Chesapeake Bay Science Fully Supports Accountable Market-Based Solutions

Rich Batiuk

Associate Director for Science, Analysis and Implementation

U.S. EPA Region 3 Chesapeake Bay Program Office

Annapolis, Maryland

Four Pages of Acknowledgements from the 2003 EPA Chesapeake Bay Criteria Document

These Chesapeake Bay-specific water quality criteria were derived through the collaborative efforts, collective knowledge and applied expertise of the following four Chesapeake Bay criteria and standards coordinator teams.

Water Clarity Criteria Team
Richard Batiuk, U.S. EPA Chesapeake Bay Program Office; Peter Bergstrom, U.S. Fish and Wildlife Service; Arthur Butt, Virginia Department of Environmental Quality; Ifeyinwa Davis, U.S. EPA Office of Water; Frederick Hoffman, Virginia Department of Environmental Quality; Charles Gallegos, Smithsonian Environmental Research Center; Will Hunley, Hampton Roads Sanitation District; Michael Kemp, University of Maryland Horn Point Laboratory; Ken Moore,Virginia Institute of Marine Science; Michael Naylor, Maryland Department of Natural Resources; and Nancy Rybicki, U.S. Geological Survey.

Without the efforts of the authors of the first and second Chesapeake Bay underwater bay grass technical syntheses, the Bay-specific water clarity criteria could not have been developed: Steve Ailstock, Anne Arundel Community College; Rick Bartleson, University of Maryland Horn Point Laboratory; Richard Batiuk, U.S. EPA Chesapeake Bay Program Office; Peter Bergstrom, U.S. Fish and Wildlife Service; Steve Bieber, Maryland Department of the Environment; Virginia Carter, U.S. Geological Survey; William Dennison, University of Maryland Center for Environmental Studies; Charles Gallegos, Smithsonian Environmental Research Center; Patsy Heasly, Chesapeake Research Consortium; Edward Hickman, U.S. Geological Survey; Lee Karrh, Maryland Department of Natural Resources; Michael Kemp, University of Maryland Horn Point Laboratory; Evamaria Koch,
University of Maryland Horn Point Laboratory; Stan Kollar, Harford Community College; Jurate Landwehr, U.S. Geological Survey; Ken Moore, Virginia Institute of Marine Science; Laura Murray, University of Maryland Horn Point Laboratory; Michael Naylor, Maryland Department of Natural Resources; Robert Orth, Virginia Institute of Marine Science; Nancy Rybicki, U.S. Geological Survey; Lori Staver, University of Maryland; Court Stevenson, University of Maryland Horn Point Laboratory; Mirta Teichberg, Woods Hole Oceanographic Institution; and David Wilcox, Virginia Institute of Marine Science.

Dissolved Oxygen Criteria Team
Richard Batiuk, U.S. EPA Chesapeake Bay Program Office; Denise Breitburg, Academy of Natural Sciences; Arthur Butt, Virginia Department of Environmental Quality; Thomas Cronin, U.S. Geological Survey; Ifeyinwa Davis, U.S. EPA Office of Water; Robert Diaz, Virginia Institute of Marine Science; Frederick Hoffman, Virginia Department of Environmental Quality; Steve Jordan, Maryland Department of Natural Resources; James Keating, U.S. EPA Office of Water; Marcia Olson, NOAA Chesapeake Bay Office; James Pletl, Hampton Roads Sanitation District; David Secor, University of Maryland Chesapeake Biological Laboratory; Glen Thursby, U.S. EPA Office of Research and Development; and Erik Winchester, U.S. EPA Office of Research and Development.

Scientists from across the country, well-recognized for their work in the area of low dissolved oxygen effects on individual species up to ecosystem trophic dynamics, contributed their time, expertise, publications and preliminary data and findings to support the derivation of Chesapeake Bay-specific criteria: Steve Brandt, NOAA Great Lakes Environmental Research Laboratory; Walter Boynton, University of Maryland Chesapeake Biological Laboratory; Ed Chesney, Louisiana Universities Marine Consortium; Larry Crowder, Duke University Marine Laboratory; Peter deFur, Virginia Commonwealth University; Ed Houde, University of Maryland
Chesapeake Biological Laboratory; Julie Keister, Oregon State University; Nancy Marcus, Florida State University; John Miller, North Carolina State University; Ken Paynter, University of Maryland; Sherry Poucher, SAIC; Nancy Rabalais, Louisiana Universities Marine Consortium; Jim Rice, North Carolina State University; Mike Roman, University of Maryland Horn Point Laboratory; Linda Schaffner, Virginia Institute of Marine Science; Dave Simpson, Connecticut Department of Environmental Protection; and Tim Target, University of Delaware.

Chlorophyll *a* Criteria Team
Richard Batiuk, U.S. EPA Chesapeake Bay Program Office; Claire Buchanan, Interstate Commission on the Potomac River Basin; Arthur Butt, Virginia Department of Environmental Quality; Ifeyinwa Davis, U.S. EPA Office of Water; Tom Fisher, University of Maryland Horn Point Laboratory; David Flemer, U.S. EPA Office of Water; Larry Haas, Virginia Institute of Marine Science; Larry Harding, University of Maryland Horn Point Laboratory/Maryland Sea Grant; Frederick Hoffman Virginia Department of Environmental Quality; Will Hunley, Hampton Roads Sanitation District; Richard Lacouture, Academy of Natural Sciences; Robert Magnien, Maryland Department of Natural Resources; Harold Marshall, Old Dominion University; Robert Steidel, Hopewell Regional Wastewater Facility; and Peter Tango, Maryland Department of Natural Resources.

Without the efforts of the Chesapeake Bay Phytoplankton Restoration Goals Team forging connections between reference phytoplankton communities and resulting chlorophyll *a* concentrations would not have been possible: Claire Buchanan, Interstate Commission on the Potomac River Basin; Richard Lacouture, Academy of Natural Sciences; Harold Marshall, Old Dominion University; Stella Sellner, Academy of Natural Sciences; Jacqueline Johnson, Interstate Commission on the Potomac River Basin/Chesapeake Bay Program Office; Jonathan Champion, Chesapeake Research Consortium/Chesapeake Bay Program Office; Marcia Olson, NOAA Chesapeake Bay Office; Fred Jacobs, AKRF, Inc.; John Seibel, PBS & J, Inc.; and Elgin Perry.

Water Quality Standards Coordinators Team
Richard Batiuk, U.S. EPA Chesapeake Bay Program Office; Jerusalem Bekele, District of Columbia Department of Health; Libby Chatfield, West Virginia Environmental Quality Board; Joe Beaman, Maryland Department of the Environment; Thomas Gardner, U.S. EPA Office of Water (Criteria); Jean Gregory, Virginia Department of Environmental Quality; Denise Hakowski, U.S. EPA Region III; Elaine Harbold, U.S. EPA Region III; Wayne Jackson, U.S. EPA Region II; James Keating, U.S. EPA Office of Water (Standards); Larry Merrill, U.S. EPA Region III; Garrison Miller, U.S. EPA Region III; Joel Salter, U.S. EPA Office of
Water (Permits); John Schneider, Delaware Department of Natural Resources and Environmental Control; Mark Smith, U.S. EPA Region III; Scott Stoner, New York State Department of Environmental Conservation; and Carol Young, Pennsylvania Department of Environmental Protection.

Without the efforts of the Chesapeake Bay Tidal Monitoring Network Design Team, the development of the criteria attainment procedures contained in this document would not have been developed: Claire Buchanan, Interstate Commission on the Potomac River Basin; Paul Jacobson; Marcia Olson, NOAA Chesapeake Bay Office; Elgin Perry; Steve Preston, U.S. Geological Survey/Chesapeake Bay Program Office; Walter Boynton, University of Maryland Chesapeake Biological Laboratory; Larry Haas, Virginia Institute of Marine Science; Frederick Hoffman, Virginia Department of Environmental Quality; Bruce Michael, Maryland Department of Natural Resources; Jacqueline Johnson, Interstate Commission for the Potomac River Basin; Kevin Summers, U.S. EPA Office of Research and Development; Dave Jasinski, University of Maryland; Mary Ellen Ley, U.S. Geological Survey/ Chesapeake Bay Program Office; and Lewis Linker, U.S. EPA Chesapeake Bay Program Office.

The contributions of the 12 independent scientific peer reviewers, selected based on their recognized national expertise and drawn from institutions and agencies from across the country, are hereby acknowledged. Without the contributions of the more than 100 individuals listed as authors or technical contributors to various syntheses of Chesapeake Bay living resource habitat requirements over the past two decades, the scientific basis for a set of designated uses tailored to Chesapeake Bay tidal habitats and species would not have been forged. Without the efforts of the many individuals involved in all aspects of collection, management and analysis of Chesapeake Bay Monitoring Program data over the past two decades, these criteria could not have been derived. Their collective contributions are hereby fully acknowledged.

The technical editing, document preparation and desk-top publication contributions of Robin Bisland, Donna An and Susan Vianna are hereby acknowledged.

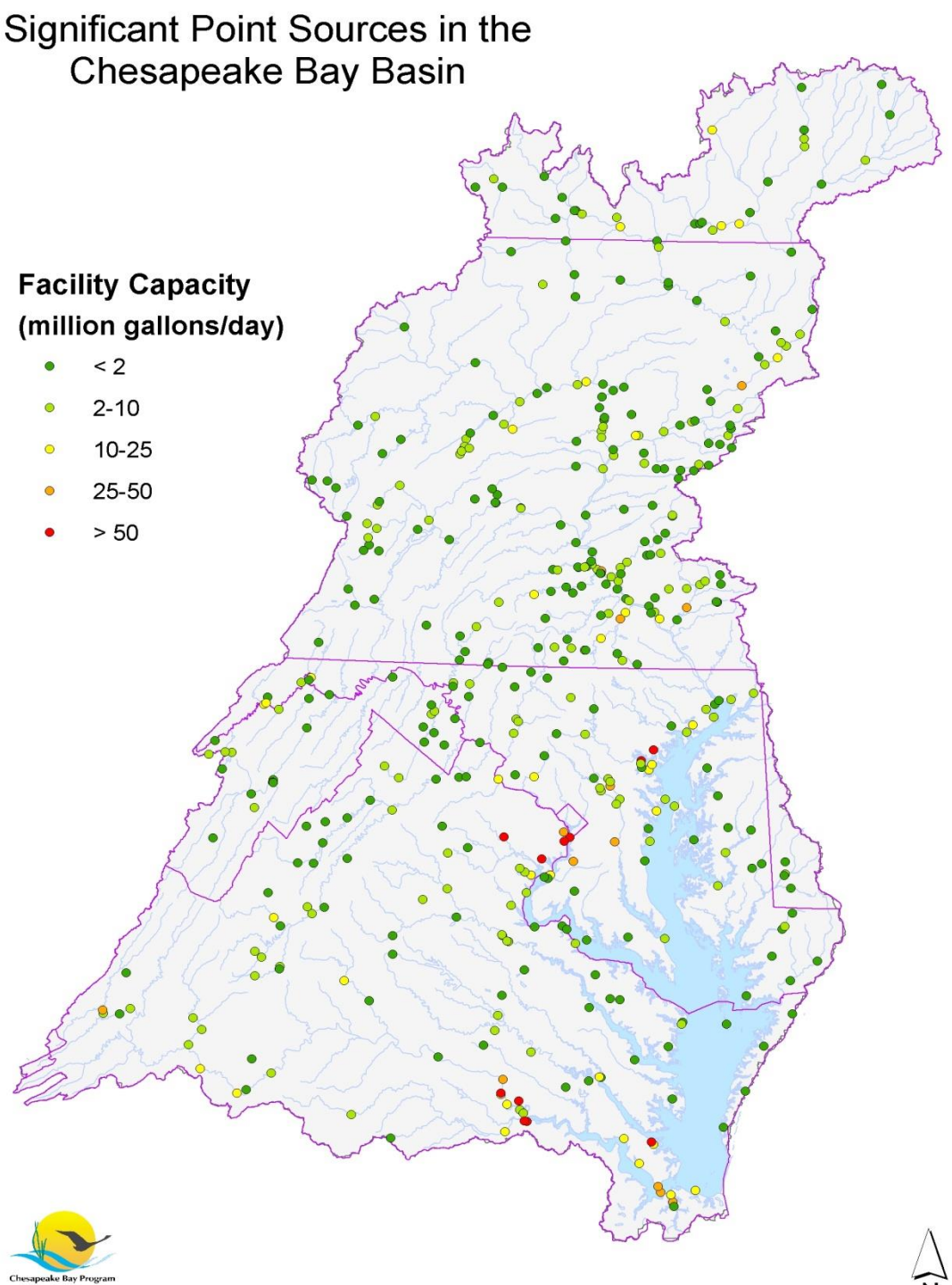
Got Science?

Key Science Elements Critical to Market-Based Solutions

- Sources, their location, loads
- Pollutant load reduction potential of practices
- Pollutant loads transportation to local waters and the Bay
- Relative influence of watershed loads on different tidal waters

Sources of Nutrient and Sediment Pollutants are Known

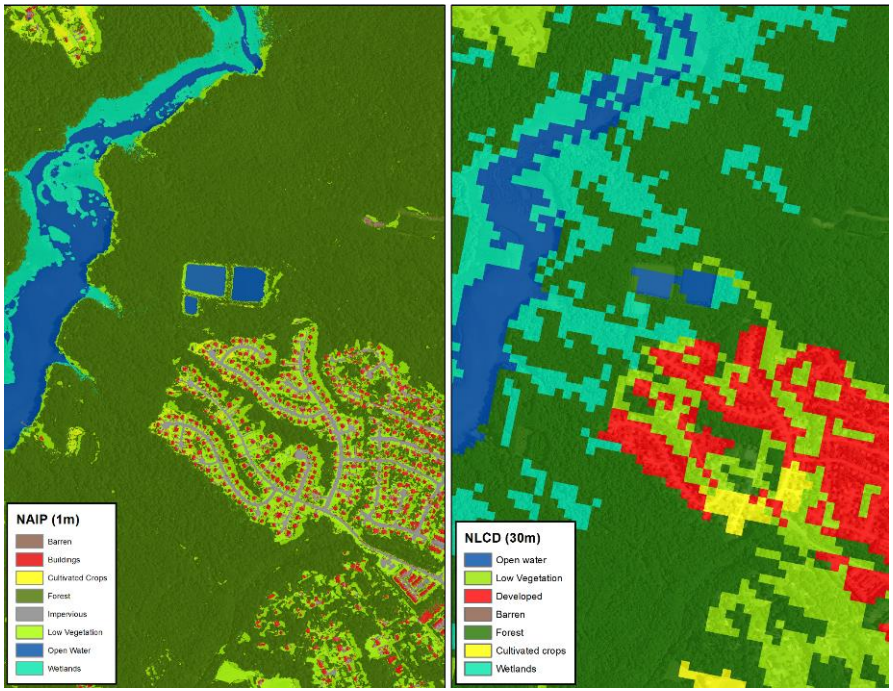
- 468 significant municipal and industrial wastewater facilities
- 5,215 non-significant municipal and industrial watershed facilities
- Each with measured or estimated loads at point of discharge and loads delivered to Bay tidal waters



High Resolution Land Cover Imagery is Changing How We View our Watershed…

1 Meter

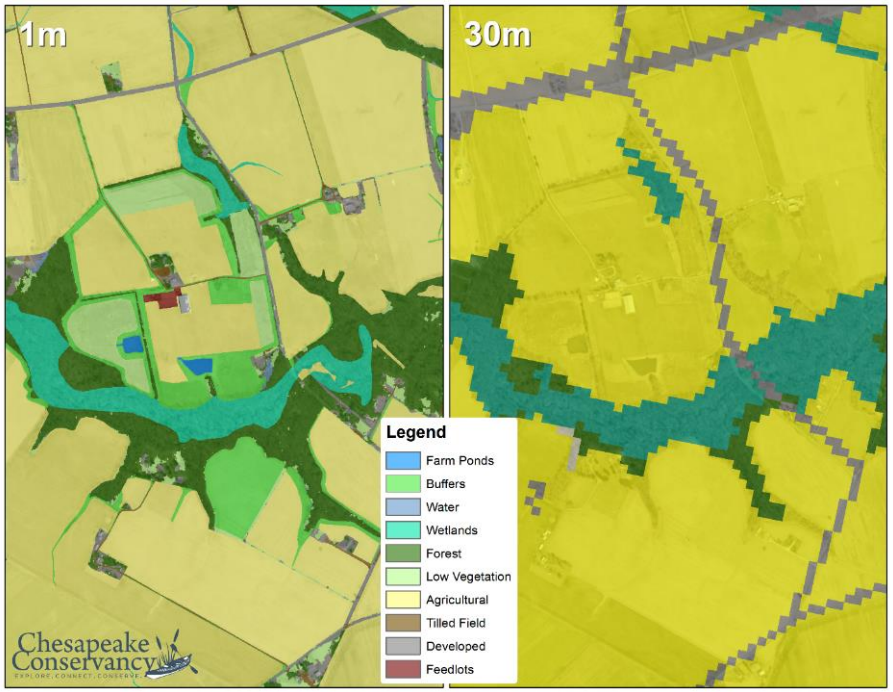
30 Meter



Urban/Suburban Lands

1 Meter

30 Meter



Rural Lands

…and Greatly Improving Our Understanding of the Location and Extent of Pollutant Sources

Partnership Has Approved 100's of BMPs

Alternative Crops
Animal Waste Management System
Barnyard Runoff Control
Biofilters
Conservation Tillage - Additional Acres
Conservation Tillage - Total Acres
Continuous No Till
Continuous, High Residue, Minimum Soil Disturbance Tillage Management
Cover Crops (A LOT!)
Dairy Precision Feeding and/or Forage Management
Decision Agriculture Efficiency Version
Dirt & Gravel Road Erosion & Sediment Control - Driving Surface Aggregate + Raising the Roadbed
Dirt & Gravel Road Erosion & Sediment Control - Outlets only
Dirt & Gravel Road Erosion & Sediment Control - with Outlets
Enhanced Nutrient Application Management Efficiency Version
Forest Buffers
Grass Buffers; Vegetated Open Channel – Agriculture
Horse Pasture Management
Lagoon Covers
Land Retirement to hay without nutrients (HEL)
Land Retirement to pasture (HEL)
Loafing Lot Management
Manure Transport
Mortality Composters
Non Urban Stream Restoration
Off Stream Watering Without Fencing
Poultry Litter Treatment (alum, for example)
Poultry Phytase
Precision Intensive Rotational Grazing
Prescribed Grazing
Shoreline Erosion Control
Soil Conservation and Water Quality Plans
Stream Access Control with Fencing
Streamside Forest Buffers
Streamside Grass Buffers
Streamside Wetland Restoration
Tier 1 Crop Group Nutrient Application Management Efficiency Version
Tree Planting
Water Control Structures
Wetland Restoration

Dirt & Gravel Road Erosion & Sediment Control - Driving Surface Aggregate + Raising the Roadbed
Dirt & Gravel Road Erosion & Sediment Control - Outlets only
Dirt & Gravel Road Erosion & Sediment Control - with Outlets
Forest Harvesting Practices
Non Urban Stream Restoration
Shoreline Erosion Control
Septic Connection
Septic Denitrification
Septic Pumping

Abandoned Mine Reclamation
Bioretention/raingardens - A/B soils, no underdrain
Bioretention/raingardens - A/B soils, underdrain
Bioretention/raingardens - C/D soils, underdrain
Bioswale
Dirt & Gravel Road Erosion & Sediment Control - Driving Surface Aggregate + Raising the Roadbed
Dirt & Gravel Road Erosion & Sediment Control - Outlets only
Dirt & Gravel Road Erosion & Sediment Control - with Outlets
Dry Detention Ponds and Hydrodynamic Structures
Dry Extended Detention Ponds
Erosion and Sediment Control Level 1
Erosion and Sediment Control Level 2
Erosion and Sediment Control Level 3
Forest Conservation
Impervious Urban Surface Reduction
MS4 Permit-Required Stormwater Retrofit
Permeable Pavement w/ Sand, Veg. - A/B soils, no underdrain
Permeable Pavement w/ Sand, Veg. - A/B soils, underdrain
Permeable Pavement w/ Sand, Veg. - C/D soils, underdrain
Permeable Pavement w/o Sand, Veg. - A/B soils, no underdrain
Permeable Pavement w/o Sand, Veg. - A/B soils, underdrain
Permeable Pavement w/o Sand, Veg. - C/D soils, underdrain
Shoreline Erosion Control
Stormwater Management by Era 1985 to 2002 MD
Stormwater Management by Era 2002 to 2010 MD
Street Sweeping 25 times a year-acres (formerly called Street Sweeping Mechanical Monthly)
Street Sweeping 25 times a year-lbs
Street Sweeping Pounds
Urban Filtering Practices
Urban Forest Buffers
Urban Grass Buffers
Urban Growth Reduction
Urban Infiltration Practices w/ Sand, Veg. - A/B soils, no underdrain
Urban Infiltration Practices w/o Sand, Veg. - A/B soils, no underdrain
Urban Nutrient Management Plan
Urban Nutrient Management Plan High Risk Lawn
Urban Nutrient Management Plan Low Risk Lawn
Urban Stream Restoration
Urban Tree Planting; Urban Tree Canopy
Vegetated Open Channels - A/B soils, no underdrain
Vegetated Open Channels - C/D soils, no underdrain
Wet Ponds and Wetlands

368 BMPs Available for Tracking, Verifying Reporting and Crediting by the Partners

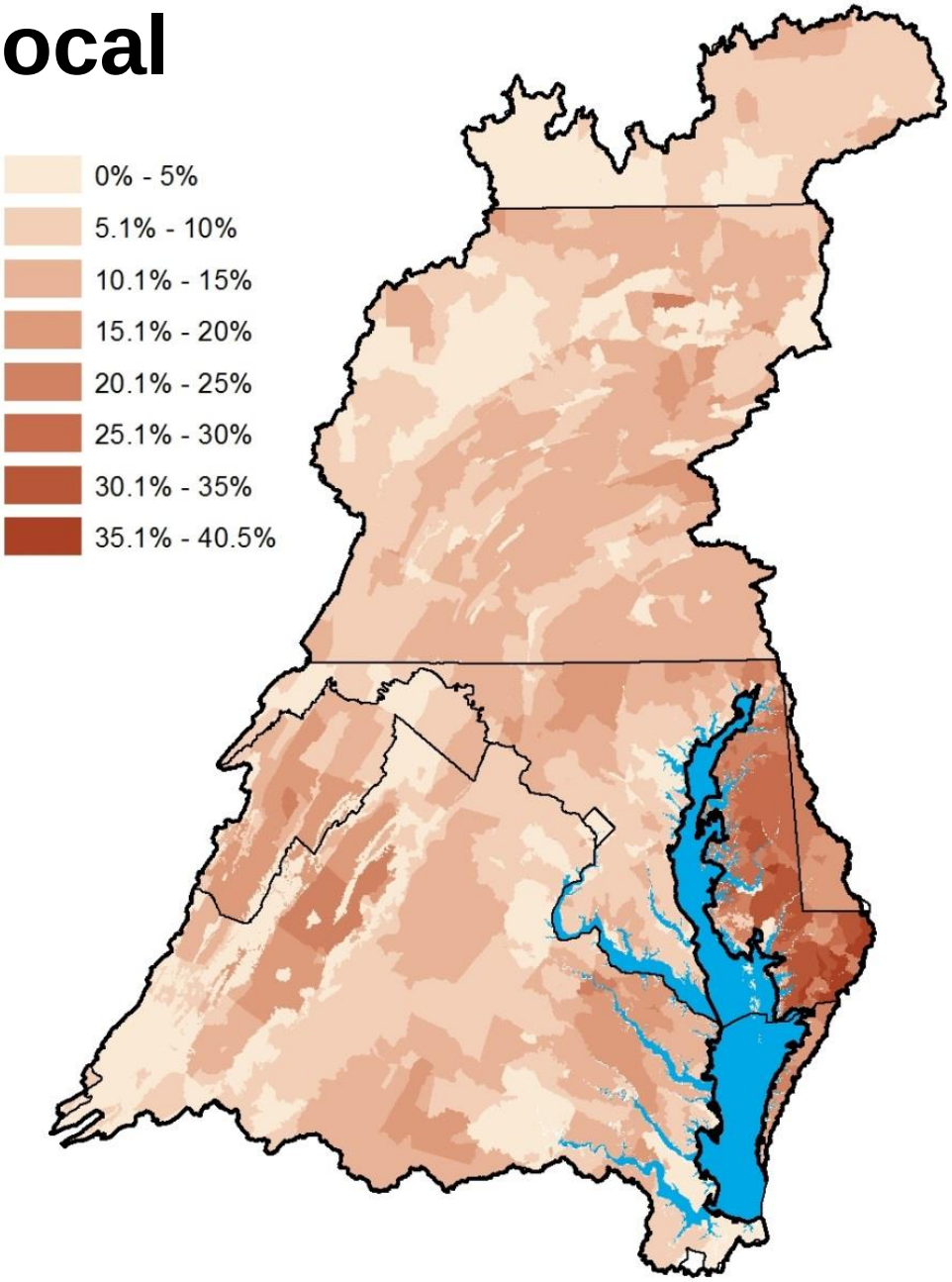
State-Specific Practice Name for NEIEN Reporting	Bay Program Practice Name
Land Reclamation, Abandoned Mined Land	Abandoned Mine Reclamation
Advanced Grey Infrastructure Nutrient Discovery Program	Advanced Grey Infrastructure Nutrient Discovery Program
Alternative Crop/Switchgrass RI	Alternative Crops
Alternative Crops	Alternative Crops
Animal Waste Management Systems (All Types)	Animal Waste Management System
Dry Waste Storage Structure RI	Animal Waste Management System
Solid/Liquid Waste Separation Facility	Animal Waste Management System
Waste Control Facilities	Animal Waste Management System
Waste Control Facility	Animal Waste Management System
Waste Storage Facility	Animal Waste Management System
Waste Storage Pond	Animal Waste Management System
Waste Storage Structure	Animal Waste Management System
Waste Treatment - Beef	Animal Waste Management System
Waste Treatment - Dairy	Animal Waste Management System
Waste Treatment - Horse	Animal Waste Management System
Waste Treatment - Poultry	Animal Waste Management System
Waste Treatment - Swine	Animal Waste Management System
Waste Treatment - Turkey	Animal Waste Management System
Waste Treatment Lagoon	Animal Waste Management System
Animal Trails and Walkways	Barnyard Runoff Control
Barnyard Clean Water Diversion RI	Barnyard Runoff Control
Barnyard Runoff Controls	Barnyard Runoff Control
Barnyard Runoff Management	Barnyard Runoff Control
Roof runoff management	Barnyard Runoff Control
Roof Runoff Structure	Barnyard Runoff Control
Stormwater Runoff Control	Barnyard Runoff Control
Wastewater Treatment Strip	Barnyard Runoff Control
Bioretention	Bioretention/raingardens - A/B soils, no underdrain
Biofiltration	Bioretention/raingardens - A/B soils, underdrain

State-Specific Practice Name for NEIEN Reporting	Bay Program Practice Name
Green Parking Lot	Bioretention/raingardens - A/B soils, underdrain
Rain Garden	Bioretention/raingardens - A/B soils, underdrain
Green Roofs	Bioretention/raingardens - C/D soils, underdrain
Bioswale	Bioswale
Dry Swale	Bioswale
Commodity Cover Crop- Early	Commodity Cover Crop Early Other Wheat
Cover Crops - Harvestable	Commodity Cover Crop Early Other Wheat
Commodity Cover Crop- Standard	Commodity Cover Crop Standard Other Wheat
Harvestable Cover Crop	Commodity Cover Crop Standard Other Wheat
Conservation Tillage	Conservation Tillage - Additional Acres
Residue and Tillage Management, Mulch Till	Conservation Tillage - Additional Acres
Residue and Tillage Management, No-Till/Strip Till/Direct Seed	Conservation Tillage - Additional Acres
Residue and Tillage Management, Ridge Till	Conservation Tillage - Additional Acres
Residue Management -Direct Seed	Conservation Tillage - Additional Acres
Residue Management, Mulch Till	Conservation Tillage - Additional Acres
Residue Management, No-Till/Strip Till	Conservation Tillage - Additional Acres
Residue Management, Ridge Till	Conservation Tillage - Additional Acres
Residue Management, Seasonal	Conservation Tillage - Additional Acres
High Residue Tillage Management	Continuous, High Residue, Minimum Soil Disturbance Tillage Management
Cover Crops- Early Planting	Cover Crop Early Arial Barley
Cover Crops - Early Planted Rye	Cover Crop Early Other Rye
Cover Crops - Early Planting	Cover Crop Early Other Wheat
Cover Crop	Cover Crop Late Other Wheat
Cover Crops - Wheat	Cover Crop Late Other Wheat
Plant an annual grass-type cover crop that will scavenge residual nitrogen	Cover Crop Late Other Wheat
Cover Crops - Rye	Cover Crop Late-Planting Other Rye
Cover Crops	Cover Crop Standard Other Barley
Cover Crops	Cover Crop Late Other Wheat
Cover Crops	Cover Crop Early Arial Rye

List continues for 11 more slides…

We Have Tools to Transport Pollutant Loads to Local Streams…

Chesapeake Bay Watershed Model Estimated Reduction in 2012 Total Nitrogen Loads due to Best Management Practices Implementation



…Factoring in BMPs on the Way to the Bay

•Management filter (Application BMPs)

•Atmospheric deposition
•Biosolids
•Fertilizer
•Manure

Precipitation

Applications

Applications

Hydrology submodel

Sediment submodel

Phosphorus submodel

Nitrogen submodel

Land Use

Loads

•Management filter (Efficiency BMPs)
•Sediment delivery factor

Loads

Edge-of-stream

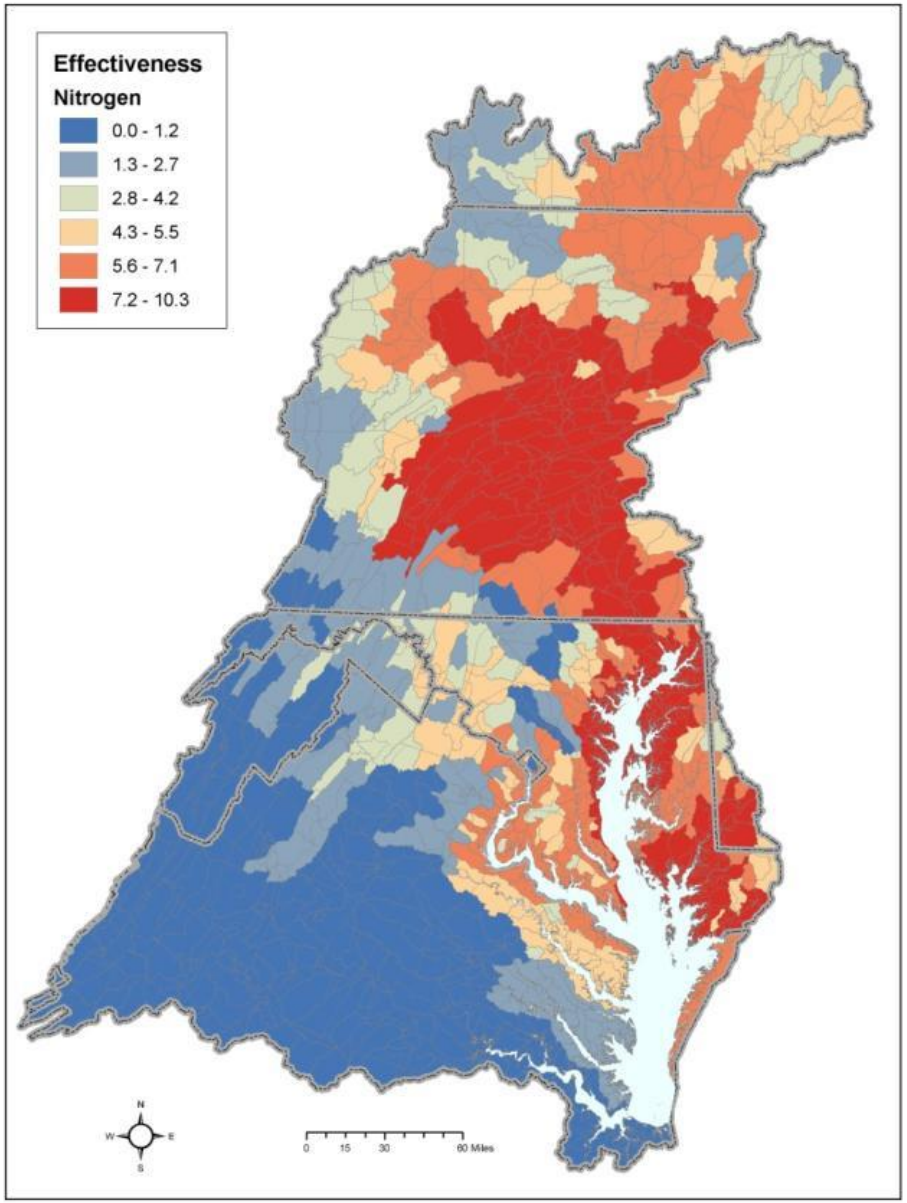
River

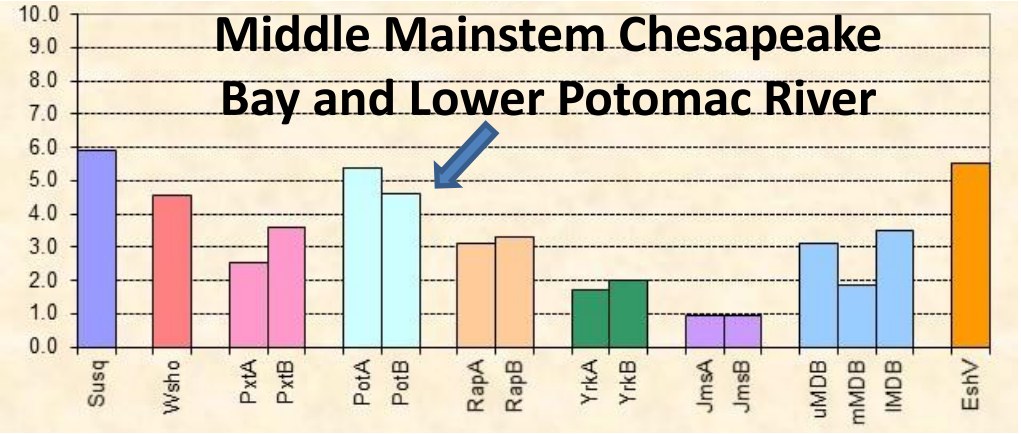
•Management filter (Pound BMPs)
•In-stream transport processing

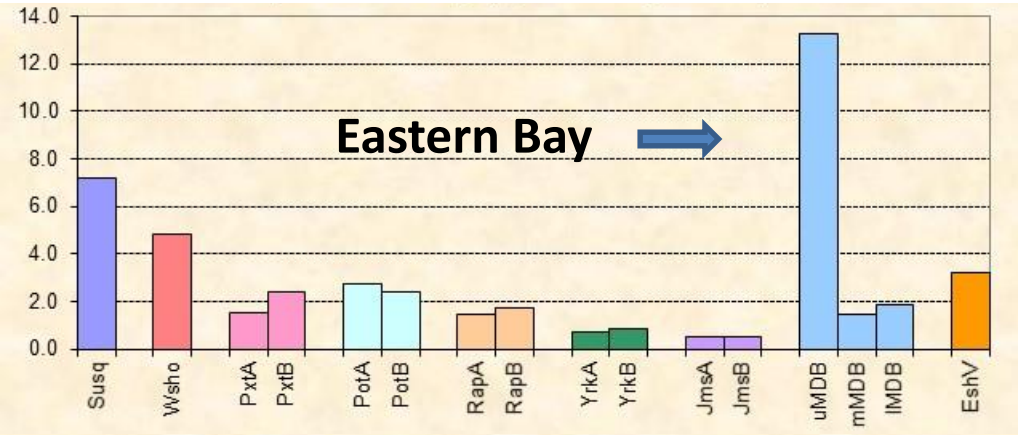
In-Stream

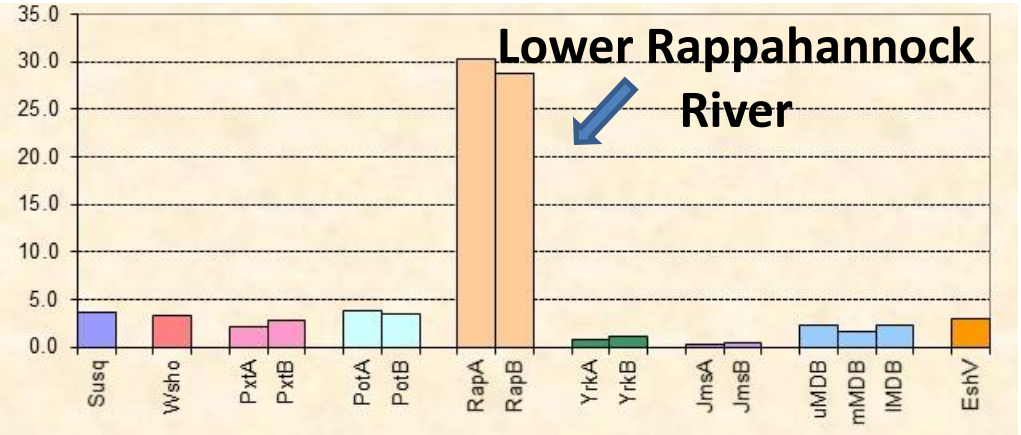
To Bay

We can Quantify the Relative Effect of a Pound of Nutrient Pollution on Bay Water Quality…









…and Determine Which Watersheds Pollutant Loads Most Influence Local Tidal Water Quality

Got Accountability?

Key Accountability Elements Critical to Market-Based Solutions

- Understandable, science-based end goals
- Accepted basis for measuring goal achievement
- Ability to quantitatively link actions taken to reduce/prevent pollutant loads with the end goals
- Holding partners accountable to practice implementation and load reduction commitments

Our States' WQ Standards Protect Bay Habitats

Minimum Amount of Oxygen (mg/L) Needed to Survive by Species

Migratory Fish Spawning & Nursery Areas

Shallow and Open Water Areas

Deep Water

Deep Channel

6

5

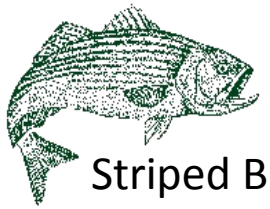
4

3

2

1

0



Striped Bass: 5-6

American Shad: 5

White Perch: 5

Yellow Perch: 5

Hard Clams: 5

Alewife: 3.6

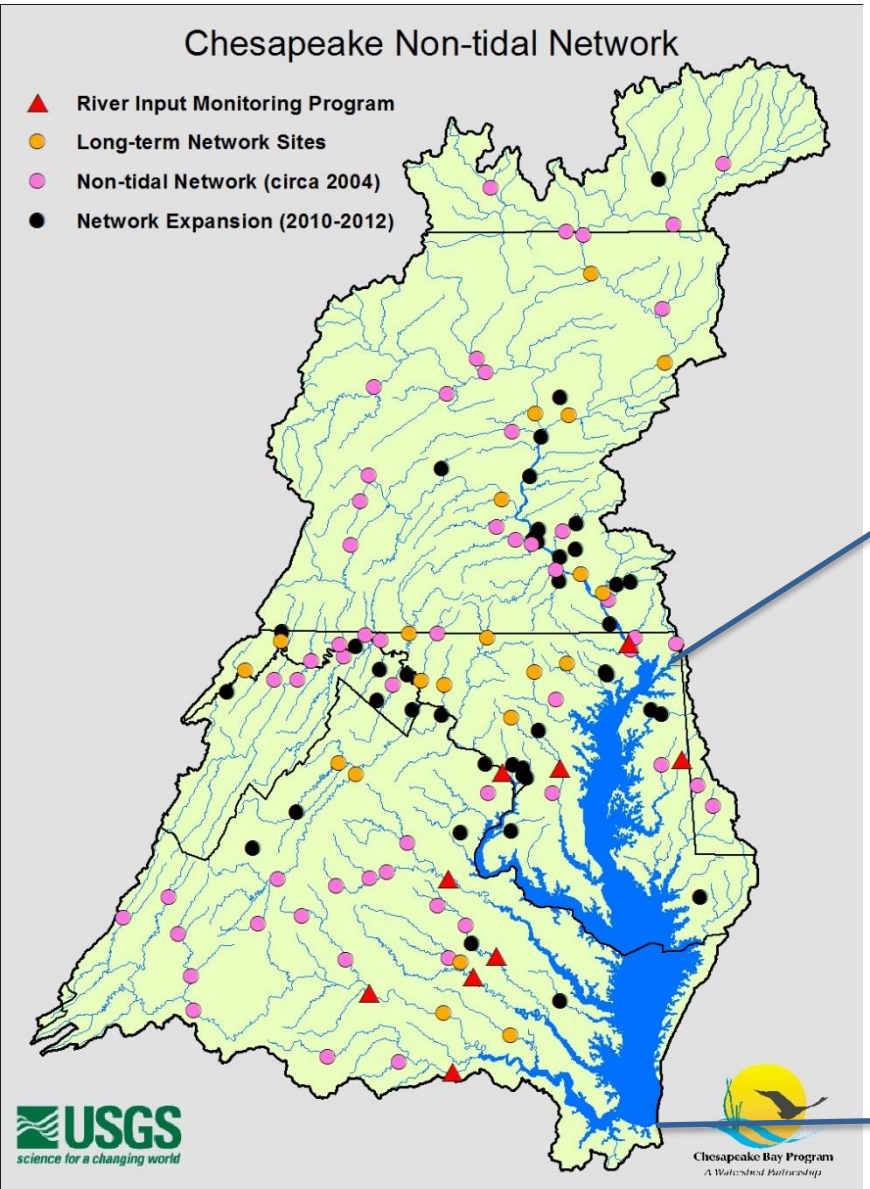
Crabs: 3

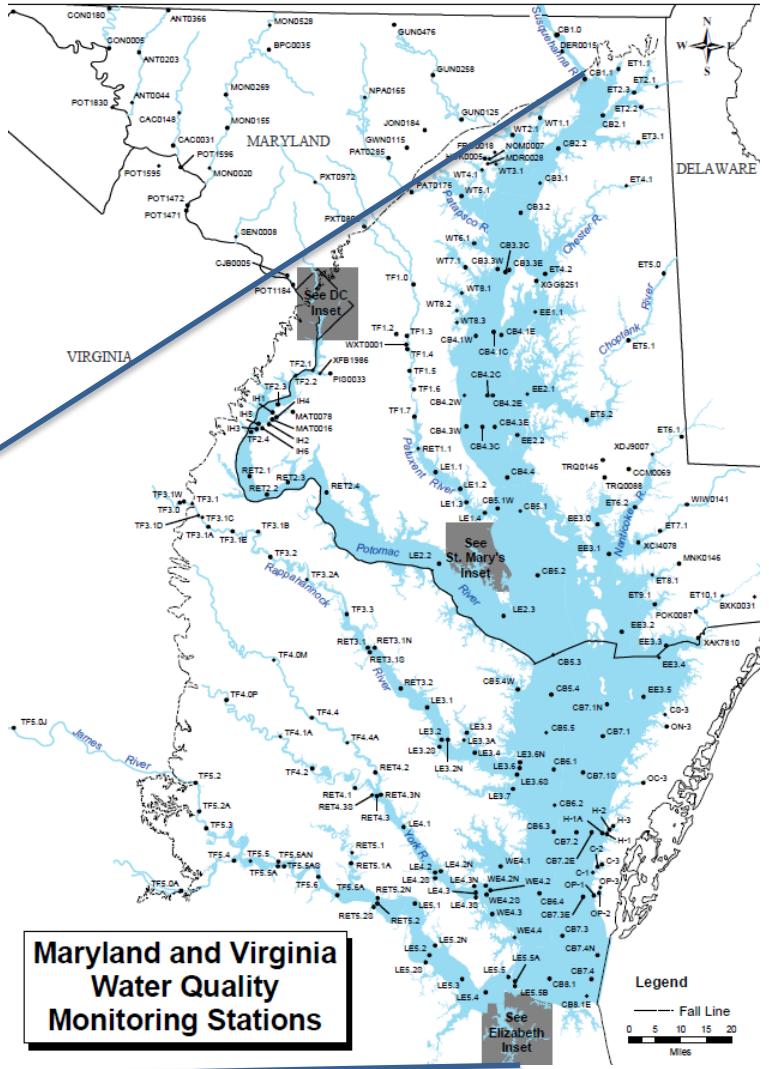
Bay Anchovy: 3

Spot: 2

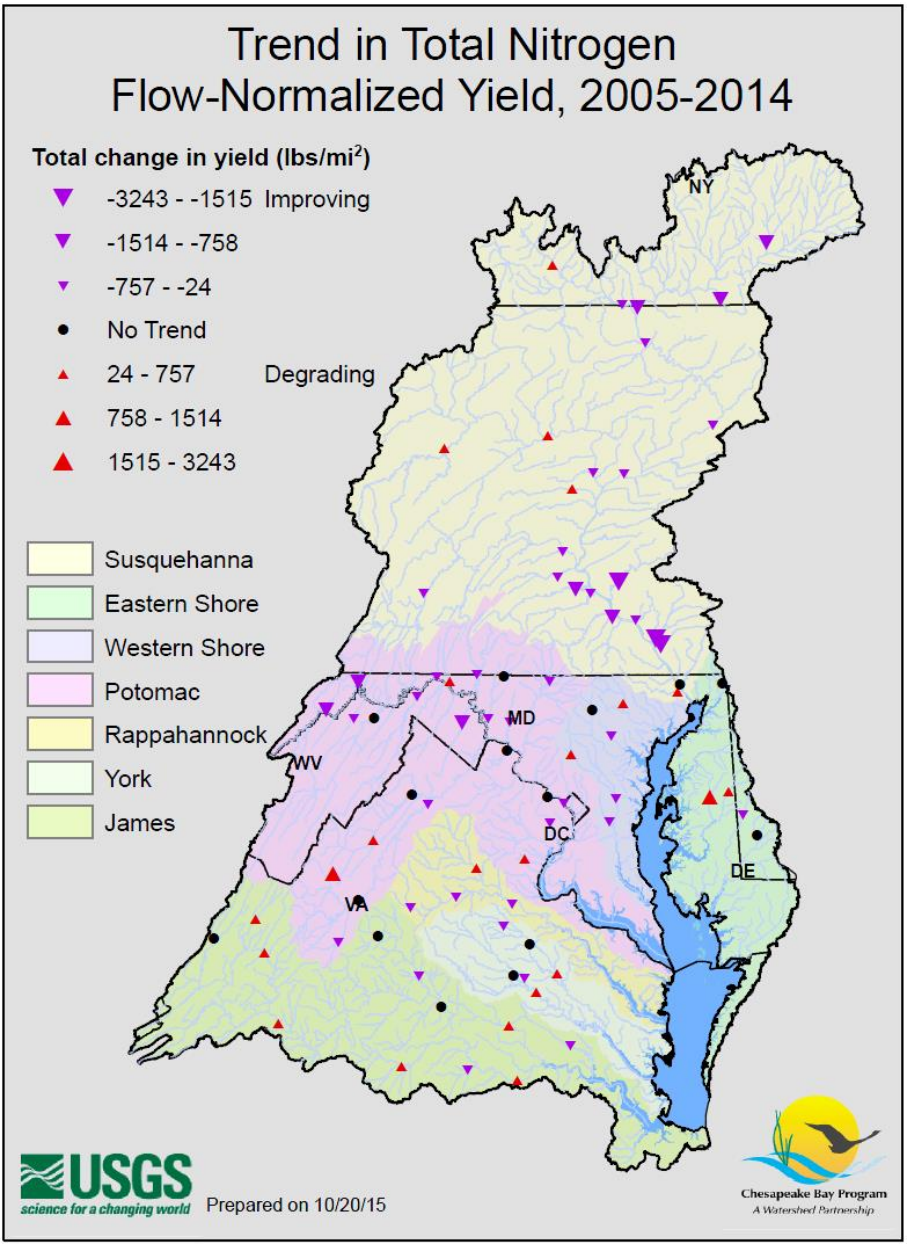
Worms: 1

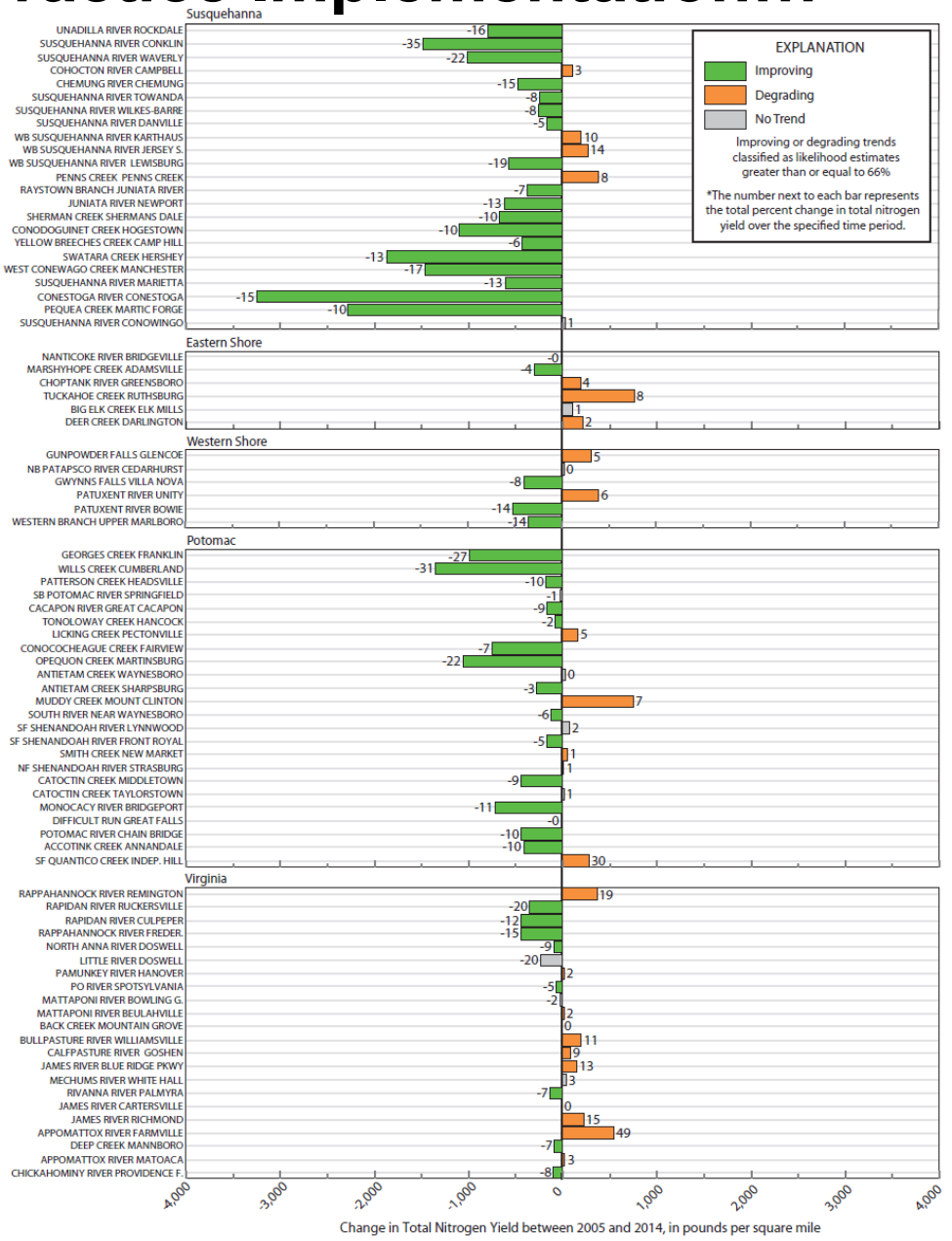
Our Multi-State Monitoring Networks Generate Data Used as Ultimate Measures of Progress





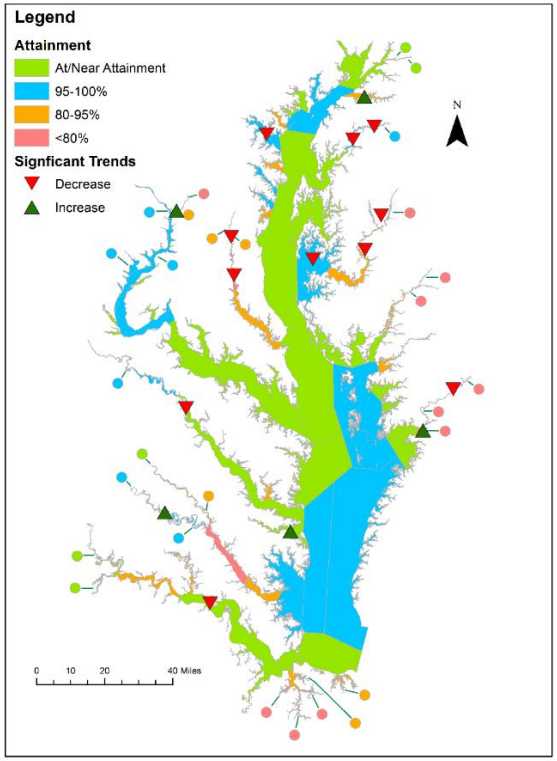
We Measure the Response of Watersheds and Local Streams and Rivers to Practice Implementation…



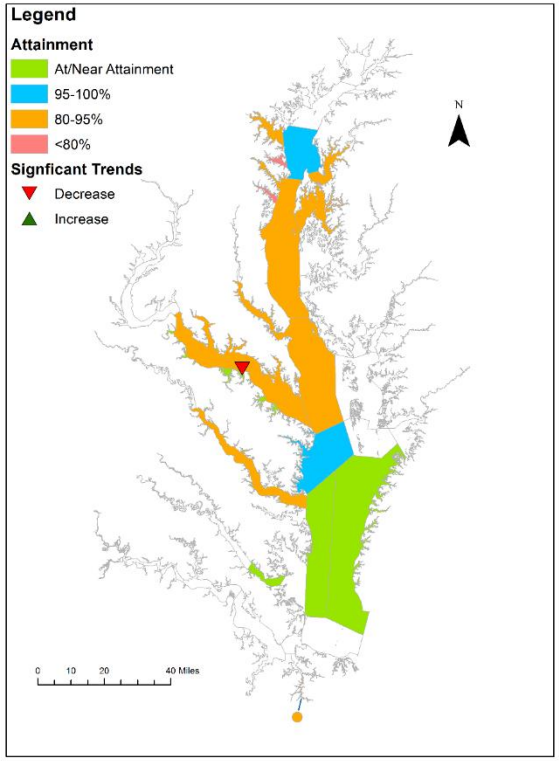


…and We Measure Progress Towards Attainment of States' Bay Water Quality Standards

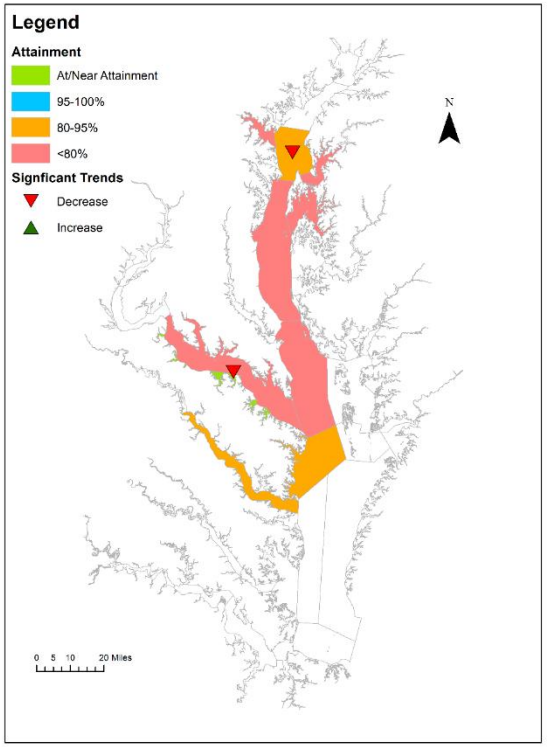
Open-Water Habitats



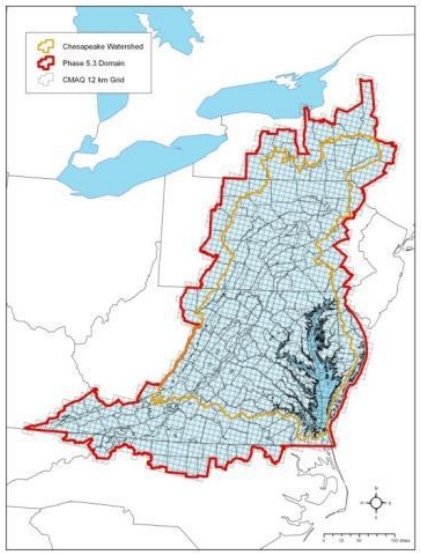
Deep-Water Habitats



Deep-Channel Habitats

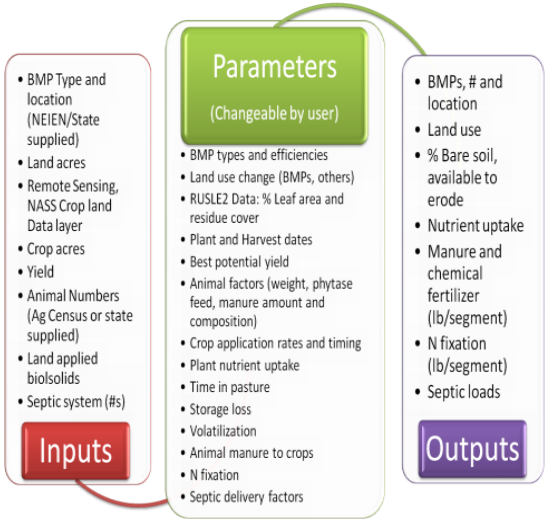


We Are Heading Towards our 6th Generation of Partnership Models Supporting Decision-making

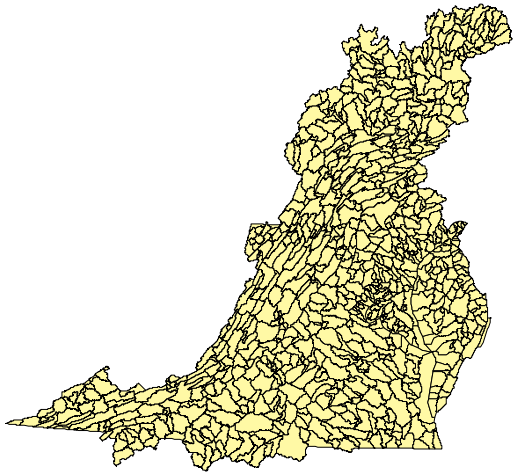


Chesapeake Bay Airshed Model

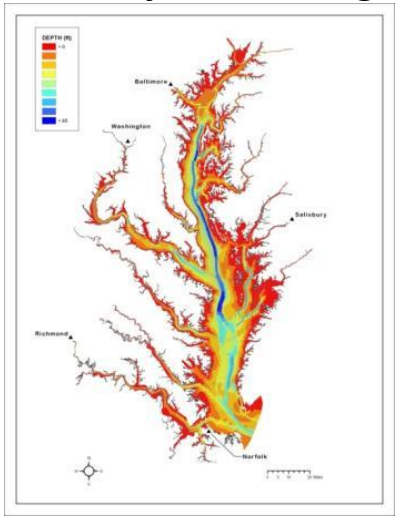
Chesapeake Bay Land Change Model



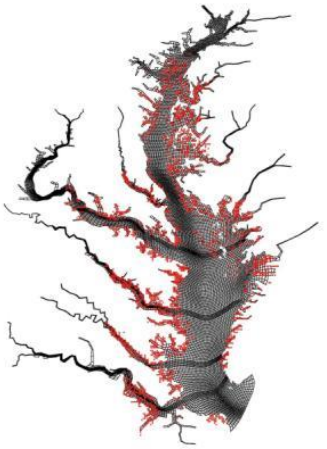
Chesapeake Bay Scenario Builder



Chesapeake Bay Watershed Model



Chesapeake Bay Water Quality and Sediment Transport Model



Chesapeake Bay Filter Feeder Model

BMP Verification is a Partnership Priority…

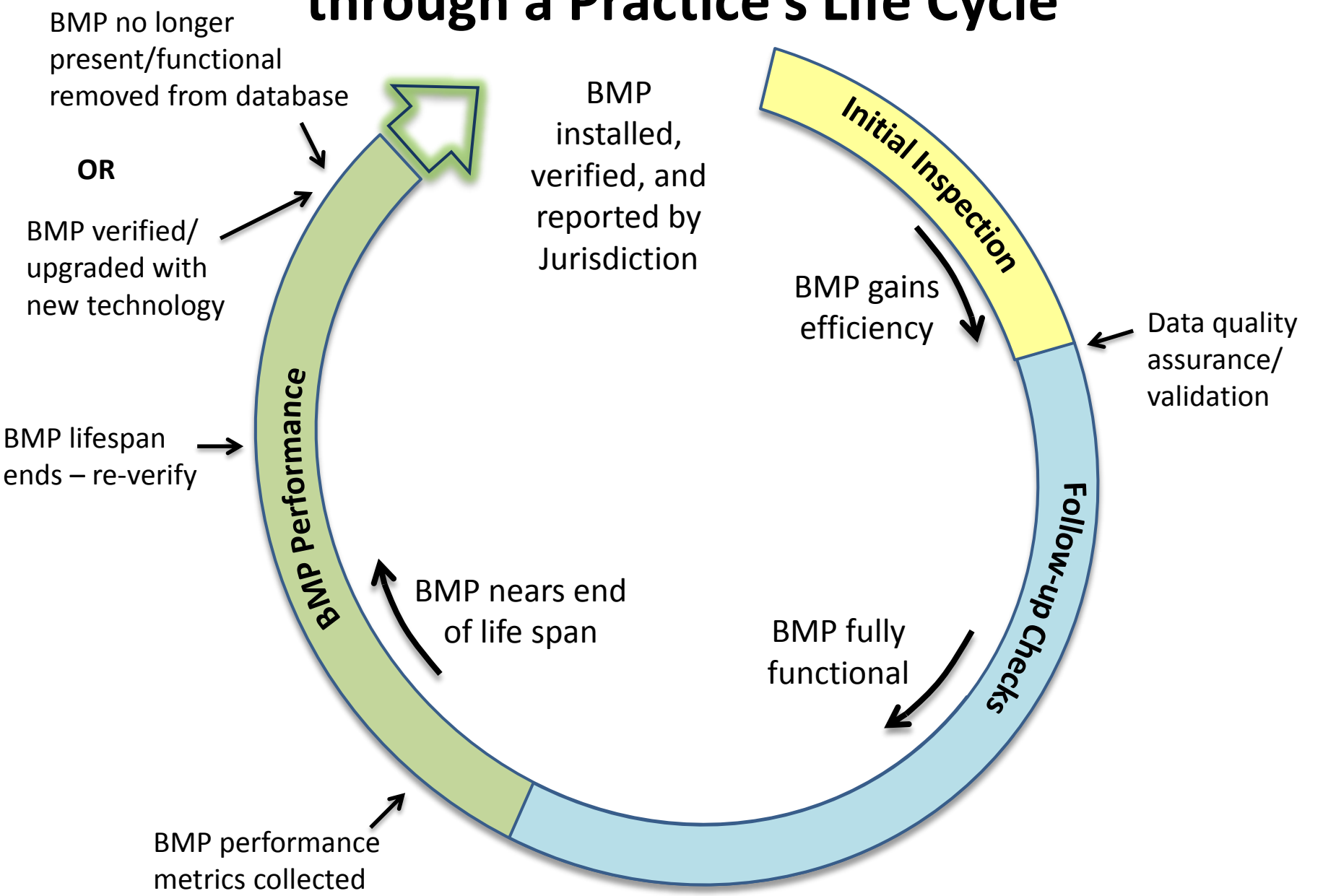
Strengthening Verification of Best Management Practices Implemented in the Chesapeake Bay Watershed: A Basinwide Framework

Report and Documentation from the Chesapeake Bay Program Water Quality Goal Implementation Team's BMP Verification Committee

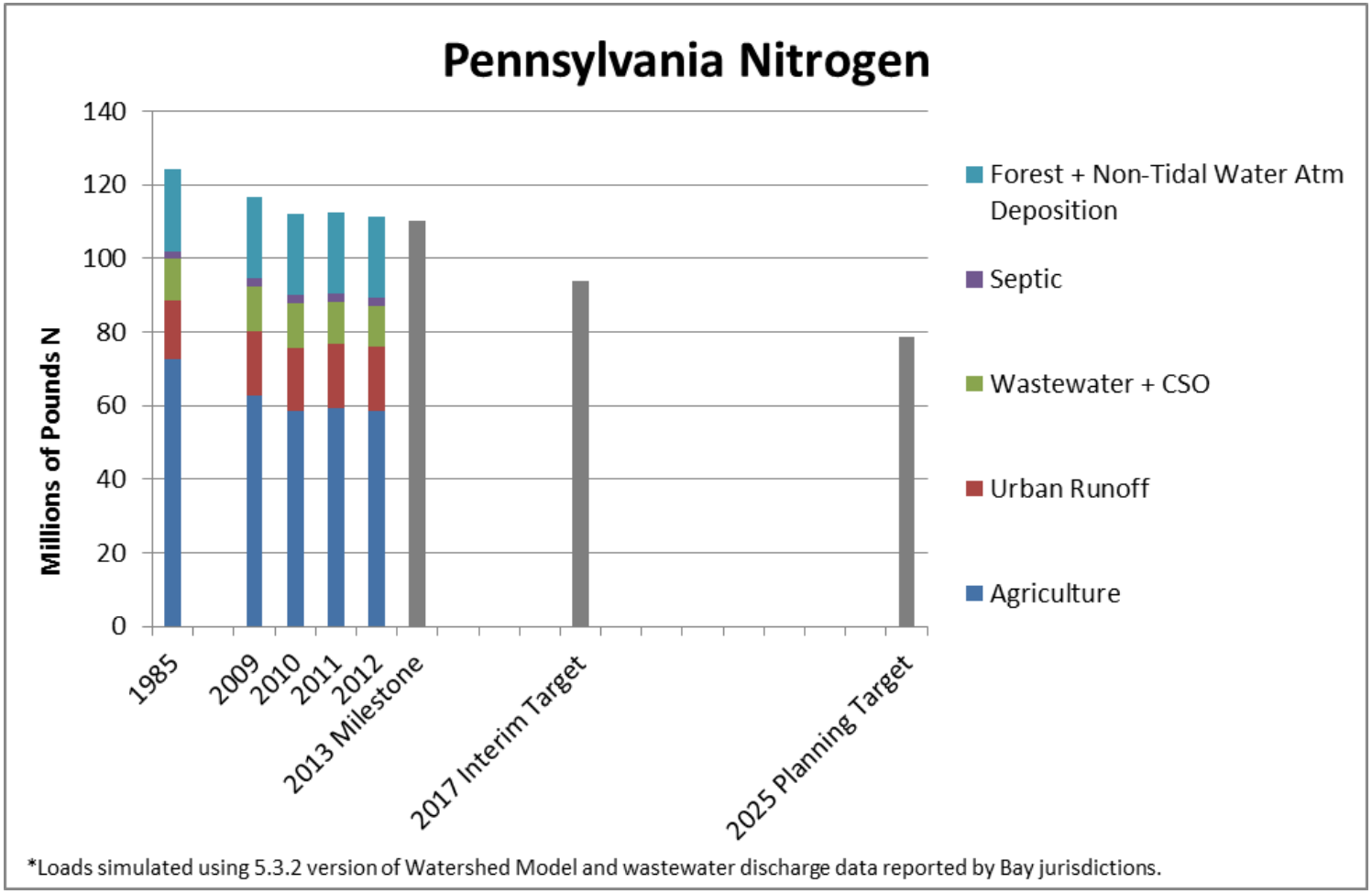
October 2014

Chesapeake Bay Program
Science. Restoration. Partnership.

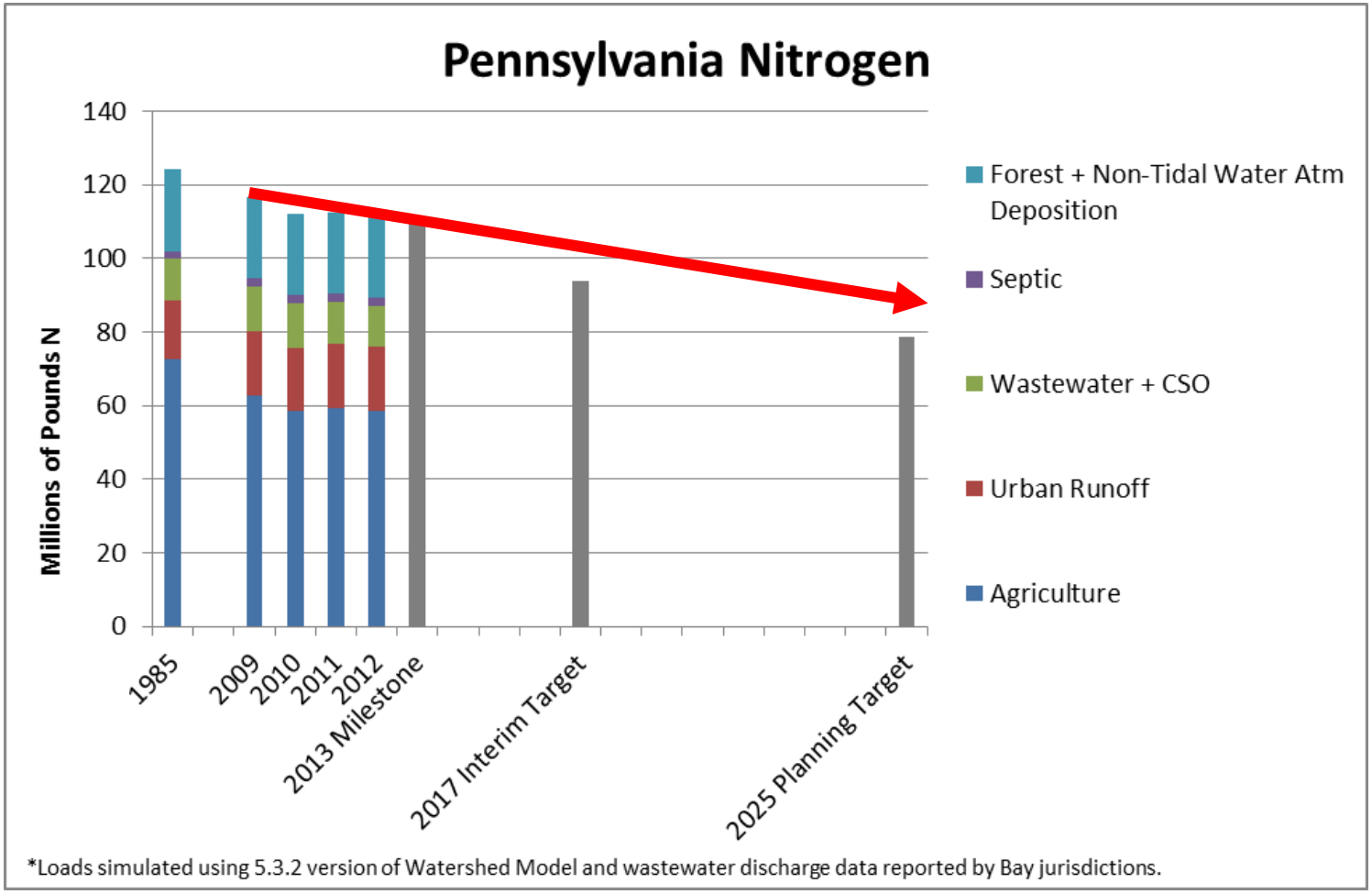
…and We Have Clear Expectations for Verification through a Practice's Life Cycle



EPA Evaluates Progress Towards Each States' 2-Year Milestones Annually…



EPA Evaluates Progress Towards Each States' 2-Year Milestones Annually…



…and Reports Back to the Public

* Green fading to yellow indicates potential downgrade at the end of the 2014-2015 milestone period if specific actions aren't taken.

Got Science?

- ✓ Sources, their location, loads **known**
- ✓ Pollutant load reduction potential of practices **estimated**
- ✓ Pollutant loads transportation to local waters and the Bay **understood**
- ✓ Relative influence of watershed loads on different tidal waters **simulated**

Key Accountability Elements Critical to Market-Based Solutions

- ✓ Understandable, science-based end goals
- ✓ Accepted basis for measuring goal achievement
- ✓ Ability to quantitatively link actions taken to reduce/prevent pollutant loads with the end goals
- ✓ Holding partners accountable to practice implementation and load reduction commitments

Rich Batiuk
Associate Director for Science, Analysis and Implementation
U.S. EPA Chesapeake Bay Program Office
410-267-5731 Office
443-223-7823 Cell
batiuk.richard@epa.gov

www.epa.gov/chesapeake-bay-tmdl

www.chesapeakebay.net