Local-Scaled Ocean Acidification Monitoring Efforts

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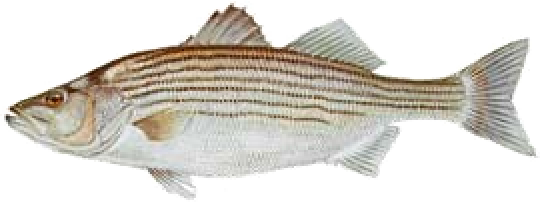
Image: NASA MODIS

Chesapeake Bay Watershed

Maryland DNR's Tidal Water Quality Mission

- Monitor ambient water quality conditions to assess habitat for living resources in Maryland's Chesapeake and Coastal Bays



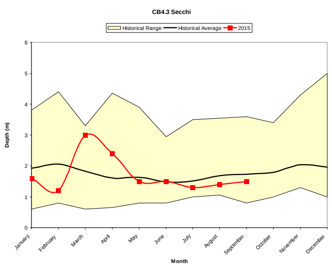


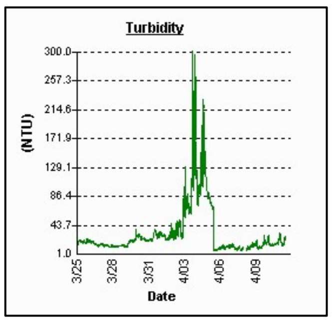

- Historically, efforts have focused on measuring sediments and nutrients (nitrogen & phosphorus) and their impacts on habitat (low dissolved oxygen (hypoxia), water clarity for aquatic grasses, and primary productivity (algal concentrations).

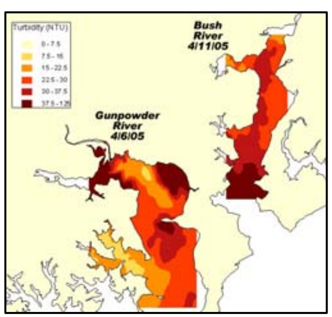
- Data informs research, modeling, restoration, management, event response, and public outreach

- Impacts of acidification are just starting to be considered and monitoring, other than pH, is sparse.

Maryland DNR Water Quality Monitoring Programs







Long-Term Fixed Station Monitoring

- Monthly/Twice Monthly cruises year round
- Collected Since 1985
- 80+ Stations
- Full suite of parameters and depth profiles

Continuous *In Situ* Monitoring

- 30-50 monitors deployed annually
- Water quality monitoring at 5 NOAA buoys
- Vertical Profilers (1 DNR / 1 NOAA)
- Data collected every 15 minutes
- Parameters: D.O., Turbidity, Chlorophyll
  W.Temp, Salinity, pH, Depth
- Calibration Data Every 2 weeks

Water Quality Mapping

- Monthly cruises Apr.-Oct over large areas.
- Surface data collected every 4 seconds
- Parameters: D.O., Turbidity, Chlorophyll
  W.Temp, Salinity, pH, Water Depth
- Calibration Data at ~5 Sites each Cruise

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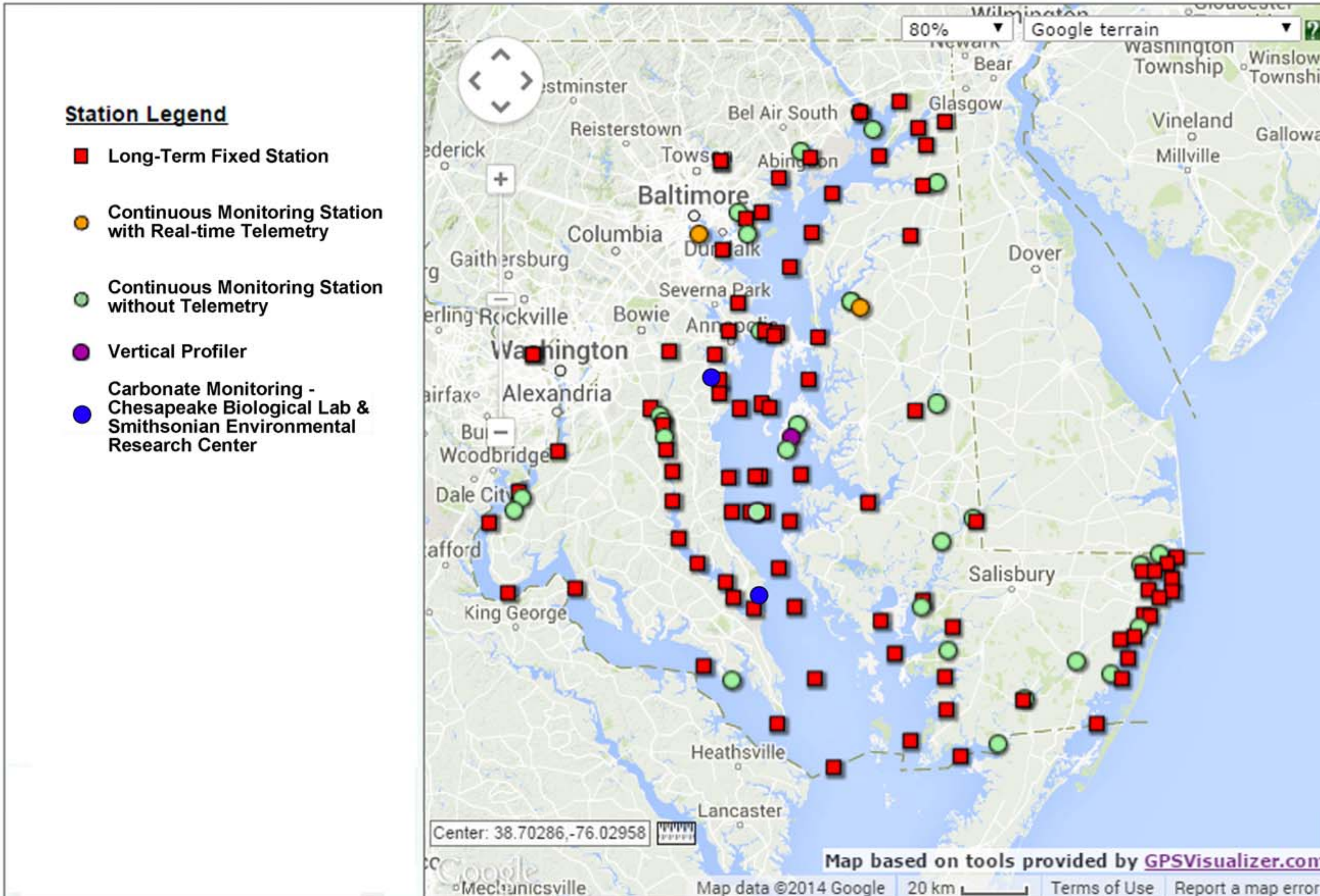
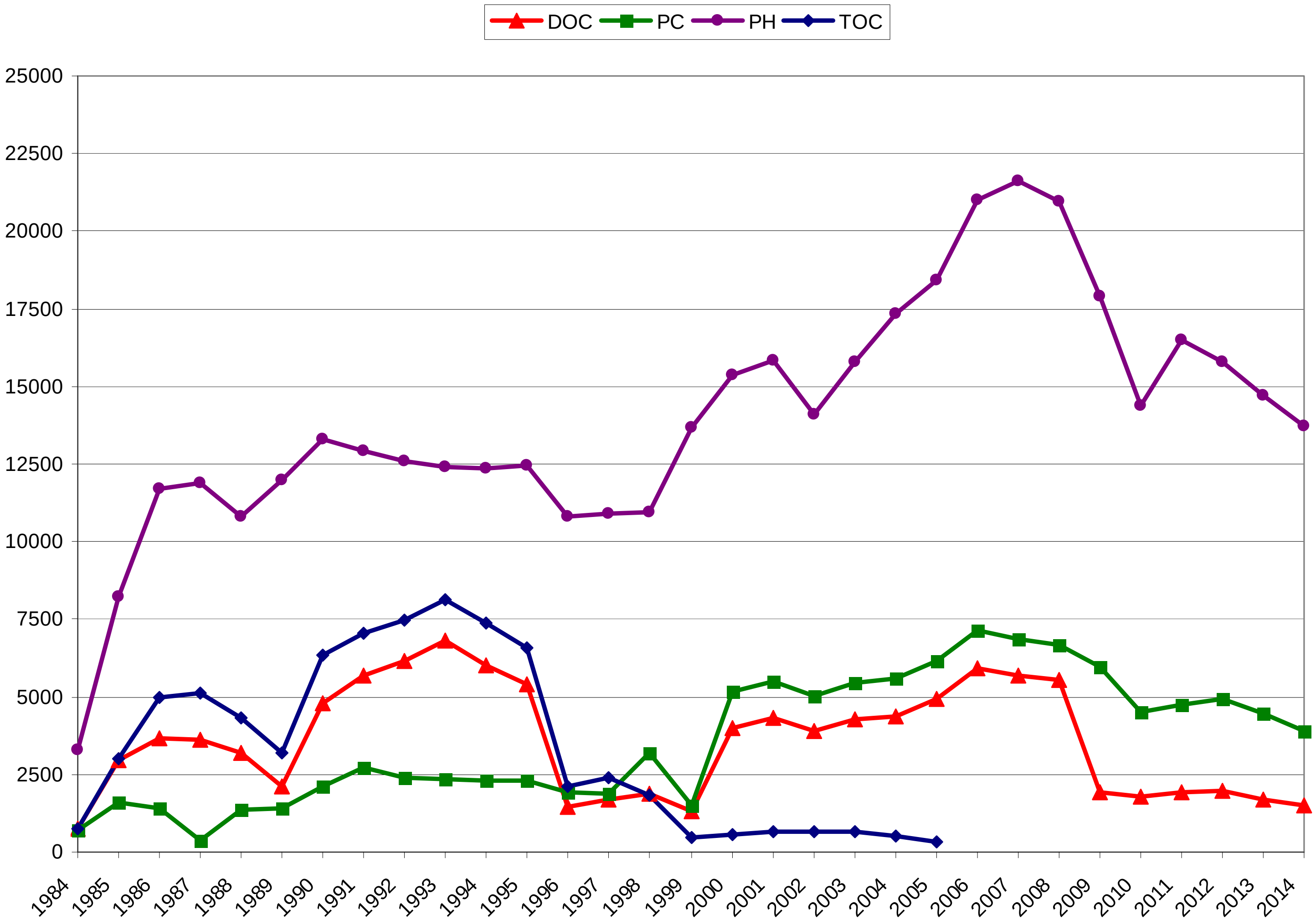
Maryland DNR Long-Term and Continuous Monitoring and CBL/SERC Carbonate Monitoring Sites



CBL = University of Maryland Center for Environmental Science – Chesapeake Biological Lab
SERC = Smithsonian Environmental Research Center

Annual Measurements of Select Parameters at In Situ Sites



__Totals__:

DOC: **111,306**
PC: **111,731**
pH: **433,738**
TALK: **39,292**
TOC: **74,553**

Continuous Sonde pH Measurements: **~11.5 Million**

WQ Mapping pH Measurements: **~ 4.75 Million**

DOC = Dissolved Organic Carbon
PC = Particulate Carbon
TOC = Total Organic Carbon

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Maryland Ocean Acidification Task Force

- Convened in 2014, with a final report in January 2015
  http://msa.maryland.gov/msa/mdmanual/26excom/defunct/html/27oceanacid.html

- Seven key findings were reported:
  1. Maryland needs to enhance monitoring to quantify OA scale, patterns, and trends
  2. Establish additional research priorities in estuarine and coastal waters
  3. Improve coordination with other states and federal resource managers
  4. Focus on impacts to key species and associated activities
  5. Provide direct support to affected industries
  6. Pursue legislative action
  7. Improve communications and outreach

- Possible impacts to key aquatic species was reviewed

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Impacts to Key Species

Oysters:

Alters metabolism, growth, survival and resistance to environmental stressors, such as low dissolved oxygen and disease. Can alter the rate of reef building and maintenance.

Blue Crabs:

Few studies on blue crabs, which have a varied life cycle in marine and estuarine waters. Greater bicarbonate (HCO_3^-) availability could increase calcification rates for crabs. Larvae would be more exposed to pCO_2 due to their life cycle

Striped Bass:

Acidification could impact larval survival and affect otoliths, which are vital structures for fish orientation and sensing.

Submerged underwater grasses (SAV):

Increased CO_2 could increase growth, but higher temperatures could negate or supercede any effects.

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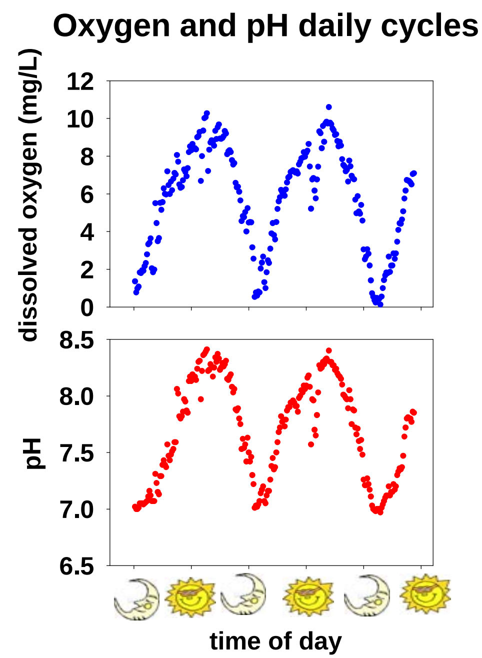
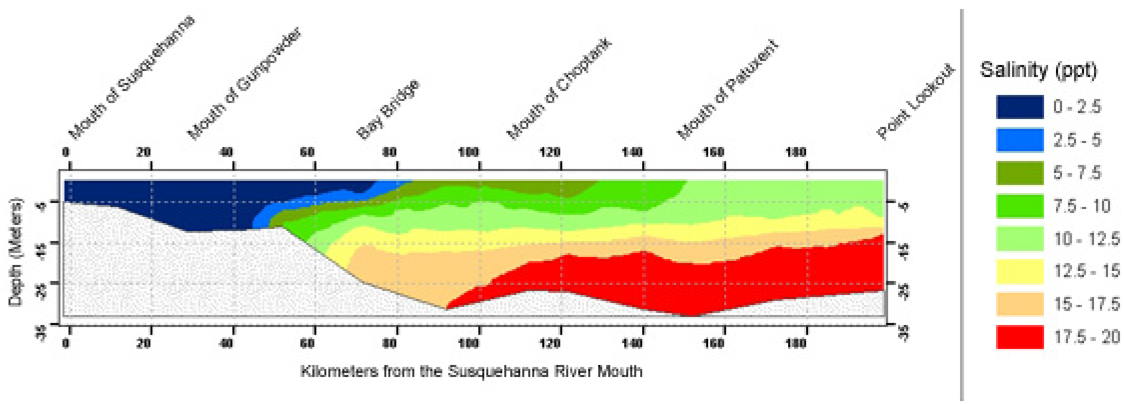
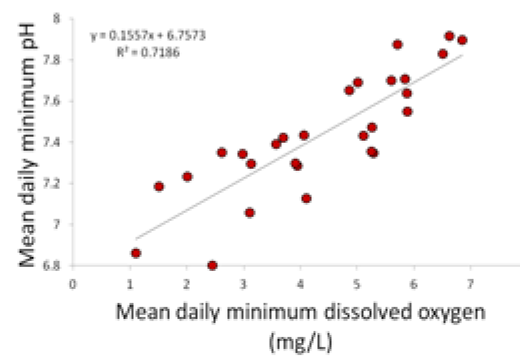
The Complexities of Monitoring Acidification in Coastal Waters

- Hypoxia is a large contributor of CO2
- Large diurnal swings in pH
- Local management actions can regulate hypoxia
- Large and fluctuating salinty gradients with differing buffering capacities
- Landscape factors can influence carbon inputs and cycling
- Cost
- What is the tipping point for atmospheric CO2 contributions?







Breitburg, et al. 2015. PLOS ONE

How Would Data Be Used?

- Accelerate or increase management goals to alleviate hypoxia effects
- Guide oyster restoration site selection or scale
- Guide aquaculture and hatchery decisions
- Improve our understanding of the Bay(s) carbonate system which could lead to revised management actions
    - Best management practices on land
    - Fisheries management strategies

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Monitoring on the Horizon

Recently funded NOAA Grant: Interactions between ocean acidification and eutrophication in estuaries: Modeling opportunities and limitations for shellfish restoration

Dr. Jeremy Testa (Principal Investigator; University of Maryland Center for Environmental Science (UMCES) Chesapeake Biological Laboratory), Dr. Wei-Jun Cai (University of Delaware), Dr. George Waldbusser (Oregon State University), Dr. Jeffrey Cornwell (UMCES Horn Point Laboratory), Dr. Ming Li (UMCES Horn Point Laboratory), Dr. Michael Kemp (UMCES Horn Point Laboratory)

Mid-Atlantic Ocean Acidification Network

Organized under MARACOOS and led by Dr. Grace Saba – Rutgers

Collaborative Monitoring

MD DNR – SERC (Dr. Whitman Miller)

Other Possible Grant Opportunities

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UMCES- U of Delaware-Oregon State U. Sampling Plan

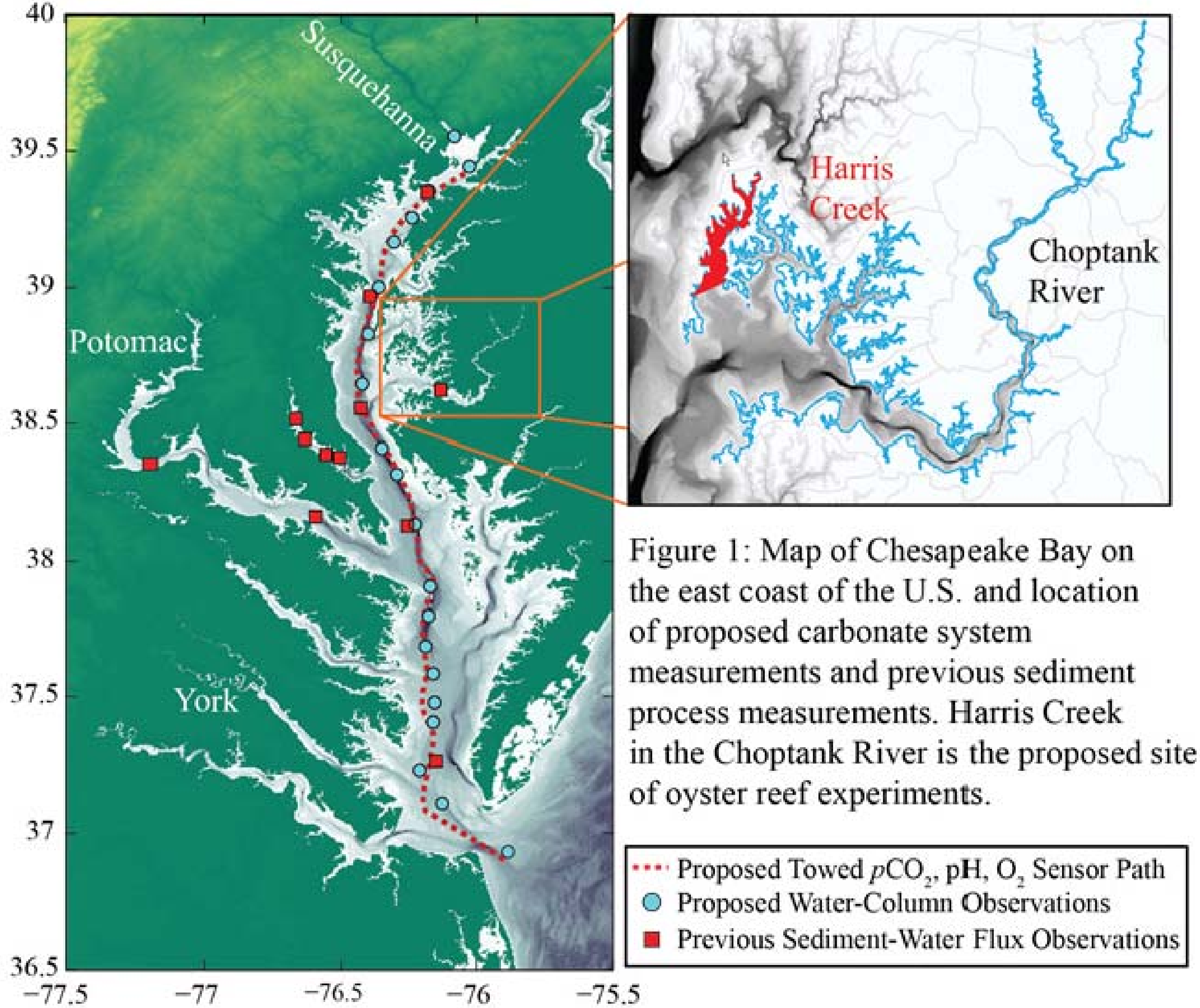

Figure 1: Map of Chesapeake Bay on the east coast of the U.S. and location of proposed carbonate system measurements and previous sediment process measurements. Harris Creek in the Choptank River is the proposed site of oyster reef experiments.

(1) 3-5 Day cruises in mainstm April, June, August, and October (above)

(2) Measurements of pCO2, pH and alkalinity in large rivers

The Mandatory Take Home Questions

What carbon science information do you need/want to support your organization's decision framework?

What are your needs in terms of timeframe, spatial scale, and frequency of data products and updates? More specifically, what information do you need for any decision support/policy/action this year, in 2 years and in 5 years?

When and how should the carbon science information be delivered?

Are there any CMS products that you would like to learn more about? Please review this list of 2012, 2013, and 2014 CMS products before attending the workshop.

Products desired by UMCES led project:
(1) Oceanic carbon (pCO2) fluxes (18 km resolution)
(2) Estimates/maps of ocean atmosphere fluxes of carbon dioxide
(3) Estimates/maps of land atmosphere fluxes of carbon dioxide (5 km resolution)
(4) Any and all phytoplankton biomass estimates

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