



April 12-13, 2016

UMCES Horn Point Laboratory, Cambridge, MD

**INTEGRATING AND LEVERAGING MONITORING NETWORKS TO  
SUPPORT THE ASSESSMENT OF OUTCOMES IN THE NEW BAY  
AGREEMENT**

**The workshop steering committee requests your participation as one of a group of experts who will join a discussion on identifying approaches to overcoming barriers and aligning program objectives to develop recommendations on an integrated regional monitoring program.**

# Acknowledgements: Steering Committee and Coordinators

CBP STAR  
Leadership



Bill Dennison



Scott Phillips



Mark Bennett



Mindy Ehrich



Peter Tango



Rachel Dixon



Carl Friedrichs



Kathy Boomer



Peter Kleinman



Natalie Gardner

# INTEGRATING AND LEVERAGING MONITORING NETWORKS TO SUPPORT THE ASSESSMENT OF OUTCOMES IN THE NEW BAY AGREEMENT

## Objectives of Workshop

1. Supporting adaptive management (including use of models and indicators) of the Chesapeake Bay ecosystem
2. Aligning monitoring program objectives
3. Assessing compatibility of sampling and analytical techniques
4. Highlighting where and how we can increase spatial and temporal resolution to monitoring networks, modifying network designs (e.g., networks design, operations, analyses) that supports accountability needs of the Partnership.
5. Product – recommendations on an integrated regional monitoring program that integrates across two or more programs today.

# Adaptive Management Supporting Progress to Achieve Restoration Goals Established in the Chesapeake Watershed Agreement 2014

## VISION

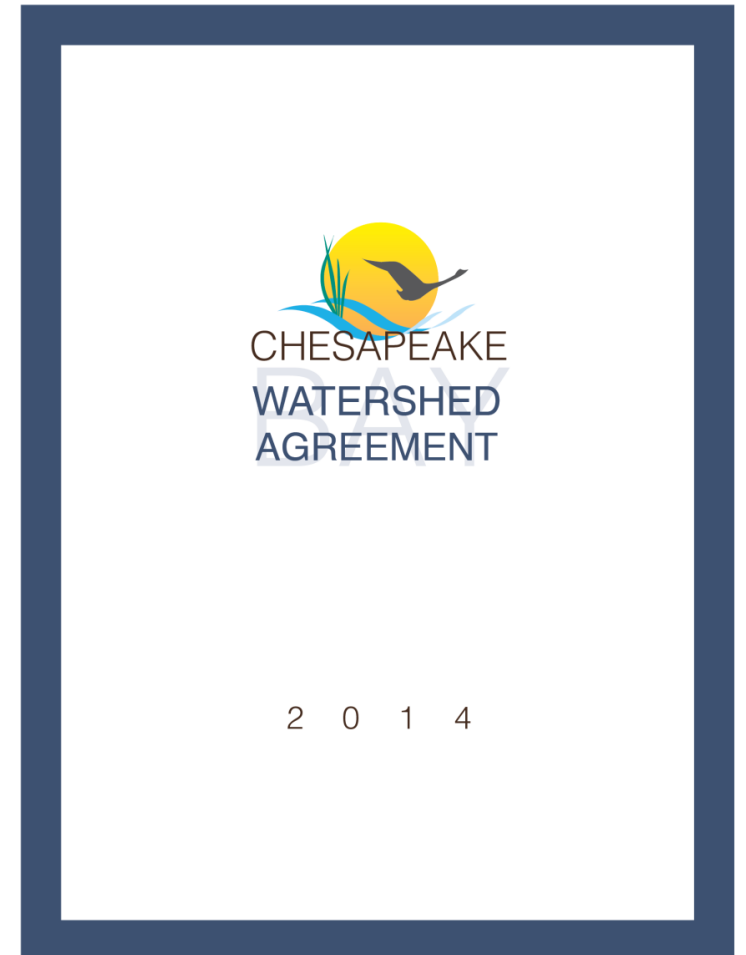
- Chesapeake Bay Program partners envision an environmentally and economically sustainable Chesapeake Bay watershed with clean water, abundant life, conserved lands and access to the water, a vibrant cultural heritage, and a diversity of engaged citizens and stakeholders.

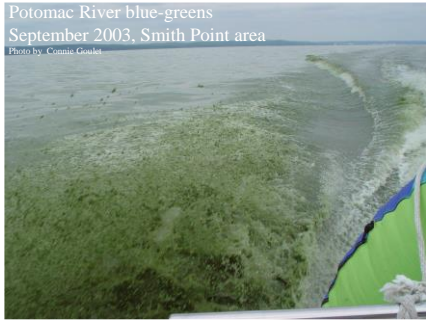
10 Goals

31 Outcomes

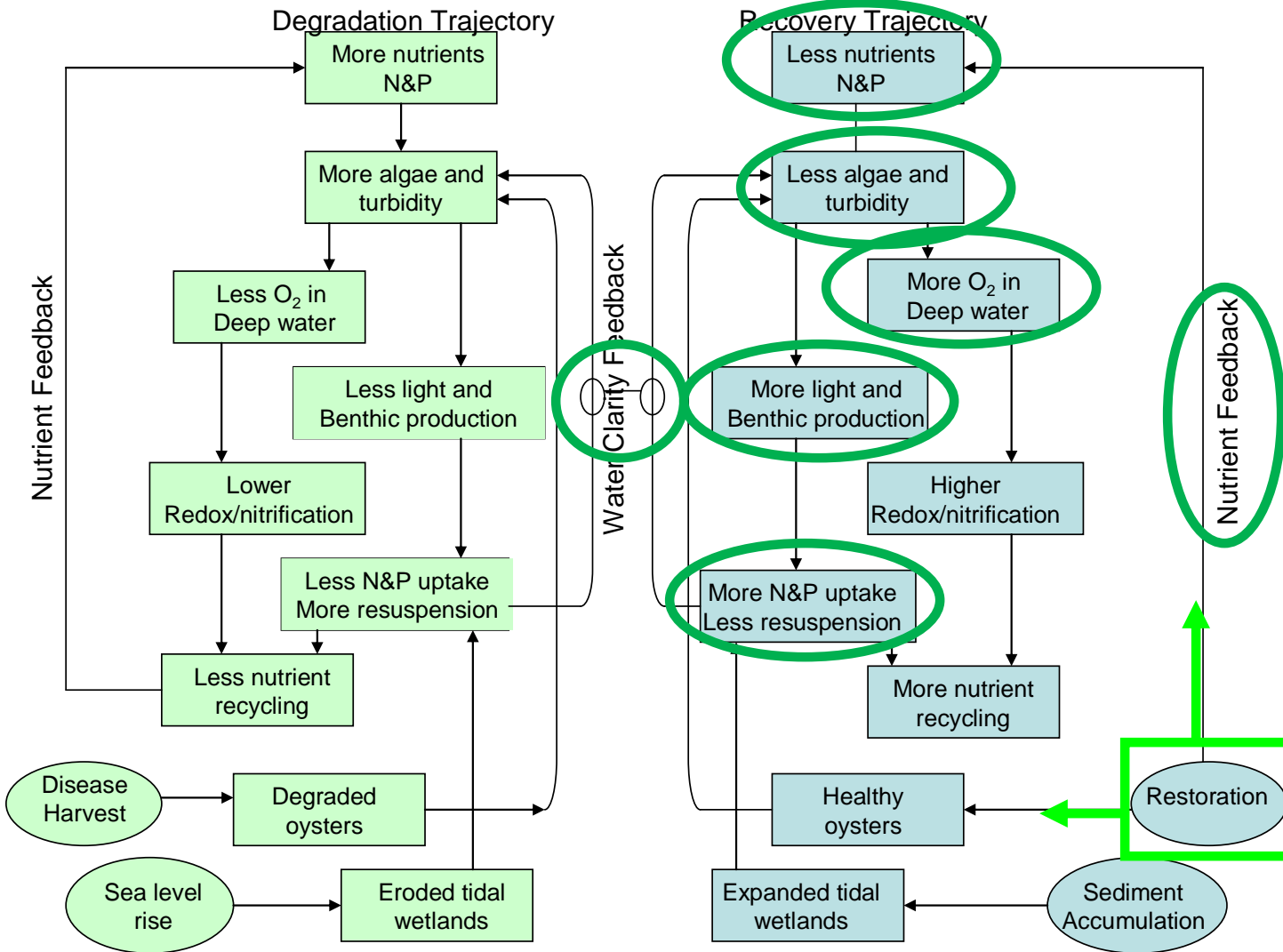
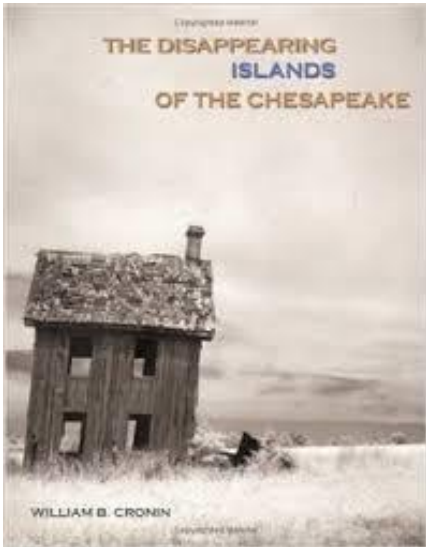
Accountability Indicators

Factors affecting patterns and trends





Credit: UMCES



Conceptual model of Chesapeake Bay degradation and recovery. Page 21 in Kemp et al. 2005. Eutrophication of Chesapeake Bay: Historical trends and ecological interactions. Mar. Ecol. Prog. Ser. 303:1-29.

## Conceptual Model of the Chesapeake Bay Ecosystem and Response Trajectories



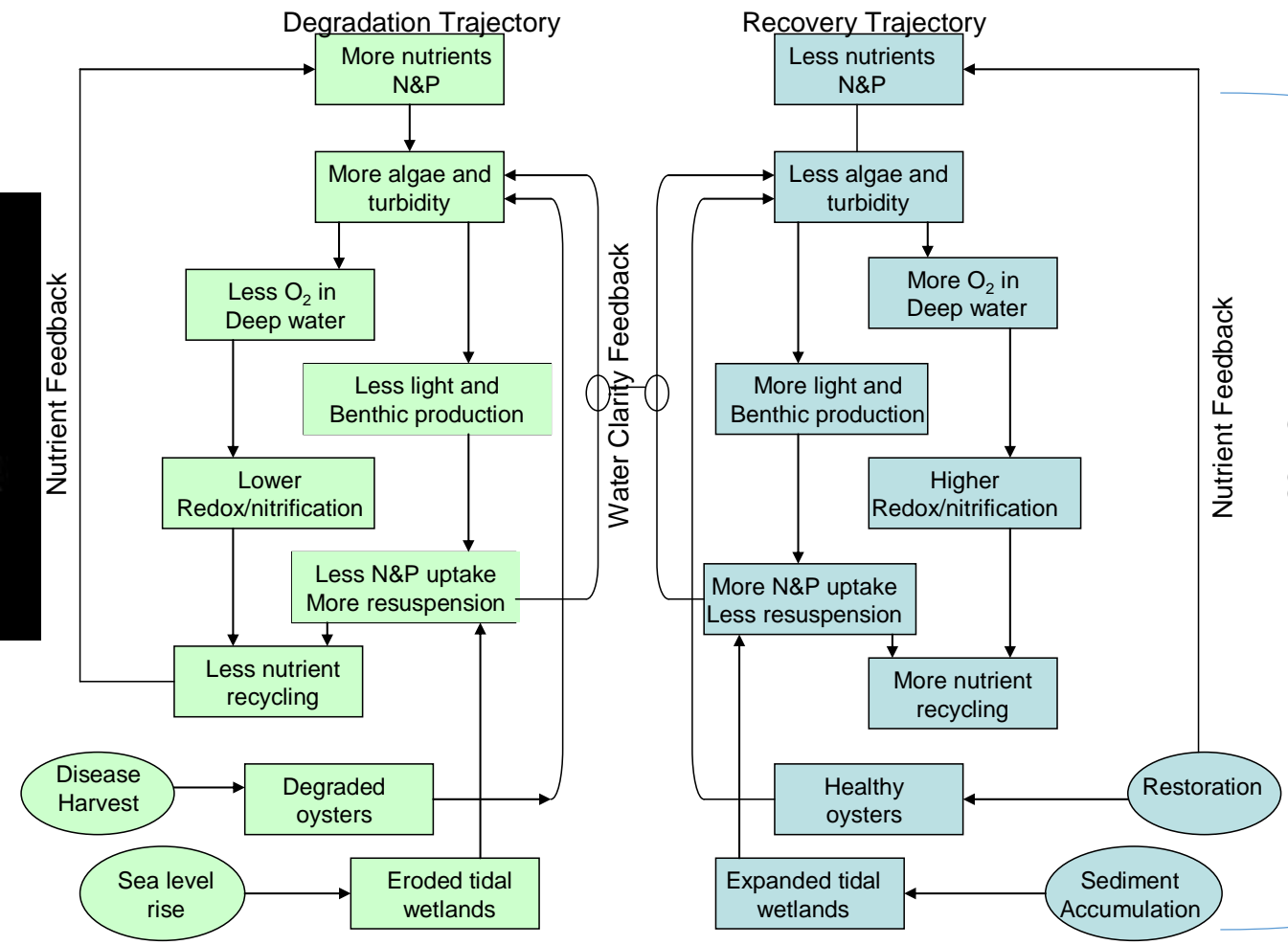
Credit: Bay Journal



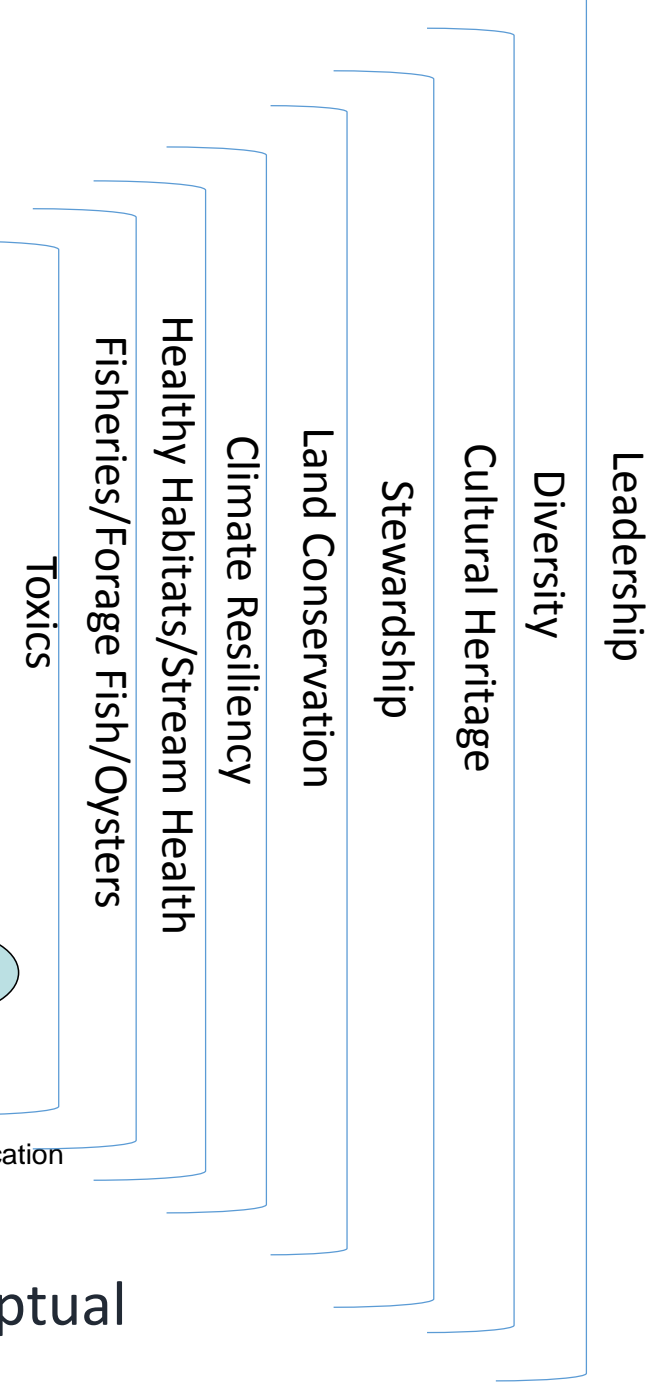
Credit: UMCES



Credit: CBF



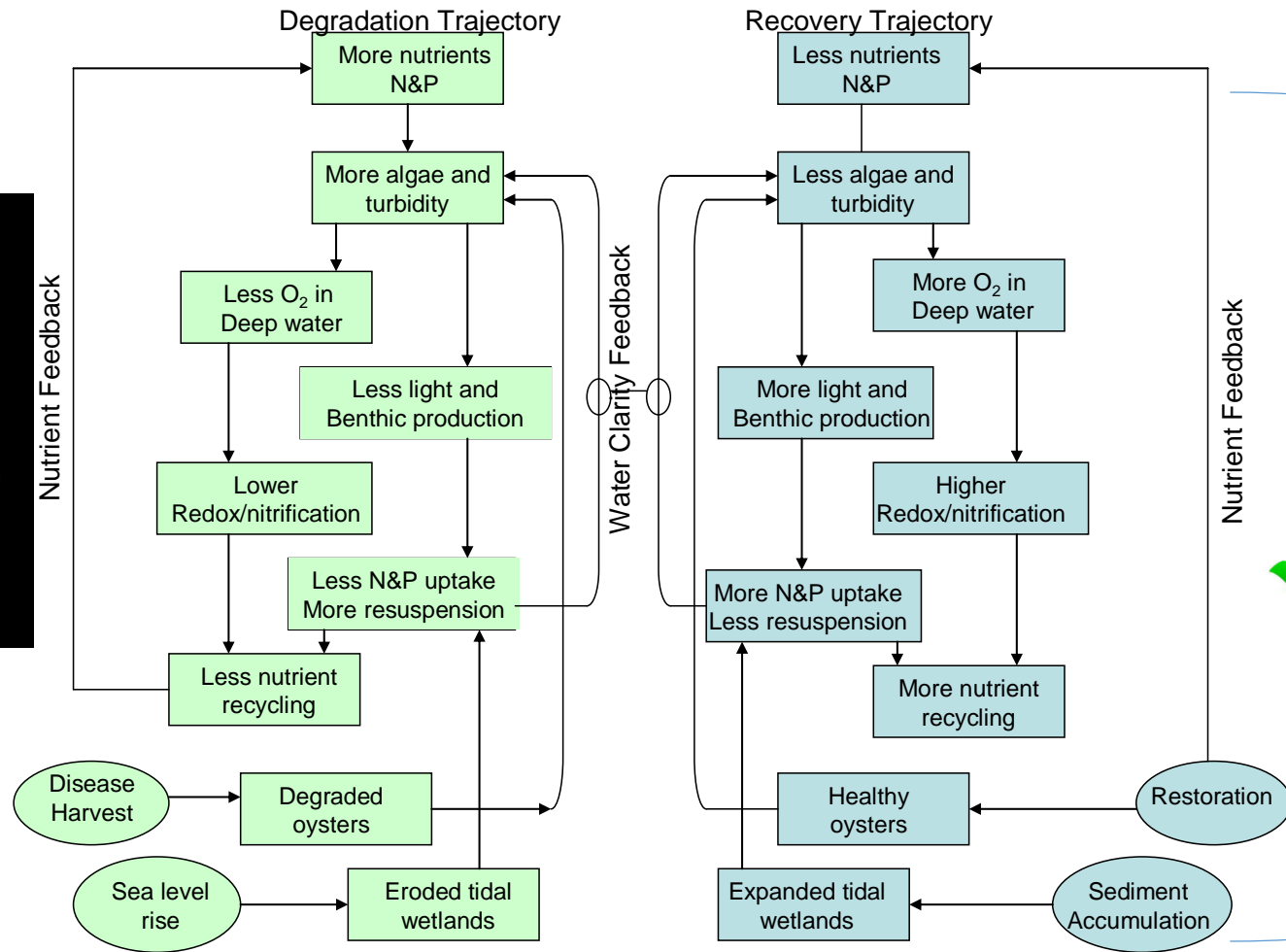
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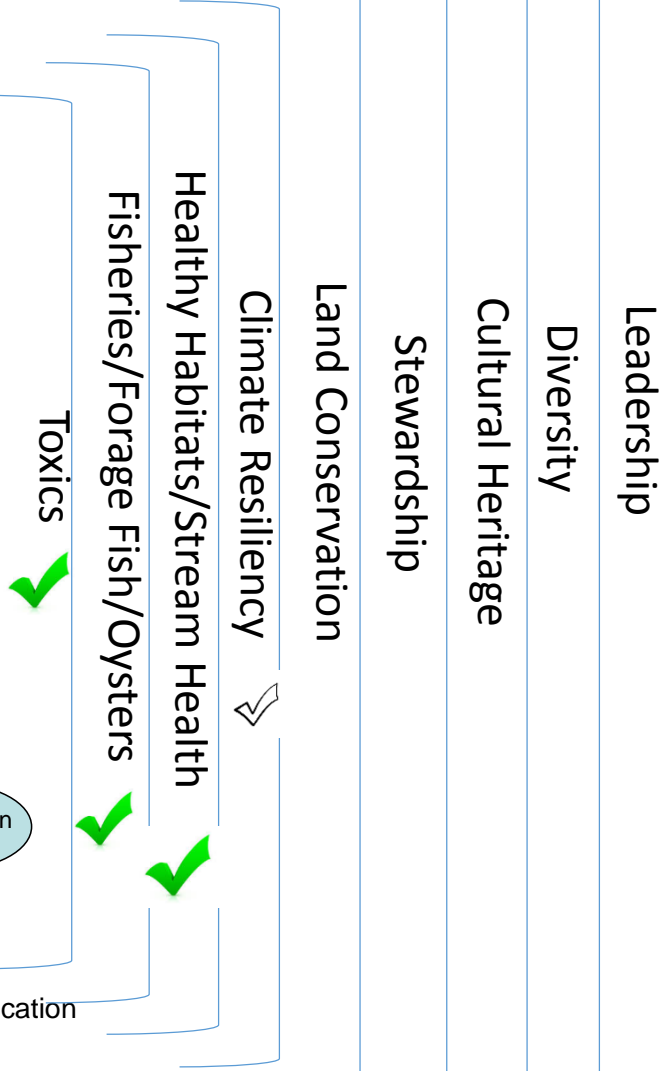
# The 2014 Bay Agreement Vision Expands the Conceptual Model of the Chesapeake Bay Ecosystem

✓ = Workshop Focus Areas

✓ Water Quality and SAV ✓



Conceptual model of Chesapeake Bay degradation and recovery. Page 21 in Kemp et al. 2005. Eutrophication of Chesapeake Bay: Historical trends and ecological interactions. Mar. Ecol. Prog. Ser. 303:1-29.



The 2014 Bay Agreement Vision Expands the Conceptual Model of the Chesapeake Bay Ecosystem

Topic Area/Outcome	Status	Needs
Water Quality	<ul style="list-style-type: none"> <li>Established CBPO monitoring program</li> <li>Other monitoring programs occurring (not incorporated)</li> </ul>	<ul style="list-style-type: none"> <li>Increases in spatial and temporal scale for use in CBPO Water Quality Standards</li> <li>Collaboration/data quality assurance between various water quality collectors</li> </ul>
SAV	Aerial surveys & ground surveys	Continuation of sampling and possible collaboration
Fisheries (Fish Habitat/Forage Fish/Oysters)	<ul style="list-style-type: none"> <li>Oyster restoration projects and monitoring</li> <li>Forage Fish and Fish Habitat metrics are TBD <ul style="list-style-type: none"> <li>Some data collection occurring</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Oysters: Continuation of surveying in future</li> <li>Increased sampling to populate metrics of Forage Fish &amp; Fish Habitat (what, where, when?)</li> </ul>
Toxic Contaminants	<ul style="list-style-type: none"> <li>Various samples taken/analyzed</li> </ul>	<ul style="list-style-type: none"> <li>Increased spatial and temporal sampling of fish toxic sampling</li> <li>Database</li> </ul>
Stream Health	<ul style="list-style-type: none"> <li>Benthic sampling</li> </ul>	<ul style="list-style-type: none"> <li>Additional parameters to be considered for stream health</li> </ul>

# Indicator Development Status

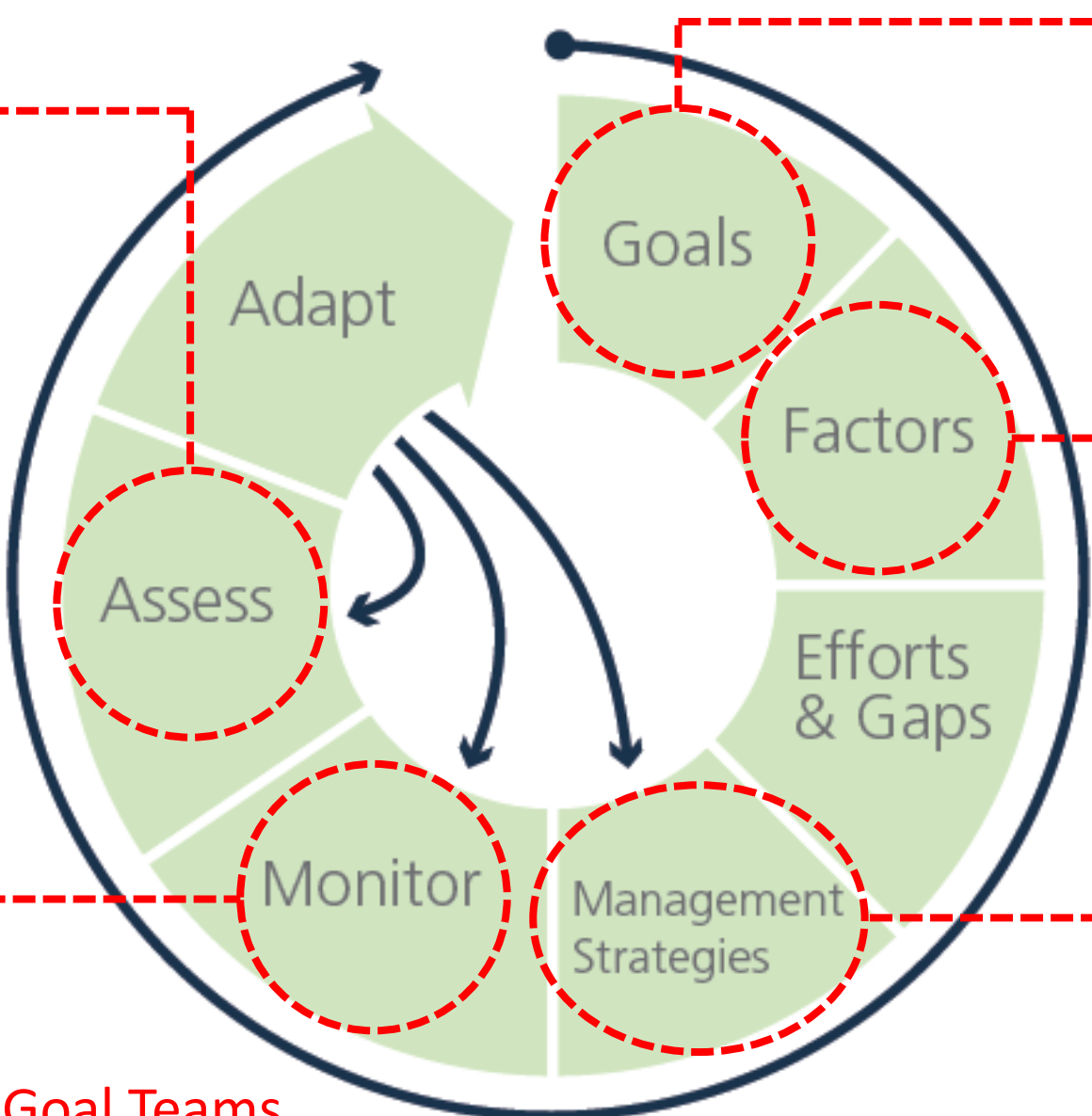
Per each MS (some combined outcomes)

(Summer 2015 M.E.)

Green	Yellow	Red
Fish Passage	Oyster	Forage Fish
SAV	Forest Buffer	Fish Habitat
Water Quality	Tree Canopy	Black Duck
Protected Lands	Brook Trout	Toxic Contaminants Research
Public Access	Environmental Literacy	Toxic Contaminants Policy and Prevention
		Healthy Watersheds
		Citizen Stewardship
Others: Blue Crab, Stream Health, Wetlands, Land Use Options, Land Use Metrics & Methods		Local Leadership
		Diversity
		Climate Resiliency

**Indicators:** *A summary measure that provides information on the state of, or change in, the system that is being measured.*

**STAC** ●  
Performance Assessment.  
Effectiveness of Management Actions.



● **STAC**  
What are the Current Conditions? Identify need for progress.

● **STAC**  
Identify the Impacts of stressors.

**STAR** ●  
Monitoring Network Design to Support Adaptive management.

● **STAR**  
How do we fill Monitoring, Research, and Assessment Gaps? Implementation.

**STAR and STAC Support of Goal Teams**

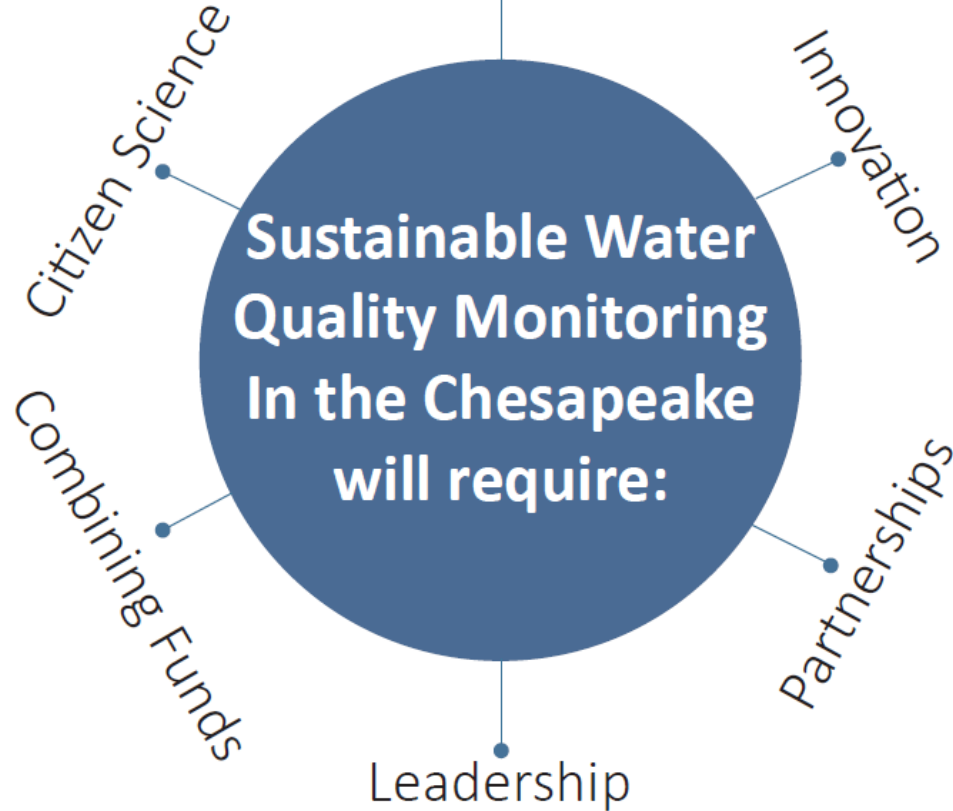
# 14 Operating Principles of the new Bay Agreement include:

- **Collaborate** to achieve the goals and outcomes of the Agreement.
- **Maintain a coordinated watershed-wide monitoring and research program** to support decision-making and track progress and the effectiveness of management actions.
- **Use place-based approaches**, where appropriate, that produce recognizable benefits to local communities while contributing to larger ecosystem goals.
- **Engage citizens** to increase the number and diversity of people who support and carry out the conservation and restoration activities necessary to achieve the goals and outcomes of the Agreement.

# Building Environmental Intelligence



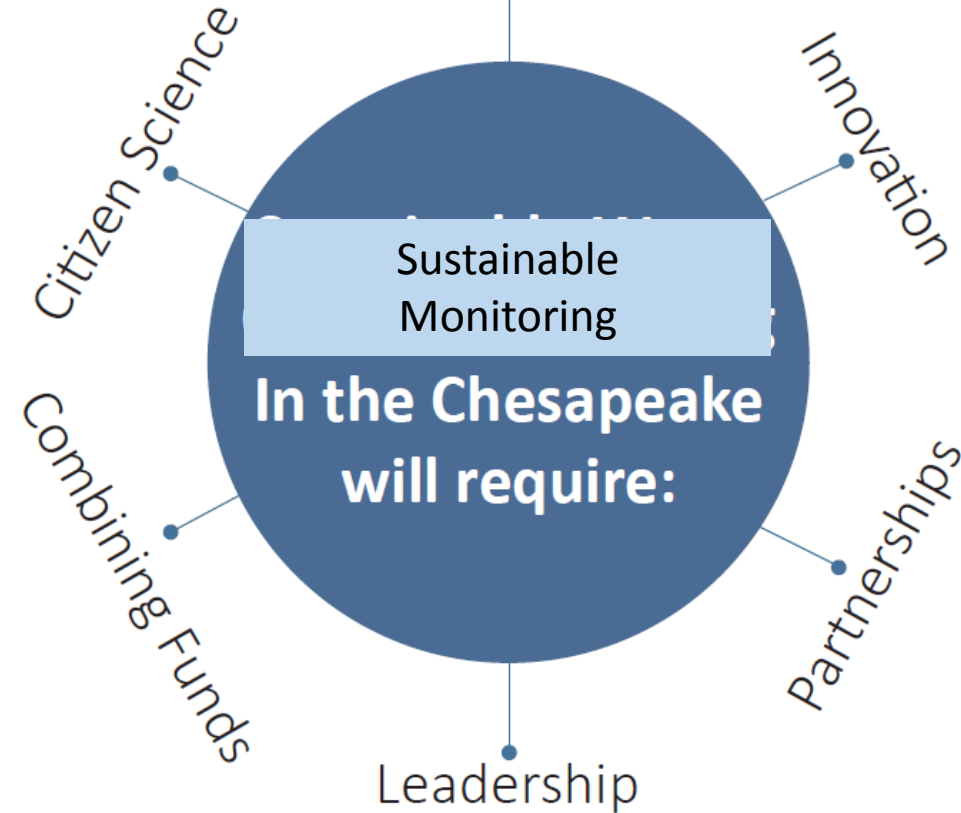
Decision Support



# Building Environmental Intelligence



Decision Support

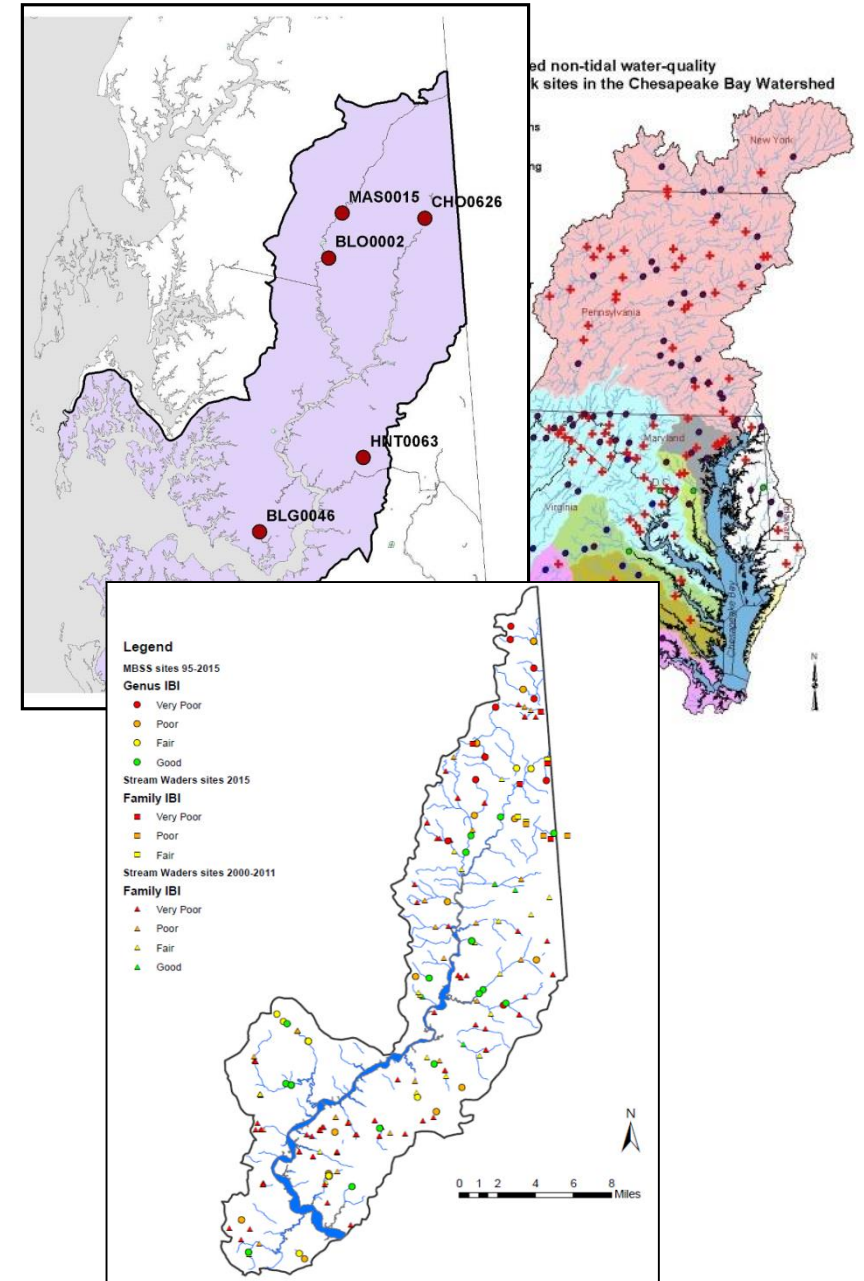


# Agenda

- **Day 1, Session 1 – Common Understanding Phase**

**Overview of Existing Monitoring Networks in the Choptank River Basin related to select Chesapeake Bay Agreement outcomes. (Moderator: Peter Tango)**

- Plenary: Water Quality (*Tom Fisher, UMCES-HPL*)
- Beyond Nutrients: Factors important for understanding, measuring, and tracking non-tidal stream biological condition (*Scott Stranko, MD DNR*)
- SAV in the Bay – Going Beyond the “What” to the “Why” (*Bob Orth and Ken Moore, VIMS*)
- Fisheries (*Bruce Vogt, NOAA*)
- Toxic Contaminants – MDE Fish Tissue Monitoring Program (*Charlie Poukish and Matthew Stover, MDE*)
- EPA Ft. Meade Laboratory Capacities and Opportunities (*Jennifer Gundersen, USEPA*)
- Review: Summary and mapping of monitoring (*Bill Dennison, UMCES-HPL*)



# Agenda

- Day 1, Session 2 – Participatory Challenge Phase: Barriers to Integration Exercise.

***Session 2: Barriers to integration of these networks and initial solutions to overcome barriers. Prioritize and discuss the types of barriers to enhance monitoring integration (Moderator Bill Dennison)***

## Conceptionary and The List:

- Different protocols between programs
- Unaware of what other groups are doing and need
- Different instrumentation limits
- Overcoming vested interest
- “This is how we always do it”
- Lack of aligning objectives
- Establishing the validity of data collected by others
- Lack of rewards to keep people engaged
- Database compatibility



# Agenda

- Day 1, Evening Networking Dinner and Libations



# Agenda

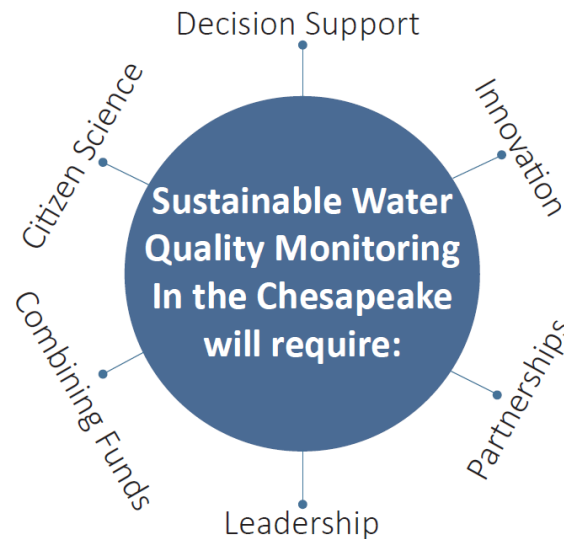
- Day 2, Session 3 – Participatory Action-Solution Phase

## ***Session 3: Opportunities and Solutions to Better Integrating Networks (Moderators: Peter Tango and Mindy Ehrich).***

### Past efforts:

- Urban Waters Monitoring Assets Workshop (2014)
- Farm to Phrag: Eastern Shore Research Network Meeting
- Delmarva Conservation Partnership Meeting (Summer 2015)
- Maryland Water Monitoring Council Roundtable (2016)
- Urban Waters Monitoring Assets Workshop II (2016)

### Applying Principles for Collaboration

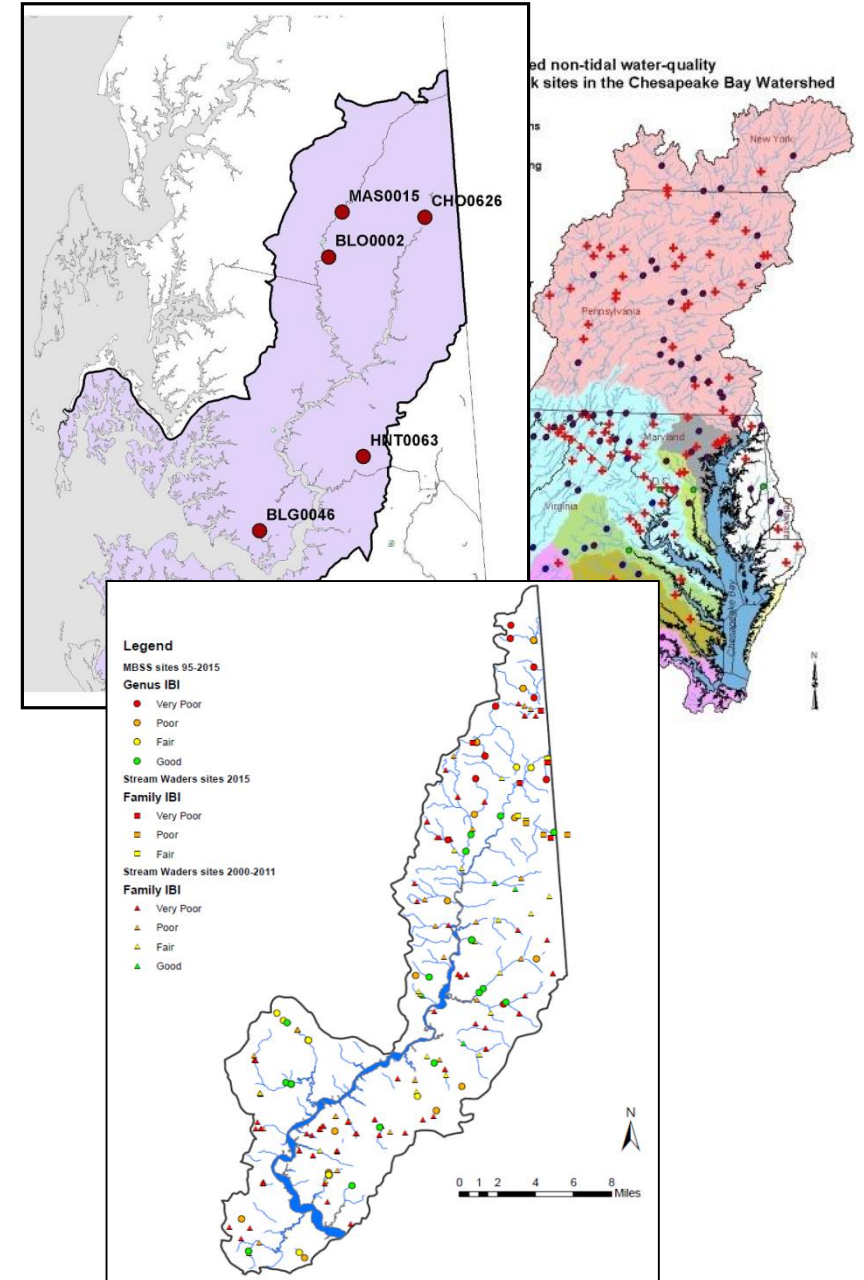


### Implications for Network Integration Actions and Indicator Support

- Analyses to Synthesis
- Ships of Opportunity
- Piggybacking
- Leadership
- New Partnerships

# Agenda

- Day 1, Session 1 – Common Understanding Phase
- Day 1, Session 2 – Participatory Challenge Phase: Barriers to Integration Exercise.
- 
- Day 1, Evening Networking Dinner and Libations
- Day 2, Session 3 – Participatory Action-Solution Phase







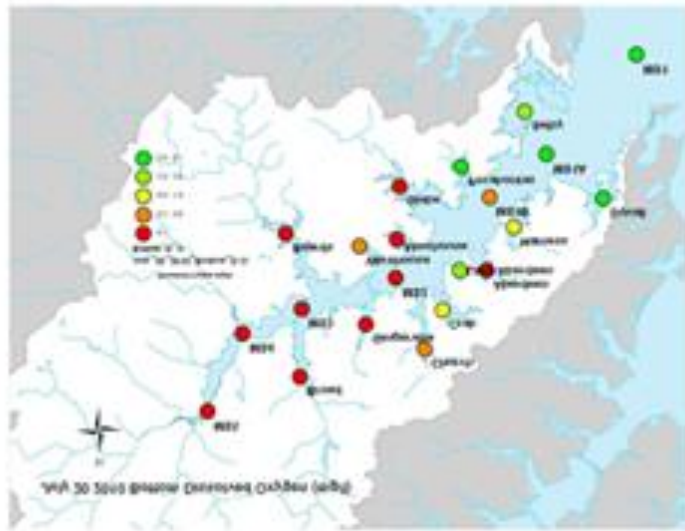
# Agenda

## Different Styles:

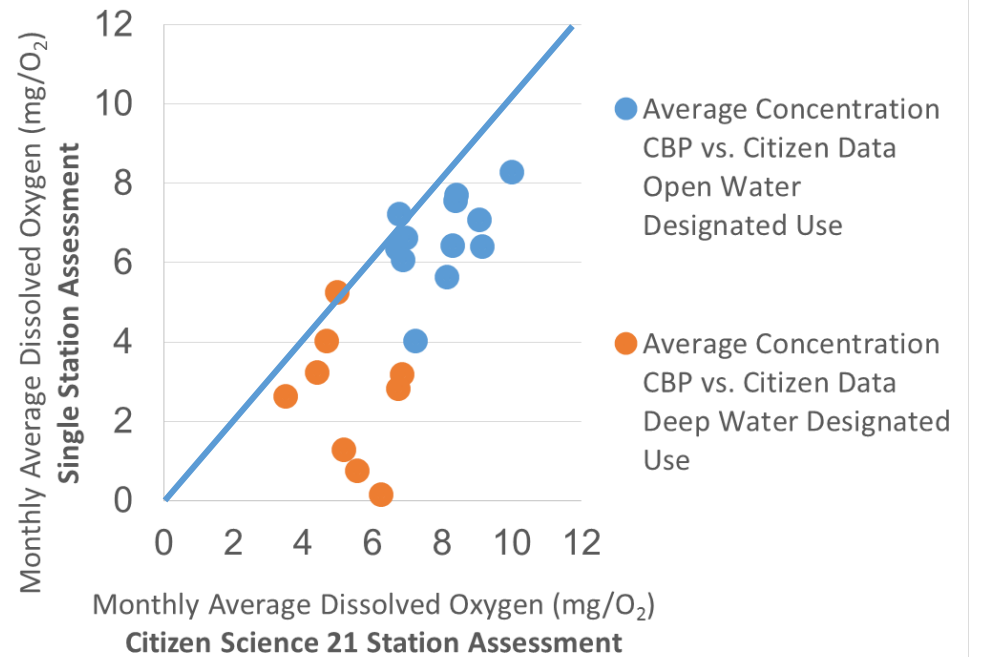
- Streams Roundtable (and the MWMC website)
- Baltimore Roundtable at USGS
- Delmarva Conservation Mtg.
- NOAA Sentinel Site Cooperative
- MARACOOS
- LTER's?
- NAWQA

## Efforts for Choptank:

- Urban Waters Monitoring Assets Workshop (2014)
- Farm to Phrag: Eastern Shore Research Network Meeting
- Delmarva Conservation Partnership Meeting (Summer 2015)
- Maryland Water Monitoring Council Roundtable (2016)
- Urban Waters Monitoring Assets Workshop II (2016)



Comparison of summer monthly average dissolved oxygen conditions of South River 2010-2012 assessed with Chesapeake Bay Program single monitoring station versus Citizen Science-based 21 station assessment.



# Bay Agreement

The outcome indicators will

- Assess status
- Evaluate trends
- Explain patterns

## Oyster:

1. Monitoring success of reef restoration sites
2. Identification of metrics to assess reefs before attaining 'restored' status

## Blue Crab:

3. Update stock assessment
4. Compare gear efficiency between MD and VA
5. Studies of recreational harvests (needed in VA)
6. Account for population changes between winter and summer surveys

## Fish Habitat:

7. Monitoring species in spawning, nursery, and forage areas
8. Develop indicators of fish habitat (fresh and tidal waters)
9. Understand habitat requirements of fish and how habitat conditions affect productivity, health, and function

## Forage Fish:

10. Increased sampling of forage fish in their habitats
11. Zooplankton and phytoplankton monitoring

## All Fisheries:

12. Survey of fish species in shallow waters

## Wetlands:

13. Improve mapping tidal and non-tidal wetlands

## SAV:

14. Funding to continue aerial surveying of SAV

## Brook Trout:

15. Continue sampling of brook trout patches
16. Translation of sampling data into an indicator depicting progress toward the 8% increase in occupied patch area

## Stream Health:

17. Expand metrics of stream health beyond benthic indices (Chessie BIBI)
18. Support for annual update of the stream health indicator

## Black Duck:

19. Guidance on developing a habitat-based indicator

## Water Quality:

20. Select primary indicators of progress toward the TMDL and attainment
21. Conduct Mid-Point Assessment (enhance models and explain trends)

## Toxic Contaminants:

22. Toxic concentration sampling, especially PCBs in fish tissue
23. Sources and loadings of PCBs to the Bay and in watershed
24. Guidance on displaying changing status PCBs in the system
25. How can we integrate toxic contaminant reductions through multi-benefits of water-quality BMPs for TMDL?

## Healthy Watersheds:

26. Formation of a cross-GIT tracking workgroup to track health of the state-identified healthy watersheds in future: identify metrics

## Land Use:

27. Guidance on the best use of review/study determining the range of policy options and tools to reduce land conversion & repository of these results
28. Assessing the impacts of land conversion on water quality, healthy watersheds and communities

## Citizen Stewardship:

29. Funding for continued surveying for the newly developed citizen stewardship index

## Environmental Literacy:

30. Analysis and statistical support with completed school district survey results

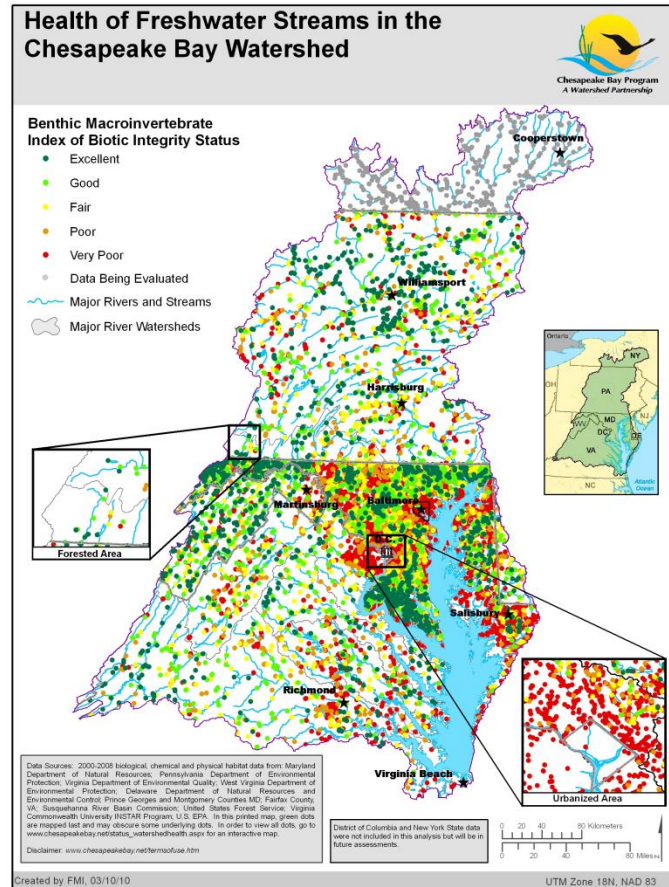
## Local Leadership:

31. Guidance on establishing a baseline of local leadership knowledge of water resources.

# Monitoring Expansion Necessary

Environmental Literacy  
Toxic Contaminants  
Brook Trout  
Water Quality  
Fish Habitat  
Land Use Forage Fish  
Oyster Blue Crab  
Wetlands Stream Health  
Healthy Watersheds  
Black Duck Local Leadership  
SAV  
Citizen Stewardship

# Analytical Collaborations on Indicators



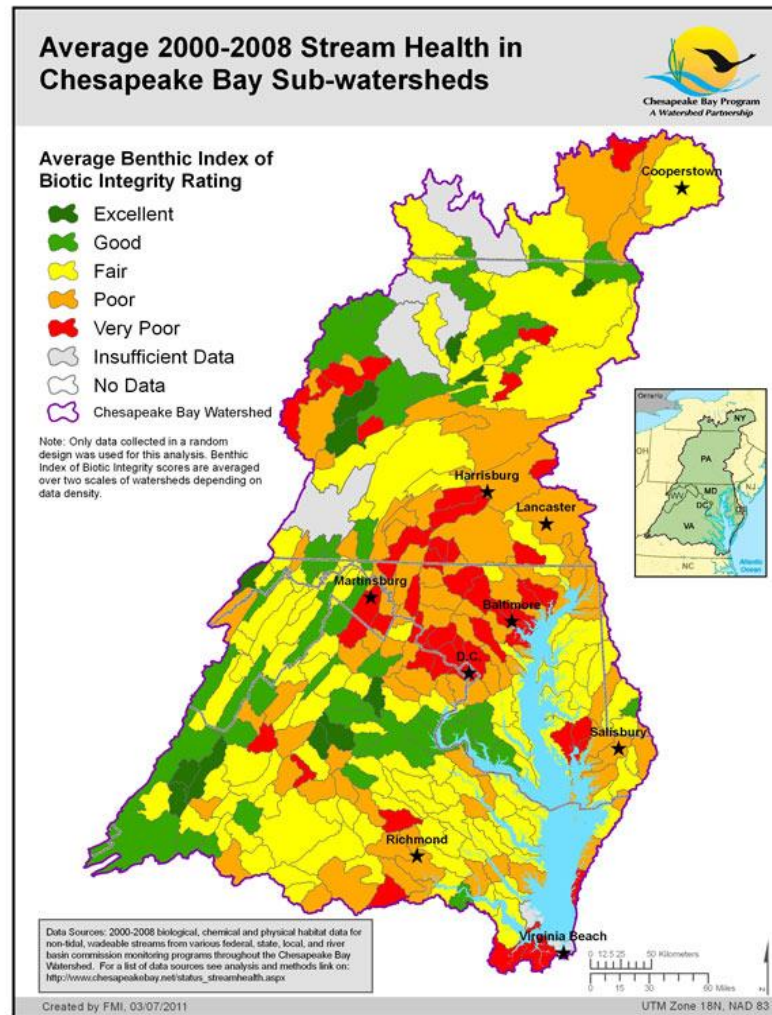
## Data providers :

DE Biological Monitoring Program  
Fairfax Co. (VA) Stream Quality Assessment Program  
Frederick Co. (MD)  
Howard Co. (MD) Bio-Monitoring and Assessment Program,  
Loudoun Co. (VA) Stream Quality Assessment Program,  
Montgomery Co. (MD) Stream Protection Program,  
MD Biological Stream Survey,  
NY Routine Statewide Monitoring Program,  
PA Surface Water Monitoring Programs,  
Prince Georges Co (MD) Biological Assessment  
and Monitoring Program,  
SRBC Watershed Assessment Program,  
EPA EMAP Wadeable Stream Assessment,  
EPA Mid-Atlantic Highlands Assessment,  
National Forest Service Stream Assessment,  
USGS National Water Quality Assessment Program,  
Virginia DEQ Benthic Monitoring Program,  
V CUs Interactive Stream Assessment Resource Program,  
WV Watershed Monitoring Program.

“Measles Map”

Creative management product development with  
diverse data sources

# Bay Watershed Health Indicators



Buchanan et al. 2010. Acknowledgements

"An adhoc CBP workgroup created to guide development of the Chessie B-IBI consisted of benthic macroinvertebrate experts from the six states in the watershed (New York, Pennsylvania, Maryland, Virginia, West Virginia, and Delaware) as well as federal, academic, and River Basin Commission partners. The authors wish to give special thanks to the members of the adhoc workgroup for their diligence in providing technical guidance and feedback: A.J. Smith (NYDEC), Aimee Budd (VADEQ), Bill Richardson (US EPA Region 3), Brian Chalfant (PADEP), Charlie Poukish (MDE), Dan Boward (MD DNR), Ed Reilly (NYDEC), Ellen Dickey (DNREC), Greg Garman (VCU), Greg Pond (US EPA Region 3), Hassan Mirsajadi (DNREC), Jeff Bailey (WVDEP), Jen Hoffman (SRBC), John Wirts (WVDEP), Kevin McGonigal (SRBC), Maggie Passmore (US EPA Region 3), Mike Fritz (EPA-CBPO), Nita Sylvester (EPA-CBPO), Peter Tango (USGS-CBPO), Rick Hoffman (VADEQ), Rod Kime (PADEP), Ron Klauda (MD DNR), Scott Stranko (MD DNR), Tony Prochaska (MD DNR), and Wayne Davis (EPA). Other members of the Chesapeake Bay Program's Non-Tidal Water Quality Workgroup as well as the Indicator Workgroup provided input on final presentation of the results."

Furthering product development: status and targeting map

Watershed Organizations - Google Maps - Windows Internet Explorer

http://maps.google.com/maps?f=q&source=s\_q&hl=en&geocode=&q=http://archive.chesapeakebay.net/%2Fgeo/

File Edit View Favorites Tools Help

Watershed Organizations - Google Maps

Web Images Videos **Maps** News Shopping Gmail more

Sign in

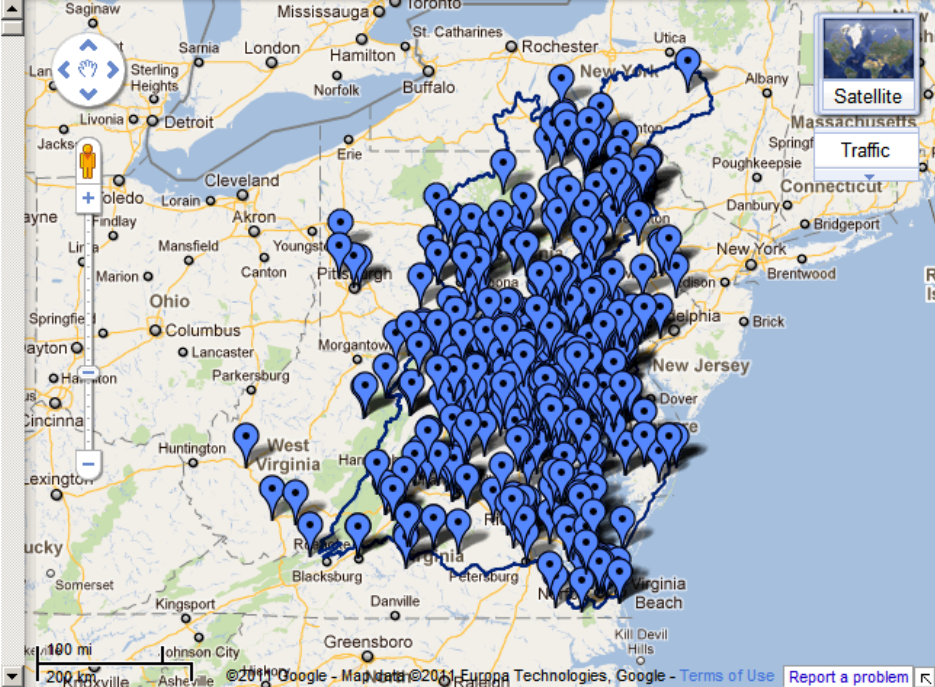
Google maps <http://archive.chesapeakebay.net/geo/WatershedOrgs1019> Search Maps

Get Directions My places View in Google Earth Print Send Link

Displaying content from [archive.chesapeakebay.net](http://archive.chesapeakebay.net)  
The content displayed below and overlaid onto this map is provided by a third party, and Google is not responsible for it. Information you enter below may become available to the third party.

Watershed Organizations

- Watershed Organizations
- 1000 Friends of Maryland
- Accokeek Foundation
- Adams County Conservation District
- Alexandria Seaport Foundation
- Alice Ferguson Foundation
- Allegany Soil Conservation District
- Alliance for Aquatic Resource Monitoring
- Alliance for the Chesapeake Bay
- American Canoe Association
- American Chestnut Land Trust, Inc.
- American Fisheries Society



Done

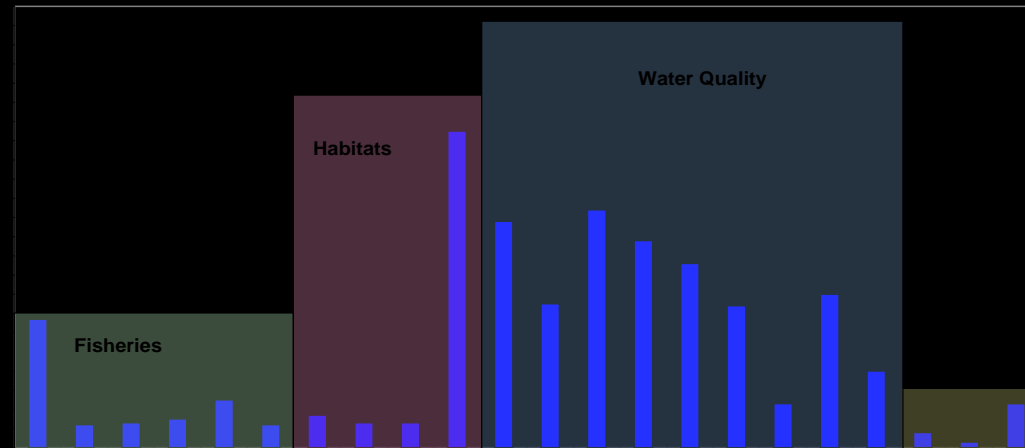
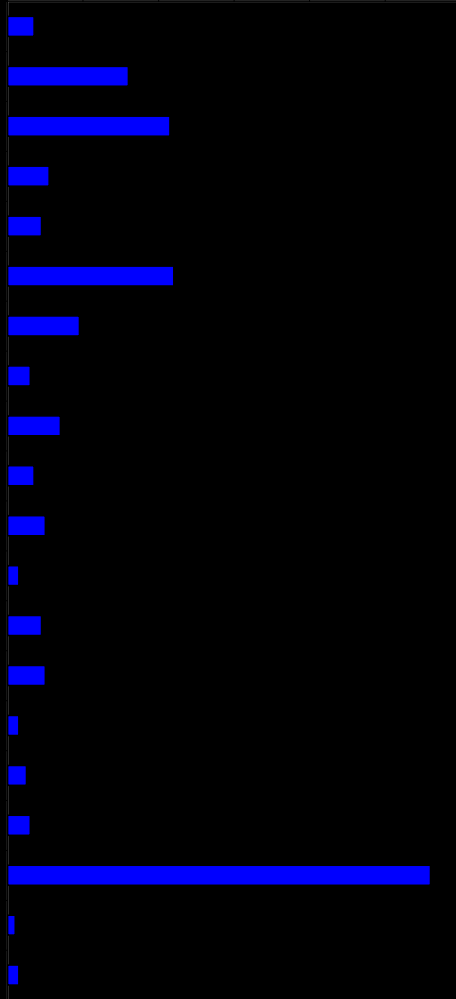
Start 8 Microsoft Offi... 4 Microsoft Offi... Partnership repor... Map of the envir... Find a Watershe... Watershed Org... 12:04 PM

Over 600 Watershed Organizations and counting!

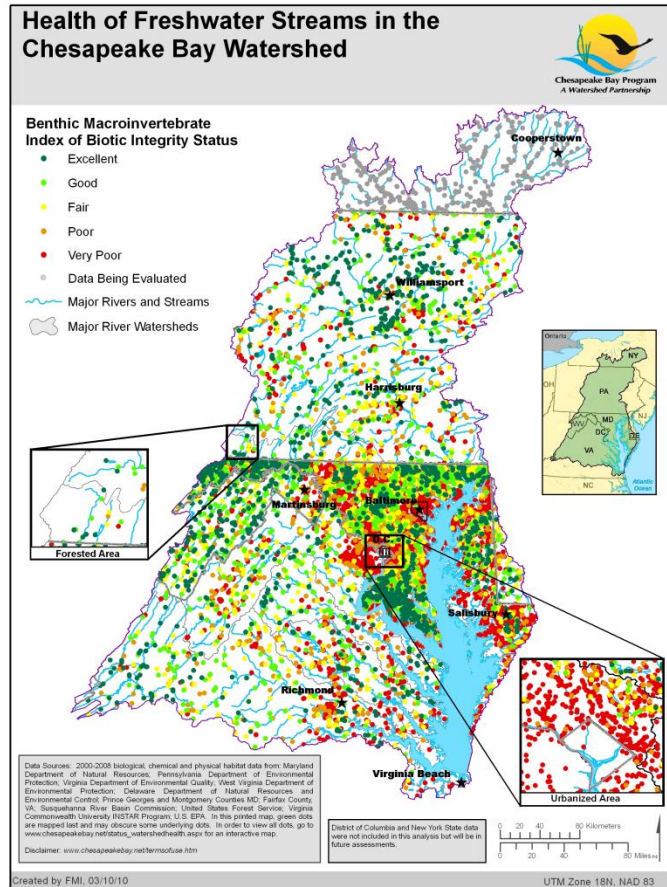
<http://www.chesapeakebay.net/findabaygroup.aspx?menuitem=14797>

# Monitoring Realignment 2009 Partnering Workgroup findings:

*295 monitoring programs identified in the watershed and counting!*



# Bay Watershed Health Indicators



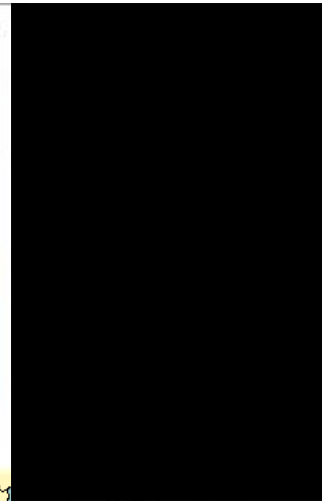
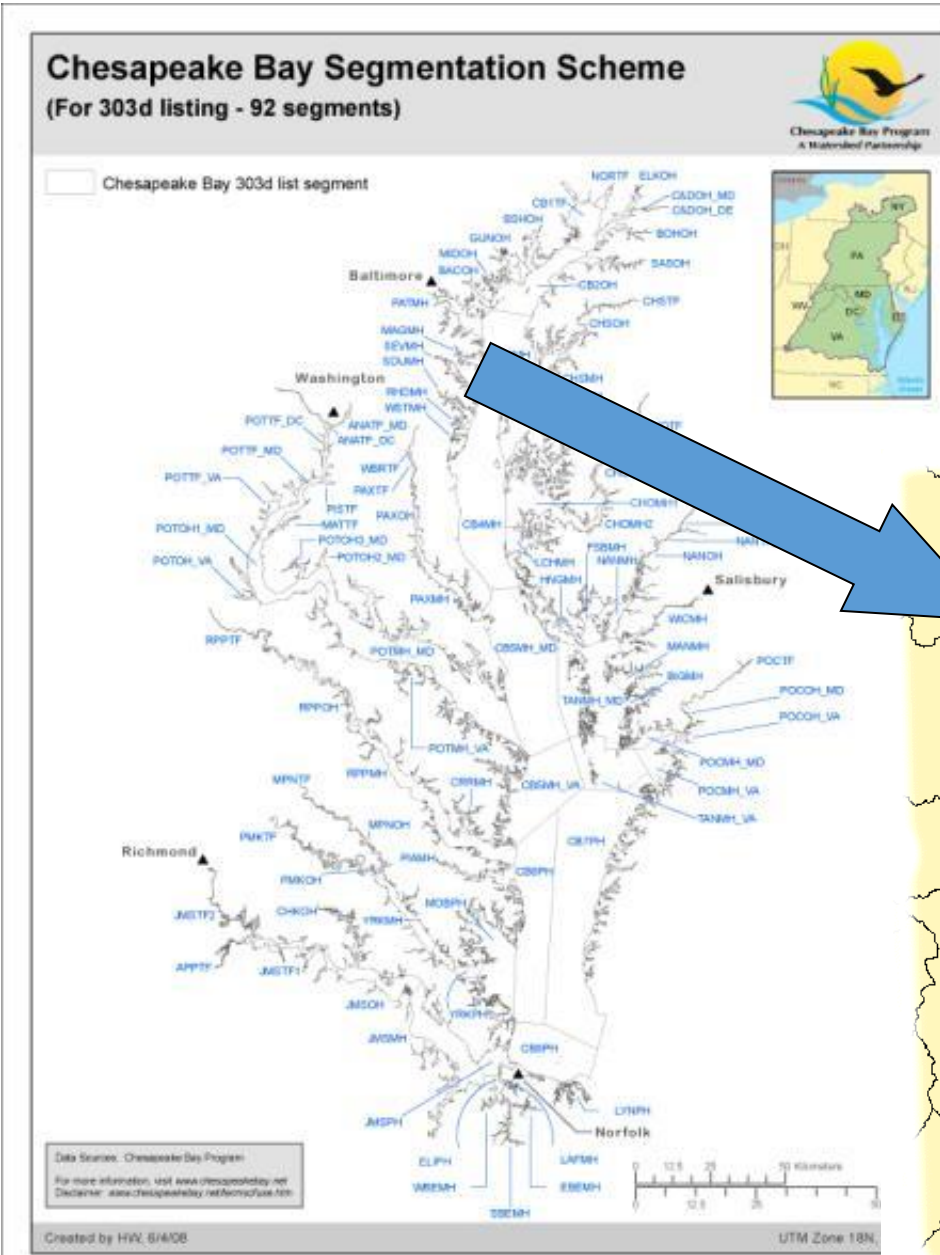
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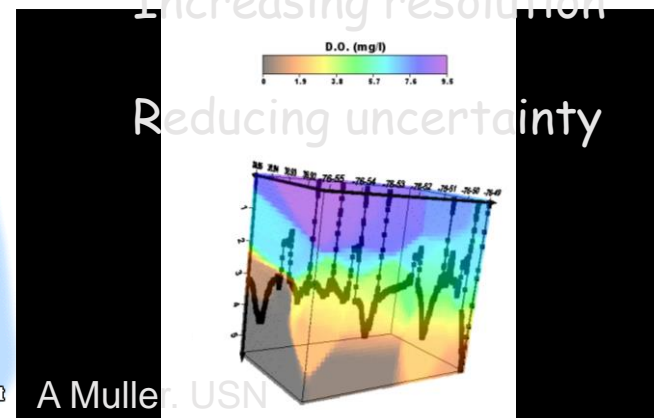
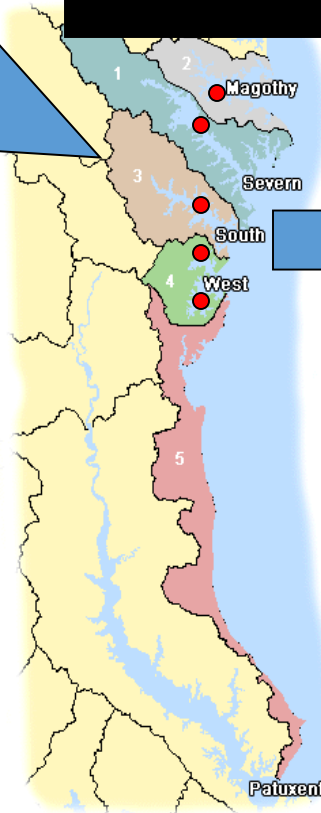
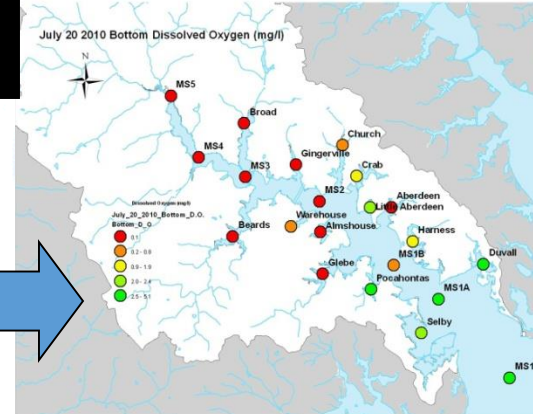
“Measles Map”

Creative management product development with diverse data sources

# Maryland is piloting work for Regulatory Assessments: South River Federation



## South River Federation





# We have regional examples of collaborations

- Chessie BIBI
- MBSS using trained volunteers for sampling, sometimes analysis
- Pfiesteria monitoring involved extra samples collected at water and fish monitoring locations for plankton community analyses, genetics analyses, toxin analysis and more.
- LTERs (VA Coast Reserve, Baltimore Ecosystem) – a fundamental principle of LTERs is that studies provide infrastructure upon which related studies can build.
- NERRs – Water quality and weather stations
- MARACOOS – 5 themes supported by the integrated networks

# What We Need-> Increased Collaboration and Barrier Removal

## More Specific Needs Identified

- What Metrics Needed?
- Where?
- When/how frequently need the sampling?
- What species? What size?

## Where can we combine efforts to enhance monitoring and support improved environmental intelligence gathering?

- Sharing objectives
- Alternative sampling technology
- Additional sampling resources

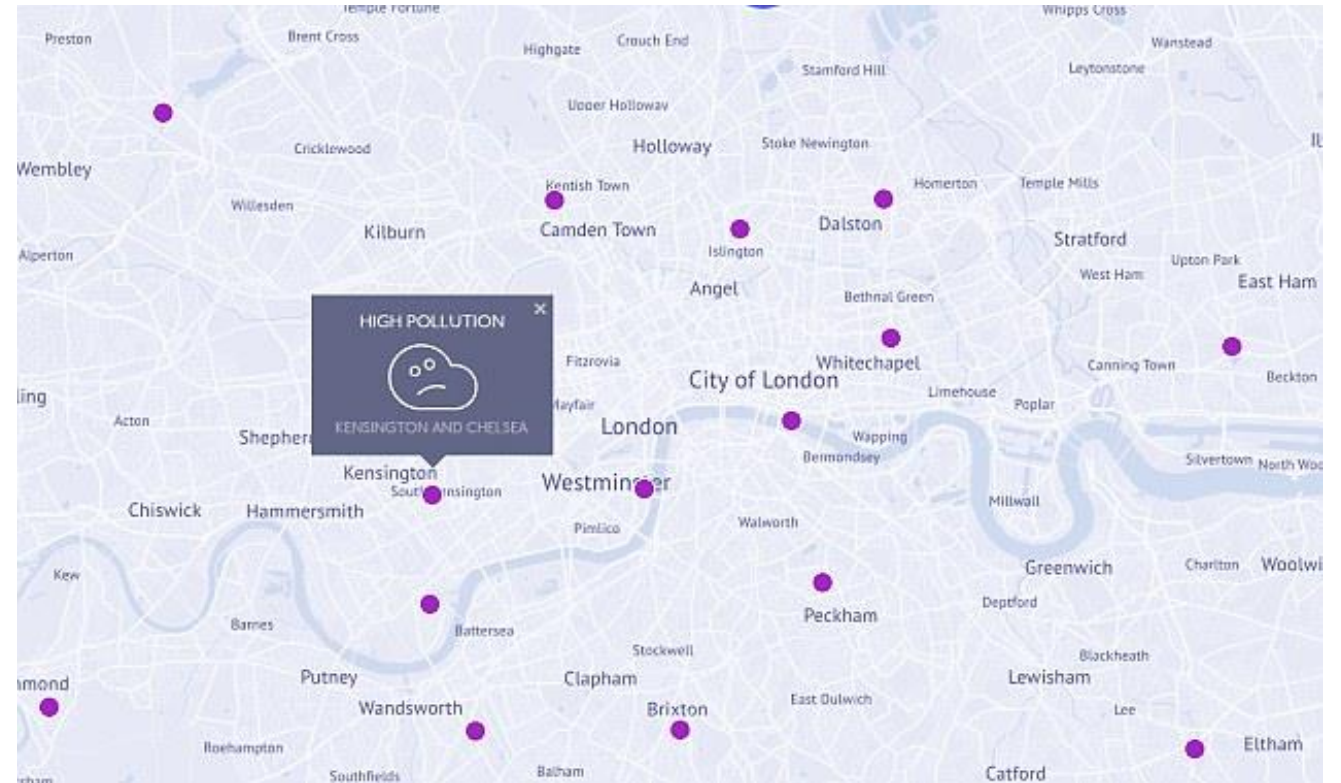
# The Workshop Agenda

- Review infrastructure and programs on a select subset of Bay Agreement goals and outcomes.
- Identify approaches to overcoming barriers
- Gaining commitments to combining efforts
- Highlighting where and how we can increase spatial and temporal resolution to monitoring networks.
- Identifying what additional parameters might be sampled and processed for (e.g. supporting “Factors Affecting Trends” analysis needs)
- Product – recommendations on an integrated regional monitoring program that integrates across two or more programs today.

# Pigeon Air Patrol! Air pollution monitoring



© DigitasLBI



London, UK, 2016

## Ships of opportunity

### FerryMon: Ferry-Based Monitoring and Assessment of Human and Climatically Driven Environmental Change in the Albemarle-Pamlico Sound System†

HANS W. PAERL\*  
KAREN L. ROSSIGNOL  
RODNEY GUAJARDO  
NATHAN S. HALL  
ALAN R. JOYNER  
BENJAMIN L. PEIERLS

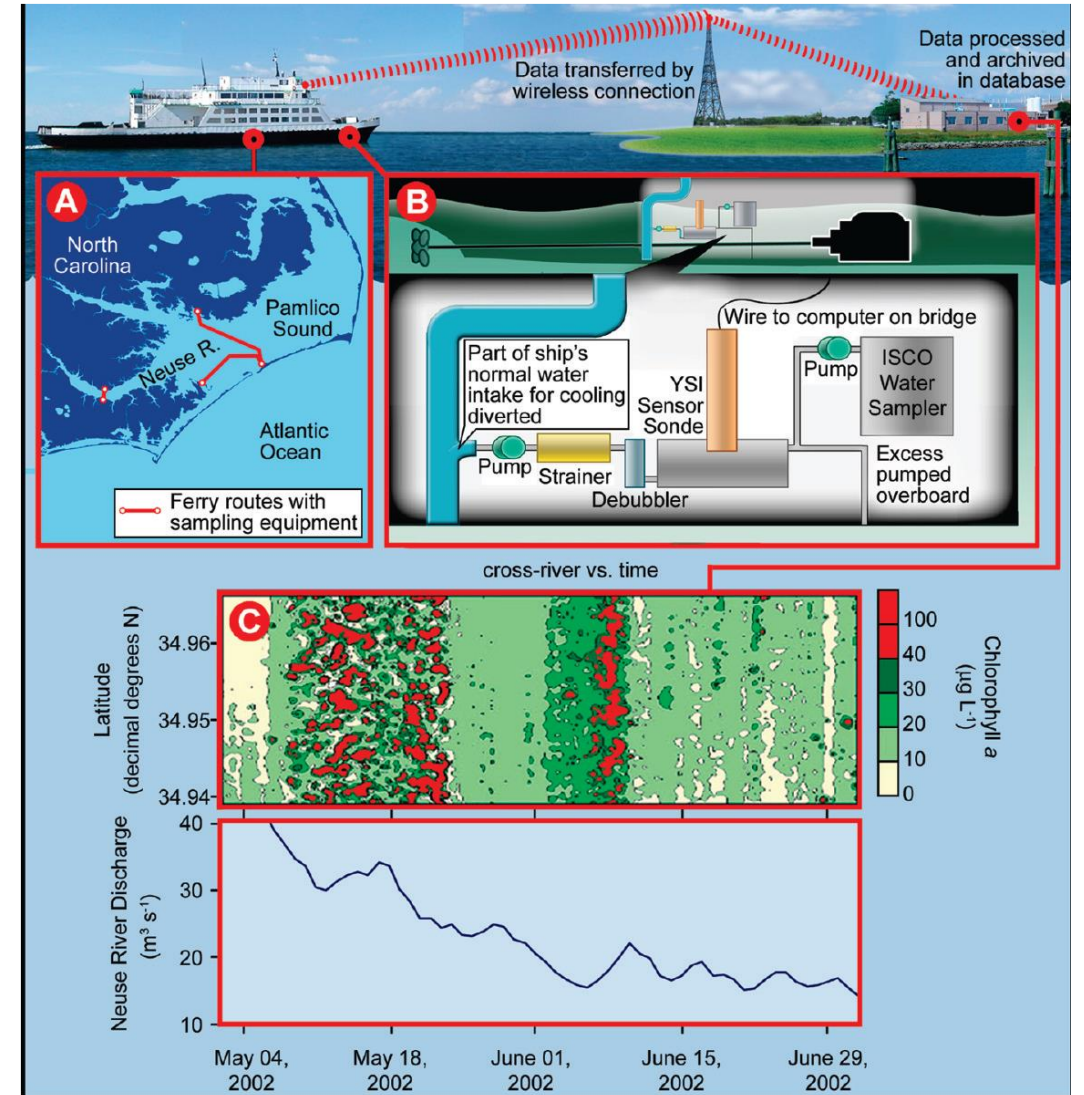
*Institute of Marine Sciences, University of North Carolina at Chapel Hill*

JOSEPH S. RAMUS  
*Duke University Marine Laboratory*

ES&T, 2009. 43:7609-7613

Data uses include:

- Event based monitoring
- Remote sensing ground truthing
- Chlorophyll a criteria assessments



# Adding Tech to Ships of Opportunity

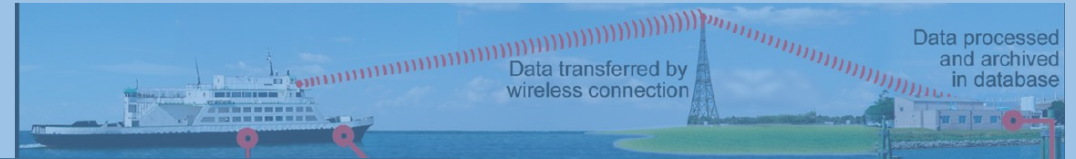
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JOSEPH S. RAMUS  
*Duke University Marine Laboratory*

ES&T, 2009. 43:76

Data uses include:

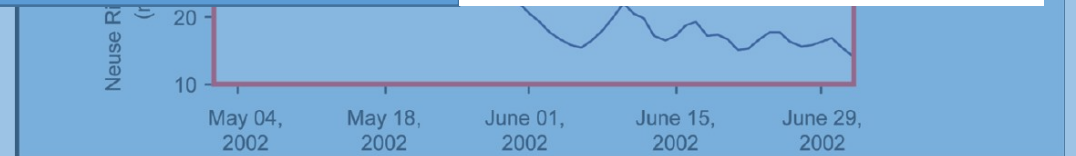
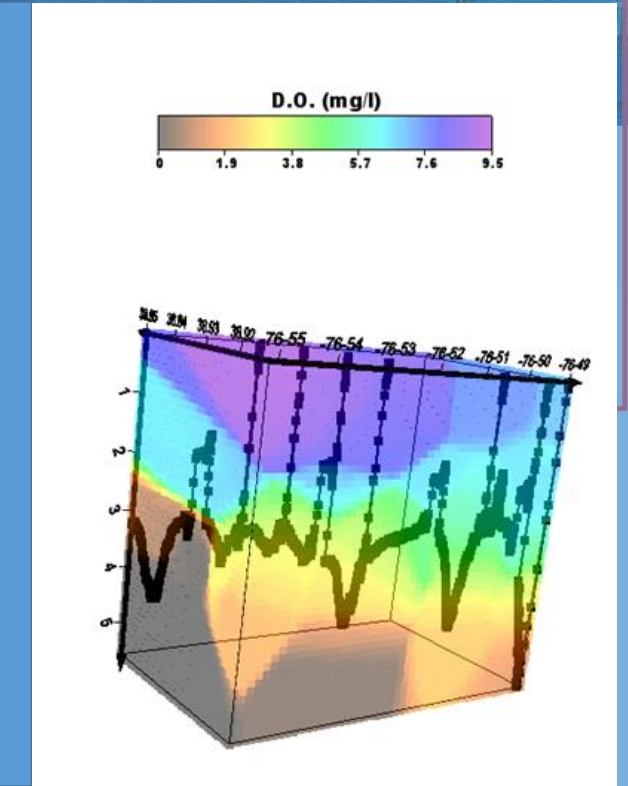
- Event based monitoring
- Remote sensing ground truthing
- Chlorophyll a criteria assessments



Summer on Chesapeake Bay



Just a few boats...



# Piggybacking Activities: Adding analytes to network activities. Multnomah Co, OR.

Moss samples collected across Portland, OR = 346 in 2013



Estimated cadmium concentrations

Search for an address

Risk

- Above 30 (Cancer risk >50 in 1 million)
- 10-30 (Cancer risk 20 to 50 in 1 million)
- 5-10 (Cancer risk 9 to 20 in 1 million)
- 0.6-5 (Cancer risk 1 to 9 in 1 million)
- Below 0.6 (Cancer risk < 1 in 1 million)

About

Cancer risks listed here assume exposure for 24 hours a day 7 days per week for a 70 year lifetime and that air concentrations estimated for October 2015 are constant over that exposure time. Actual exposures that are shorter duration or frequency mean lower risk than what is presented here.

This map is not exact or precise. It uses a limited data set from October 2015 to correlate cadmium air concentrations with concentrations in moss, an approach to mapping air pollutants that is new and still developing. People should expect updates and changes to this map over time as DEQ collects additional data and the approach to

Boise-Eliot/Humboldt K-8

Uroboros Glass

Bullseye Glass Co.

Portland

esri

MRLC, Bureau of Land Management, State of Oregon,...

4:54 PM 4/5/2016

Moss samples collected across Portland, OR = 346 in 2013



http://multco.maps.arcgis.com/apps/SimpleViewer/index.html?app

### Estimated cadmium concentrations

Search for an address

**Risk**

- Above 30 (Cancer risk >50 in 1 million)
- 10-30 (Cancer risk 20 to 50 in 1 million)
- 5-10 (Cancer risk 9 to 20 in 1 million)
- 0.6-5 (Cancer risk 1 to 9 in 1 million)
- Below 0.6 (Cancer risk < 1 in 1 million)

**About**

Cancer risks listed here assume exposure for 24 hours a day 7 days per week for a 70 year lifetime and that air concentrations estimated for October 2015 are constant over that exposure time. Actual exposures that are shorter duration or frequency mean lower risk than what is presented here.

This map is not exact or precise. It uses a limited data set from October 2015 to correlate cadmium air concentrations with concentrations in moss, an approach to mapping air pollutants that is new and still developing. People should expect updates and changes to this map over time as DEQ collects additional data and the approach to

Boise-Eliot/Humboldt K-8  
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Portland

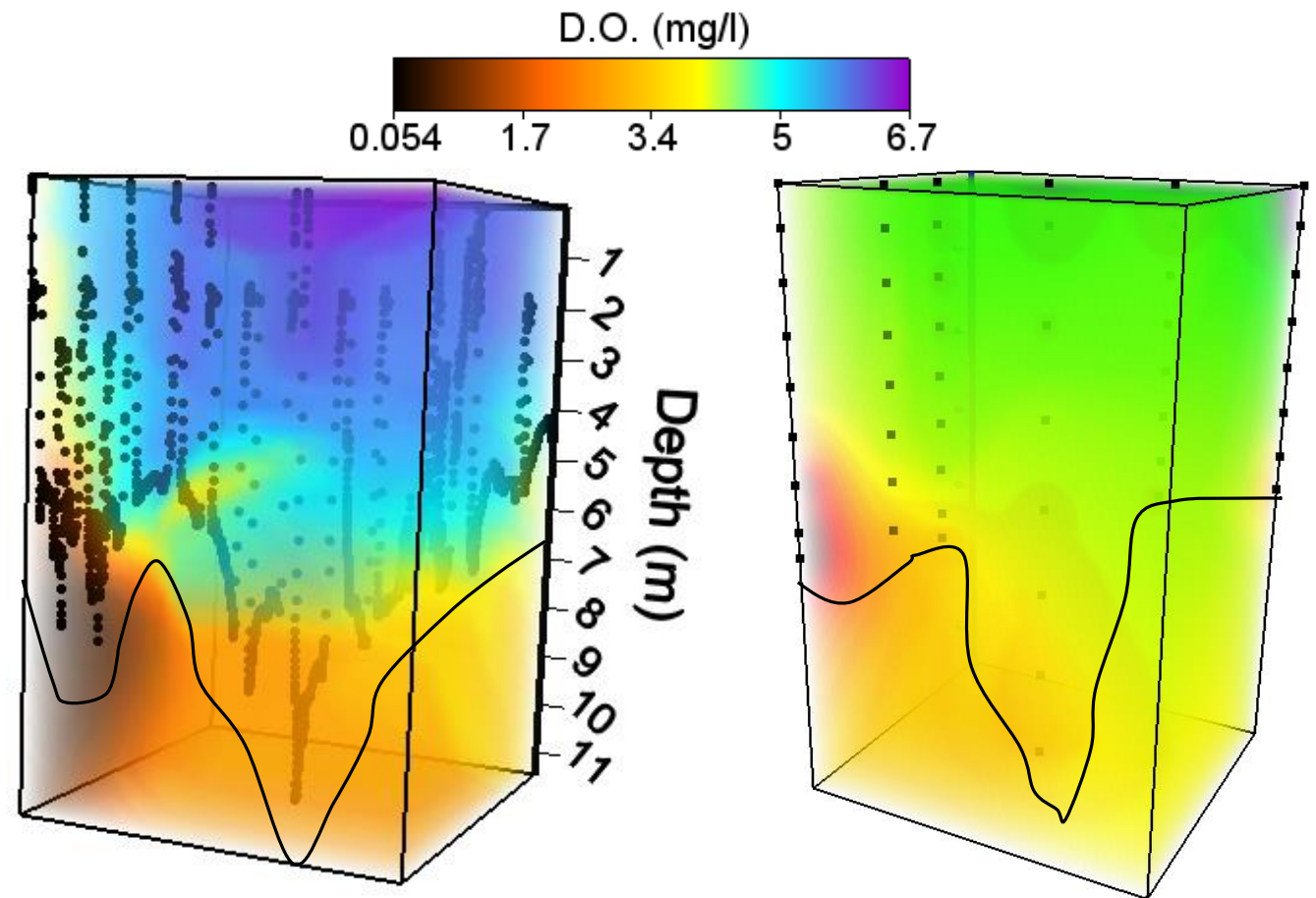
MRLC, Bureau of Land Management, State of Oregon, esri

4:54 PM 4/5/2016

# Innovation



*Credit: UC Santa Barbara*



REMUS 100 AUV (6-8 AM)

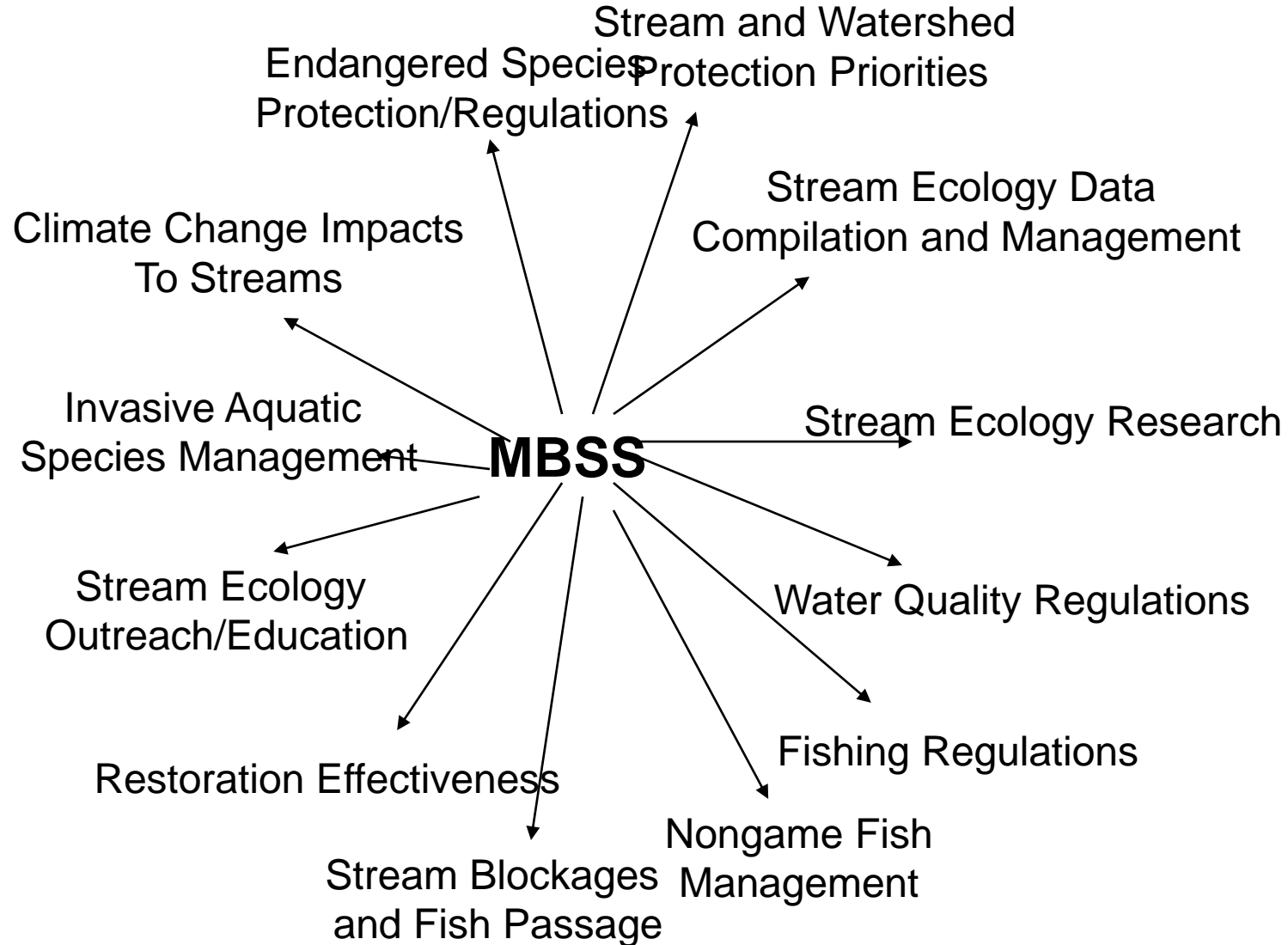
*Credit: U.S. Naval Academy*

Severn River Keeper weekly  
monitoring (8 AM – 2 PM)

- Improved interpretation of the monitoring information
- Efficiencies in monitoring



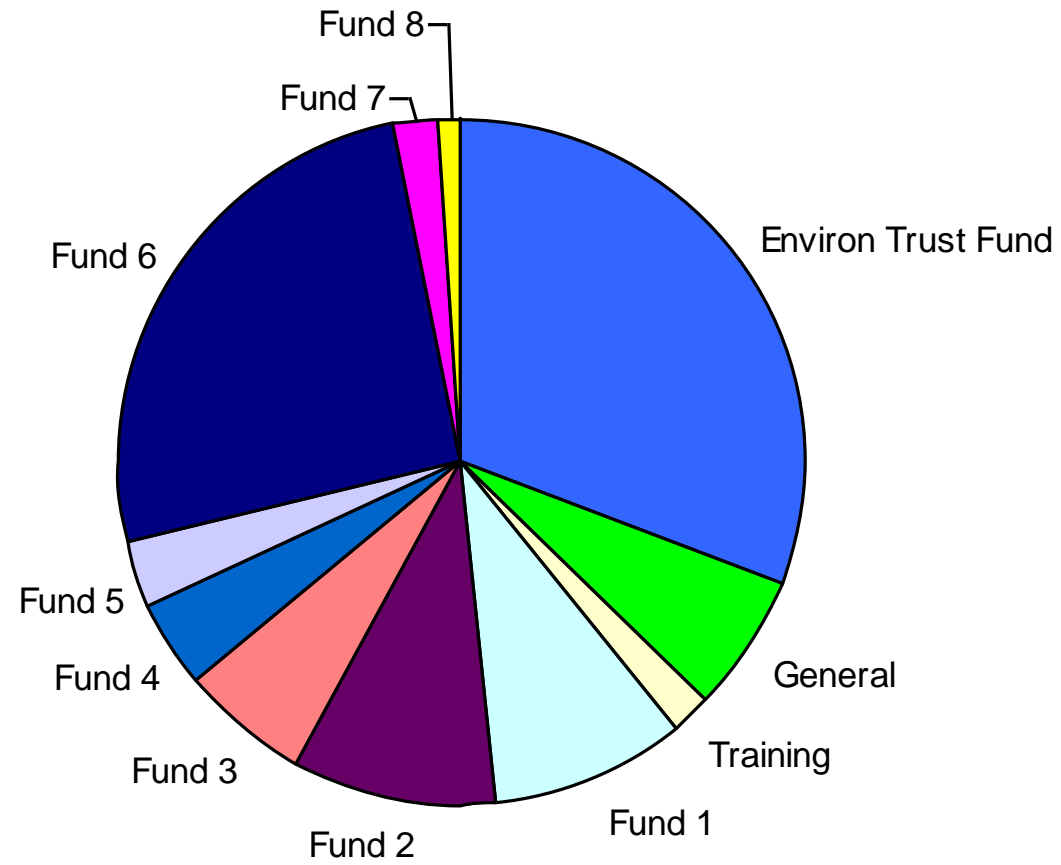
# MBSS Information/Data Used to Support Regulations and Policies



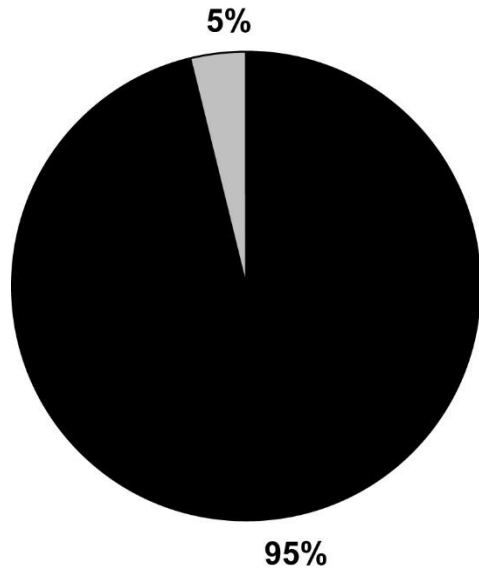
# MBSS Funding

- 1995 Funding for MBSS = 100% General and Special Funds
- 2014 Funding = 41% General and Special Funds and 59% Grants
- Total of about 12 funding sources for 2014

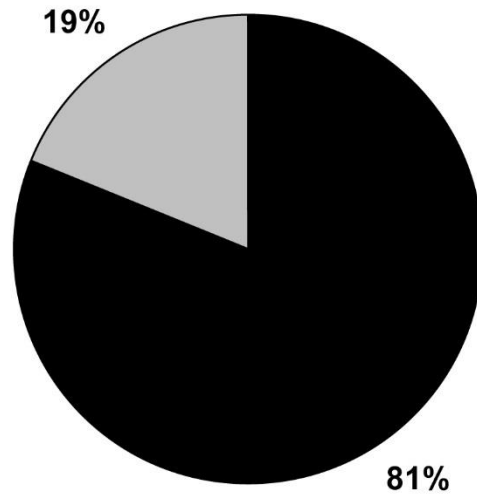
# MBSS Budget 2015



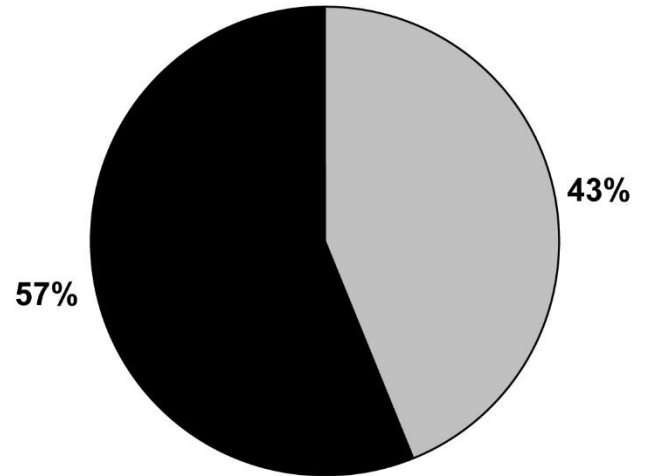
# MBSS: Sample Design Evolution



**Round 1**  
**(1995 - 1997)**



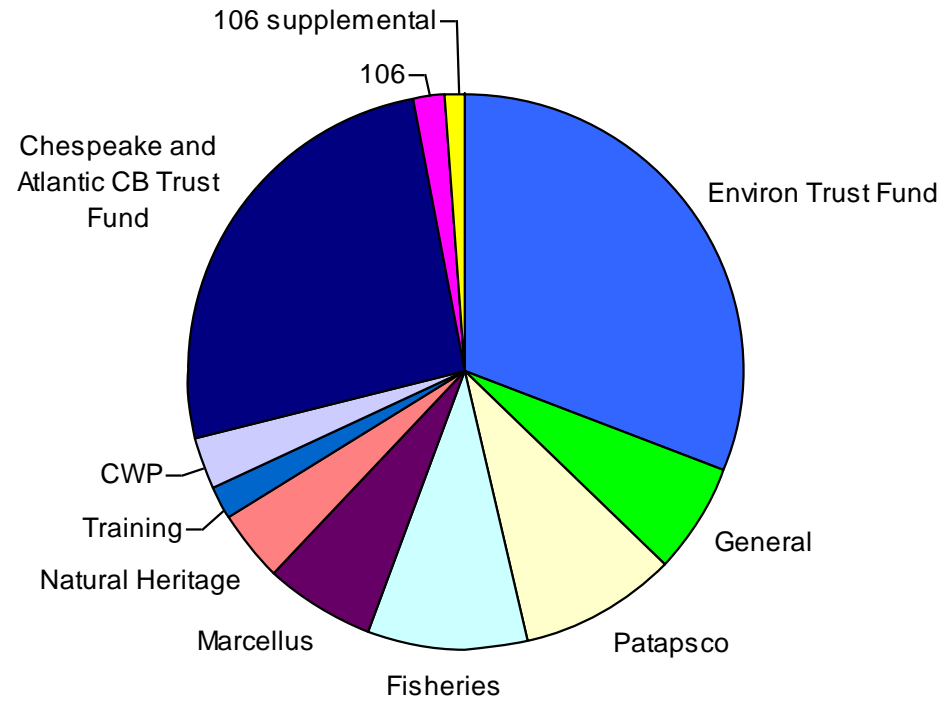
**Round 2**  
**(2000 - 2004)**



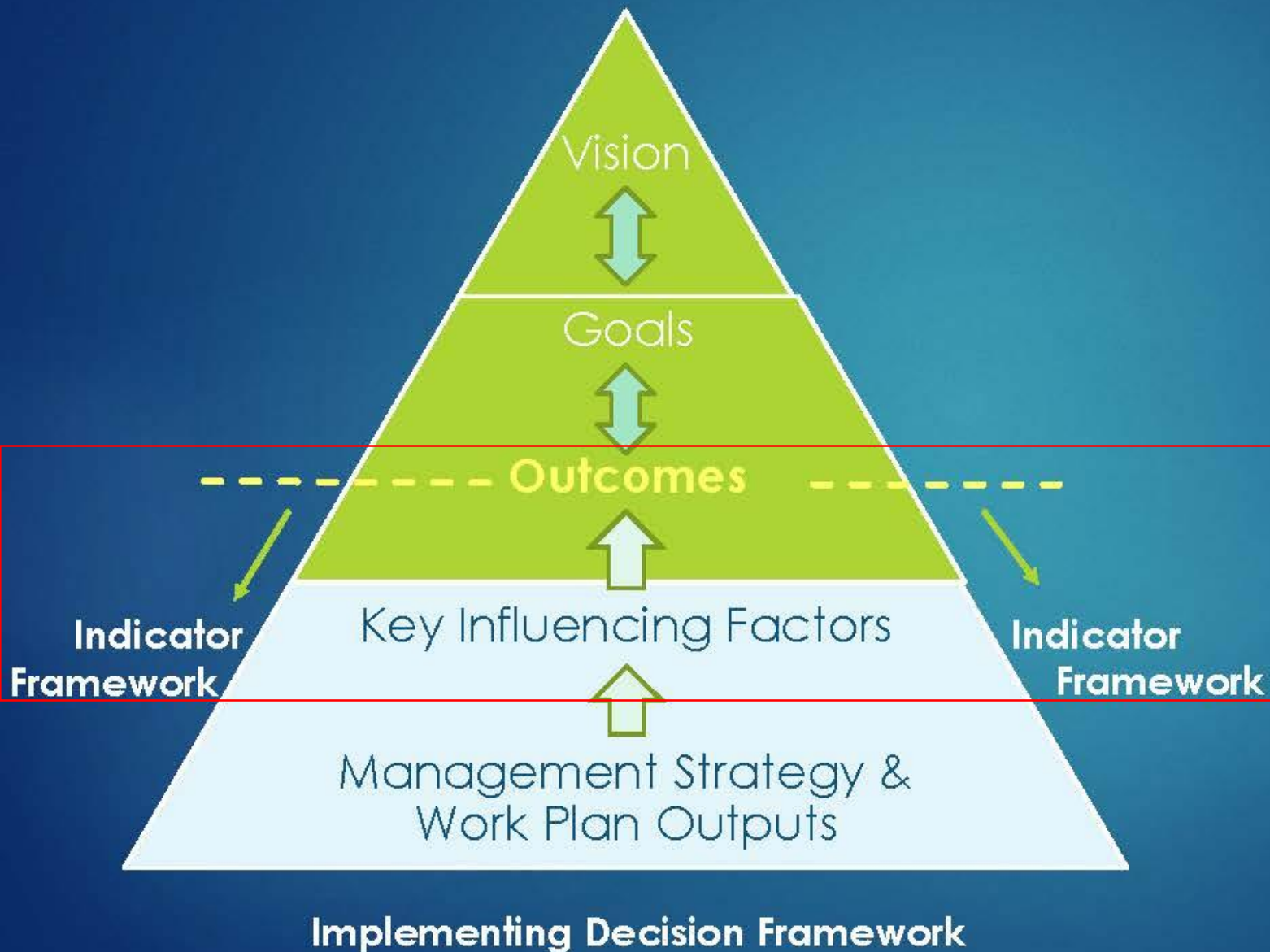
**Round 3**  
**(2007 - 2009)**



# MBSS Budget



# Aligning with the Agreement



**FINDING:** The NEW Indicators Framework is **ALIGNED** with the Agreement at the Outcome level.

**Agreement GOALS** that support achieving the **VISION** flow from the Vision and are aligned with the mission of the CBP.

**Agreement OUTCOMES** are those aligned with the CBP mission, programs and resources and support achieving the Goal.

**Outcomes are achieved through implementing the Decision Framework.**

# Examples of the Creativity of our Monitoring Community

- Analyses: Stream Health Indicator

