The Chesapeake Bay Program Partnership's Long-term Water Quality Monitoring Program: Supporting Assessment, Synthesis, Science and Communications

Peter Tango, USGS at Chesapeake Bay Program Office

National Water Quality Monitoring Conference

Tampa, FL

May 5, 2016

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Chesapeake Bay Program
A Watershed Partnership

Outline

- Assessment
- Science
- Synthesis
- Communication
- Management linkages to our regional monitoring programming

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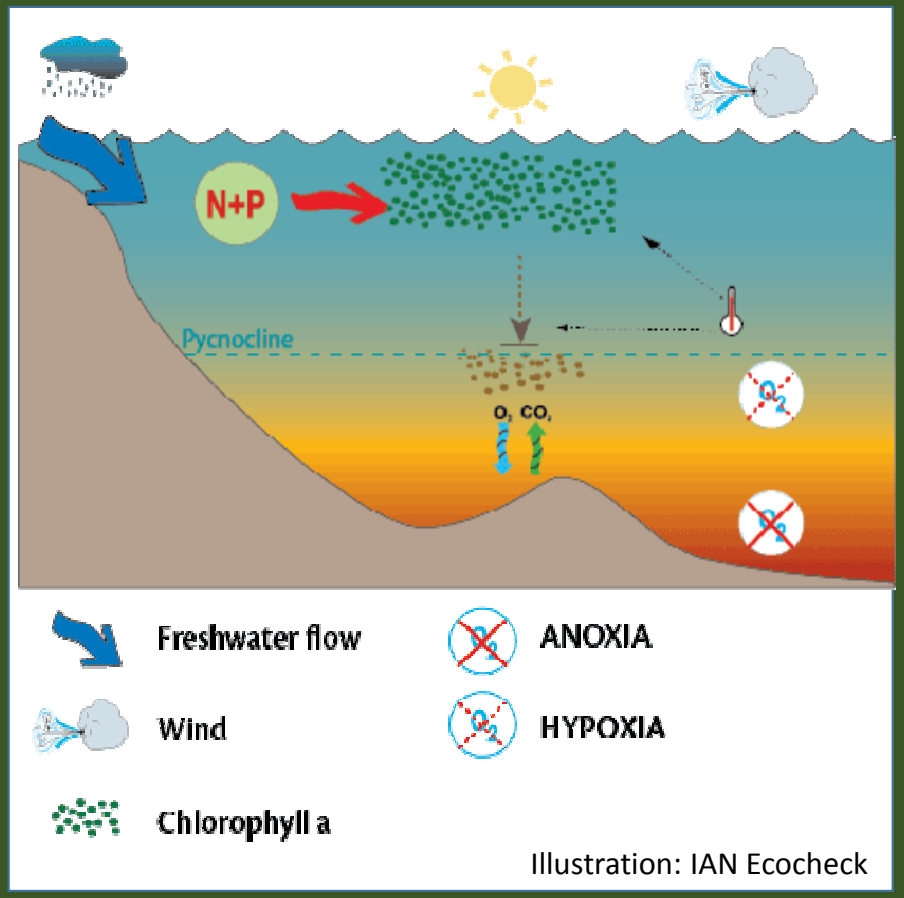
Conceptual Model of Chesapeake Bay Water Quality

Climate Forcing

External Loads



Bay Conditions and Processes

- Physical
- Chemical
- Biological

Conceptual models define our universe, the issues, and provide the framework for supporting the monitoring program structure and assessment strategies

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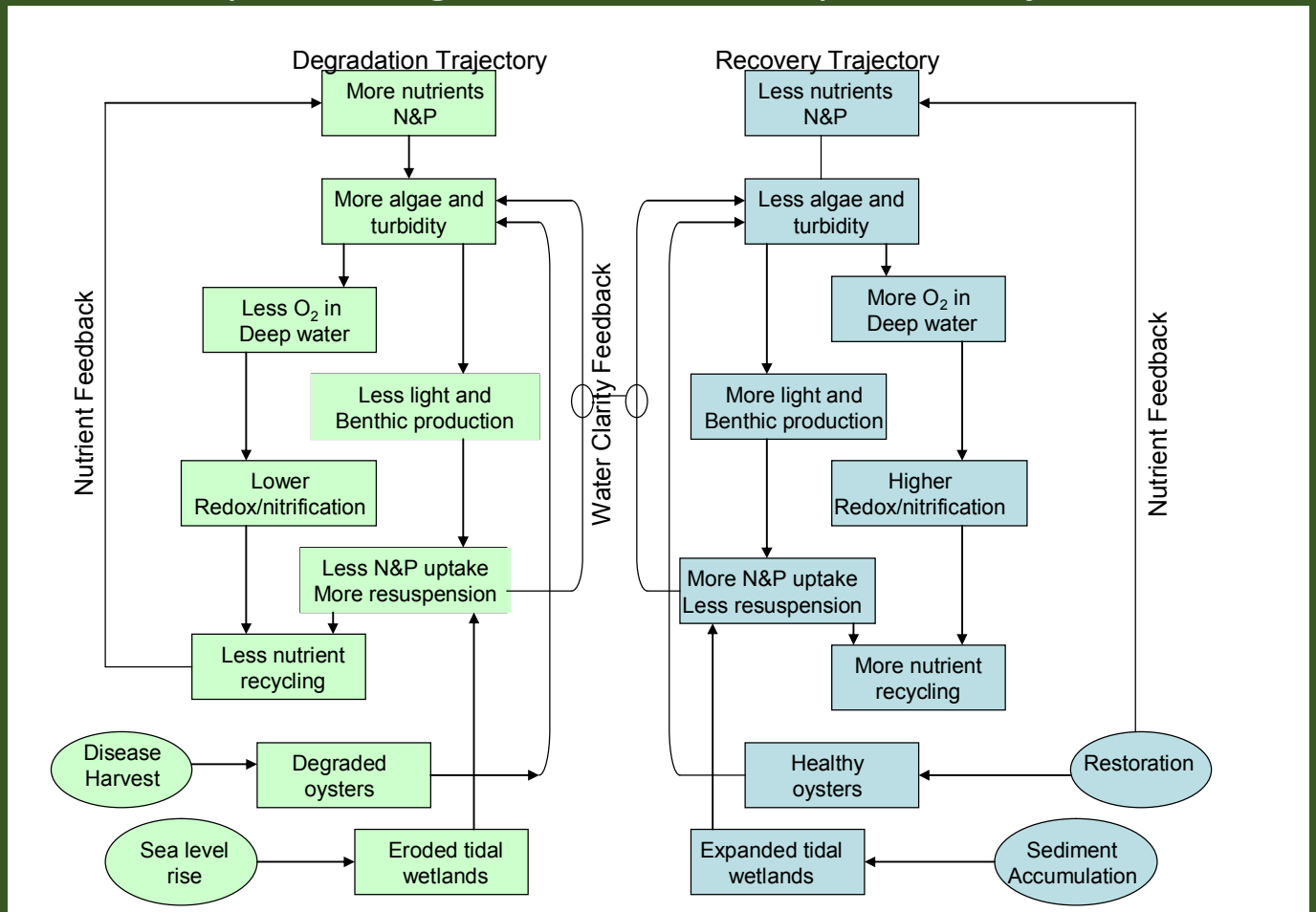
A Conceptual Model of How Chesapeake Bay Functions is one Foundation to Prioritizing Monitoring Needs: Ecosystem Degradation and Response Trajectories



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.

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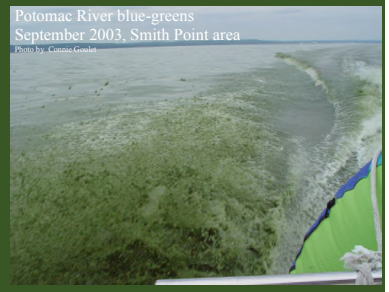
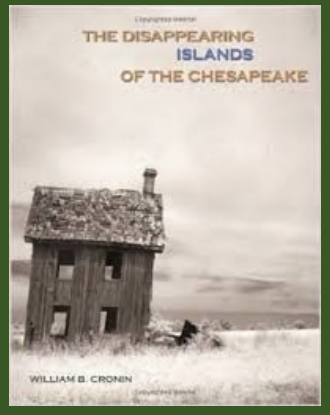
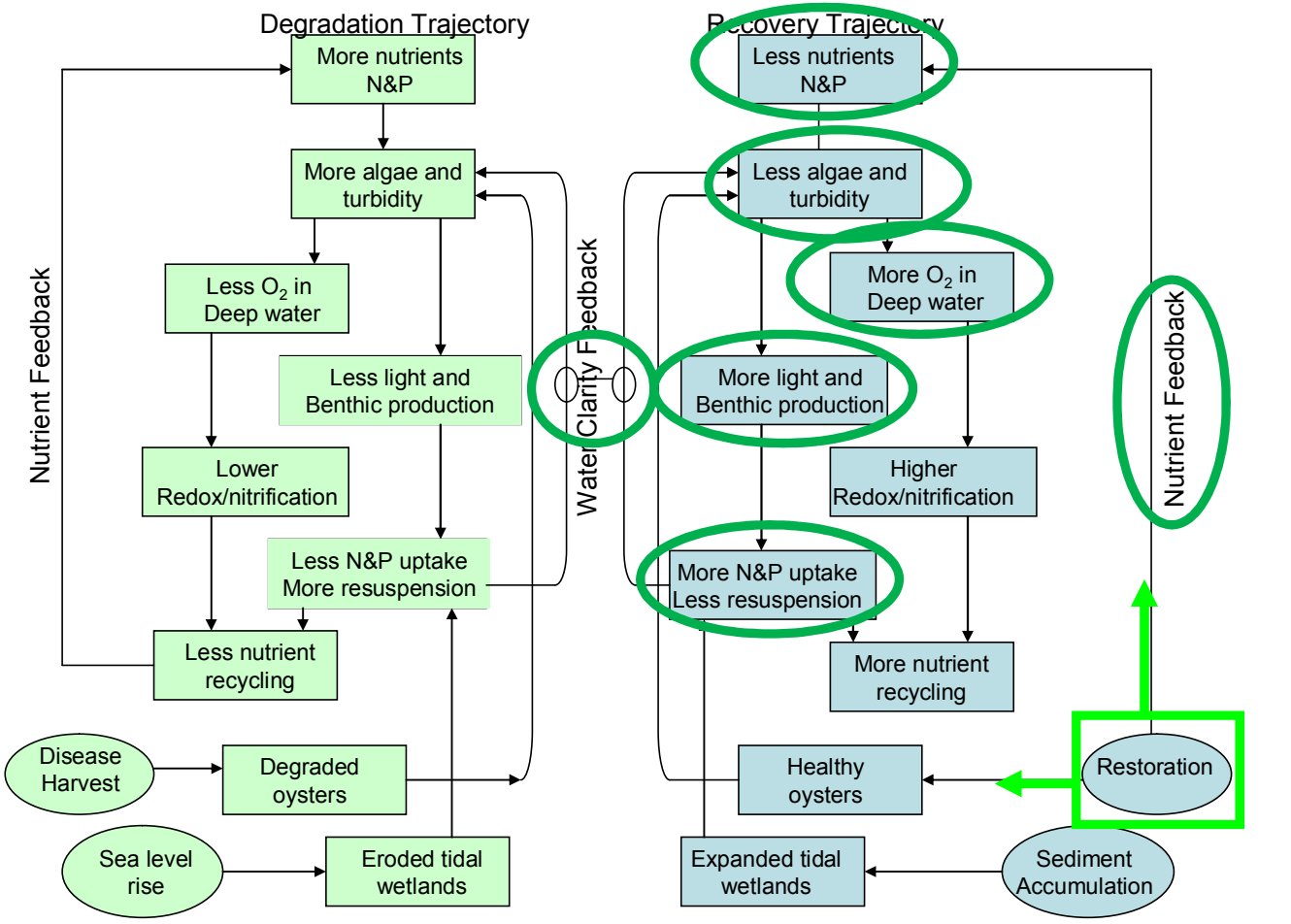


Credit: UMCES





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Credit: Bay Journal

Credit: UMCES

Credit: CBF

Conceptual Model of the Chesapeake Bay Ecosystem and Response Trajectories

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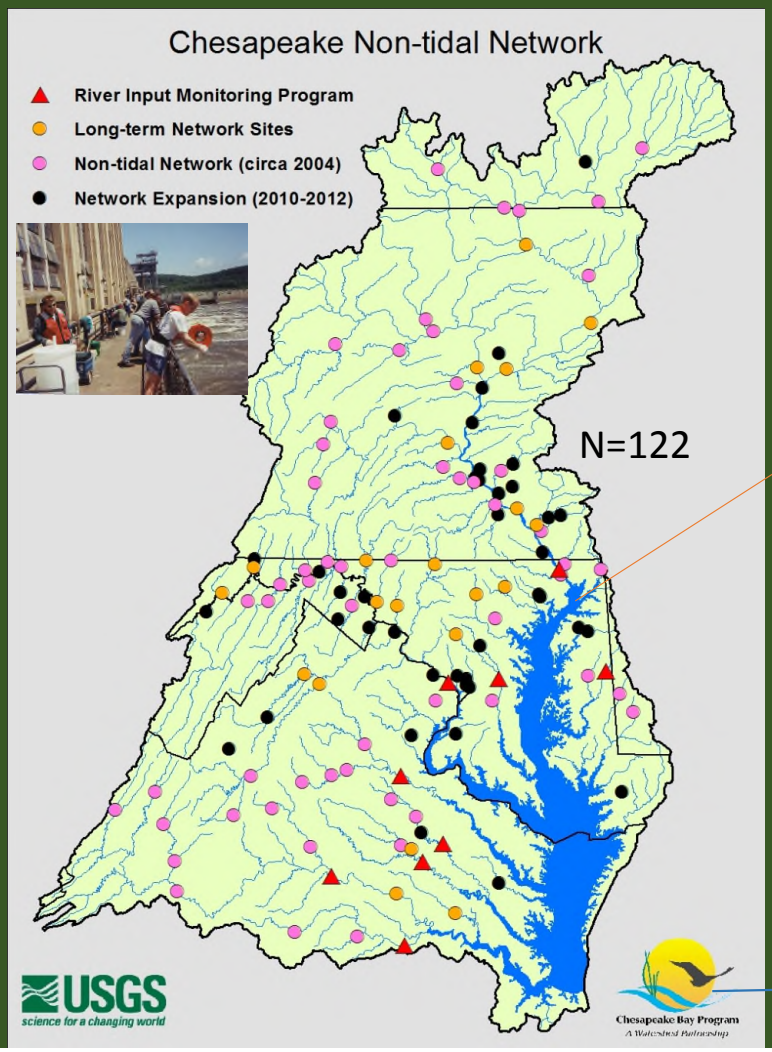
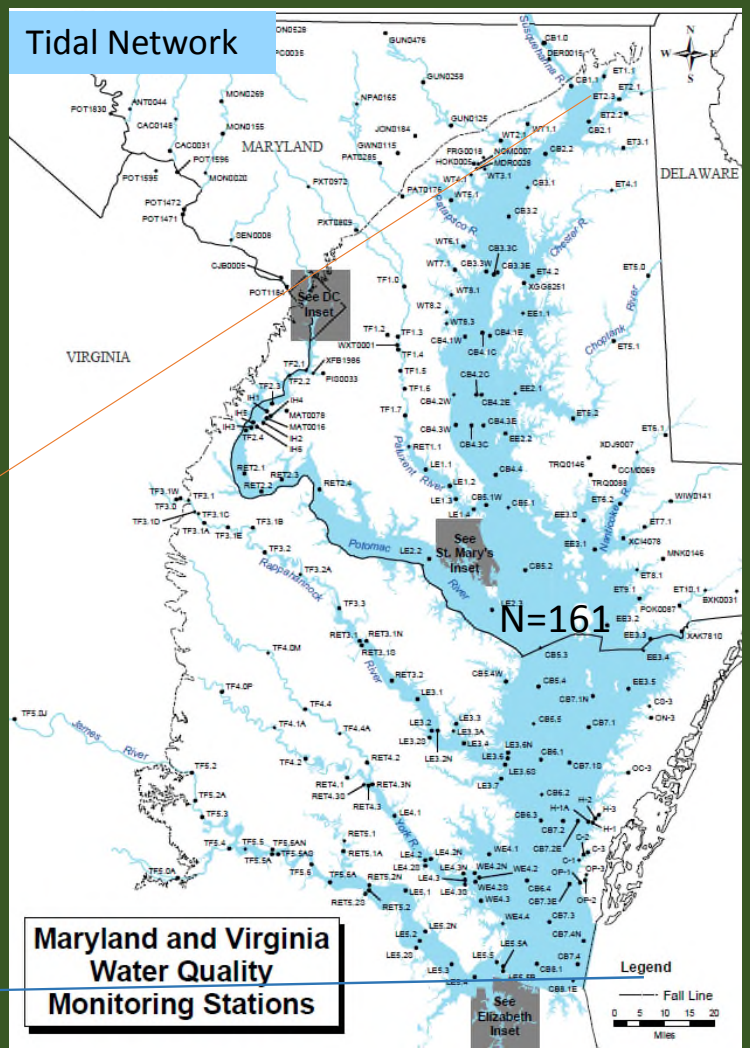
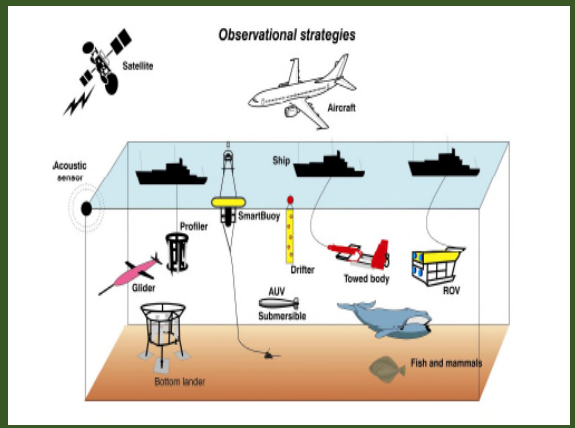
Assessment

Monitoring Networks and Diverse Approaches Supporting Water Quality Assessments



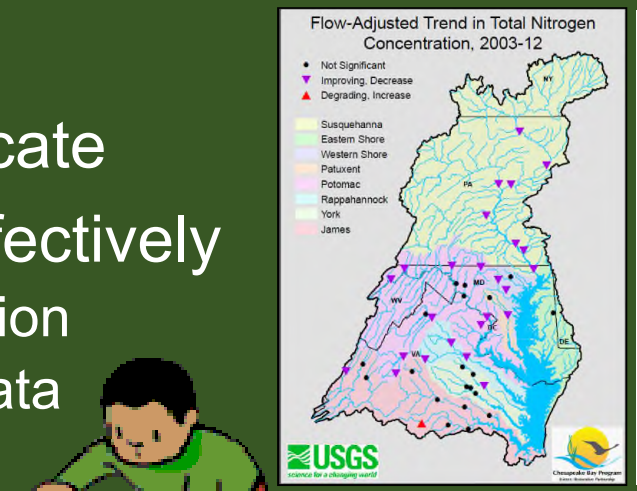


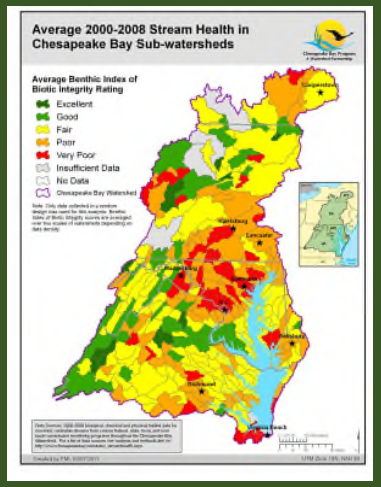


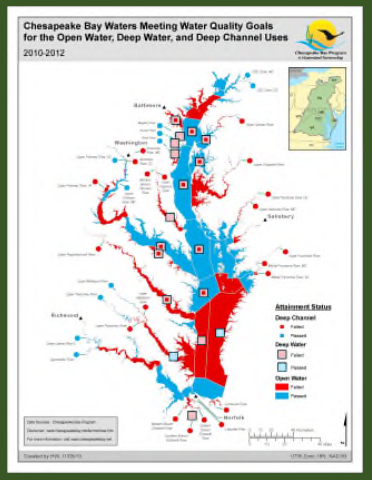
Measures:
- Physical
- Chemical
- Biological
- Hydrodynamic
- Meteorological

Assessment: Building Environmental Intelligence

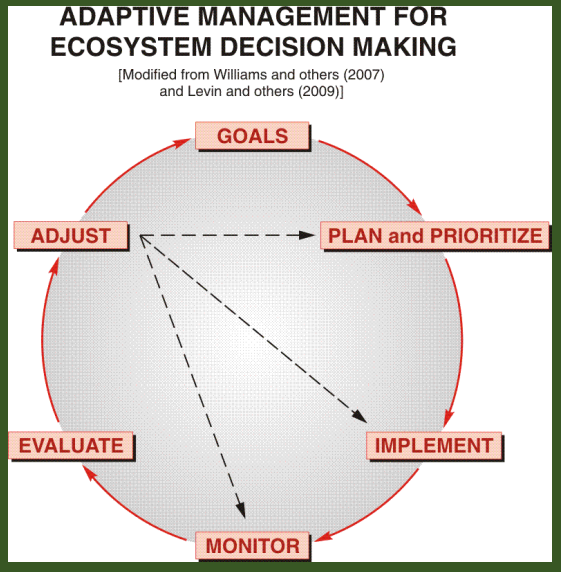
- Assess and Communicate Status and Change Effectively
  - Separate Fact from Fiction
  - Confront models with data







- Adaptive Monitoring Supporting Adaptive Management
  - Target limited resources for restoration activities



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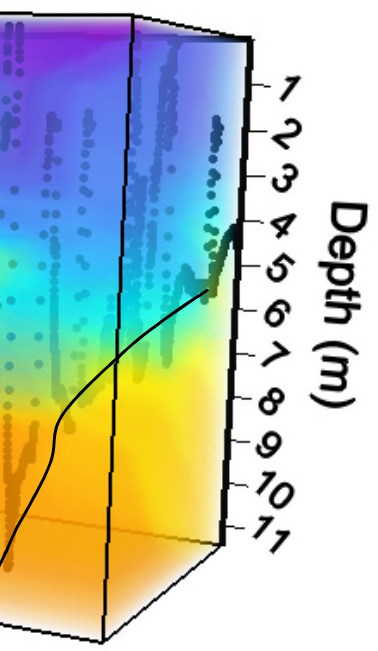
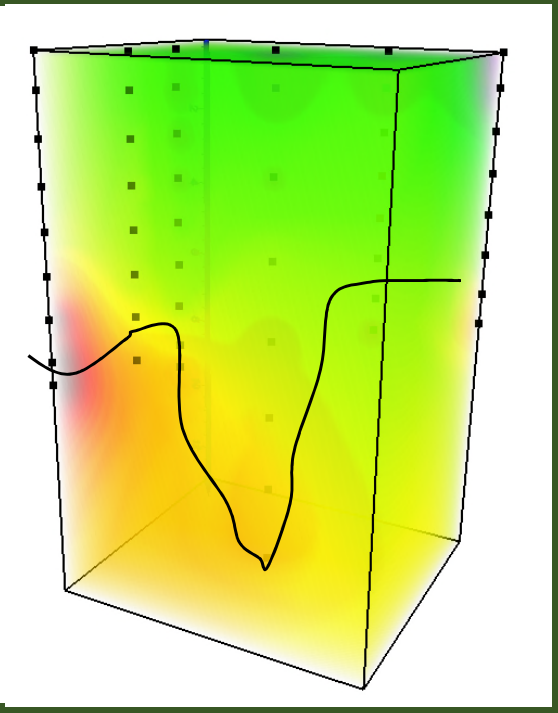
Program Adaptation Incorporating Innovation

Credit: UC Santa Barbara



REMUS 100 AUV (6-8 AM)
Credit: U.S. Naval Academy



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

- Reduced uncertainty in our assessments
- Improved interpretation of the monitoring information
- Efficiencies in monitoring

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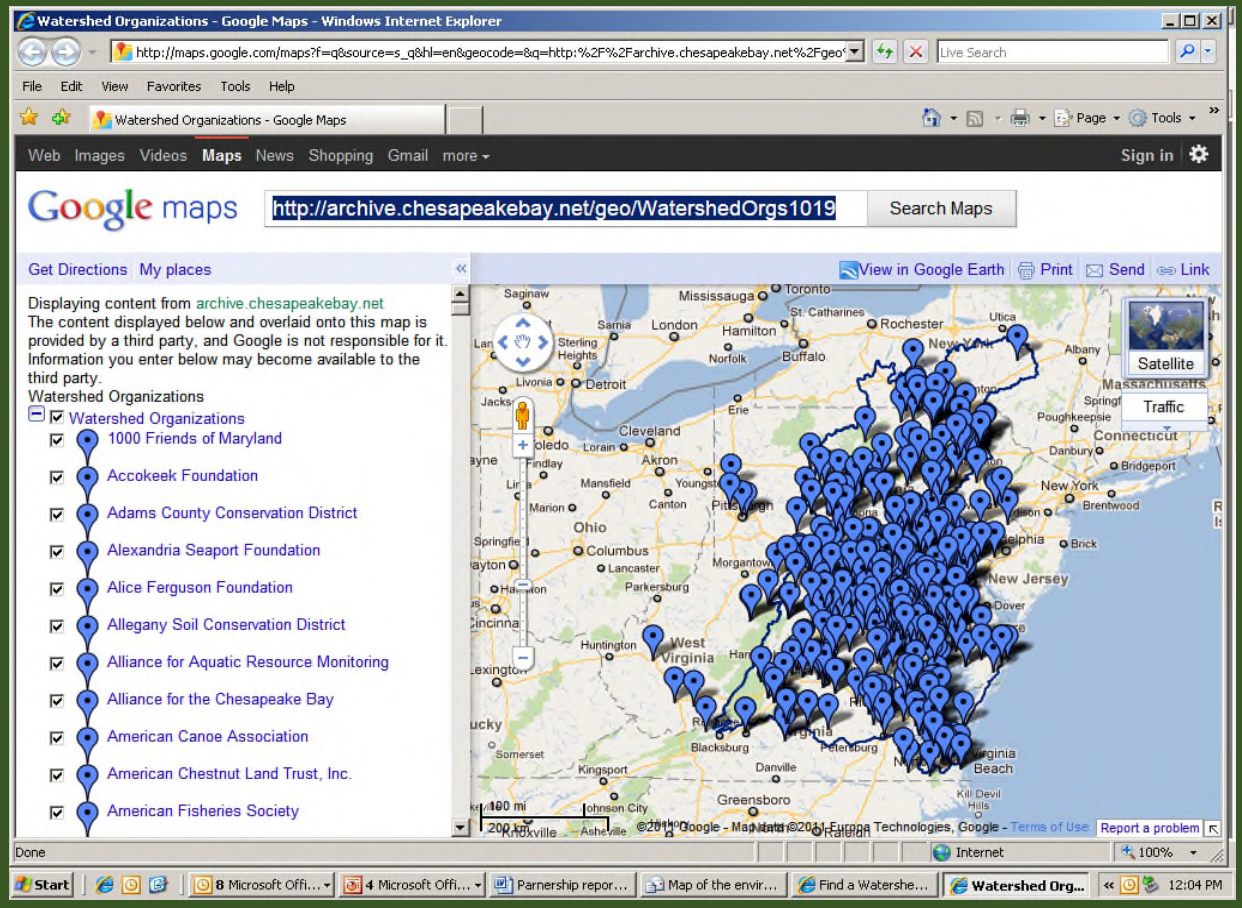
Integration of Citizen Science is Increasingly Informing Assessments



2009: Over 600 Watershed Organizations and counting!

2016: *Alliance for the Chesapeake* Expands the Accounting

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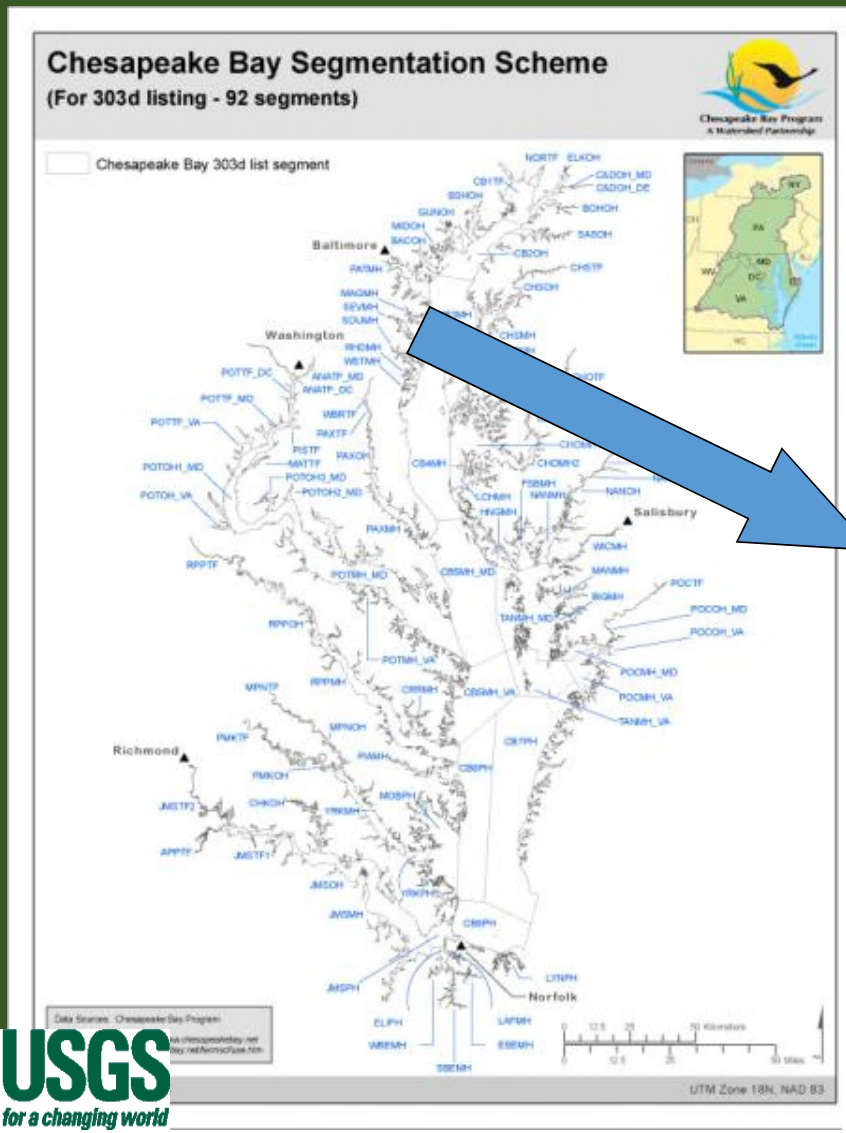
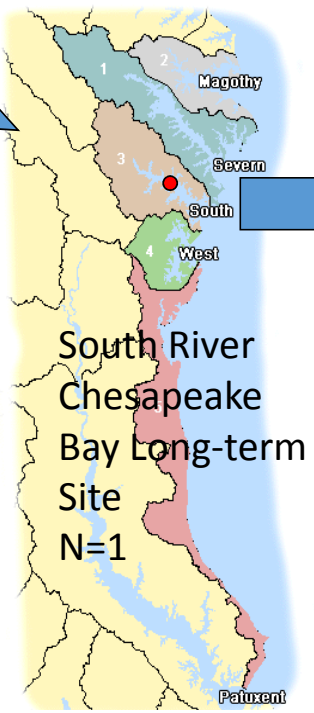
2009: http://www.chesapeakebay.net/findabaygroup.aspx?menuitem=14797

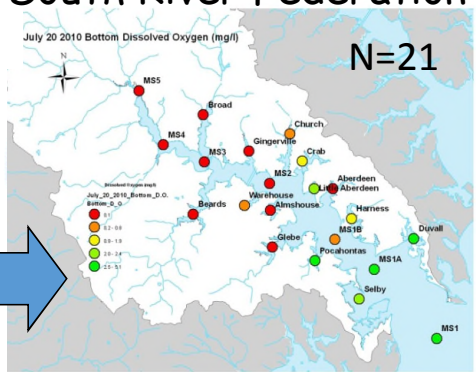
Program Growth, New Insights With New Partnerships.





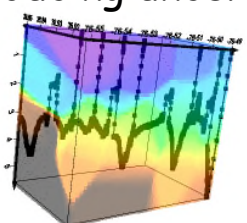
South River Chesapeake Bay Long-term Site N=1

South River Federation

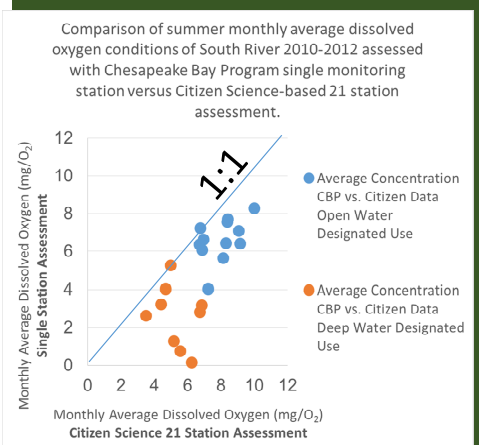


Increasing resolution

Reducing uncertainty



A Muller. USN



Enhanced spatial resolution suggesting dissolved oxygen conditions may be better than we show with 1 site in South R.

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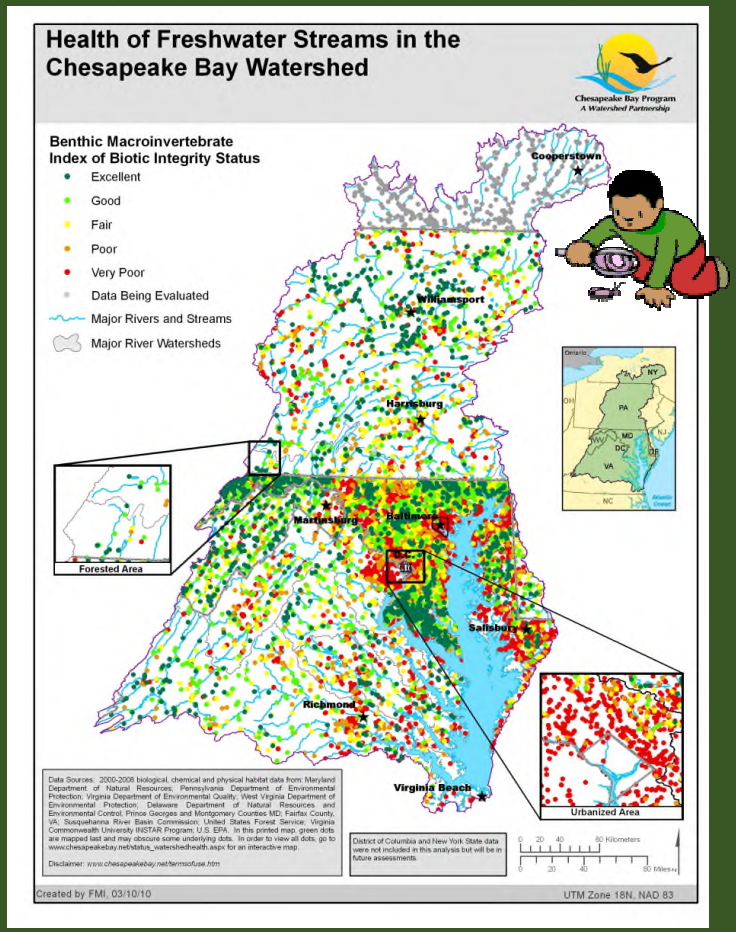
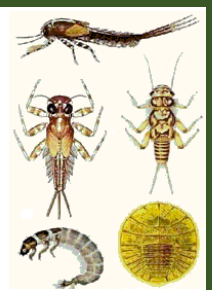
Partnerships Developing and Supporting a Watershed Health Indicator



Buchanan and others 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."



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Furthering communication product development:
Watershed-wide status and targeting maps

Science

Science-driven management framework:

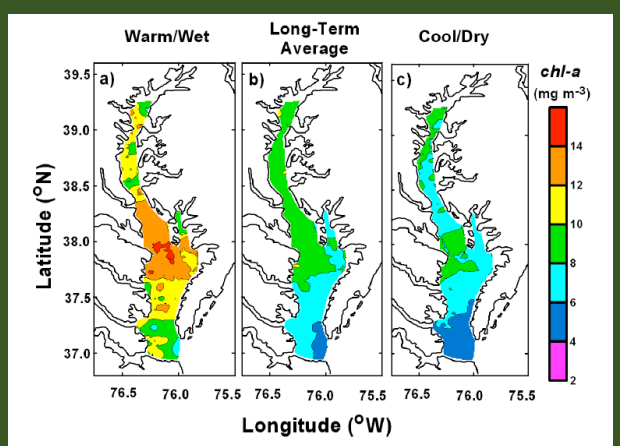
Chesapeake Bay Segmentation Scheme

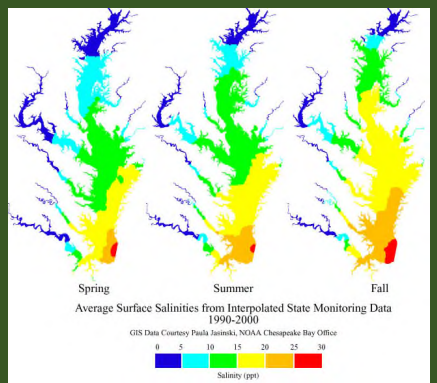
TABLE 2. WATER AND SEDIMENT QUALITY DATA BASES

Physical Variables/Nutrients

Agency	Temporal Coverage	Data Base Description	Parameters
Chesapeake Bay Institute	1949-1980	Bay, river, nutrient, AESOP, Special, Model, Whaley-Carpenter, Pro-Con	Temperature, salinity D.O., pH, Chl-a, nutrients
Virginia Institute of Marine Science	1970-1980	Slackwater	Temp., sal., D.O., BOD, Secchi, Chl-a, nutrients
Maryland Office of Environmental Programs	1966-1972 1973-1980	STORET/MD 106	Temp., sal., D.O. Temp., D.O., BOD, pH, Chl-a, nutrients
Virginia State Water Control Board	1964, 1969-1980	STORET/VA 106	Temp., D.O., BOD, pH, turbidity, nutrients

Historical data sets
1949-1980s
+
Contemporary data
1984-present





Boundary Characterization

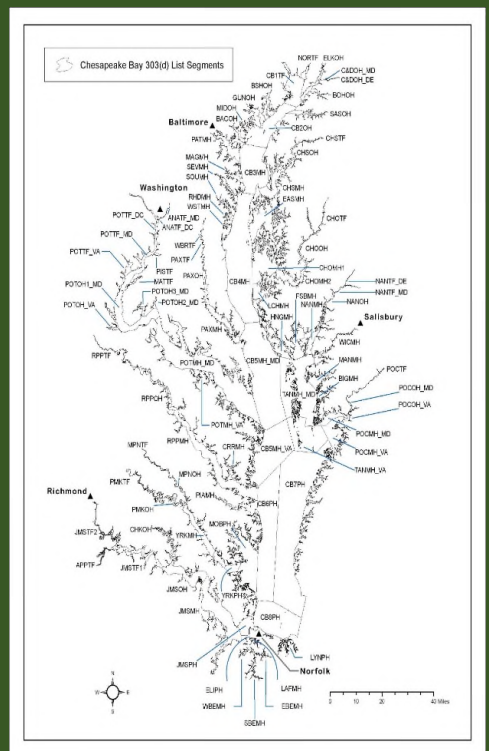
Biological
- plankton, fish

Chemical
- Salinity
- Turbidity max
- D.O.
- Nutrients

Hydrodynamics

Bathymetric

Geographical



Year	Segments
1983	78
1997	89
2003	104
2008	92 (TMDL)

USEPA CBPO 2008

Responsive updates to new science

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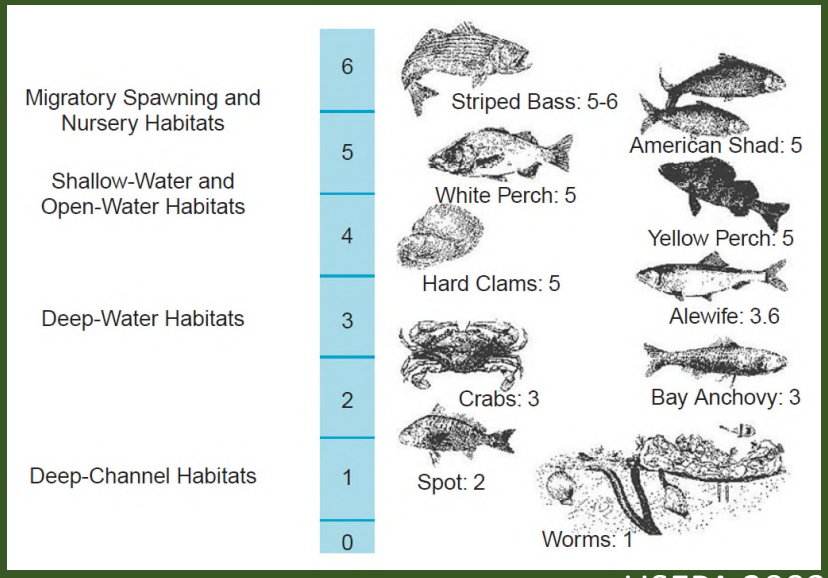
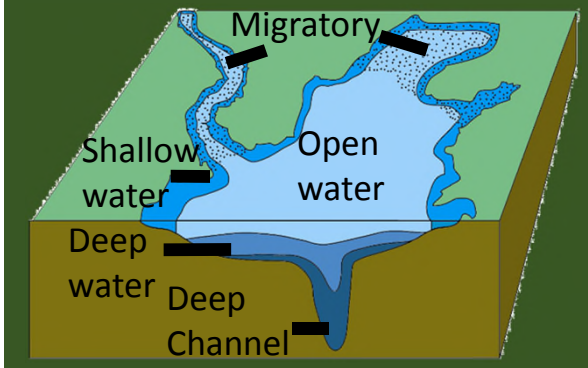
Bay Health Status – Spatial Snapshot of Indicators

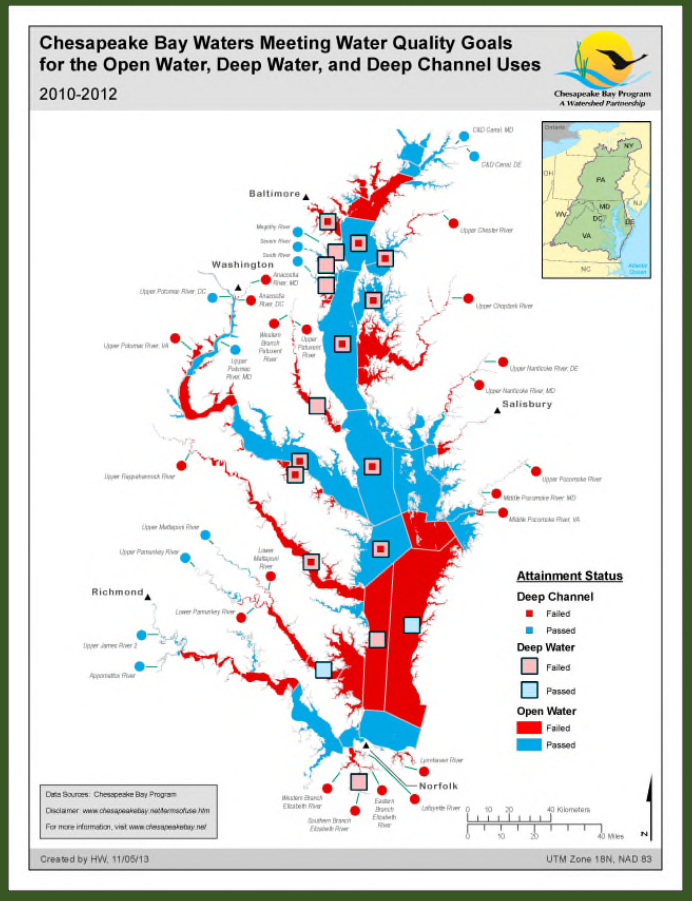


USEPA 2003

The Dissolved Oxygen Criteria Yardstick: Science-derived species requirements for protecting survival, growth and reproduction in different Bay habitats.



Science-based habitat Classifications: Designated Uses



Status – water quality meets or fail standards. Decision Making tools.

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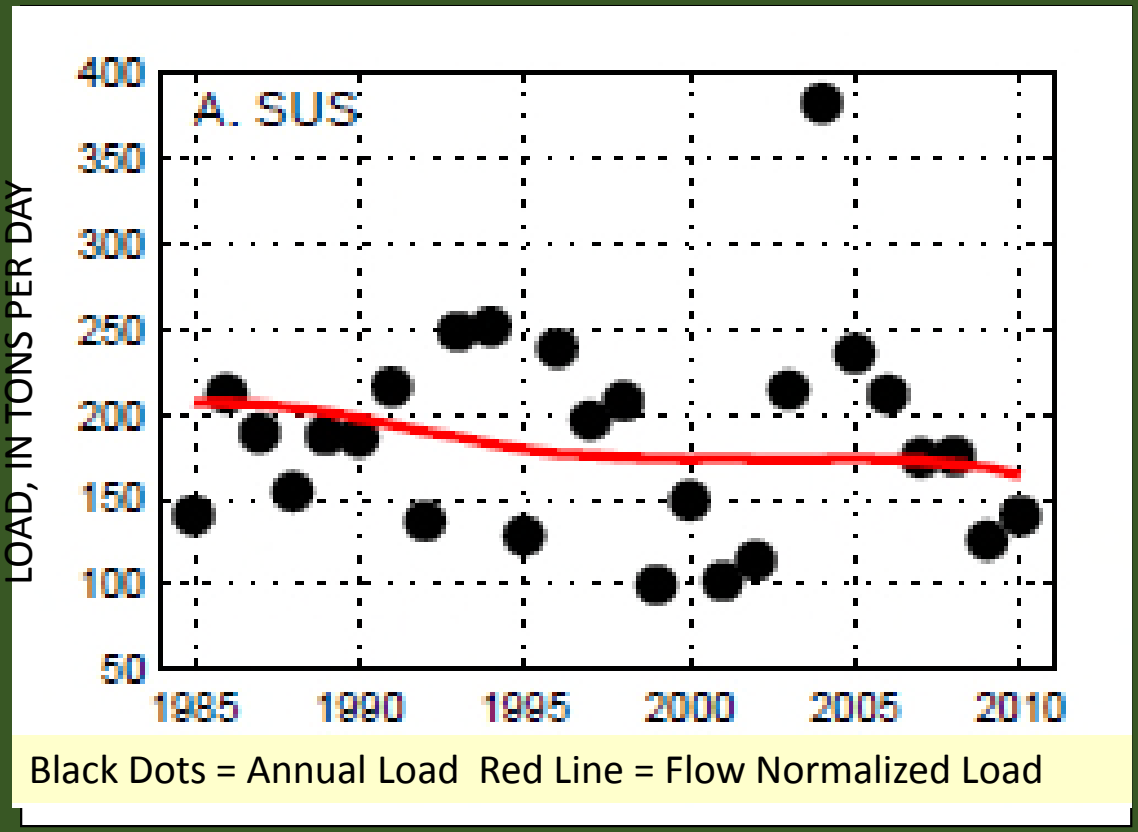
Trends in Total Nitrogen Annual Load: New Trend Analyses Weighted Regression on Time, Discharge and Season (WRTDS). Hirsch and others 2010

Total Nitrogen Load: Susquehanna River River Input Monitoring Station.

With WRTDS, we now can communicate how annual loads have changed once the year-to-year variation in Q has been removed



Trend in load for:
1985 to 2010 = Total reduction of 21%
2001 to 2010 = Total reduction of 5.8%

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Synthesis

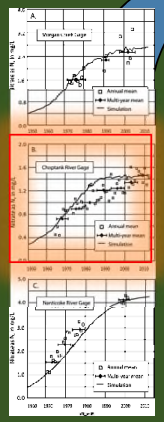
Watershed-specific Scientific Syntheses: Supporting Adaptive Management

Choptank River

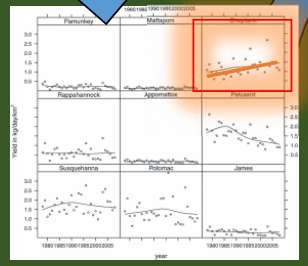
As long-term nutrients continue to increase, estuarine water quality has declined.

Ator and Denver 2015 USGS

History of Fertilizer and Manure applications On the Eastern Shore

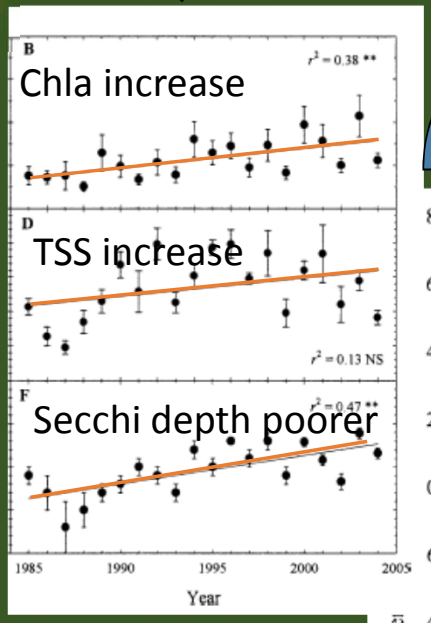


1950-2011 Choptank R. Groundwater (Baseflow) Degrading N trends Sanford 2013 USGS

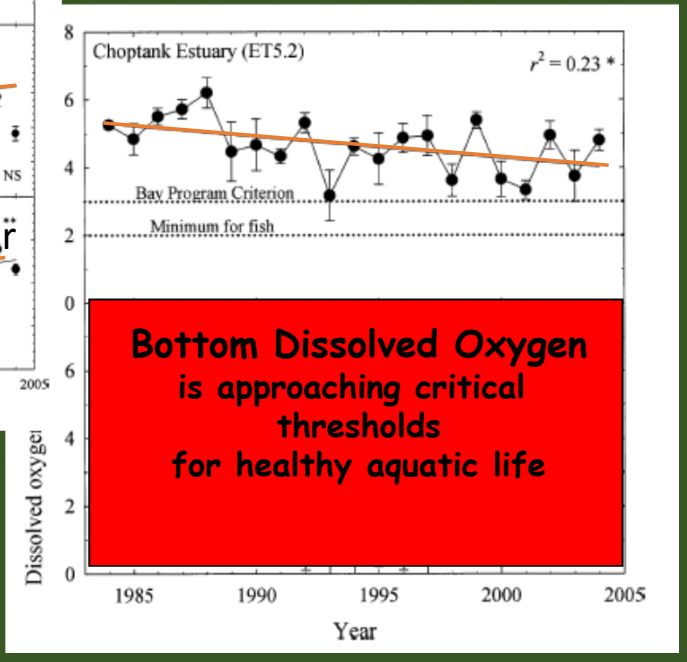


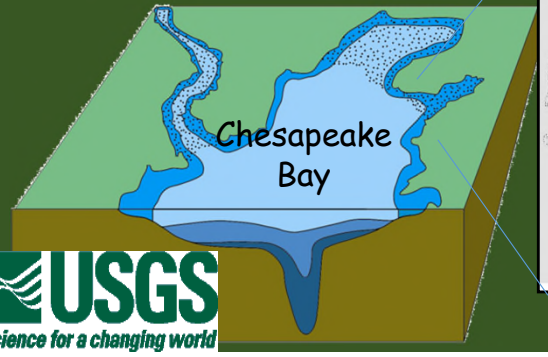
Nitrate+Nitrite Yields Increasing Hirsch and others 2010 USGS.

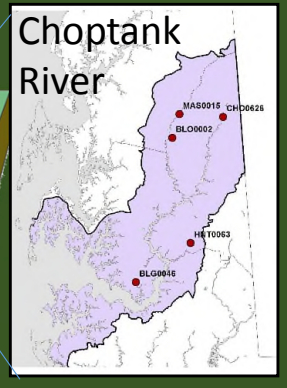
Watershed to estuary linkages in degrading trends



Fisher and others 2006 L&O Degrading Water Quality







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Management Synthesis: 2014 Synthesis Report of Management Effectiveness

- **40 case studies from around the watershed**

The science-based evidence summarized here shows that:

- Several groups of pollution-reducing practices, also known as best management practices or BMPS, are effective at improving water quality and habitats;
- Specific challenges can still impede water quality improvements; and
- More practices that focus on the

Lyerly and others, 2014

http://ian.umces.edu/pdfs/ian_report_438.pdf

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Chesapeake Bay Key Policy Actions with Goals and Outcomes

Chesapeake Watershed Agreement 2014

10 Ecosystem Health Goals
31 Outcomes

- 1983 Chesapeake Bay Agreement
- 1987 Chesapeake Bay Agreement
- 1992 Amendments
- Chesapeake 2000
- Presidential Executive Order 2009
- Chesapeake Bay TMDL 2010
- 2014 Bay Agreement

Key Policy Actions Influence Timing of Monitoring Program Reviews and Program Tuning

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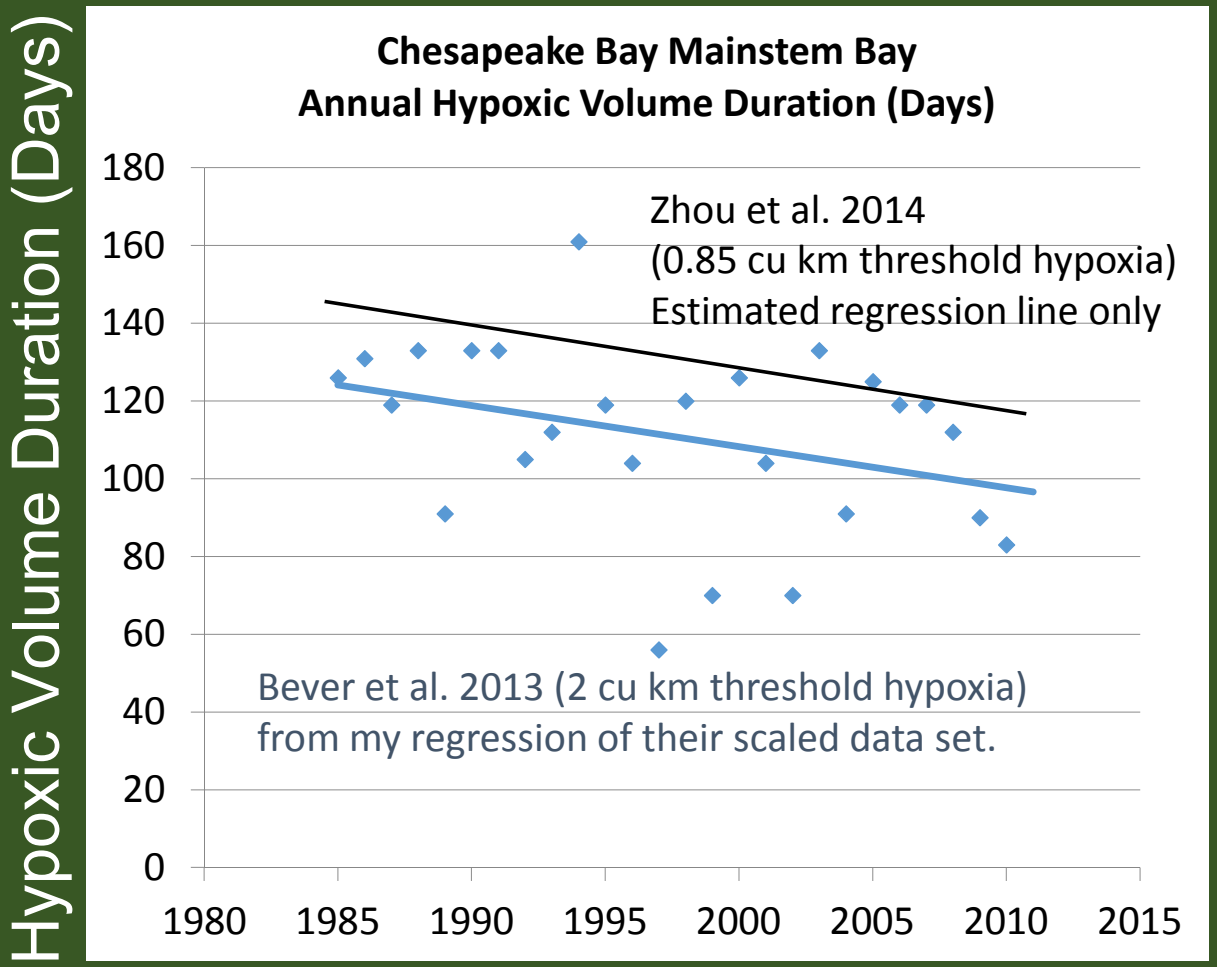
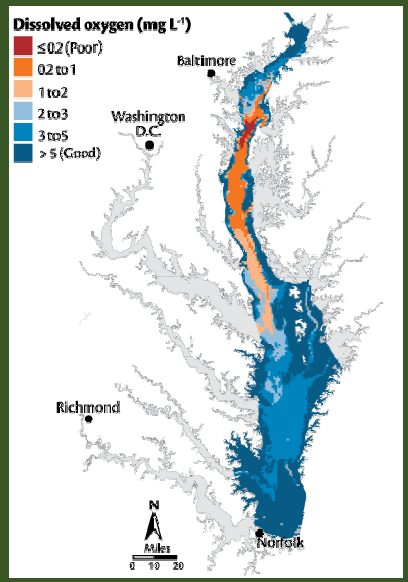
Communication

Indicators and the Indicator Framework: What the Public Sees of Our Water Quality Monitoring Program





Chesapeake Bay Hypoxia Summer 2012

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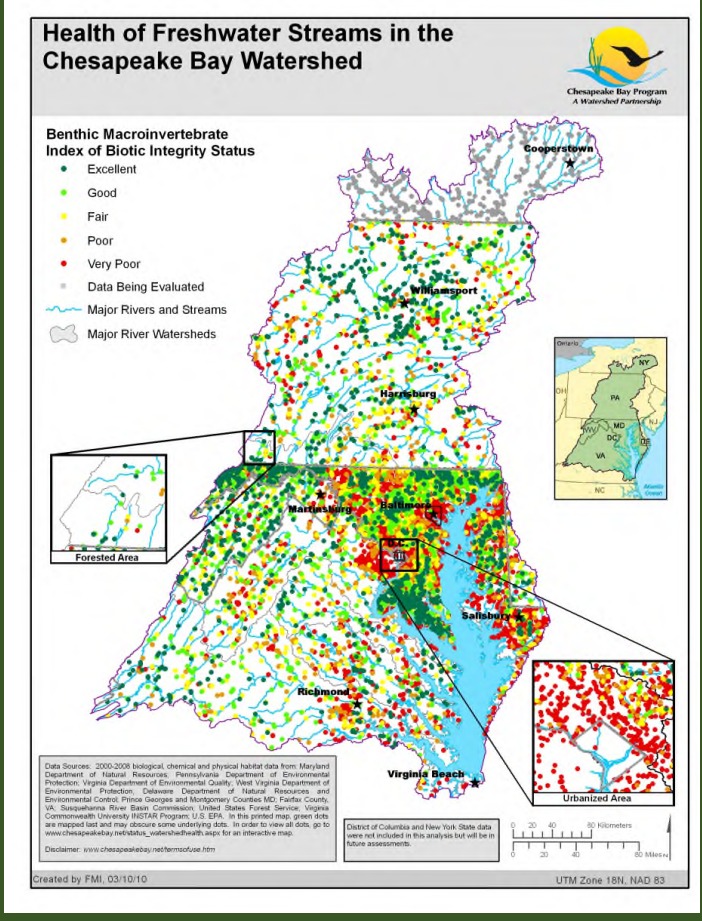
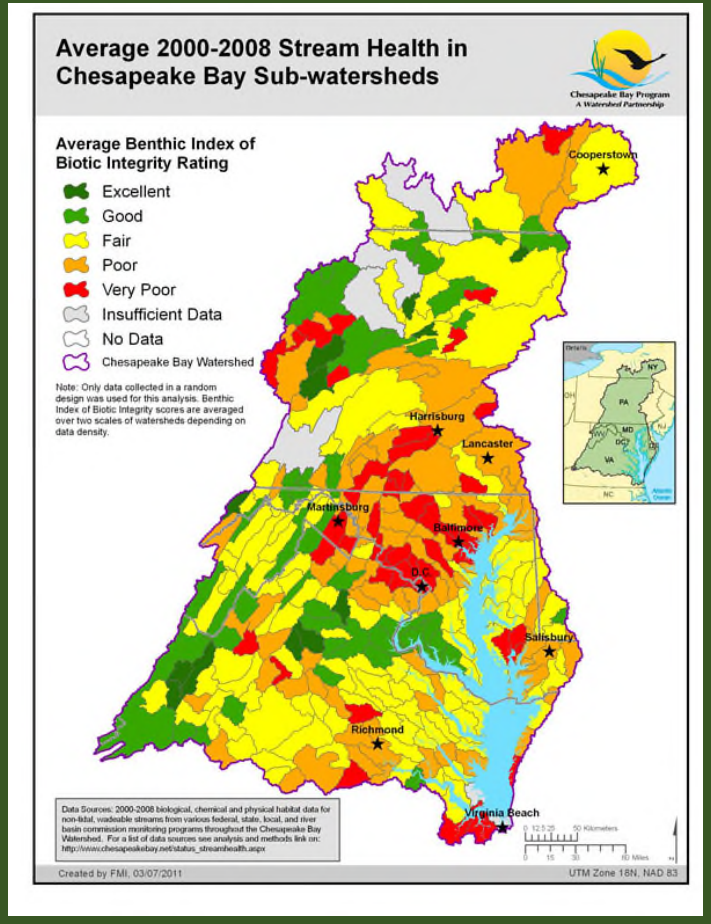
Product Development: Multiple presentations of the same data.





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Principles of good science communication

- Provide synthesis, visualization & context

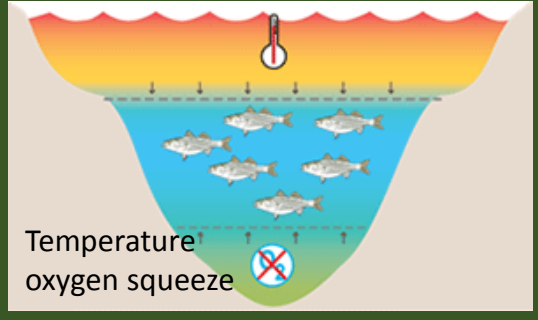
- Respect your audience
  - Relate to audience
  - Simplify terms but not content
  - Prepare for & invite questions

- Don't be a geek
  - Lose the jargon, dude
  - Define all terms
  - Minimize AU (acronym use)

- Make it look good
  - Assemble self-contained visual elements
  - Consistent *style* and *format*
  - Use color, but use it judiciously

Develop a Synthesis

Use Visualization



Provide Context: So what about the results?

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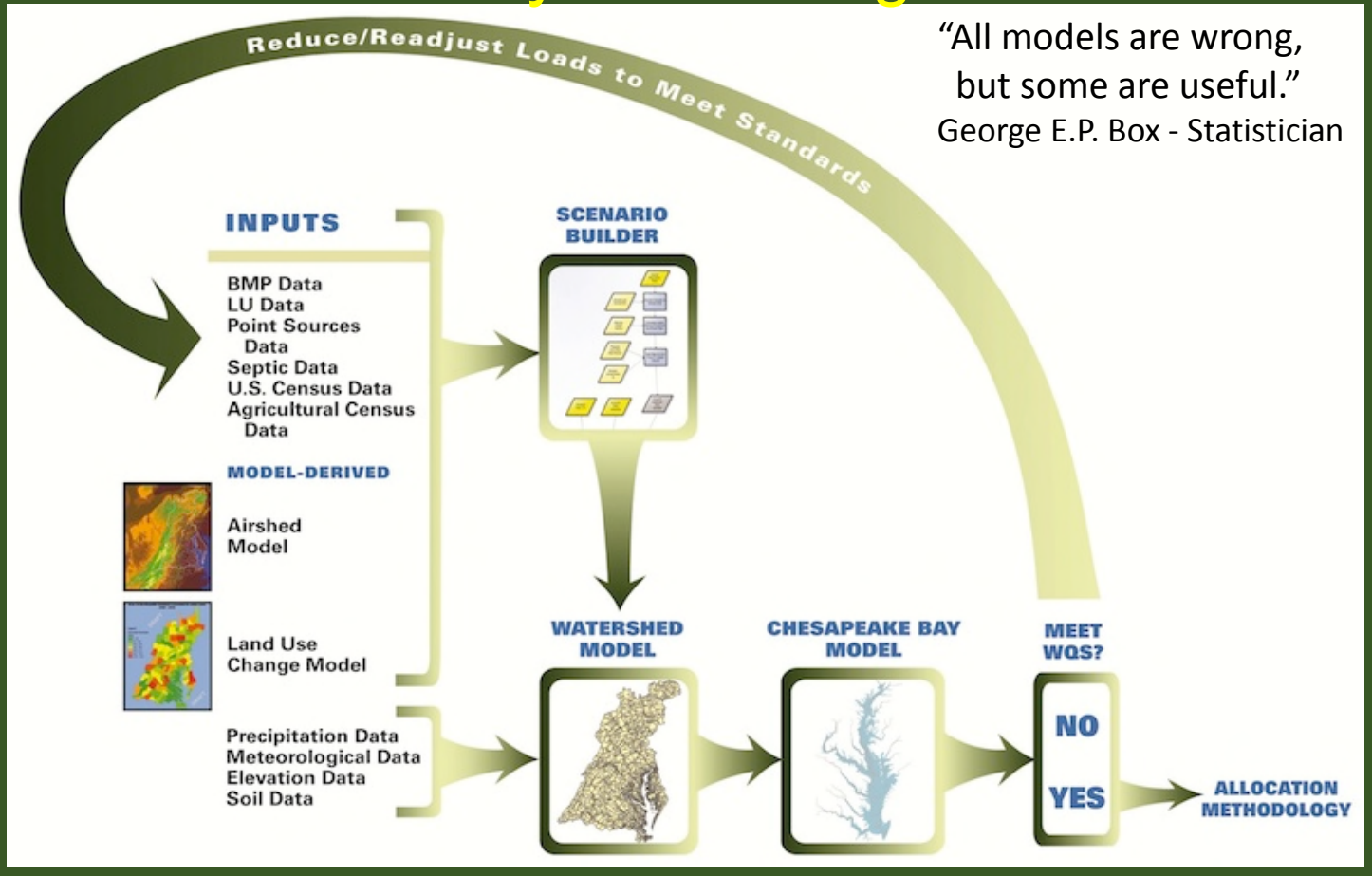
http://ian.umces.edu/learn/science_communication/

Management Links With Regional Monitoring Programming

Chesapeake Bay Ecosystem Modeling Suite: Synthesizes Science, Decision-making tool, Calibration and Verification with Water Quality Monitoring Data



"All models are wrong, but some are useful."
George E.P. Box - Statistician

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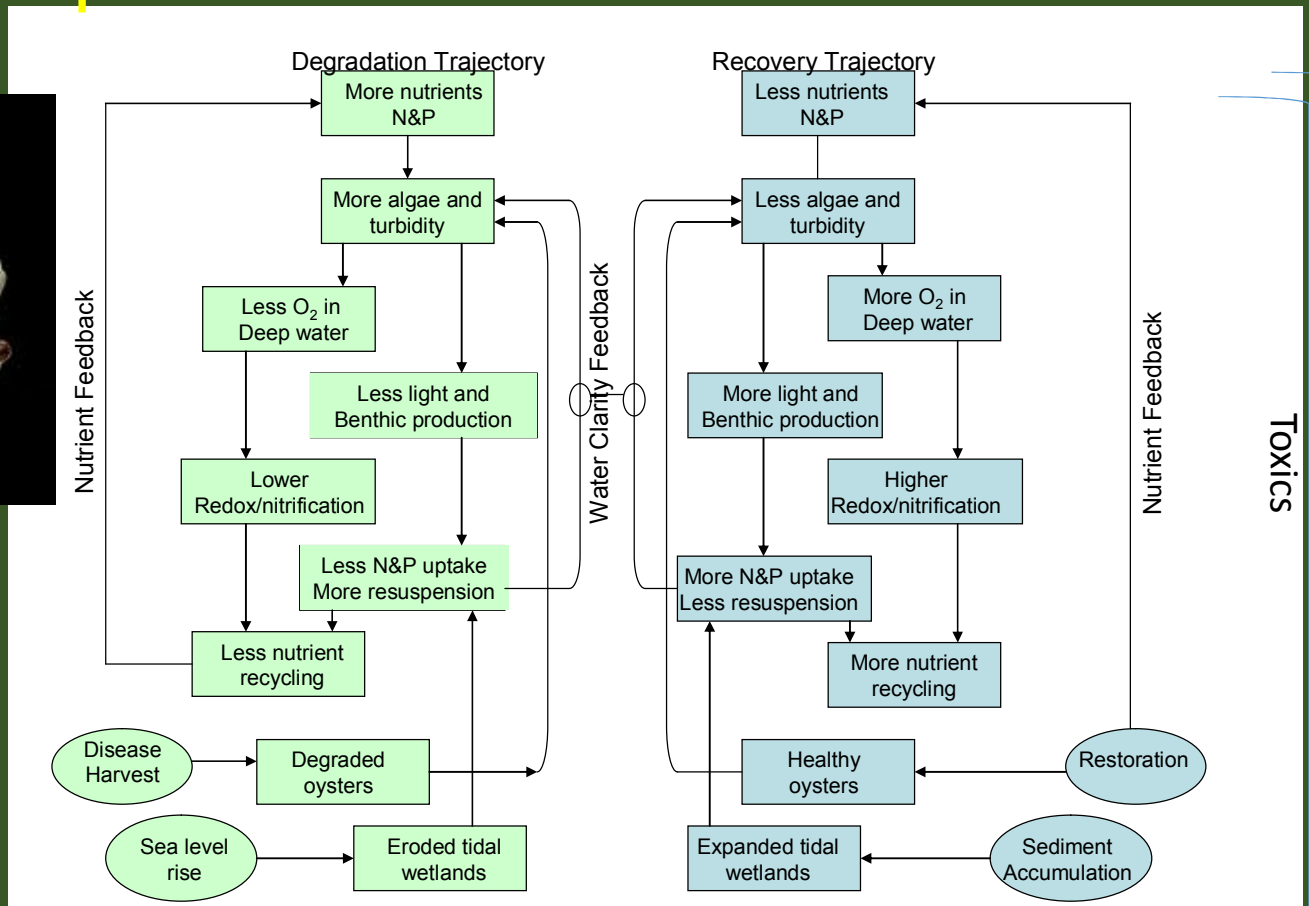
Our Conceptual Models Have Grown

Chesapeake Watershed Agreement 2014

10 Ecosystem Health Goals
31 Outcomes



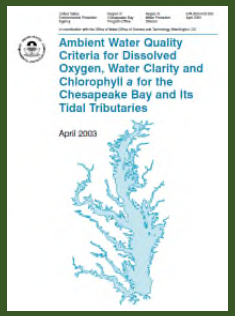
Conceptual model of Chesapeake Bay degradation and recovery. Page 21 *in* Kemp et al. 2005. Eutrophication of Chesapeake Bay: Historical trends and ecological interactions. Mar. Ecol. Prog. Ser. 303:1-29.

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

Monitoring Supports the Gap Analysis: Indicators are needed for each of the 2014 Bay Agreement's 31 outcomes.

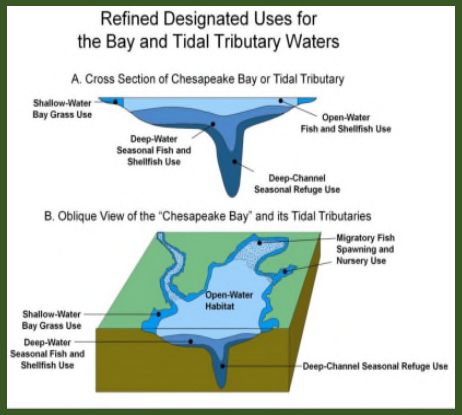
Green Supported	Yellow Some Support	Red Unsupported
Fish Passage	Oyster (NOAA)	Forage Fish
SAV	Forest Buffer (NPS, USGS)	Fish Habitat
Water Quality	Tree Canopy (NPS, USGS)	Black Duck
Protected Lands	Brook Trout (USFWS, USGS, EBTJV)	Toxic Contaminants Research
Public Access	Environmental Literacy	Toxic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

May 2015. Chesapeake Bay Program Indicator Action Team Update. M. Ehrich.

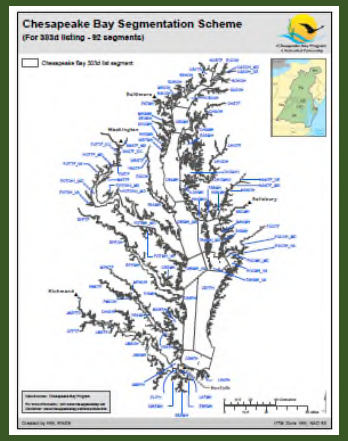


Established Water Quality Criteria, Assessment Framework and Protocols with updates. 2003-2016.

- USEPA 2003 October: Tech support for identification of five water designated uses to be protected
- USEPA 2004b, 2005, 2010 DU refinements

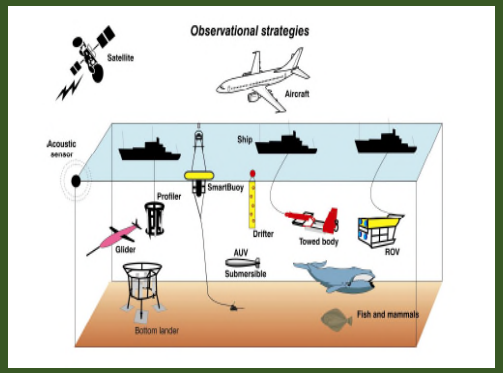


- USEPA 2004b, 2005, 2008. Bay segmentation described and updated



- USEPA 2004a, 2007a, 2008, 2010:

Criteria attainment assessment procedures and updates



- USEPA 2007b, 2010:

Numerical Chlorophyll *a* Criteria and updates

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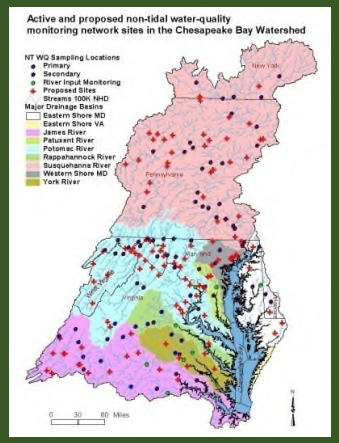
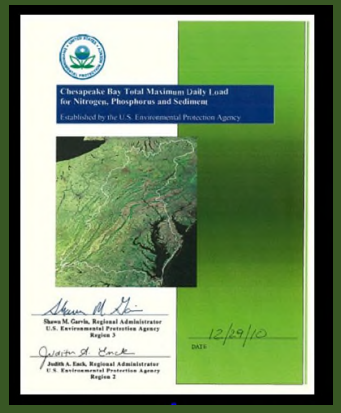
Summary

Chesapeake Bay Program Partnership Monitoring Program Networks:

- We are *building environmental intelligence* to tell the stories to address stakeholder interests
- Adaptive monitoring supporting Adaptive Management



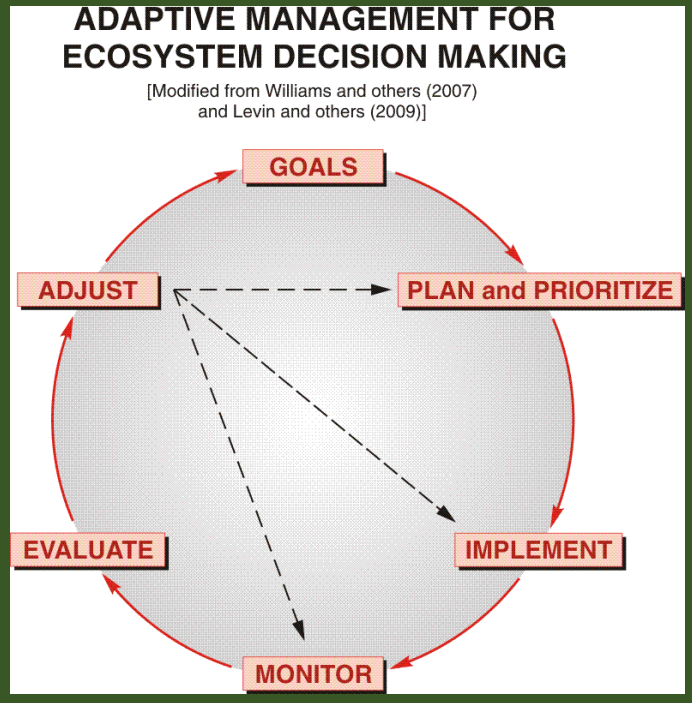
Sustaining Core Networks and Conducting Peer-reviews, Planning, Coordination and Implementation

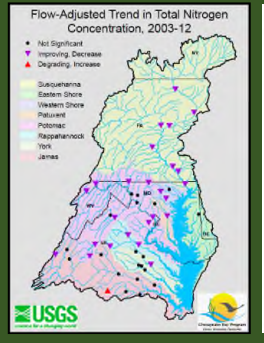


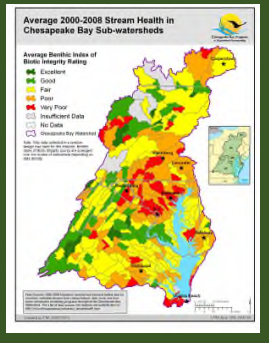
Evolving Policy

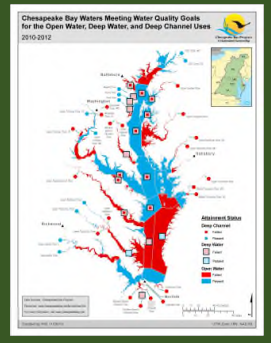
Chesapeake Bay Program
A Watershed Partnership

Leveraging & Growing Partnerships









Managing Uncertainty,

Assessing and Communicating Ecosystem Status and Change Effectively

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Thank you and Acknowledgements

NY DC VA MD PA DE WV

Bay Commission

Federal Government

Chesapeake Bay Program

A vast partnership of all the major players in the Chesapeake region, working collaboratively on science, policy and restoration efforts

Alliance for the Chesapeake Interstate Commission on the Potomac River Basin Commission Susquehanna River Basin Commission Academic Institutions (U of MD, VIMS, UMCES HPL UMCES CBL, and more), NGOs, Advisory Committees and more.