that correct?
    - Pouyan Nejadhashemi said The BMPs can be added in later on. They're looking for what type of questions might come from the different groups from a design standpoint.
    - Dave Montali said he was thinking from an interface standpoint.
    - Pouyan Nejadhashemi said it will be a multistage development so that technical work will come later. But he invites anyone to join them and try to accommodate for a first draft version at the end of this year.
    - Dave Montali said when they send out an announcement to folks, make sure there's at least some instruction on how to get into the tool and use it, so they can test it out before meeting with them.
    - Olivia Devereux suggested they can choose people that use CAST. She'd be happy to include an announcement in a newsletter to get folks involved. It should also go to the Watershed Technical Workgroup (WTWG).
    - Lew Linker said that's a great idea Olivia. He thinks it'd be beneficial to get a CAST user from each of the different jurisdictions so that all of the watershed is represented and responded to with the same degree of attention.
    - Dave Montali asked how many people do you think?
    - Pouyan Nejadhashemi stated preferably not more than 15, but if more folks are interested, they can separate it into two different groups.
    - Lew Linker said if we had one person from each of the jurisdictions, they'd have around 7 people.
    - Dave Montali said they should also consider a federal facility person and a local person. They might give a different perspective than state people.
    - George Onyullo said they should also consider having an alternate for people because there is usually more than one person working on this from jurisdictions.
- James Martin asked when they speak about banned practices - does that mean those are excluded or constrained? Or both?
    - Kalyan Deb said for a particular optimization run, they can do both, but it changes from county to county. They can make it less dominant or just put a penalty on it, such as cost. Nothing is ever permanently excluded.
    - James Martin commented right, just excluded for the next run.
    - Gregorio Toscano said they also have precedence. A BMP can be fixed or banned. For the geographies that have fixed BMPs, they can be preserved, and someone won't be able to use it for any other geography in the county, so they can exclude that BMP from the remaining counties or any part of that county.
- James Martin asked if they start the optimization at a certain point at a different base condition.
    - Kalyan Deb stated that's a good question - it's good to hear ideas like this from folks. That's something they will be looking into later. They hope to discuss more things like this at the small group meetings, such as what is possible, what is not, what is desired, etc.

Action: Please reach out to Lew Linker (linker.lewis@epa.gov) if you are interested in participating in the optimization feedback group.

1:30 **High-Resolution Land, Tidal Water, and Tidal Wetland Boundaries to Inform the Phase 7 Models – Andy Fitch, USGS**

The high resolution Phase 7 Models require an attention to detail not previously needed in the lower spatial resolution Phase 6 Models. Andy will describe work to differentiate at high spatial resolution the Watershed Model and Tidal Bay Model domains. In addition, the 2017 land use/land cover data will be used to identify wetlands within or intersecting with the tidal shoreline boundary. The resulting tidal wetland areas will be a tabulated as part of the Watershed Model land cover, but will be simulated in the new tidal Bay model.

2:00 **Discussion of High-resolution Landscape Characterization**

- Norm Goulet asked how does this relate to the wetlands and the hydrography data that Peter Claggett and the Conservancy are doing right now?
    - Andy Fitch said this is a product of their work, based on the 2017 imagery. It came from Peter's group.
- Lew Linker said they're about to put out a request for assistance with an unstructured grid Bay model that will have a much finer segmentation. They will be able to match the shoreline much more closely. One of the questions they'll be asking involves clarifying the boundaries of the tidal bay model.
- James Martin asked if the goal is to include the tidal wetlands in the water quality model, the red line would have to be on the upper edge of where the bright green land use ends, right?
    - Lew Linker commented right, one would think, but when he says calculated in terms of the increase/decrease of tidal wetland acres being tallied in the land use model, the calculation of the influence really only requires area - what the area of the wetland is and how much of that area is at an adjacent tidal bay cell. Using that, the effect of the tidal wetland can be calculated. There's more to develop as they move forward, but that's the ground level of what they'd be able to do in Phase 7.
    - Gary Shenk commented in the watershed model, they don't have tidal wetlands, that's completely in the estuary model. So, it's tracked in the land change model and then given to the estuary model. He thinks they'd just need the area, not really the boundary. And maybe some characterization of what's in red.
    - Lew Linker said right, the volume of those areas can also be covered in the linkage assessment. He wouldn't think an unstructured grid would want to go into these tidal guts. That volume would be added into the bay model adjacent cells.
- Dave Montali asked if the boundary of the watershed model is over along the forest line, and they're saying it will change with climate change, will they have the means to change the area of the watershed model land river segment? Is that doable?
    - Gary Shenk said he thinks so because it's not completely spatial in its distribution. The total amount of land would reduce to that land river segment.
- James Martin asked so, which data set to use to represent that coastline doesn't really matter in either model? Correct?
    - Gary Shenk said it doesn't matter in the watershed model. He guesses it doesn't matter in the estuary model unless it was really detailed.

    - Lew Linker said he thinks there also needs to be some downstream decisions in how to communicate running these scenarios. They'd have to track it somewhere. But the principle is that they're not doing the calculation of tidal wetlands in the watershed model, they're doing the calculation of the influence of tidal wetlands in the bay model. Once they interface the cells with the watershed model and the wetlands, they'll make decisions about tidal guts, forests, etc.
- James Martin thinks they also need to be clear if they're talking about tidal vegetated wetlands or tidal wetlands more inclusively. There are other things that, while they might not be vegetated wetlands along every coastline, if the tide is rising and falling there is an intertidal zone and it has some land use.
    - Lew Linker agreed. Next steps: Move forward once they have delineation of tidal waters, which will then be given to Bay practitioners, and then they start to prepare over the next few quarters how to link the watershed, tidal bay model, and wetlands. Most likely over the next four quarters before they can link it to the Bay Model.
- Dave Montali thinks Andy said the boundaries that they have are the best that they have right now, but the CUSP shoreline product may be improved in the future. What do you see in store for that, Andy?
    - Andy Fitch read on the site that the gap in the NE part of the Bay is in development. He's not sure what the specific timeframe is to be included in the layer.
    - James Martin asked why they need this data?
    - Andy Fitch said in the past it has been represented as part of the model segmentation boundaries. In CAST, the wetland areas are treated differently, but it has served as part of those boundaries, as well as boundaries in the estuary model.
    - Dave Montali said to recap - part of the work for the shoreline for the CBP high-res shoreline came from NOAA. NOAA CUSP will give the advantage of showing how the boundary may have changed over time, which will be helpful when they do a climate assessment.
    - Andy Fitch said yes. He's not sure of frequency update though.
    - James Martin asked if it's the outer edge of wetlands and they update the land use every four years then wouldn't it already be updated?
    - Lew Linker said they would have to freeze the land use in the watershed model. Once they got to Jan 1, 2025, say, they'd freeze the land use and say no further changes, make their decisions, and then go on.
    - James Martin asked they wouldn't be changing the land use then? They'd be applying change to the land use with the effect of changing that boundary?
    - Lew Linker said right, with scenarios.
    - James Martin said no, with updates to the land use from Peter's team. Just like they're doing in CAST-21 supposedly.
    - Lew Linker said yes, okay. They would follow that precedent.
    - James Martin commented what that means though is that wetland inputs will be changing in the Bay model. Are they prepared to have an updated water quality model every two years?

    - Lew Linker said no, once they get to the release of the fully operational model, he doesn't think they need to do that. There would be no changes in decision making.
    - James Martin said he's talking about the extent of tidal wetlands in each cell.
    - Gary Shenk said he thinks that would essentially be a climate change scenario. If they're making decisions based on 93-95, it would be whatever the shoreline is at that time. If the NOAA CUSP is producing change over time that they're attributing to climate change sea level rise, then he thinks any effect of that would be rolled into the climate change decision.
    - Lew Linker said that sounds like a fair statement Gary. He thinks as we go forward we'll inevitably see changes in wetlands which would be captured every 4 years with updates in the data. I wouldn't see any meaningful change in the tidal wetlands to the extent that they're changing currently. So that wouldn't warrant an update every time the NOAA data is updated.
- James Martin he just wonders if they should re-ask the question of which model the wetland should be in, because he doesn't think the wetland WGs and climate WGs would like to hear that the loss of tidal wetlands wouldn't affect water quality. Should it be put back into the watershed model?
    - Lew Linker said fair question James. They wouldn't be able to use the increments over a 4-year assessment because it's not a big enough difference. In longer term scenarios, however, they would of course see that difference. But with respect to the tidal wetlands, it does have the real focus of different parts of the Bay program, and communicating effectively what's happening with the watershed in terms of sea level rise, for example, and what happens with the tidal wetlands, is important. I think there's a difference between how we do it operationally in the simulations and how we communicate it effectively to the CB watershed and tidal bay communities.
    - James Martin said he thinks it could be both. Communication will be key, but they already have BMPs that add tidal wetland in the watershed model, so he could see value in both.
    - Lew Linker said right. We have time to determine our approach.

2:15 CMAQ Tracer Runs – Jesse Bash and Sarah Benish, EPA-ORD

Work on estimates of the transport and fate of atmospheric emissions of oxidized nitrogen (NOx) and ammonium (NH_4^+) will be presented. The analysis centers on the question, "For a nitrogen emission source from different regions in the Chesapeake watershed, what is the fraction that is deposited to a particular region or point?". In addition, the analysis can be used to estimate reductions in nitrogen deposition to the Chesapeake watershed and tidal Bay under future conditions of greater penetration of electric vehicles into the existing mobile fleet, greater wind and solar electric generation, and other types of future economic conditions.

3:00 Discussion of CMAQ Tracer Runs

- Sarah Benish said the OTH category is all other emissions that they are not tracking.
- Gary Shenk asked if OTH emissions would be from anywhere within the model domain, right?

    - Sarah Benish said correct.
    - Gary Shenk asked if they can you break it up by region?
    - Sarah Benish said no, they don't track it explicitly so they can't.
- Lew Linker asked any expansion or thoughts on the summary? Also, will they be getting the other three seasons produced?
    - Sarah Benish said the future simulations will be interesting. Not quite able to look at it yet because it requires the next release of the model.
- Jesse Bash said they've built more tools into the next version of the model. The big tools are being able to manipulate the emissions more or less on the fly as they move forward, and then using that to bring in these studies that look at future emission productions and then map them to our current emission scenarios. The model release isn't until the Fall, they will have an early version of the model before that. They're testing and running before the official release but we still have some time.
- Lew Linker commented the Delmarva poultry seems surprisingly small when looking at OT poultry and other regional poultry, there's a lot more reduced deposition from that source.
    - Sarah Benish said she thinks that has more to do with the prevailing winds and meteorology during the winter. She imagines that the manure from Delmarva is going somewhere but may not be the watershed. It will be interesting to see how that plays out in the rest of the year.
    - Lew Linker said yes, and the Delmarva is right next to all of the Atlantic to its east, so perhaps there's a lot of deposition going on where they're not tracking it.
- James Martin asked if they could speak to the hot spot around Richmond.
    - Sarah Benish said shes not sure what that is but she definitely wants to keep an eye on it in the model simulation.
- Randy Larson asked as coal power plants are being closed/replaced with LNG power plants, will they be able to see a decrease in NOx contributions?
    - Sarah Benish said she expects so but they won't be able to see those because this was done with 2016 data.
    - Gary Shenk said from a partnership standpoint, one of our purposes was to be able to incorporate things like that into our TMDL accounting, so is seen today is the source apportionment, but the secondary thing they want to do is develop coefficients to determine how much goes up from a source in a region, how much goes down within the different counties of the watershed, and then they can develop a coefficients to say how much from those individual power plants, eventually makes its way to the bay.
- Lew Linker commented they can even see the ammonia from vehicles travelling on I-95.

3:15 Dynamic Reservoir Operation Rules and Evaporation Simulation Impact on Model Goodness of Fit in Lake Anna" – Rob Burgholzer and Joseph Kleiner, DEQ

The VAHydro operational rules model combines edge of stream inflows from the Phase 6 model with a temperature-based regression model of power plant evaporative cooling, and a detailed simulation of reservoir release rules required by the Virginia Water Protection Permit for the operation of the nuclear power plant in Lake Anna. This

approach provides for improved goodness of fit in both downstream flows and lake surface elevation drawdown during drought conditions.

3:35 Discussion of Dynamic Reservoir Operation Rules

This presentation was postponed to the October Modeling Quarterly Review meeting.

3:45 ADJOURN

Participants: Gary Shenk, Lew Linker, Dave Montali, Mark Bennett, Breck Sullivan, Andy Fitch, Arianna Johns, Bhanu Paudel, Bill K, Cassandra Davis, Cathy Wazniak, George Onyullo, Gopal Bhatt, Gregorio Toscano, Hassan Mirsajadi, Isabella Bertani, James Martin, Jennifer Keisman, Jesse Bash, KC Filippino, Kyle Hinson, Mukhtar Ibrahim, Nicole Cai, Norm Goulet, Olivia Devereux, Rebecca Murphy, Richard Tian, Ryann Rossi, Sarah Benish, Steve Bieber, Randy Larsen, Ted Tesler, Sam Merrill, Clint Gill, Denice Wardrop, Jeremy Hanson, Jim George, Karl Berger, Lee McDonnell, Vanessa Van Note, Karl Blankenship, Patrick Thompson,

Modeling Workgroup Quarterly Review

July 7, 2020

Event webpage:

https://www.chesapeakebay.net/what/event/july_2021_modeling_workgroup_quarterly_review_meeting_day_2

For Remote Access - WebEx Link:
https://umces.webex.com/umces/j.php?MTID=mf136d8221a185f8ebc7a62a1802f8937

Meeting number: 120 471 9812 **Password:** u2bh7M8x

Phone number: +1-408-418-9388 **Access code**: 120 471 9812

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

==========

9:00 Announcements and Amendments to the Agenda – Mark Bennett, USGS and Dave Montali, Tetra Tech

9:05 SAV Nutrient Cycling – Nicole Cia, VIMS

Nicole will describe work in the San Francisco and Chesapeake Bays examining SAV nutrient cycling with an unstructured grid model.

9:35 Discussion of SAV Nutrient Cycling

- Lew Linker said he'd be interested in Nicole's thoughts on the idea of what's happening with the chlorophyll in the middle shoal - without the SAV, it's pushing up towards 100 micrograms, but with the SAV it's down about half of that. That's pretty significant. What is going on here? Is it imported from the channel because of light limitations?
    - Nicole Cai said the San Francisco Bay area is so different from the Chesapeake Bay area. When she looks at the stations, in the freshwater components in the data, the concentration is not as small as they thought. Without SAV, the chlorophyll-a concentration looks quite large, but it's possible but at that time they did not have an explicit simulation of total suspended solids (TSS) in that area, so that might explain the growth. In terms of nutrient control, the SAVs definitely block the nutrients for these phytoplankton blooms and that blocks the summer blooms.
- Lew Linker asked if there was observed data for this area? It would be good to see where they can.
    - Nicole Cai said they are spoiled at the Bay Program with all of the big datasets. In the SF Bay area, it's hard to find a large coverage of data. They don't focus much on nutrients. It would be great if they had observations there.
- Richard Tian asked for Nicole's thoughts on slide 25. When they compare the continuous sets of data in terms of the DO, in the Chesapeake Bay it was changing from saturated to supersaturated. In the SF Bay, it was changing from super saturated to way

undersaturated. Given that, the consumption of DO is a major deal. The dynamic is so different from San Francisco Bay compared to the saturation they have in the Chesapeake Bay.

  - Nicole Cai they are looking at the margin of error, they definitely have to consider the difference between these two Bays. SF Bay has super deep channels that are mostly human built. The flow in those channels is incredibly fast and the tidal energy is much larger than what we have in the Chesapeake Bay. In this region, it's so easy for them to get super saturated. On a daily scale, they have the value close to saturation or super saturated based on the production of these plants and phytoplankton. At night time, the submerged vegetation respiration sucks out a lot of the oxygen because the biomass is so large. So even if the oxygen to cover ratio is a little smaller for those plants (SAV or marsh), the respiration from the plant is still significant for the oxygen dynamics, which is what she observed from some of the stations. This kind of phenomenon doesn't happen everywhere or every time, mostly in specific periods of time, such as summer. For areas where the marsh or SAV are submerged under a high tide, it contributes to this kind of low DO event. If there is a refresh of the water or if they can take up nutrients from atmosphere directly, those kind of events will largely be limiting.

- Richard Tian asked if SAV density is a parameter in the model or not?
  - Nicole Cai said so far, the density is considered in two ways: on the biological side, they have the biomass (grams of carbon per cubic meter), but also the real density (number of plants per square meter and diameter of plants).
- Bhanu Paudel asked how did they set up an experiment to see SAV impact on hydrodynamics?
  - Nicole Cai said the base one is they have everything. They have a stable distribution and conduct one year of tests. Then we have two cases, one is a total removal of SAV. SAV is not considered either the biological effects or the feedback acting on the hydrodynamics. The second scenario is to have the SAV grow there, but we don't think about how it affects the flow, so the flow keeps the same as the total removal case. We compare the SAV performance between the best case and the no feedback case. The SAV changes so little because it doesn't have substantial nutrient limitations. So the change of flow changes more from those suspended traces instead of the SAV themselves, but from there that is how they isolate for those local biological effects.
- Lew Linker asked how did they initiate the SAV in the simulation?
  - Nicole Cai said she basically put a constant biomass everywhere in the model domain including the channels. She did this because SAV is really sensitive to the bathymetry.
- Guido Yactayo asked if SAV is good for water quality based on their ammonium and DO simulations? And how does it align with field work?
  - Nicole Cai commented this is a typical study for a certain area, so it's quite unique. It depends on the needs of the people there. The reason why they want to remove SAV in this area is because they want to add suspended solids. Generally, SAV can be good and serves as an important habitat for fish. But it depends on the area. It's hard to say if it's good or bad. SAV tends to be a natural source of

nutrients for the water column. But if we don't want more nutrients, then this might not be good. Again, it impacts the hydrodynamics though as well, so it's not so straightforward.

9:45 SAV Nutrient Dynamics and DO Impacts – Carl Cerco, Attain and Richard Tian, UMCES

The 2017 WQSTM estimated SAV nutrient flux by submerged aquatic vegetation will be presented. Examination of seasonal net nutrient flux is anticipated to simulate net import of nutrients to SAV in the growing season, augmented by simulated enhanced settling of particles in SAV beds. After the SAV growing season a nutrient flux out of the SAV beds, mostly as organics, is anticipated.

10:15 Discussion of SAV Nutrient Dynamics and DO Impacts

- Dave Montali asked if they looked at the base conditions '93 and '95 and say here are the places where they have occurrences and let's examine the effects of SAV or no SAV on those instances, but they didn't study the effect of having less or more occurrences in places?
    - Carl Cerco said that's what the histogram is. There were 1,080 points in space in time. Then they looked at how it's distributed in those 1,080 points. And then they study how DO was diminished across the cases. The comparison between no SAV and SAV is a diminishment of 0.1 in four points or occurrences. It doesn't tell where or when these occurrences are, but just how many instances did they see a diminishment of this magnitude.
    - Dave Montali wanted to know about the other locations, time, or segments that they didn't examine the effect of with or without SAV.
    - Carl Cerco said the other places might be open water or deep water. They haven't looked at those.
    - Dave Montali asked if they picked the places where there were occurrences of DO violations and then they studied the effect of SAV and no SAV on those instances?
    - Carl Cerco said no, he did not pick places where there were violations. He picked places where the standards are examined. There are 108 occurrences where they examined deep channels, but those were not violations.
- Robert Burgholzer asked if SAV versus no SAV is a situation that is within the model's calibrated operating range? How much can they trust that the simulation is capable of this?
    - Carl Cerco said no SAV is calibrated with the existing SAV biomasses. It is an extreme that helps us determine impact.
    - Robert asked if this is difficult to assess because it's outside the range of the calibrated model?
    - Carl Cerco responded yeah, they don't have a calibrated condition where there's no SAV, so in a sense it can't be compared to any data. But that's sort of what sensitivity runs are about.
- Robert Burgholzer asked if they've never had a Bay without SAV in their monitored capacity, they don't really know what the unintended consequences are.

    - Lew Linker said they have plenty of designated uses where there have been historically during the Bay Program measured no SAV. The simulation runs through the historic to no SAV. He thinks the sensitivity scenario is sound. It seems to hold together.
    - Robert Burgholzer commented with the SAV they have this in essence and decomposition. It's dynamic, so rather than a "No SAV" scenario, it's actually a decaying SAV.
- Lew Linker asked about Carl's thoughts on the sequence they're seeing here (in slide 7) in terms of export, no export, and also your thoughts on when they're in CB1, a lot of that nutrients would be sticking around as they release more nutrients in the Fall. But if they were down in the lower bay, much of that could be exported. So would the SAV bed have an influence on hypoxia as well?
    - Carl Cerco said they haven't looked at this completely, how far it would go. He's going to claim that it's organic matter which is released from the plants in CB1 and swept from that system from the Susquehanna River, whereas some organic matter that may be released in Tangier Sound would probably stick around in the sound, as it is wide and there are no big net fresh water flows. They could look at that but they haven't yet. It's difficult to draw some of these conclusions.
- Jeni Keisman commented it is so interesting. Please keep these ideas and questions in mind when they talk about how they might use the tributary summaries later.
- Larry Sanford asked if there is a seasonal lag effect in nutrient release due to SAV? In other words, do the decreases in DO happen in the middle of the summer, or a little later?
    - Carl Cerco responded they haven't looked at the time in that level. They could in the future though. There are so many interacting parts and segments so it's tough to really determine what is influencing what.
- Andy Stoddard asked if there is DO data from surface, bottom, depth integrated over water column grid?
    - Carl Cerco responded no, it's not depth integrated. These occurrences are averaged over segments and regions of segments. For example, what they call open water is an average over spatial area as well as the upper 3 model layers. So its averaged not from top to bottom, but rather, over increments spatially. Deep water is the opposite, averaged cells within a depth increment.
- James Martin asked do each of these occurrences (in slide 7) have the same biomass of SAV simulated? If they were to break out the time aspect of the occurrences, do they think they would see a pattern in the histogram? Water temperature driven? Wetter/drier month/year driven?
    - Carl Cerco said each of the occurrences do not have the same biomass of SAV. In some, there may be no SAV. A question he wants to explore is if the ones who have the largest changes in DO, for example, have the largest changes in biomass. There are a lot of things to look at moving forward.
    - James Martin said it would be good to see why they're seeing the range and distribution in the histograms as one of the next steps.
- Gary Shenk said assuming an average effect of 40 ug/l in the DW and DC, they can convert this to load using the relative effectiveness values used in the TMDL exchange ratios. An order of magnitude effect would be about 3 million lbs lf N.

- Dave Montali commented that's a big deal.
- James Martin said it's a big deal in terms of trying to reduce loads from the landscape, but relatively modest in terms of the total nitrogen load in the Chesapeake Bay.
- Carl Cerco said keep in mind these are sensitivity runs. They're not talking about restoring SAV to these levels from zero. They're just talking about restoring a certain amount of biomass and hopefully we'll get a better idea of the magnitude or the equivalent nutrient reduction.
- Bill commented 3 Million pounds delivered could be many multiples of that in reductions needed from the watershed.
- Dave Montali commented fair enough, he guesses they could have that .04 increase in some places and that would not return a violation of water quality criteria. Right?
- Gary said if they took herbicide and got rid of all the SAV, then they'd have to reduce 3 million fewer pounds, and that really doesn't seem worth it. That's kind of how he was looking at it.

- Andy Stoddard asked if DO data is observed rather than molded results?

10:30 Analysis of Chesapeake Bay Marine Discharges – Richard Tian, UMCES and Carl Cerco, Attain, Inc.

An analysis of the movement of marine discharges in the lower Bay using modeled tracers will be described. The analysis provides insight into the fate, transport, and residence times of marine discharges based on nonreactive dissolved and particulate tracers in the 2017 Bay Model.

11:15 Discussion of Chesapeake Bay Marine Discharge Analysis

- James Martin said they have seen some preliminary results and appreciate the help to understand the type of discharges and the impacts on those sites. He is interested about what people think about the approach.
  - Lew Linker said it was important the range was used. He thinks the approach is technically sound.
- Carl thinks they should assess the outputs a bit more.
- James Martin said looking at the results, he wonders what the effect would be of establishing no discharge zones and would there be a concentration of discharge in other areas.
  - Richard said they should focus on sensitive areas, and the entire Bay should be taken into account for an overall assessment.
  - Lew said for next steps they could meet with a small group to do a final check by the end of July that all the information needed is in the documentation for VA DEQ. James said this is a good suggestion.

11:30 BREAK

11:40 The Importance of Scale in the Simulation of Chesapeake – Pierre St-Laurent and Marjy Friedrichs, VIMS

A tidal Bay model with a 1.8 km grid versus 600 m grid are compared with the findings that the finer scale grid provided more realistic coastlines, little to no bathymetric smoothing required, and a more realistic geometry for the deep channel hypoxia and of the tributaries.

12:10 Discussion of The Importance of Scale

- Lew Linker asked why Pierre used one standard deviation around the monitoring data? He stated the modeling workgroup should consider if they would want to adopt this metric in their work.
    - Pierre said he is trying to recover some of the information about how one year is different from the next which is lost in climatology.
- James Martin said the 1.8 kilometer model presented some challenges in the shallow water area. He wondered how that response might change with the finer scale and improved correlation with the monitoring seen in these examples.
    - Pierre asked for clarification if it was with climate scenario models.
    - James said yes, but there were some small basins that the model wasn't working for them.
    - Lew Linker said in the current Bay model one limitation is a surface cell depth of 2m, so the results Pierre show when they refine the scale, especially the depth scale, they will be seeing different results moving forward. They don't know if that will change any metrics of assessment. They are seeing evidence that they will see an estimate that improves accuracy when they improve the scale. As they refine the scale, they also refine the nutrient inputs.
- Marjy Friedrichs mentioned Pierre examined in the case of sea level rise comparison between models. Although there were some differences, all the models in the comparison gave similar results because they were focusing on the Bay as a whole. If looking at climate change on the Bay as a whole, the resolution isn't going to matter that much. If they are going to look in the tributaries and the coast, the resolution will matter.
- Nicole Cai asked if Pierre has analyzed the stratification simulation based between the two resolutions. She suspects that if the simulation is similar it guarantees success for simulating hypoxia.
    - Pierre said he has been focusing on the salinity model data comparison, and he did not consider stratification. He cannot comment how stratification has improved from the corse to the high resolution grid. It is something he can look into it.
- Nicole also asked if there is any difference on the vertical resolution.
    - Pierre said no because in both cases they are using typography following coordinates. They have the same number of levels in both cases, 20. They always have 20 points along the vertical no matter the depth, and they are stretched to have more or less resolution.

- Carl Cerco asked when considering the DO bias, is it that the model overestimates DO in the bottom of the lower half of the Bay during the summer?
    - Pierre said he is correct. The model has a little too much bottom oxygen in the lower bay.
    - Carl said their model has that same bias. It is interesting that independent model studies show the same thing.
- Isabella Bertani asked if he has looked at other metrics of model data comparison besides the Person Correlation.
    - Pierre said he only looked at the Pearson Correlation and the Spearman Rank Correlation.
    - Isabella said the Pearson Correlation plaints a partial picture, and it might downplay the improvement in the higher resolution scale. Pearson Correlation will not be sensitive to any systematic bias between observed and simulated. She is seeing the higher resolution is much better at capturing the peaks, and she expects Nash-Sutcliffe Efficiency would be much better at showing improvement to the higher resolution model.

12:20 Tributary Summary Update – Jeni Keisman, USGS

Progress with the Tributary Summaries and where they can be found on the CBP website will be described.

12:30 Discussion of Tributary Summaries

- Lew Linker said timing is good because STAC is wrapping up a synthesis on shallow water processes. There is also a STAC report coming out this year on estuary processes in the shallow water. The summaries will help get at the management questions of why they are not achieving attainment and how they can achieve it faster. He said they can look at different groups to not only use the summaries but to also fill them in.
- Jeni said the time it took to gather all the pieces was an obstacle to being able to advance the knowledge. Hopefully, they pulled all this information together in one place to help people understand the connections and so they can spend more time with the why discussions.
- Lew said the utility of the summaries will be discovered moving forward.
    - Ted Tesler said he agrees the summaries will find a broader audience in time and with continued outreach.
- James Martin said the summaries finally give managers in the CBP the tools they need to try and adaptively manage. It is really hard to pull of this information together to understand what is and what is not working.
- Jeni said one of the challenges is how to translate the information for management decisions but having all the material together provides a starting point on that discussion. She said if anyone has an area of priority, they can reach out to her.
- James challenged the Modeling Workgroup with how else the modeling tools and insights can be included in the summaries.
    - Jeni said there are some feedbacks that occur. They can look to see if the observed results are consistent with what the models are showing.

12:35 A Tidal Water Model for the Assessment of 2035 Climate Change Risk to the Chesapeake TMDL – Lew Linker, EPA-CBPO

Progress on the Chesapeake Bay Program Request for Assistance (RFA) for next generation state-of-the-science model of the Chesapeake using an unstructured grid will be discussed. The new tidal Bay model, to be fully operational in 2025, is needed for the assessment of water quality standards under 2035 climate change conditions. The approach will be consistent with the STAC Next Generation Model Workshop Report using multiple tributary model teams, all using the same model structure and code, in conjunction with an overall integrating model of the main stem Bay and all tributaries.

12:50 Discussion of a New Tidal Water Model for the Assessment of 2035 Climate Change Risk.

- Dave Montali asked what parts are they keeping from the old estuary model and what parts are they trying to improve. He also what are the directions in the RFA.
    - Lew Linker said he can't talk about the RFA. However, the Modeling Workgroup had said they have wanted to keep their investment in the ICM Water Quality Model code development. We don't want to start from scratch. The results they have seen from Nicole and Pierre simulations give them insight on how they can take the code they have now and put it on a finer scale. It will be an improvement of accuracy and direction of management action.
- Karl Berger asked if it will be one model for each tributary.
    - Lew said it is yet to be determined and it was something for the Water Quality GIT to discuss. We have the possibility to launch a few the multiple tributary models from the CBP office with the team they have. However, we would like to find funding next yar to bring in multiple PIs for further refinement on the tributaries.
- Dave Montali said more detailed discussions on this approach will be available at the October Quarterly meeting.
    - Lew Linker said he can at least discuss the RFA once it's out and is pubic information.
    - Dave asked if the RFA is intended for the tributaries. How important is it for the entire process for that to go out and be ready for their deadlines?
    - Lew Linker said it is very important. He said there will be a main Bay model covered by this RFA. It will be ready to assess 2035 climate change, in 2025 and it will be as good or better then the recent Phase 6 effort. If CBP can't secure funding, for Multiple Tributary Models (MTMs) we would be able to launch a few tributaries with the work of the CBPO team.
- James Martin asked what funding is available next year for the Multiple Tributary models (MTMs)
    - Lew couldn't speak much on this item, but he said if they start the MTMs in 2022 with the work funded on a rough magnitude level of $100k they could start a number of tributary model efforts.

    - James said the sooner he can share what that funding need is the better the partnership can help him secure it.
- James Martin said guidance from the partnership is improving the resolution of the tributaries and shallow water areas. Those are the areas they need to focus on for reassessing climate. Should they be working on the main Bay model second? Is it too late to make that switch?
    - Lew said it is too late. They need a fully operational model in 2025. They wouldn't be able to have the multiple tributary models as a standalone model. They need a scenario platform to start responding to assessing water quality standards under 2035 climate change conditions and that's the Main Bay Model (MBM). The multiple tributaries model would contribute to the MBM by providing insights of the shallow water processes to the MBM and to all the MTMs.. The tributary teams would participate in the various Modeling Workgroup meetings in order to get the insights in the area where they have only began to investigate, the shallow water for the Chesapeake.

1:00 ADJOURN

Participants: Richard Tian, Anne Schlegel, Jeni Keisman, Arianna Johns, Bill K, Carl Cerco, Carl Friedrichs, Cassandra Davis, Clint Gill, Dave Monitali, Denice Wardrop, Gary Shenk, George Onyullo, Gopal Bhatt, Isabella Bertani, James Martin, Jesse Bash, Jim George, Julie Reichert Nguyen, Karl Berger, KC Filippino, Larry Sanford, Lee McDonnell, Lew Linker, Marjy Friedrichs, Mukhtar Ibrahim, Mark Bennett, Nicole Cai, Norm Goulet, Pierre St-Laurent, Rebecca Murphy, Robert B, Sarah Benish, Ted Tesler, Breck Sullivan, Jackie Pickford, Steve Bieber