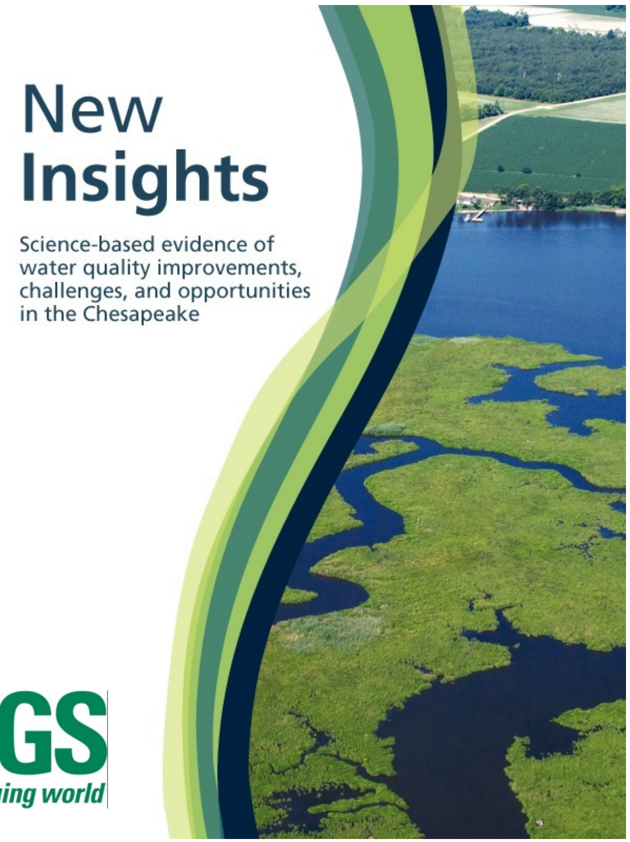
Restoring the Water-Quality Conditions in the Chesapeake Bay: *What is working and what still needs to be done*



Scott Phillips, USGS

Water-Quality Goal Team

January 12, 2015

University of Maryland Center for Environmental Science

Chesapeake Bay Program
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Many Contributors

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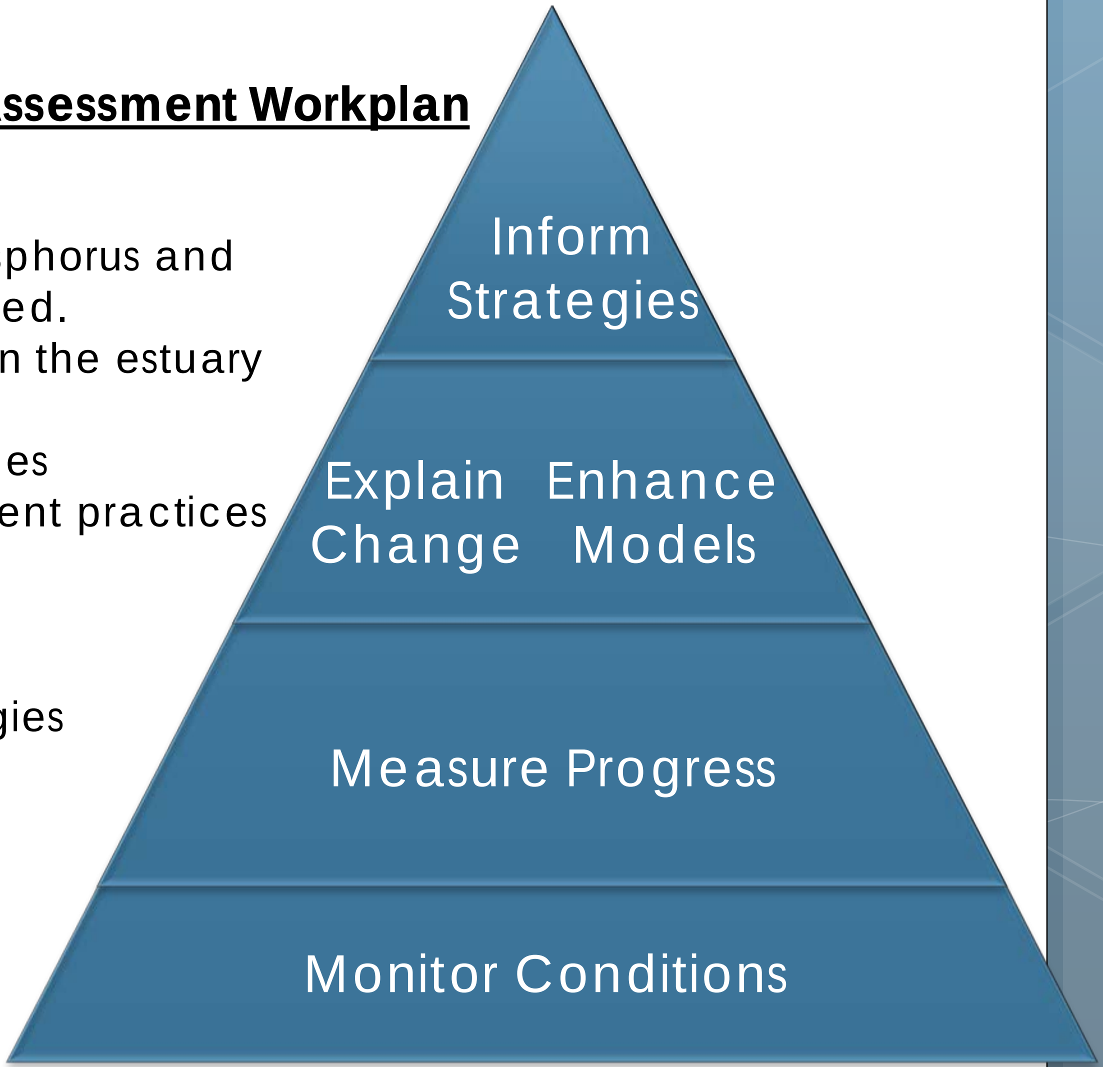
Measure Progress and Explain Change

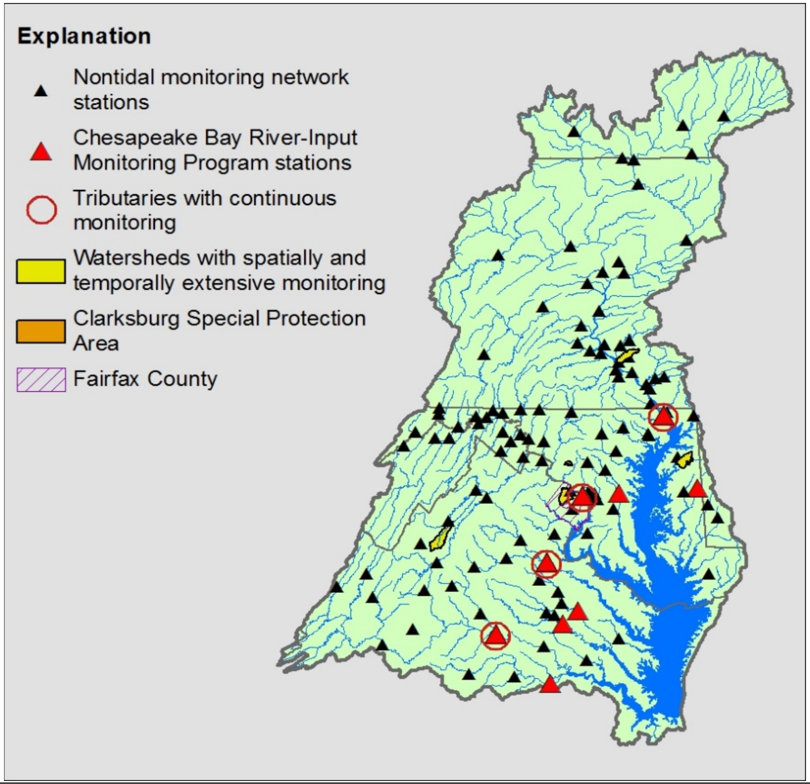
Overview: STAR Workplan Elements

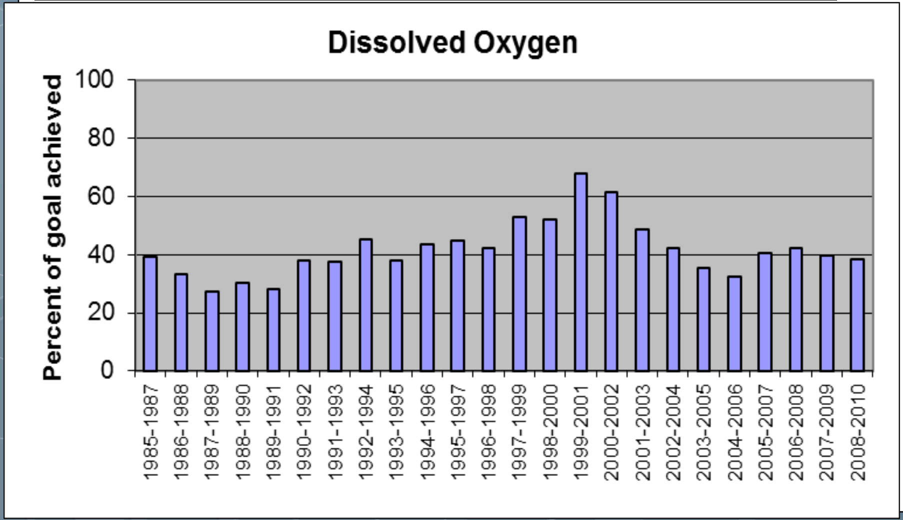
Elements of STAR Mid-Point Assessment Workplan

1. Measure progress
   - Trends of nitrogen, phosphorus and sediment in the watershed.
   - Trends of water quality in the estuary
2. Explain water-quality changes
   - Response to management practices
3. Enhance CBP models
4. Inform management strategies
   - WIPs
   - Water-quality benefits



Measuring Progress





1. Practices implemented (TMDL)
   - WSM model

2. Nutrient and sediment trends in watershed

3. Attaining standards
   - Improvements in DO clarity/SAV, and Chl.

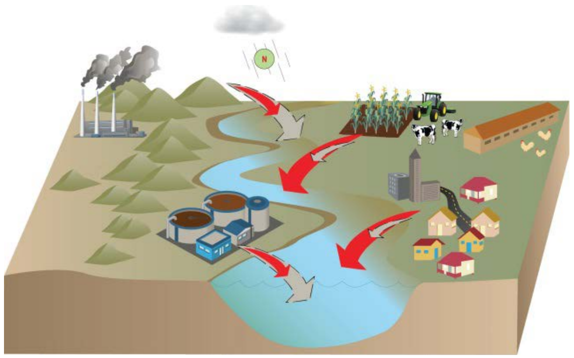
- Monitoring programs
- Summarize water-quality improvements to BMPs

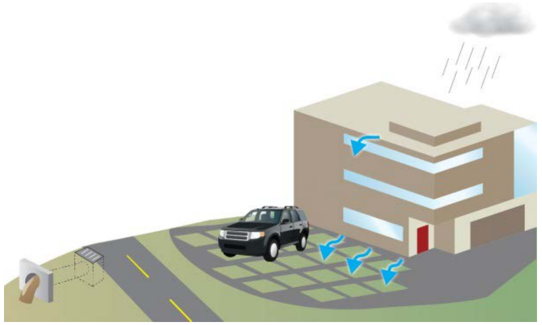
Lessons from Chesapeake Bay Restoration Efforts

- Review of over 40 case studies
- Lessons under three broad categories:
  1. **What Works**
  2. **Challenges**
  3. **What We Need**

What you will hear

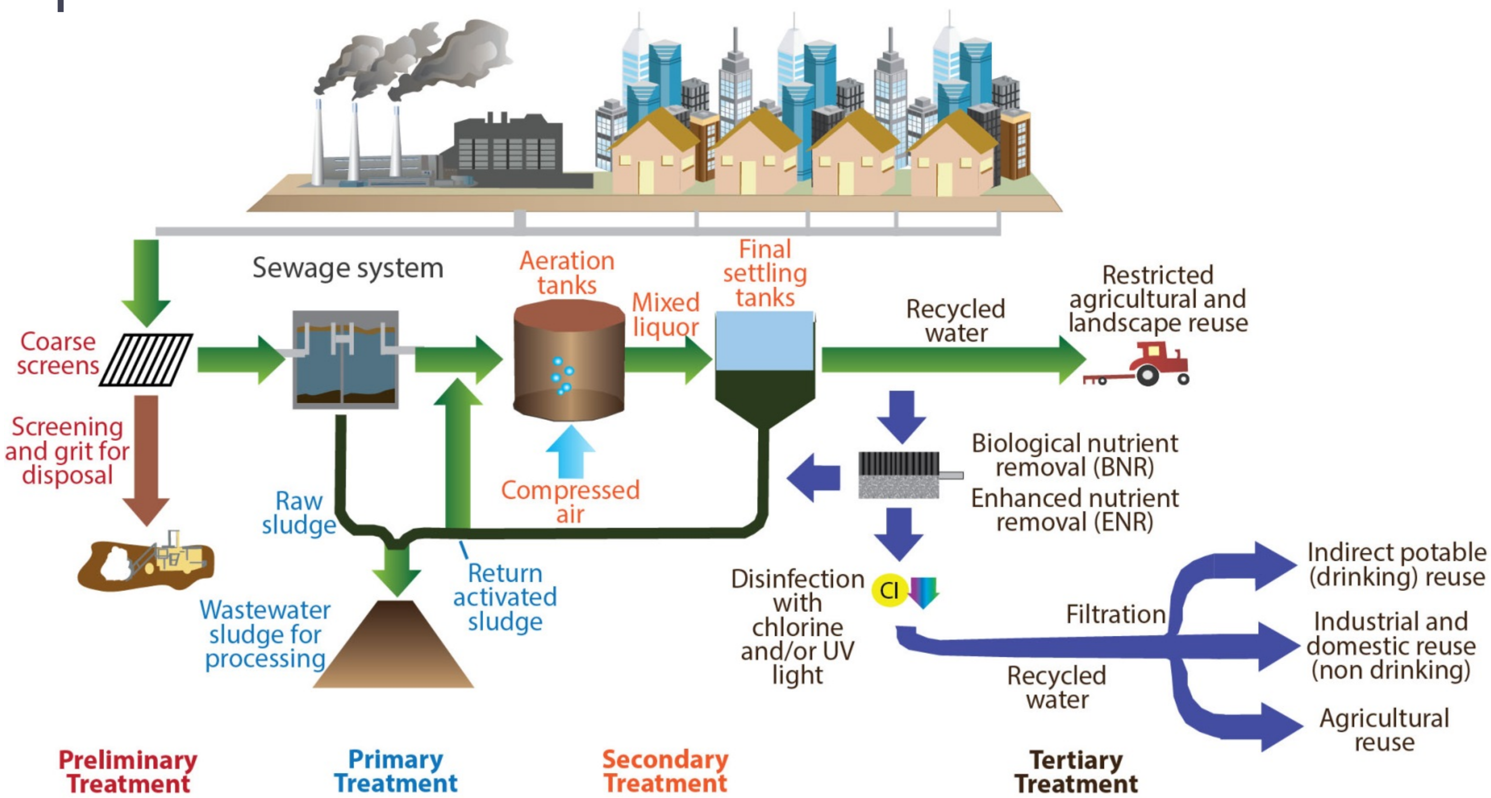
1. What Works
   - Upgrades to WWTPs
   - Reductions in air emissions
   - Some agricultural practices
2. Challenges
   - Response times
   - Population Growth
3. What We Need
   - Location should guide restoration efforts
   - Stormwater management and monitoring





Lesson 1: Wastewater treatment

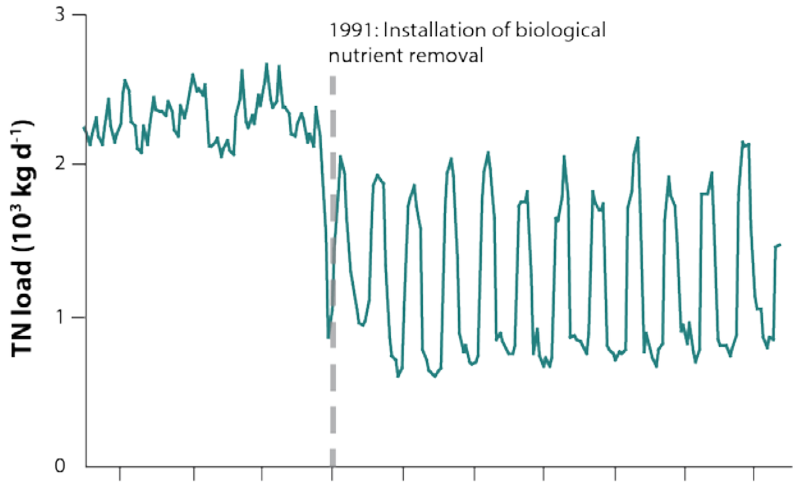
- Upgrades in both nitrogen and phosphorus wastewater treatment result in rapid local water-quality improvements



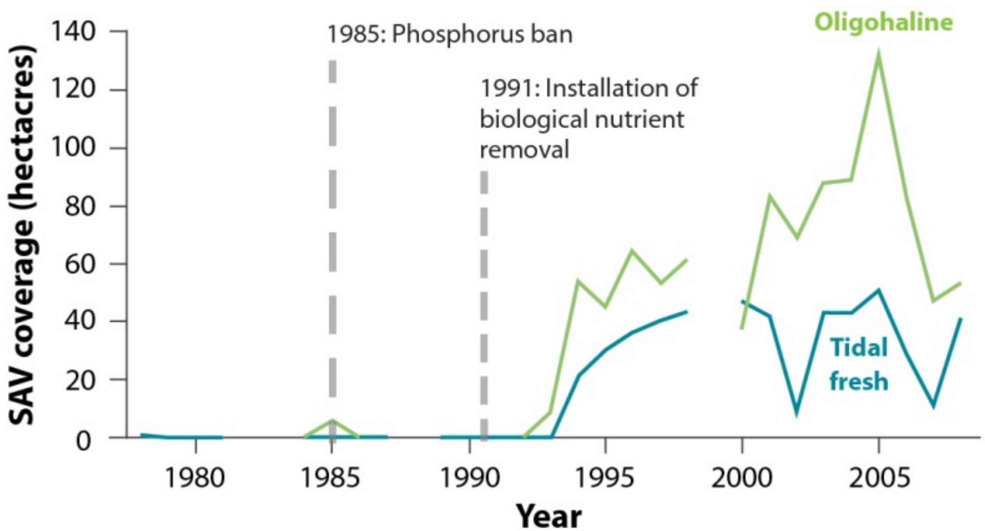
Lesson 1: WWTP

-Reduced nitrogen loads to the Upper Patuxent River

-Resurgence of submerged aquatic vegetation



Changes in TN loads (1984-2004)



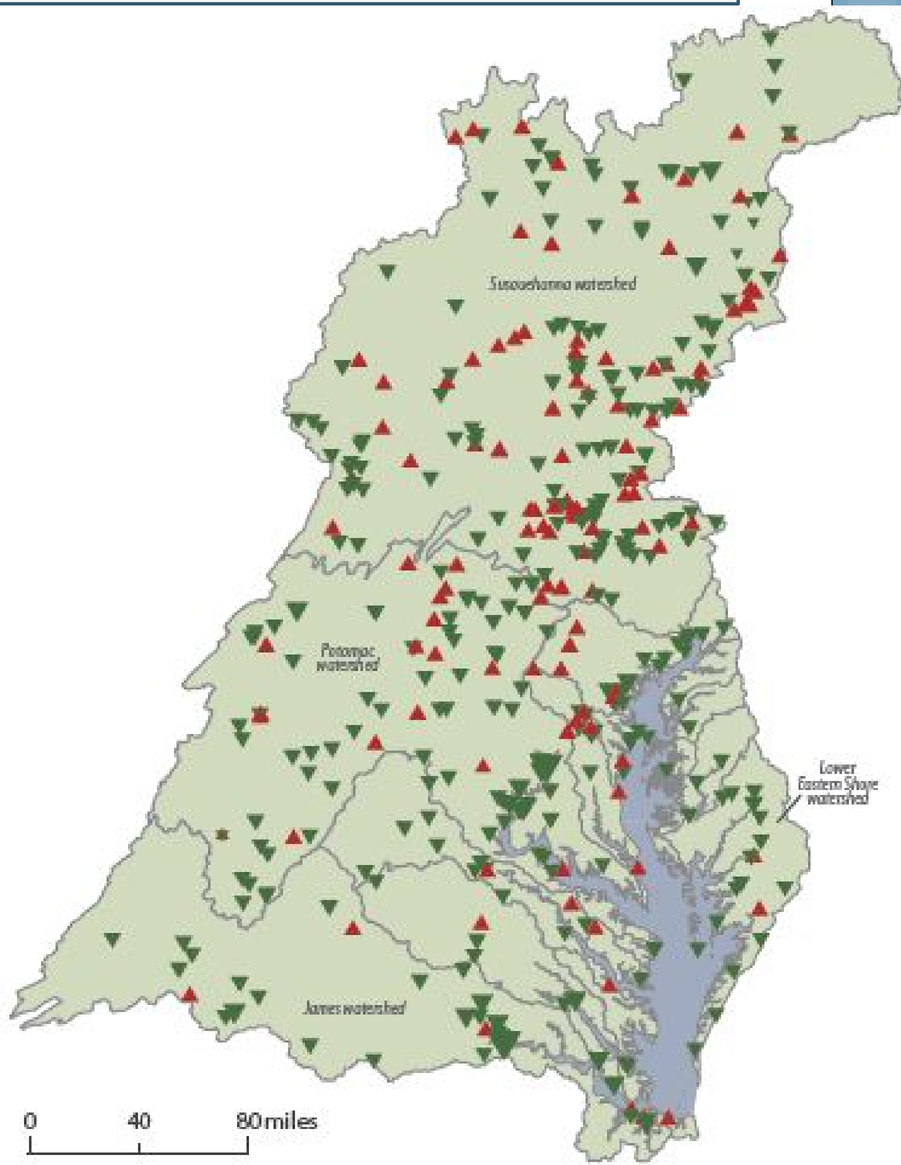
Changes in submerged aquatic vegetation (SAV) (1978-2008)

Data from Boynton et al., 2008

Data from Testa et al., 2008

WWTP Upgrades: Improvements and challenges

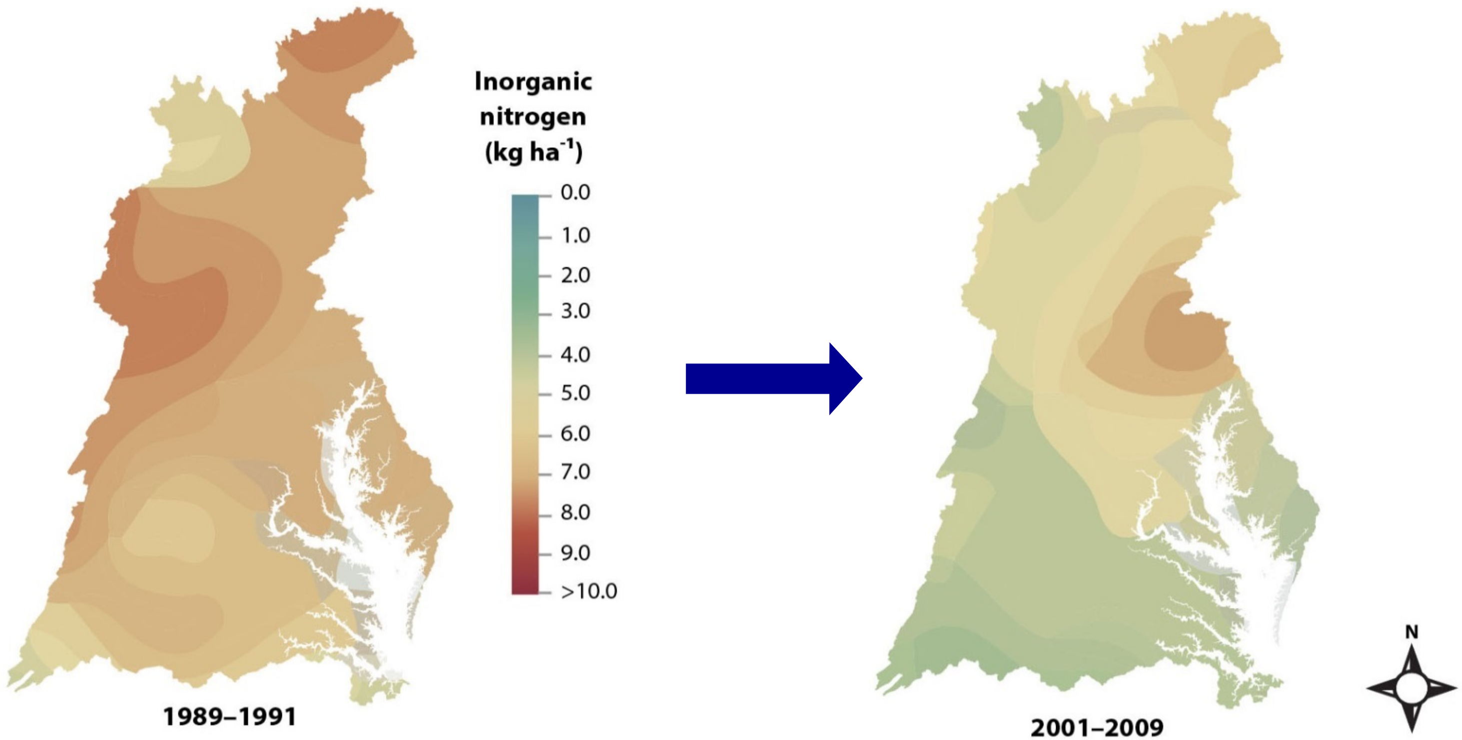
- Potomac River
  - Blue Plains (DC)
  - Fairfax County
  - Mattawomen Creek
- Challenges:
  - Increasing population
  - Costs
  - Only 20% of nutrient load



Lesson 2: Reductions in air emissions

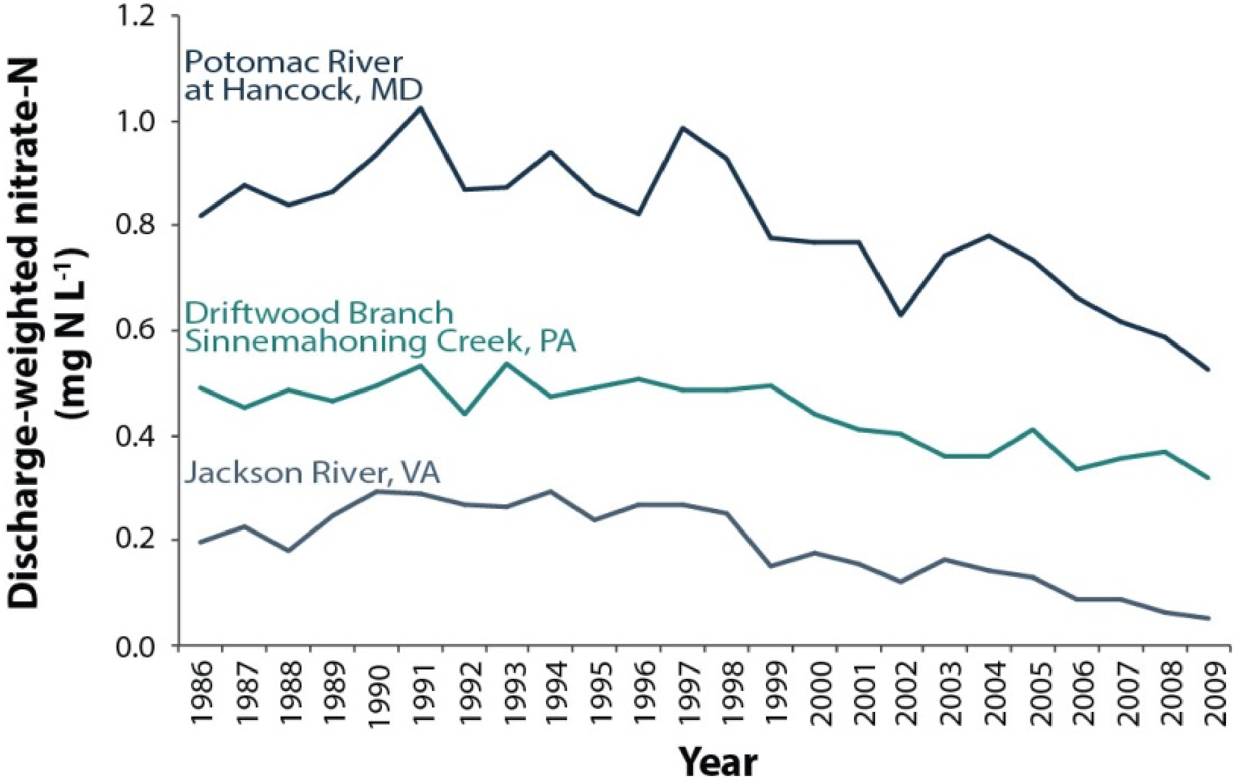
- Sources: power plants, vehicles, and manure
- Power plant controls lead to reductions in atmospheric nitrogen deposition

Annual mean wet inorganic nitrogen deposition



US EPA Clean Air Markets: 2009 Results

Power plant reductions are directly linked to improved surface-water quality in mostly-forested areas



Changes in nitrate-N concentrations at 3 water quality monitoring stations (1986-2009)

Data from Eshleman et al., 2013

Air: Vehicles and animals

- Cars and trucks
  - 58% of nitrogen in air
  - Emission controls
  - More miles driven
- Manure
  - Ammonia
  - Local effects

Lesson 3: Some agricultural practices

- Reductions of agricultural nutrient sources result in improved local stream quality

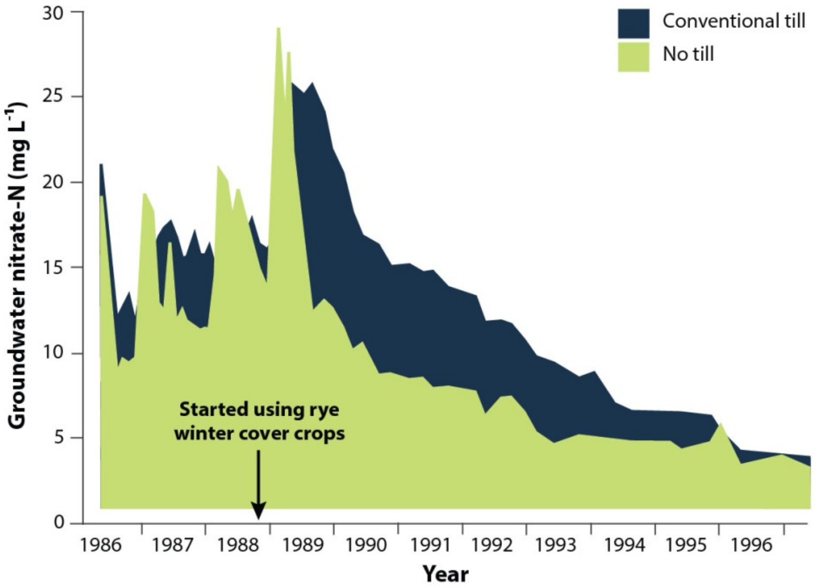
Cover crops

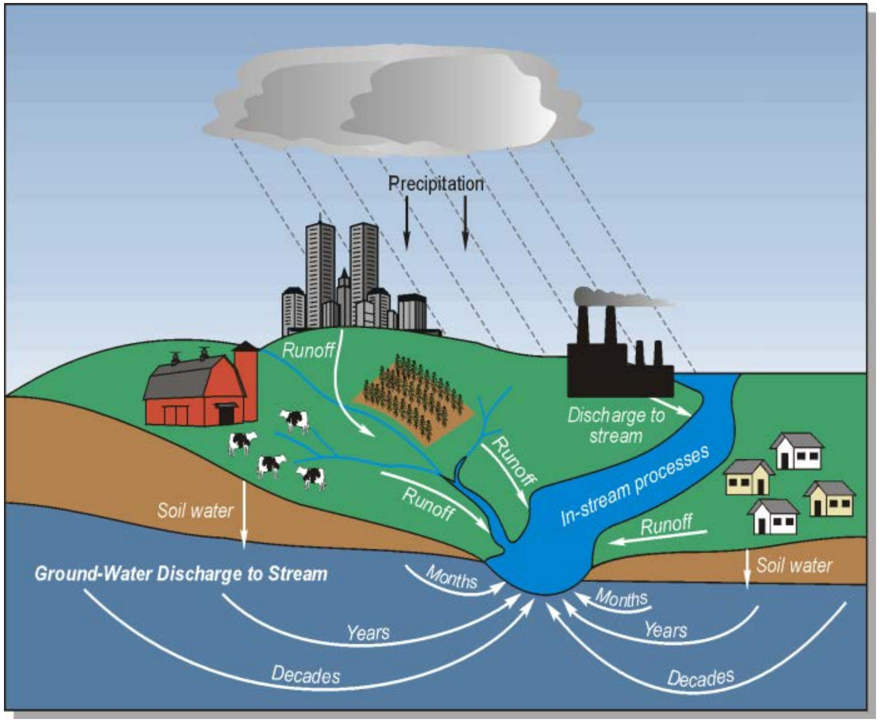
Livestock exclusion

Manure management

Photo © top left: Nicholas Tonelli, Flickr; top right: Jeff Vanuga, USDA NRCS; bottom: USDA.

Cover crops improved water quality





Changes in groundwater nitrate-N concentrations in 2 agricultural fields (1986-1998)

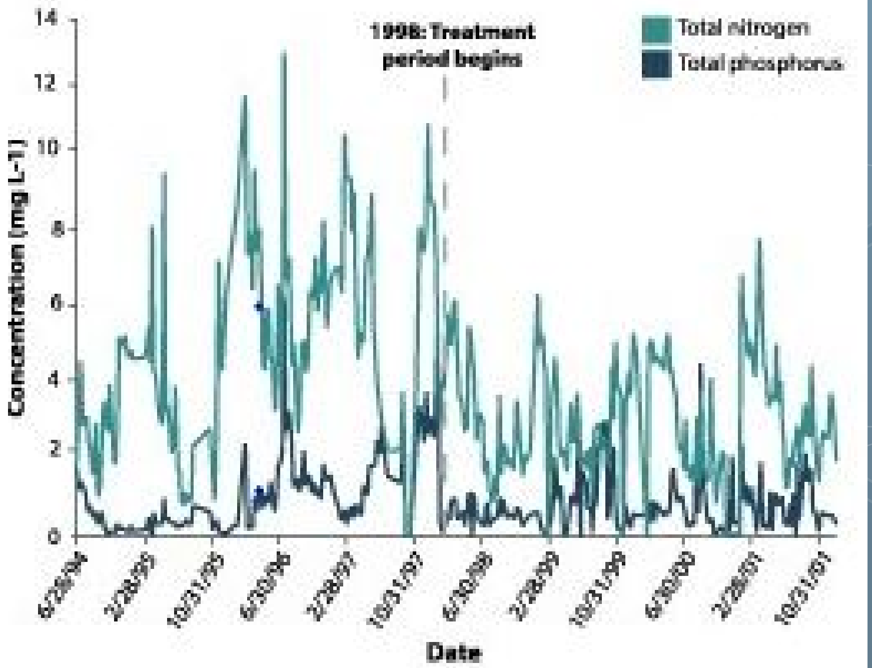
Wye River area, Eastern Shore MD

Data from Staver and Brinsfield, 1995 & 2000

Agricultural practices

- Manure and fertilizer
  - N and P changes
- Stream bank fencing
  - Lower nutrients, sediment and bacteria
  - Stream conditions

Poultry litter is a source of nutrients that can negatively affect water quality by entering streams, rivers, and the Bay through runoff and groundwater. Photo © Chesapeake Bay Program.



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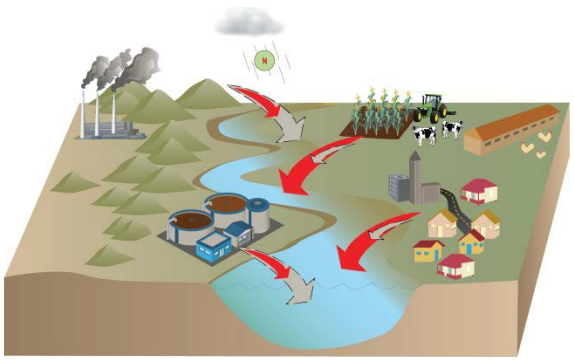
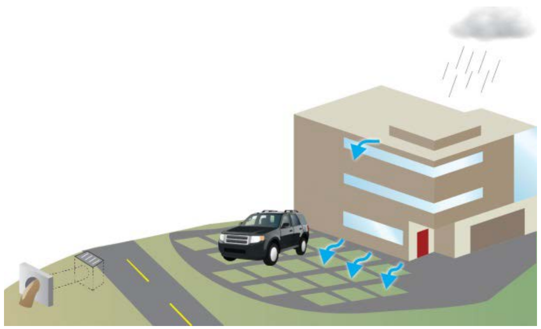
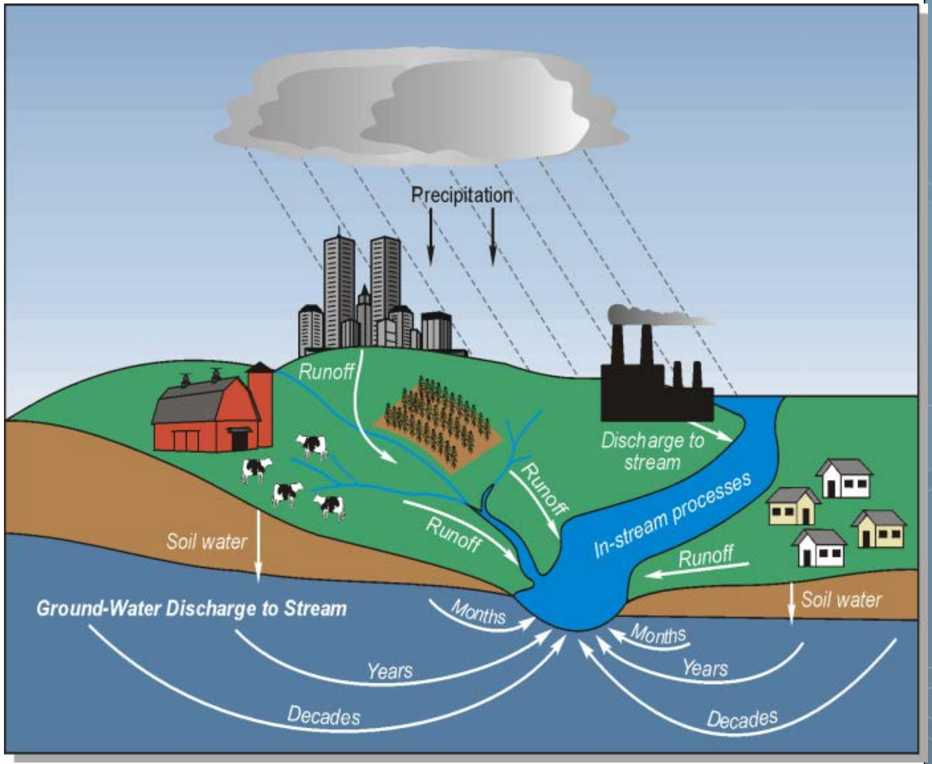




Lesson 4: Response Times

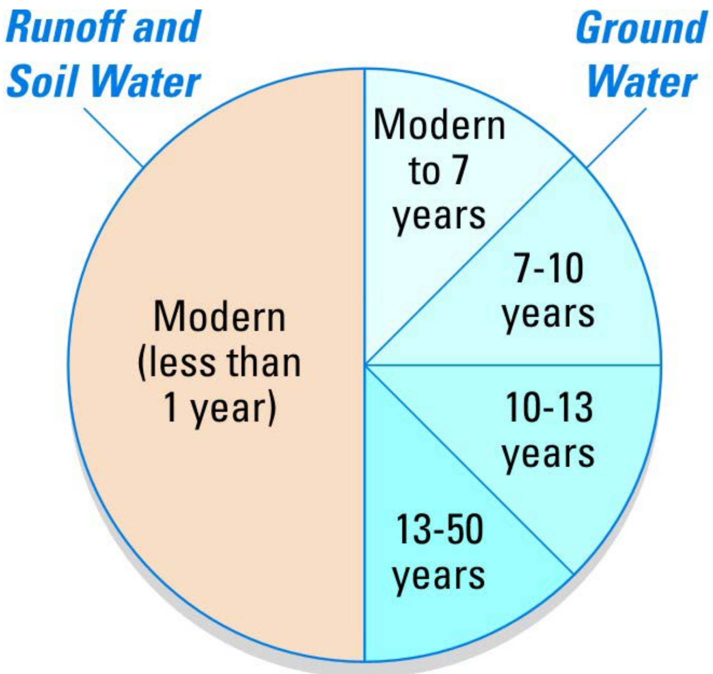
- "Lag time"
- Many practices provide initial water-quality improvements
- Full benefits to stream conditions can be delayed
  - Groundwater
  - Phosphorus storage
  - Sediment movement
  - BMP effectiveness
- Response times vary

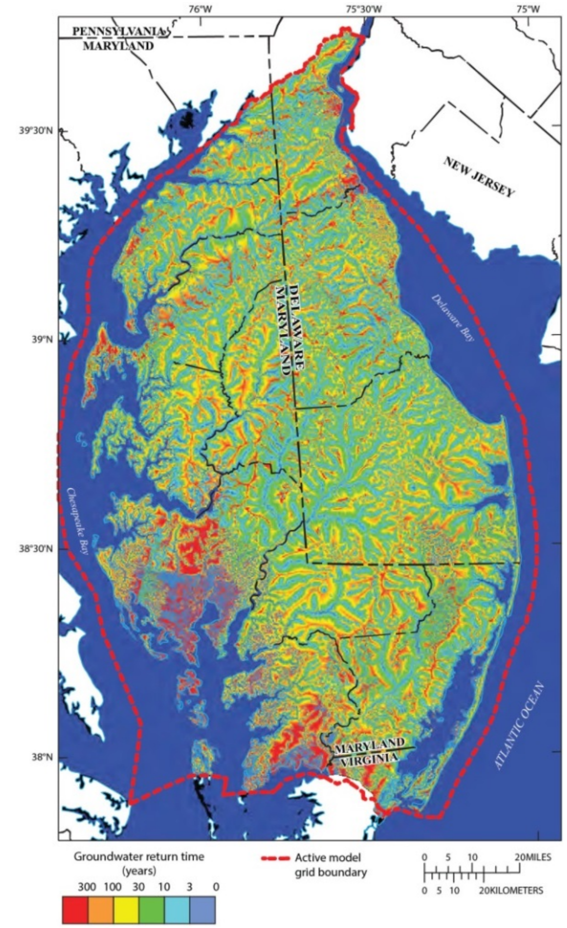


Phillips and Lindsey, 2003

Ages vary across the landscape

- **GW: modern to over 50 years**
  - **Average: decade**
  - **Coastal plain older**
- **Stream age is a mixture**



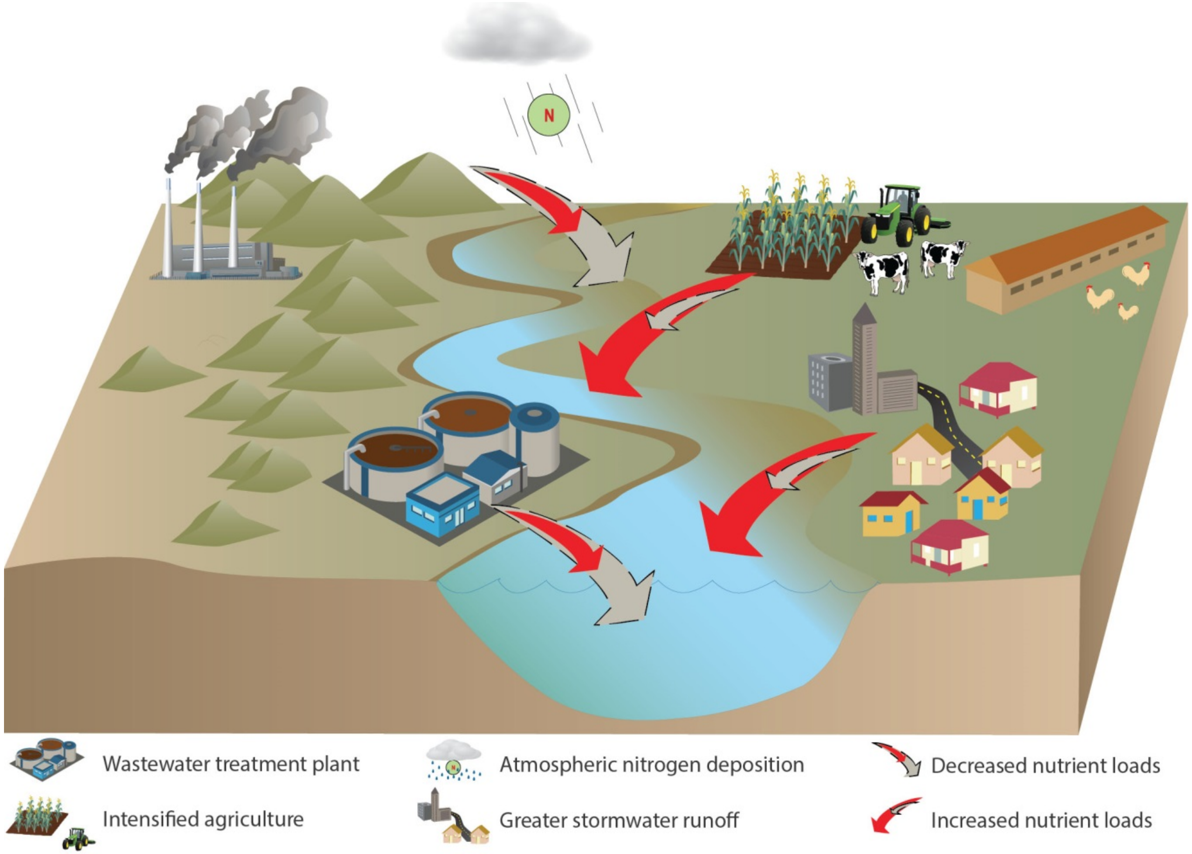


-Times vary from a few years to nearly 300 years
-Average is 20 to 30 years

Sanford et al., 2012

Lesson 5: Population growth

- Improvements in water quality can be counteracted by changes in nutrient sources and land-use practices



Counteracting BMPs

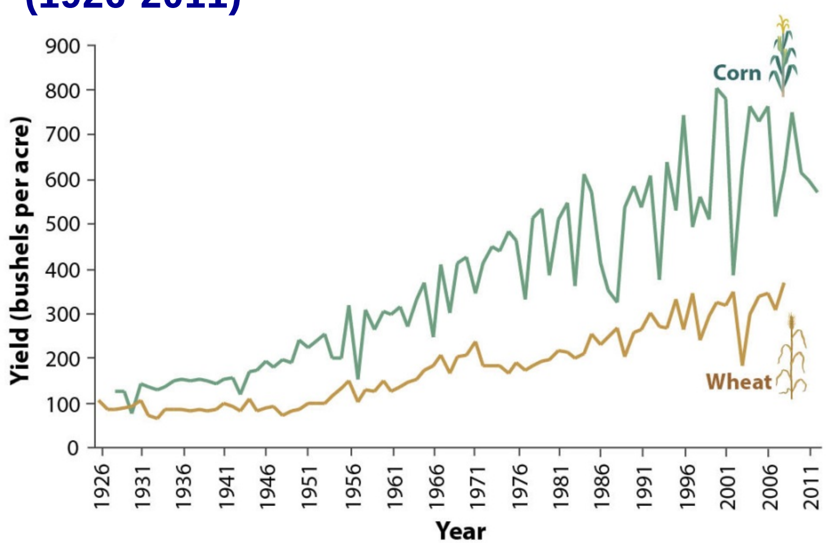
- Patuxent River
  - Point sources reduced
  - Improvements counteracted by:
    - Development
    - Crop land
    - Tidal exchange

- PA case study
  - Population cut in half; fertilizer reduced
    - No change in P
    - Increase in N
  - Fertilizer rates still above crop needs

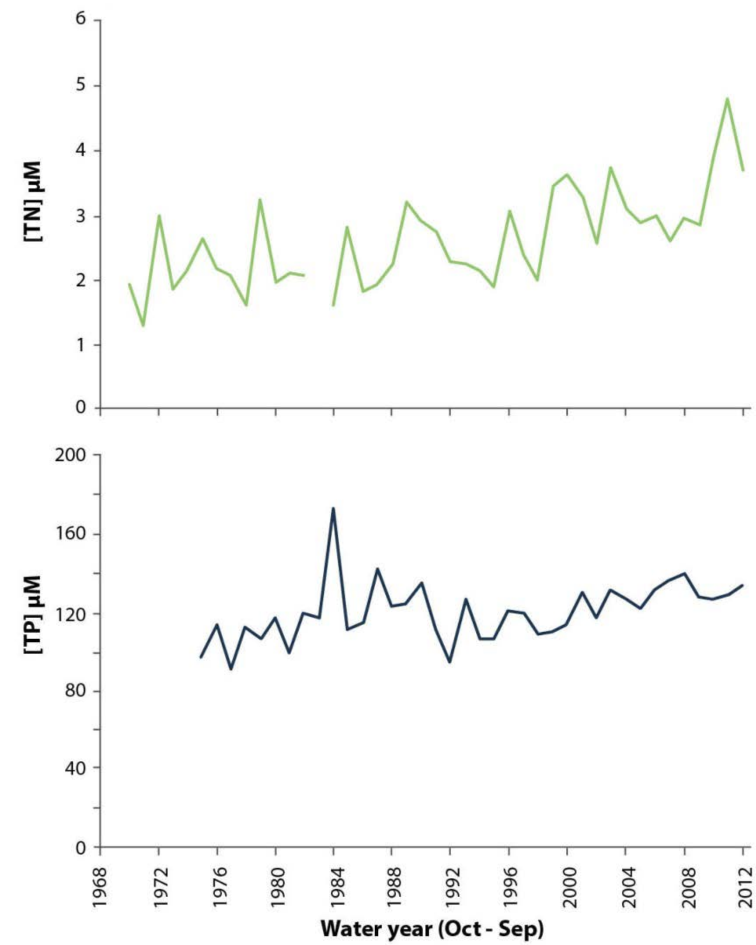
Intensified agriculture has counteracted reductions in wastewater treatment plant nutrient loads in the Choptank River

Increases in TN and TP at Greensboro water quality monitoring station (1968-2012)

Increases in wheat and corn yields in the 5 counties within which the Choptank River basin is located (1926-2011)



Data from the USDA National Agricultural Statistics Service



Data from Fisher, 2006

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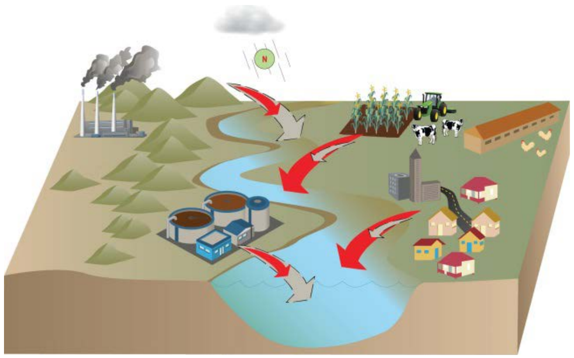
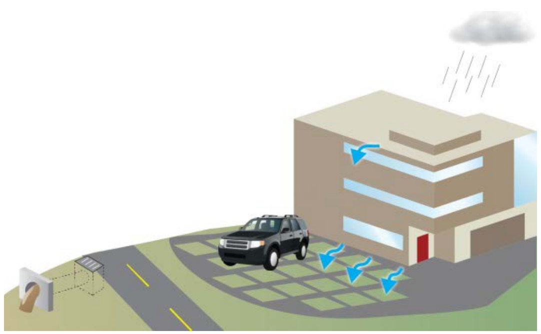
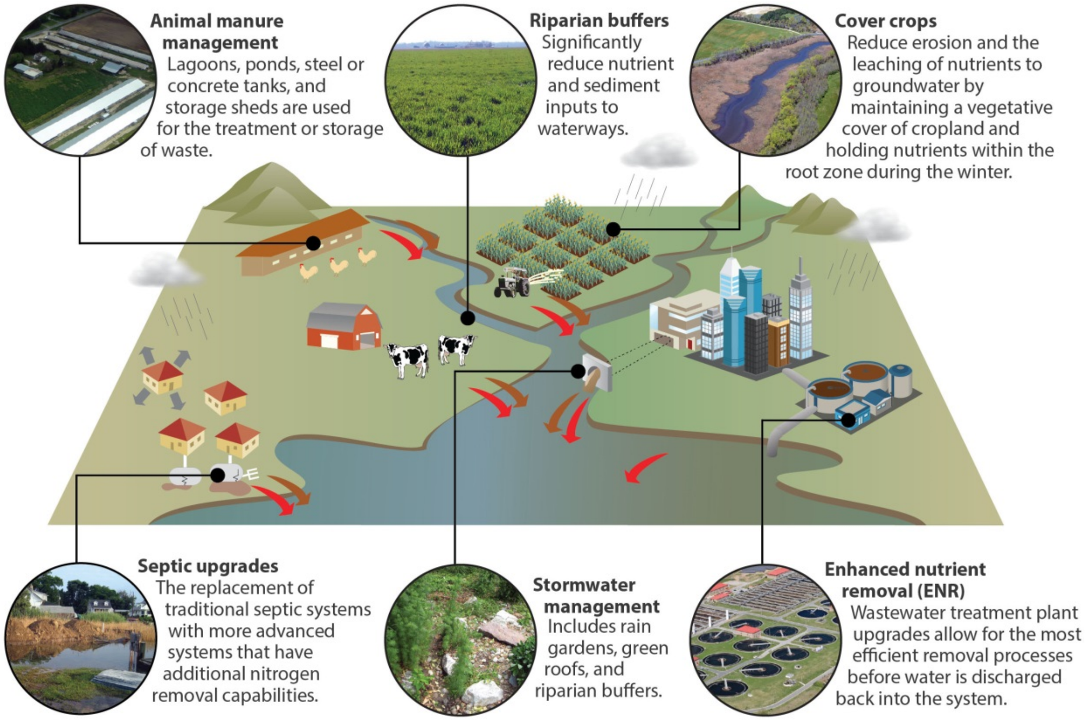




Lesson 6: Type and location of restoration

- Observable water quality responses are more likely to occur if A) location specific sources of pollution are **identified** and B) **targeted** practices are implemented.



Corsica River

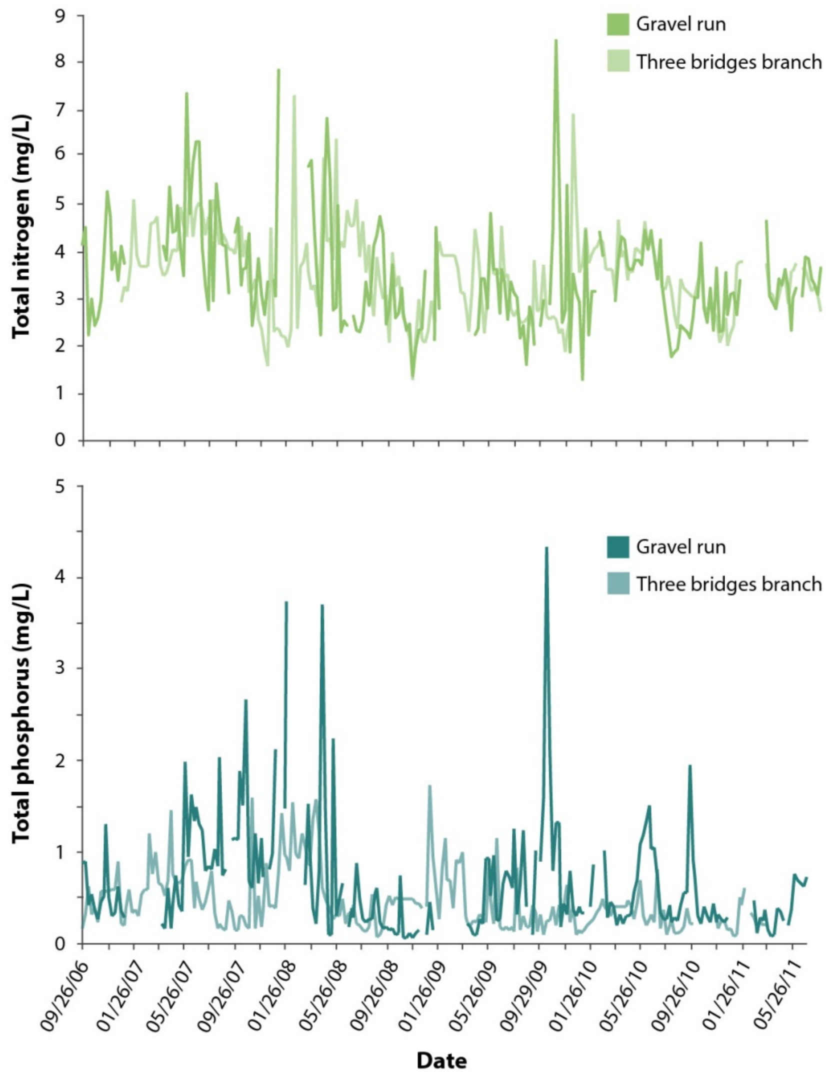
Needed to target sources

-WWTP

-Ag practices

-Water-quality improvements

Changes in TN and TP concentrations in Three Bridges Branch and Gravel Run (2006-2011)

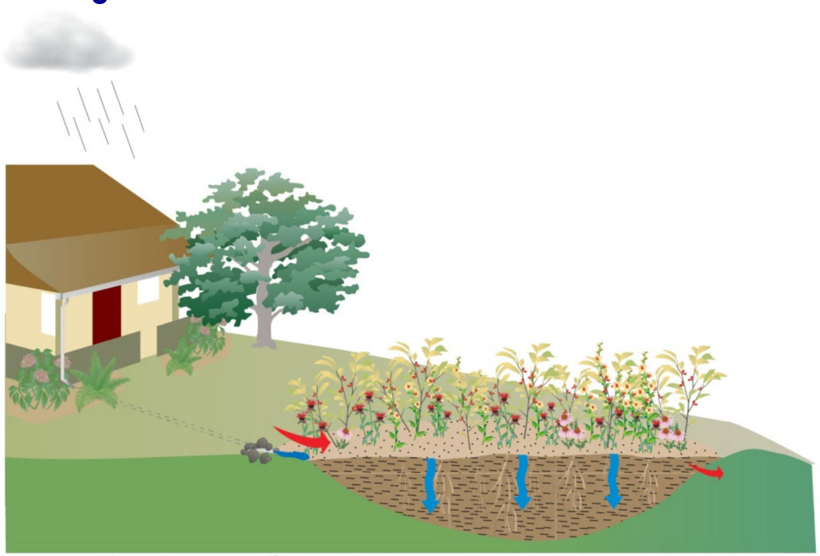


Data from Batchelor et al., 2011

Lesson 7: Innovation and stormwater

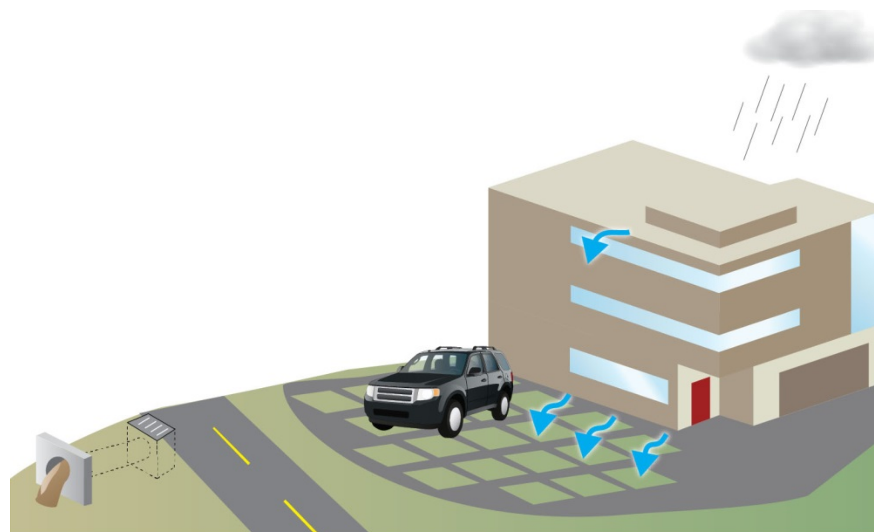
- An array of practices to promote stormwater infiltration and retention are needed in urban and suburban areas

Rain gardens



Gutters and downspouts installed onto buildings and in lawns help assist in directing rain water from the roof to the garden. A landscape of native, drought resistant plants is well adapted to local conditions and easily maintained. Plants with deep root systems encourage stormwater infiltration and help absorb excess nutrient runoff. Additionally, a berm on the downward slope of a rain garden will help hold water in the garden during heavy rains, further improving its filtering capacity.

Pervious surfaces



Impervious surfaces such as cement, asphalt and roofing prevent the infiltration of stormwater, increasing the volume and velocity of surface runoff which carries nutrients and sediments with it. Pervious surfaces, such as pervious pavement or pavers, allow for stormwater to filter through the surface and into the ground, rather than into nearby streams and storm drains.

Stormwater

Stormwater BMPs

Constructed wetlands

Stream restoration

Monitoring needed

A constructed wetland site at Stony Run in north central Baltimore was used to assess whether constructed wetlands could be effective at reducing nitrate-nitrogen. Photo © Melanie Harrison, NOAA.

Summary

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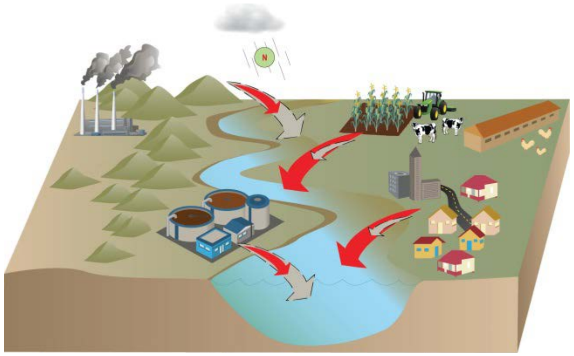

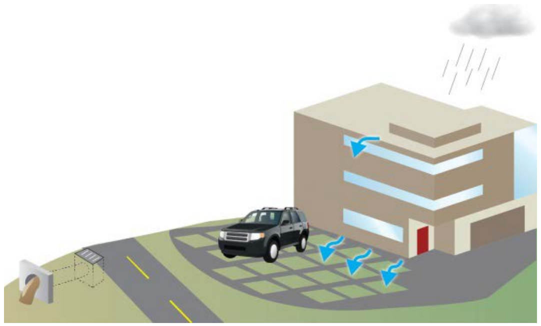

Restoring the Water-Quality Conditions in the Chesapeake Bay

Executive Summary:

http://www.chesapeakebay.net/documents/New_Insights_Executive_Summary_FINAL.pdf

Report:

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

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Improving water quality

- Improve DO and clarity for fisheries and SAV
- Reduce nutrients and sediment (TMDL)
- What have we learned from monitoring?
- How can we use to help measure progress?
- Inform implementation of practices