Scientific, Technical Assessment and Reporting
Hypoxia Meeting Notes
Date: Thursday, July 18, 1:00 - 3:30 PM
Location: National Park Service meeting room on the 3rd floor
Webinar: https://zoom.us/j/53201826
Conference Line: 929-205-6099
Meeting ID: 532-018-626

Purpose: Kickoff meeting to go over technical details of the GIT-funded realtime hypoxia monitoring mid-bay pilot study.

Key Questions to Address

- Location of sensor array
    - 2019 Short-duration test: CB 4.3E station
    - 2020 season-long test: TBD
- Distribution of the sensors in the vertical plane
- Deployment periods

Attendance: Doug Wilson, Peter Tango, Bruce Vogt, Bryon Kilbourner, Jay Lazar, Bill Dennison, Rebecca Murphy, Daniel Giddings, Aaron Bever, Qian Zhang, Richard Tian**,** Makayla Brown
(Breck Sullivan, Mark Trice, James Edward, Daniel Giddings, Richard Tian, Lewis Linker, Scott Phillips, Jennifer Keisman, Jennifer Dopowski, Sarah Koser, Emily Trentacoste, Gary Shenk, Marjy Friedrichs, Bruce Michael, Cindy Johnson)

Introduction
P. Tango: Plan to track the project through completion, discuss details and provide input before the project is too far along. Doug will present the scope, proposal, and the details of the project in his presentation.

Presentation
Doug Wilson: Chesapeake Bay dissolved oxygen profiling using a lightweight, low powered, real-time inductive CTDO2 mooring with sensors at multiple vertical measurement levels

- Doug has worked with NCBO in 2001, and in 2003 wrote and discussed proposals
- **Scope 8:** "…demonstrate a reliable, cost effective, real-time dissolved oxygen vertical monitoring system for characterizing mainstem Chesapeake Bay hypoxia."
    - "Water quality impairment caused by excessive nutrient input from runoff and groundwater, is characterized by seasonal hypoxia, particularly bottom layers of the deeper mainstream"
    - "Hypoxia represented the integrated effect of watershed-wide nutrient pollution
    - Current monitoring widely spaced in time and location with monthly or bimonthly fixed stations.

    - Cites Bevers et al. (2018) for a method that estimates hypoxic volume using a few fixed continuous DO profiles
        - Q: Inadequate data from cited research
        - A: could be improved with sensors that report continuous, real-time, vertical profiles for hypoxia modeling
    - VIMS data collected twice a day could be used for comparison to the real-time data shows the
    - Goose station has the longest data set to show how the change occurs
        - Note that DO can range from 1 to 6 over the course of 6 hours
- Requirements:
    - **Reliable** infrastructure that sustains deployment
    - **Reliable** infrastructure assessment of the gear deployed
    - Success and challenges of the piloted equipment collection, storage, and ability to provide **reliable** data
    - Details of protocols that can be adopted and invested in for deployment
    - Additionally
        - meet the data needs of the CBP and partners - desired parameters, quality, resolution, reliable delivery
        - Sustainability - long term capital and resource requirements and personal expenses
        - Flexibility - successful use in required locations, recognition of the diverse physical environments and conditions
    - Two methods to acquire vertical profiles:
        - A. moving a single sensor package through the water column
        - **B. Locating sensor packages at fixed depths with vertical sensor spacing adequate to meet requirements**
    - Selection of B with the understanding that data is simpler and more reliable than A and will be regularly transmitted to a data structure.
        - Evaluation of the methodology; goals of project are not necessarily data analysis driven
    - CTDO mooring with sensors at multiple vertical measurement levels will measure temperature, conductivity, DO
        - Lightweight, low power design
        - Modules developed by Darius Miller, President and Principal Engineer at Soundnine
        - Units are clamped to a semi-taut mooring line with surface data collection and cellular transmission buoy
    - Why fixed sensors instead of a profiler? (pictured- six senor spacing on small buoy)
        - Reliable
            - No moving parts, but the sensors attached to the cable are adjustable
            - Extremely low power (2 AA Lithium batteries will last six months with 15 minute sampling)

            - Storage within each sensor and the controller within the platform
            - Platform controller can be submersible up to 10 meters and remain semi-taut while withstanding wave conditions
        - Sustainable
            - Sensor modules are low cost
            - protected from fouling and should not require cleaning
            - Deployable by two people
        - Flexible
            - Modular components, works at any depth, designed to withstand extreme wave conditions
        - Q: Concern about previous challenges with returning continuous data, how can we ensure that the data is being collected?
        - A: the data query set for 15 minute intervals is designed to communicate with the platform, so data is stored within the sensors, platform, and data structure if transmitted correctly.
        - Q: Concern about weight and anchor to hold system in place.
        - A: 50 lbs will be enough to anchor the system.
        - Q: Normal profiles measure from the surface down, how will you know the depth?
        - A: The sensors will also collect pressure measurements which can be used to calculate depth
        - Q: Top to bottom will not give depth of the water, and we won't know the total depth during tides
        - A: the bottomost sensor might be able to cross correlate movement and pressure to estimate depth
- Meet Data Needs
    - Samples collected at fixed time interval simultaneously
    - Analysis shows reasonable number of sensors can achieve measurement of vertical hypoxia structure
    - Data storage in two locations
    - Availability to CBP and partners with low time latency and QC flags
    - Suggestion to use CBP fixed mooring station CB4.3E (38.55624 N, 76.39121 W) – about 2.5 km east of CBIBS Gooses Reef buoy
        - Reasonable location for prediction
        - Nearby surface environmental and bottom DO&pH data from GR
        - 15 years of DO charts at this station
        - Q: Where can it be subsampled for vertical profile recreation numbers to use and validate the numbers in the model for hypoxic volume?
        - A: We currently use the bottom interpolater's numbers…
        - Q: There is not enough resolution to observe the difference in DO saturation "transition layer" that would be interesting to explain in the physical models of DO. (which is fundamental and can occur over 1 m change)
        - A: Don't disagree, but the uncertainty is known

            - Q: Cannot accurately calculate hypoxic volume without the transition layer
            - A: Not a science project. Pilot is meant to test the methodology so that we can further later on. From the 20 years of data we can try to strategically cluster the sensor nodes
    - Timeline
        - Pushedback and will not be able to get out during the summer 2019 hypoxic season
        - Testing the system for the short deployment will begin October 2019
            - Expecting interesting questions that might be answered during this fall season

Questions(Q) and Answers(A)

Location

- Consider the risk of stealing
    - GPS unit to track movement and work with the NPS
    - Conduct a PR campaign to announce the project
- CB 4.3E is an exciting location; but slide 4 has some concern. Gaps and zeros may indicate wind events seen in one spot that might propogate over a large area in reality.
    - Wind turnover could affect deep hypoxia and circulation…
- A better time/space assessment is essential to CBP (1 mg/L DO is needed for healthy benthos and phosphorus)
    - Use these data to validate the model and to get numbers that cannot currently be observed

Approval of the location for the test deployment at CBP 4.3E this year, then we will reevaluate suitability before selecting the 2020 long term deployment location.

Spatial Extent

- How many will be deployed?
    - 1 mooring with 6 or 7 sensors
        - Offer from NCBO to help establish a collaborative partnership
- Identify science and technical possibilities curing the pilot and what could we concurrently run?
    - Not much interest from Wilson to get into the science. Not designed to be a science project. Could address the possible data gaps for later sampling.
- HRSD is using monthly surface data to interpret flow and infer the conditions below
- Real time assimilation into the model, as the model needs bottom DO and the data is not available
- Wilson asks for help getting the instrument deployed (NCBO acknowledged and offered vessel)
- Does this use the appropriate buoy? Smaller platform might need to worry about the visibility to the Coast Guard if that's an issue?
    - Considering the tradeoffs, the visibility and striking will be fine. Different mooring w/ the buoy not worth the cost. Possibly consider more foam.

Sensor Type

- Is the sensor type okay? Should we consider different resources
    - CTD sensors work, but seabirds would do a better job at twice the price
- Alternative if we are not confident?
    - Not at this price
    - No pre deployment before the 2019 tests
- How to handle data loss if the transmitter stops working?
    - Data is stored inside sensors and can be retrieved manually within an hour.
- What level of resolution is needed for management? Needed for TMDL attainment? Highest frequency variability? Should we aim for the lowest frequency necessary?
    - Tidal frequency, bottom DO numbers are currently not comparable
    - Measured time steps at hour rates in hydrologic models, wind done on hours, sensitivity analysis could come later
    - CBP needs are met at 15 minute frequency
    - We should measure at the lowest frequency possible and push the system to the limits in the pilot to see full range of capability. Push the system for inevitable science and research
- Concern about communications (given CBIBs issues) at the 15 minute interval?
    - This is the time to test the pilot's capabilities. Intervals can be dialed back later. It is important to capture the highest possible resolution
        - Follow on to improve sampling frequency given the battery life
        - Modelers can aggregate up to lower frequency
- Quality checks?
    - Pass, Fail system. Flags are checked later.
- Data storage?
    - FDP, possible plug into existing visualization tool
        - Validation with NCBO CTD cast
        - Check for fouling and other refurbishments through the deployment
        - Posting profiles onsite and compare, we might be able to provide as data is hand entered… would need help to create an outline for data validation
- With all this help, what is the scope of scalability given the amount of help from all these agencies? If we support one during the pilot and it goes well, then it might not be helpful moving forward with intent to scale the size of the project upwards.
    - ***List action items and decouple****. Is this feasible without the support of the others adding outside value to the project?*
    - Track the level of support

*Clarification: 2020 deployment will begin in March 2020 and end October 2020 with a midpoint report June 2020.

Next meeting set for October 2019, after the first deployment ***(Doodle Poll for date)***

- *Expect a written update before Task 4*
- Press involved in second deployment (one week prior)
- *Peter agreed to be the point of contact to track the offers of help*, but does not think he should be gatekeeper
    - ***There is a need to create a list of project leads***

Final Questions

- Given that this is an engineering pilot,
    - Buoyancy of buoy during high wave energy…
        - What is the physics behind the shockload and slack with the low weight mooring and tension on the wire
        - Buoyancy in proportion to the weight?
    - Mooring knocked down with fouling - tidal currents could cause the system to not raise back over the water to transmit data?
    - Resilience to striking?
    - Sediment loads? This will affect buoyancy and accuracy of the instruments. Copper is good with biofouling, but also serves as a clam surface for sediment to settle on.. How will you address this?