Integrated Trends Analysis Team (ITAT)
Meeting

Wednesday, July 27, 2022
10:00 AM – 12:00 PM

Meeting Materials: Link

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

ACTION ITEMS

- **Alex Gunnerson will follow up with Tish Robertson and Rebecca Murphy about looking at trends in the middle column DO data, potentially using the 4-D interpolator when it is available.**
- **Alex Gunnerson will schedule the November and December meetings based on the feedback provided in the Mentimeter Poll. – DONE**
- **Alex Gunnerson will reach out to Angie Wei to follow up on the potential of overlaying ITAT surface trends data on the 3-D segment viewer.**

Meeting Minutes

10:00 – 10:15 **Welcome – Vanessa Van Note** (EPA) and **Breck Sullivan** (USGS)

Announcements –

- Conferences of potential interest
  - Environmental measurement Conference – August 1-5, 2022, Arlington, VA.
  - World Seagrass Conference & International Seagrass Biology Workshop – August 7-12, 2022, Annapolis, MD.
  - 11th U.S. Symposium on Harmful Algae – October 23-28, 2022, Albany, NY. Abstracts/posters due July 15 and registration closes September 16.
  - Chesapeake Watershed Forum – November 4-6, 2022, Shepherdstown, WV. Request for Proposals were due June 3, 2022.
  - A Community on Ecosystem Services – December 12-15, 2022, Washington, DC. Abstracts due July 15, 2022.
  - National Water Quality Monitoring Council's 13th National Monitoring Conference – April 24-28, 2023. Location TBD. Session proposals due June 24, 2022.
- Rappahannock Tributary Summary Updates
  - If you were part of the first round of reviewers, please review the appropriate sections of the report. See the email from Alex Gunnerson on July 7th for more details and the different versions of the report.
- DC data in the tidal trends this year.
  - Breck, Vanessa, and Rebecca Murphy have been working with DC Department of Energy and the Environment (DOEE), Efeturi Oghenekaro, Blessing Edje, George Onyullo, and the Metropolitan

Washington Council of Governments (MWCOG), Mukhtar Ibrahim, Karl Berger on incorporating DC data into the tidal trends results for the Potomac and Anacostia Rivers.

- Scheduling the November and December ITAT meetings.
    - ITAT members are asked to come prepared with knowledge of their November and December availability as the typical 4th Wednesday of the month meeting time occurs when many members are typically unavailable.
- Availability for the August Meeting.
    - Some members will be on vacation during the time the ITAT meeting will be taking place in August. Members let Breck, Vanessa, and Alex know if they will be in attendance, cannot make it, or would prefer a different time.

Summary

Alex Gunnerson and Vanessa Van Note began the meeting with a brief overview of the agenda and review of the upcoming conferences.

Mike Lane then provided an update on the Rappahannock Tributary Summary, saying he has received feedback from the needed parties and is working to have those comments incorporated into a finished product soon. Mike said he needs to finish the tidal trends analysis first, but then his efforts will be focused on the Rappahannock Tributary Summary.

Rebecca Murphy shared that there has been great work by DC DOEE (Efeturi Oghenekaro, Blessing Edje, George Onyullo) and MWCOG (Mukhtar Ibrahim, Karl Berger) on incorporating DC data into the tidal trends results for the Potomac and Anacostia Rivers. Rebecca said this is an exciting collaboration and DC results will be in the tidal trends this year. George Onyullo shared that DC is on board with sharing the data through the Bay Program's tidal trend summary reports.

Alex then polled members to determine availability for the August meeting and the ideal times for the November and December meetings. Based on the votes of those in attendance, the November Meeting will be held on Wednesday, the 9th and the December meeting on Wednesday, the 7th. The August meeting will be held as planned.

Jon Harcum shared that the updated baytrendsmap has been posted to CAST. Links to the CAST page and directly to the application are https://cast.chesapeakebay.net/TrendsOverTime and https://baytrends.chesapeakebay.net/baytrendsmap/.

10:15 – 11:15 **Marine Heatwaves in the Chesapeake Bay – Piero Mazzini** (VIMS), **Cassia Pianca** (VIMS), and **Nathan Shunk** (VIMS)

10:15 – 10:35 **Marine Heatwaves in the Chesapeake Bay – Piero Mazzini** (VIMS) and **Cassia Pianca** (VIMS)

The frequency, duration, and intensity of marine heatwaves (MHWs) have been observed to increase in global oceans, but little is known about their potential variability in estuarine systems. Piero Mazzini and Cassia Pianca of VIMS conducted a study to investigate the intensity, duration and frequency of MWHs in the Chesapeake Bay using over three decades of continuous temperature records. Observed trends suggest that the Chesapeake Bay will reach a semi-permanent MHW state, when extreme temperatures will be present over half the year. Given the detrimental impacts of MWHs on ecosystems, improving our basic understanding of MHWs is important to guiding management decisions.

Summary

Piero began by explaining that marine heat waves garner a lot of attention and defined marine heat waves as when the sea surface temperature (SST) is greater than the 90th percentile threshold for five consecutive days. Piero shared some of the major impacts of marine heat waves, such as record breaking harmful algal blooms, global-scale coral bleaching, mortality of Submerged Aquatic Vegetation (SAV), geographical species shifts and changes in species composition, and impacted commercial fisheries and aquaculture. Piero then explained why marine heatwaves in estuaries are relatively understudied due to the lack of adequate satellite resolution and in situ data. There are approximately 30 years of data for marine heat waves, but a shorter time series can also yield good results. The metrics studied for marine heat waves include duration, intensity, frequency, number of marine heat wave events, and cumulative intensity.

Next, Piero overviewed the available data on marine heat waves for the Chesapeake Bay (CB), like several long-term monitoring stations in CB that are not located perfectly but show similar statistics that are representative of the CB mainstem. The results of the analysis indicated that summertime has a longer occurrence of marine heat waves than other times of the years and aligns with problems of hypoxia. Results compared the overall CB to sub-regions, like the characteristics of the Upper Bay (0-8 events per year with most in current decade, duration of 5-20 days with no significant trend, but increasing in frequency), characteristics of the Lower Bay (significant trends, a few reaching 100-day marine heat wave event), and characteristics of the overall CB (no greater overall intensity like the global trend, but yearly cumulative intensity has been increasing). One aspect of the analysis looked at how events co-occur in different region of the Bay, where estimates of co-occurrence are measurements of similarity. The analysis also looked at lag events of co-occurrence and found typical lag was about 2 days where 40% occurred simultaneously with the open ocean. The analysis also observed temperature change for the mixed layer in the ocean and estuary, where the air-sea heat flux seemed to explain the co-occurrence of heat flux in the ocean and estuary.

The analysis related the data to climate indices and showed large spatial variability across the CB, with more influence shown in the lower CB and Mid-Atlantic Bight, but not so much in the Upper and Mid-CB. While there is a need for further studies to understand the cause of marine heat wave events, the main driver behind these marine heat waves is rising atmospheric temperatures. Piero concluded that if these trends persist, by 2100 the Chesapeake Bay will reach a state of semi-permanent marine heat waves. Piero provided a brief overview of the future work that is being done on this topic.

10:35 – 10:55 **Impact of Marine Heatwaves on Subsurface Hydrography and Dissolved Oxygen (DO) in the Chesapeake Bay – Nathan Shunk** (VIMS)

The presentation characterized subsurface anomalies in temperature, salinity, and DO, along the CB main stem during MHW events. A MHW is defined as a period of five consecutive days or more with anomalies that are above the 90th percentile threshold, thus requiring a time series sampled daily with a minimum duration of twenty years. There are limited, if any, subsurface timeseries that have such temporal resolution and record length. To compensate for this data gap, daily data from the Multi-Sensor Ultra-High Resolution (MUR) sea surface temperature field from NASA's Jet Propulsion Lab were used to identify MHW events at the surface and then in-situ profiles from the Chesapeake Bay Program sampled during MHW events were examined the subsurface anomalies during these events. The presentation explored the spatial and seasonal variability in subsurface temperature, salinity, and DO anomalies across the CB main stem's salinity gradient during MHW events.

Summary

Nathan began with a review of the definition of MHW, how they are characterized, and their impacts. Nathan reiterated the conclusions of Piero and Cassia's work that MHWs in the Chesapeake Bay are seeing an increasing frequency of events, increasing cumulative intensity, a greater percentage in summer, and co-occurrence across the Bay.

Nathan next outlined the research objectives for his work (slide 14) before diving into his methods for data availability and climatology. Since the temporal availability of subsurface data is not continuous like surface trends, Nathan relied on monthly cruise profiles. For temperature and salinity, daily climatology at each point was used to produce daily anomaly profiles, which then utilized harmonic analysis to validate against the monthly climatology. The monthly average climatology was then used to examine subsurface DO.

Results showed that for temperature and salinity, winter temperature anomalies are larger and penetrate at depth, summer temperature anomalies are smaller and do not penetrate at depth, and there were no discernible patterns in salinity anomalies. Winter DO anomalies are negative throughout water column, and summer DO anomalies are negative in the middle of the water column and capped by surface mixed layer.

Nathan concluded with some directions for future work which include examining chlorophyll anomalies and investigating mixed layer depth definition and temperature anomaly discrepancies.

10:55 – 11:15 Discussion for both MHW presentations

Vanessa asked Piero about co-occurrence in MHW events across the Bay. Piero replied the results showed that 50-60% of MHW events co-occur among different regions of the Bay, and 40-50% of MHW events co-occur with the Mid-Atlantic Bight.

Mike Lane asked if Nathan could explain negative anomalies again to ensure he understood the direction of the trend presented. Nathan replied that a negative anomaly means a reduction in DO at a specific point during a MHW event and a positive anomaly means an increase in DO. Peter Tango asked if a 'negative anomaly' is worse or

better than a positive anomaly. Piero replied in chat that the negative anomaly represents a reduction in DO.

Kaylyn Gootman asked Piero if he expects co-occurrence lag times to increase, decrease, or remain the same with climate change projections. Piero replied he expects the higher number of MHW events will cause co-occurrence to increase because random co-occurrence will be higher.

Tish Robertson commented that efforts have been focused on DO and temperature trends at the surface and bottom. Tish asked if Nathan thinks we could be missing trends occurring in the middle of the water column. Nathan replied he is not sure because he has not been looking at long term trends for the middle of the water column. Tish said this is also a question to be posed to the group at large. Carl Friedrichs replied he does not think much would be missing because the surface and bottom would provide constraints on the middle. Carl added unless something very surprising at the bottom relative to the surface was found for temperature, the middle could just be interpreted from the two. Carl said for DO, it might depend on the location of the pycnocline as that could yield a surprising result for the middle of the water column. Rebecca Murphy agreed and commented this would be interesting to investigate because the boundaries of the lowest DO (southern boundary or the middle depth) would be the places where changes (both improvement and degradation) are seen. But Rebecca emphasized it would be difficult to do this because the pycnocline changes spatially so it would be difficult to do trends for it. Rebecca explained this is why hypoxia is often described in terms of area, depth, or volume. Tish suggested an approach to look at the upper boundary of the pycnocline averaged (or a median) over the whole period of the station to better characterize the pycnocline and associated variability. Tish said she suspected depth would be pretty stable, but a few stations would see considerable variability on where the pycnocline sets up. Rebecca said that sounds good to look at the oxygen right below the upper pycnocline but asked who else wants to do that. Vanessa said we could come back to this at a future meeting to discuss how to further this discussion and assign work. Rebecca said this might be more easily derived through the 4-D interpolator once it is complete.

Mike Lane asked if MHWs might influence phytoplankton primary production. Nathan replied he thinks it could influence phytoplankton primary production. Nathan said in the winter, it would probably increase primary production because temperatures are increased. However, for summer, Nathan felt it would probably limit phytoplankton primary production because of thermal tolerances.

Vanessa asked what ITAT members think about including the MHWs research in the climate change section of the tributary summaries to complement the precipitation information. Rebecca asked if there might be an expansion of data collection into the tidal tributaries to look at MHW events there. Piero replied this is a potential future next step and will involve looking at co-occurrence in the tidal tributaries, in addition to subsurface forces and patterns, and discharge from the watershed. Piero said they are looking for students to help out with this work. Vanessa and Piero agreed that if this type of work is done in the tidal tributaries, ITAT would be interested in hearing more.

11:15 – 12:00 **Overview of 3D Segment Explorer and 4D Visualization of Living Conditions for Striped Bass and Blue Crab – Angie Wei** (UMCES)

Angie Wei discussed work done with the modeling team to visualize the living conditions of blue crab and striped bass in interpolator grids, and her work on a 3D Segment Explorer showing both the 2D and 3D view of individual segments and their basic statistics, monitoring stations, and TMDLs. Questions followed the presentation.

Summary

Angie first presented on the Web-Based 4-D visualization of Habitat Condition of Living Resources. Angie said this was developed with the modeling team and the major inputs for the visualization are from the Chesapeake Bay Interpolator and monitoring data. Angie explained how for the water quality data, the interpolator produced outputs using the ten years from 1991-2000 as a baseline condition, considered three parameters (DO, Salinity, and Temperature), and four scenarios (No Action, Watershed Implementation Plan (WIP) 3, 1985 Progress, 2017 Progress) represented in this visualization. Angie connected the interpolated results to the habitat requirements for charismatic living resources associated with the Chesapeake Bay, like Striped Bass and Blue Crab (slide 4). The method for making this connection involves taking the three parameters and then masking the Bay with the relevant parameters for each species. In the case of Striped Bass, DO and Temperature are the most relevant while all three are relevant for Blue Crabs. Angie then presented both the Blue Crab and Striped Bass visualizations, showing how to toggle between different scenarios and compared a few examples to illustrate their comparison value. Angie also showcased the ability of the visualization to look at habitat volume at different depths and from different angles, including zoom and search features. Users can also see the attributes of each cell in the interpolated grid.

Angie then presented on the 3D Chesapeake Bay Segment Explorer that she and John Wolf put together. The data in this tool comes from a refined version of the Semi-implicit Cross-scale Hydroscience Integrated System Model (SCHISM), which is being used in the Phase 7 Development of the Main Bay Model. This SCHISM data uses a finer scale grid characterized by finite element/volume formulation and unstructured mixed triangular/quadrangular grid in the horizontal dimension. Finer scale grids are currently available for the Mainstem, James River, and York River. Angie then walked through the 3D Chesapeake Bay Segment Explorer and briefly highlighted how to select different segments and the metrics which are reported. Angie then shared some of the features of the segment explorer, such as: a 2D map shows boundaries of the segment, any tidal water quality monitoring stations found in the segment, and TMDL segment-sheds; the 3D scene depicts the extent of the segment in refined SCHISM grids, color-coded by bathymetric depth with 100x vertical exaggeration; both 2D and 3D scenes are synced and interactive. Angie said a potential next step for the tool is the integration of the segment explorer with water quality standards attainment information currently presented in the Watershed Data Dashboard.

Erik Leppo asked which software is used for the 3-D mapping. Angie replied they are using ESRI services. Specifically, ArcGIS Pro was used to create the models, and then they were published to ArcGIS Online in the ESRI experience builder to create the application.

Carol Cain asked if the segment explorer includes the volume of different depths by habitat type: open water, migratory, deep water, and deep channel. Angie replied currently that information is not included because the pycnocline changes spatially over time, so it is difficult to identify cells. However, Angie showed a prototype of a

pycnocline visualization she is working on which draws from the 4-D interpolator and data from Richard Tian on the Modeling Team. The visualization is for summers from 2018-2020 and uses the frequency of the pycnocline in each cell to guide the color scheme. Angie emphasized this visualization is still in an experimental stage.

Lew Linker commented this is nice work that makes a good contribution toward expanding the CBP modeling work to key living resources.

Mike Lane commented that just having the segment explorer with descriptive statistics for each segment is extremely useful.

Alex Gunnerson asked Angie if these visualizations could be linked in the tributary summaries, if ITAT members think they should be linked, and when Angie and the GIS Team would feel comfortable with them ready to be shared broadly. Angie said it would be a good idea to link them to the tributary summaries eventually, but one needs to consider that currently the visualizations are organized by segment, so there would need to be a way to tag each segment with the tributary it is associated with. Angie added they are not quite ready yet to share this information since she still needs to talk with John Wolf about adding some more standards information and making the URL shorter.

Alex asked Angie if it is possible to overlay trend data from ITAT and tidal trends on the 3-D segment viewer, and if so, if ITAT members would find this helpful as an addable map layer. Angie replied this is a good suggestion as it could inform the water quality standards information. Angie asked if it should be added to the map or if the ITAT data should be examined in 3-D. Alex said he was thinking about the first suggestion, the ITAT trend data for the surface be overlayed on top of the segments in the viewer. Angie and Alex agreed to follow up on this conversation offline.

Alex asked Angie if she would consider expanding options for the temporal time frame of the 4-D Habitat Visualization. If so, Alex asked if Angie could do 3-D visualizations to align with the periods for ITAT long-term or short-term trends. Angie asked what form the data are in. Rebecca replied that the trends are computed at the long-term monitoring stations (about 140 locations) throughout the Bay and are in point data. For most parameters, a long-term trend is calculated at both the bottom and surface for the long term (1980s to present) and the short term (previous 10 years). These data are sometimes overlaid in the tributary summaries on top of the current status for criteria, which can be useful in some cases to understand if the segment is improving or degrading. Rebecca said we can think about whether this visualization might be useful. Angie replied it seems as if this data is more discontinuous and asked if there would be interest in interpolation between those stations or between the surface and the bottom of the water column. Rebecca said Angie is right, it is discrete point data, and she emphasized that ITAT is not interpolating the trends spatially. Angie said that since this is discrete data, the visualization would probably not work.

12:00 Adjourn

Next Meeting: Wednesday, August 24, 2022

Participants: Alex Gunnerson, Amy Goldfischer, Andrew Keppel, Angie Wei, Blessing Edje, Carl Friedrichs, Carol Cain, Efeturi Oghenekaro, Elgin Perry, Erik Leppo, George Onyullo, Helen Golimowski, James Webber, John Clune, Jon Harcum, Karl Berger, Kaylyn Gootman, Lew Linker, Mike Lane, Mukhtar Ibrahim, Nathan Shunk, Piero Mazzini, Peter Tango, Qian Zhang, Rebecca Murphy, Renee Karrh, Roberto Llanso, Roger Stewart, Tish Robertson, Tom Butler, Tom Parham, Vanessa Van Note.