

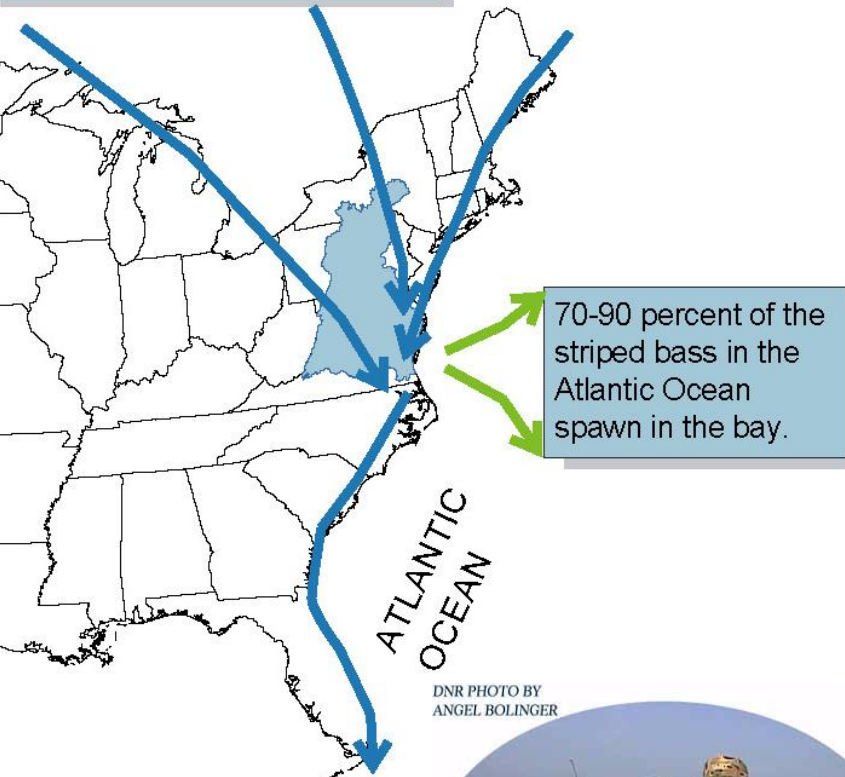
Applying Adaptive Management to Improve Water-Quality Decision Making for Restoring the Nation's Largest Estuary

**Presented by Scott Phillips
USGS**

**Scott Ator, John Brakebill, Mike Langland, Joel
Blomquist and Doug Moyer**

Importance of the Nation's Largest Estuary

The Chesapeake Bay watershed lies within the heart of the Atlantic Flyway.



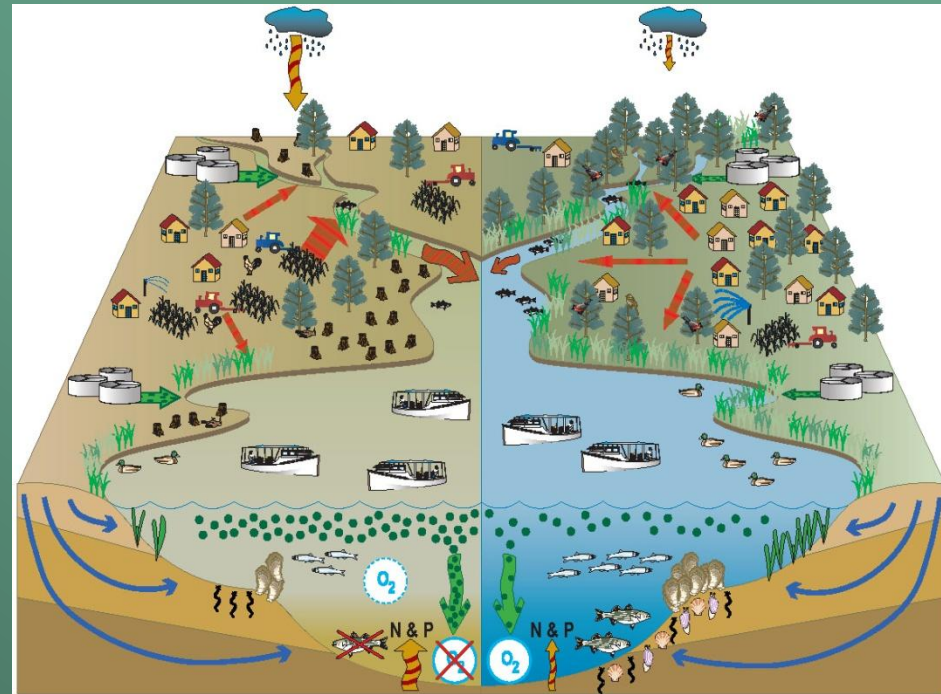
DNR PHOTO BY
ANGEL BOLINGER



- Ecological
 - Fisheries and migratory birds
- Economic
 - \$1 trillion value
- Recreation and heritage
- Degraded condition
- Chesapeake Bay Program
- Executive Order

Water Quality Issues and TMDL

- Poor DO, loss of SAV
- Decline in fisheries
- TMDL
 - Achieve water-quality standards
 - Reduce nutrients and sediment
 - States and federal agencies
 - Implement actions by 2025















(Modified from CBP and IAN, 2005)

Present

Future

Explanation of Selected Symbols

- | | | | |
|---|---|---|---|
|  | Transport of sediments, nutrients, and contaminants |  | Atmospheric nitrogen |
|  | Water treatment plant and discharge |  | Process: denitrification/phosphorus out |
|  | Concentration: high oxygen |  | Algal blooms |
|  | Concentration: low oxygen |  | Wetlands |
|  | Direct ground-water discharge |  | Loss of forests |
|  | Water withdrawal |  | Submerged aquatic vegetation |

Chesapeake Bay Program and TMDL



- **Federal**
 - EPA
 - DOI, USDA, NOAA, DoD
- **Six States & DC**
- **Bay Commission**
- **Local Governments**

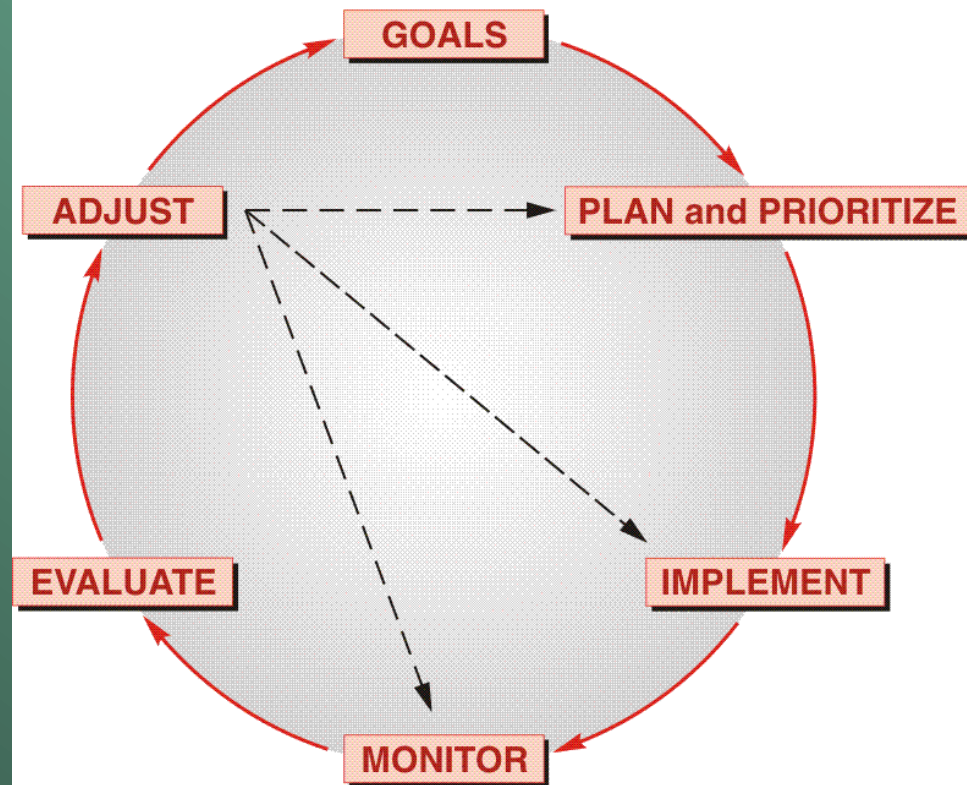
- **TMDL**
 - Watershed implementation plans
 - Two year milestones
 - 2017 evaluation
- **Adaptive management**

Adaptive Management

- Enhance use in CBP
 - CBP decision framework
 - NRC report
- Modeling, monitoring and research to assess and explain change
- Learning and applying new findings
- Reduce uncertainty in decision making

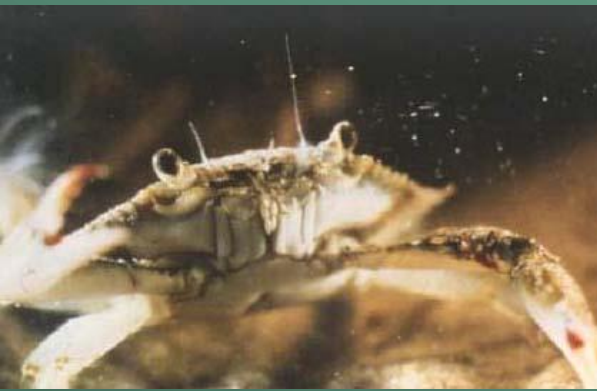
ADAPTIVE MANAGEMENT FOR ECOSYSTEM DECISION MAKING

[Modified from Williams and others (2007) and Levin and others (2009)]

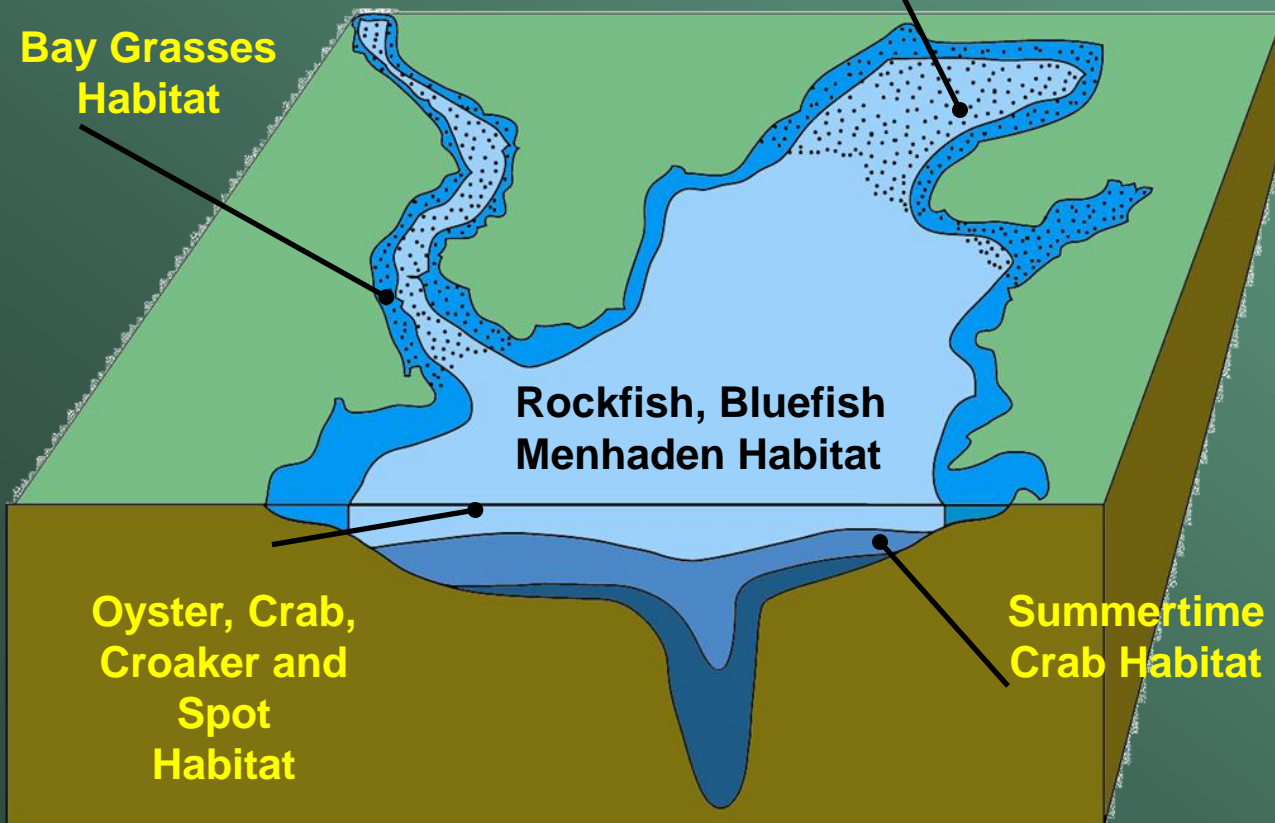


Setting Goals

- Water-quality standards
- Nutrients and sediment allocations
- Model scenarios



Shad, Herring, Perch and Rockfish Spawning Habitat



Management Strategies

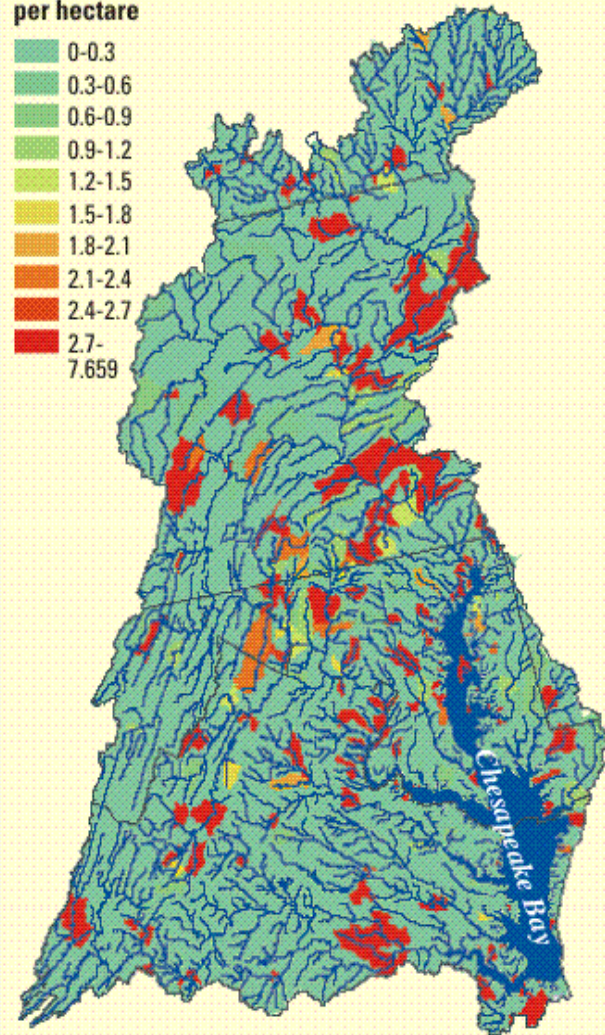
- Watershed Implementation Plans
- Plan and prioritize
- Finer spatial information
 - CBP models
 - SPARROW model



Sources-Nitrogen

EXPLANATION

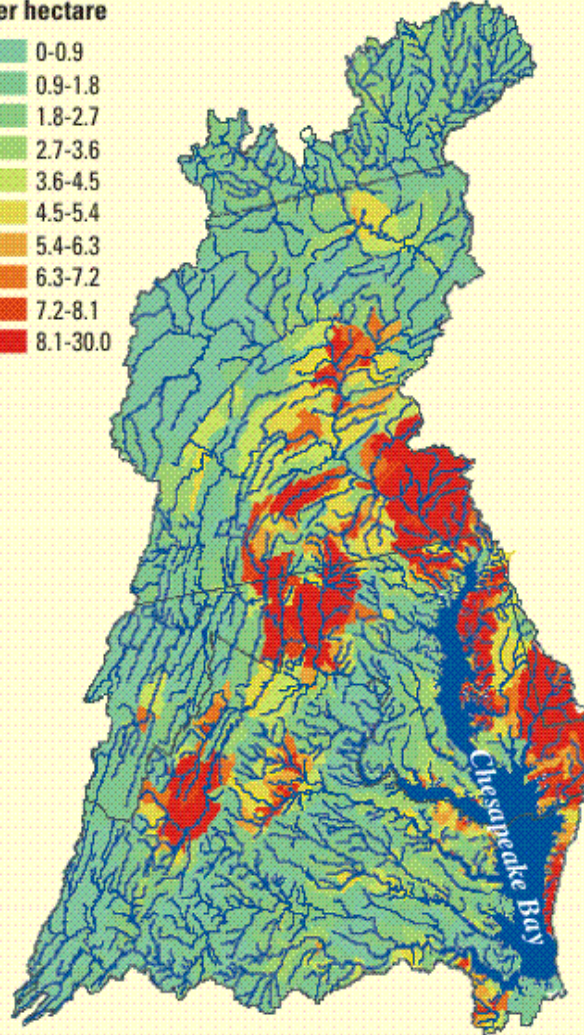
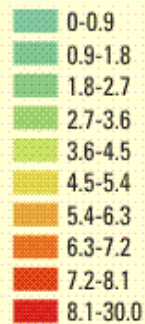
Total nitrogen, in kilograms per hectare



(A) Delivered yield of total nitrogen due to point sources

EXPLANATION

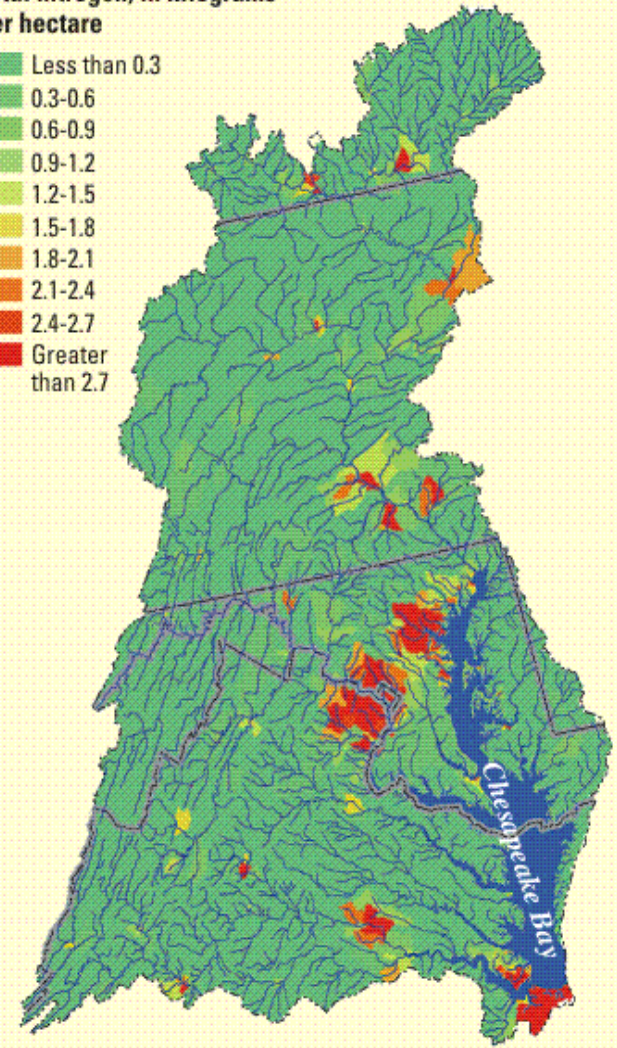
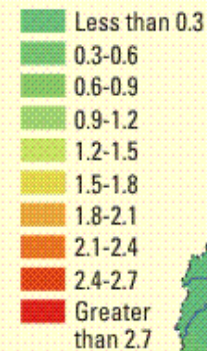
Total nitrogen, in kilograms per hectare



(B) Delivered yield of total nitrogen due to agricultural sources

EXPLANATION

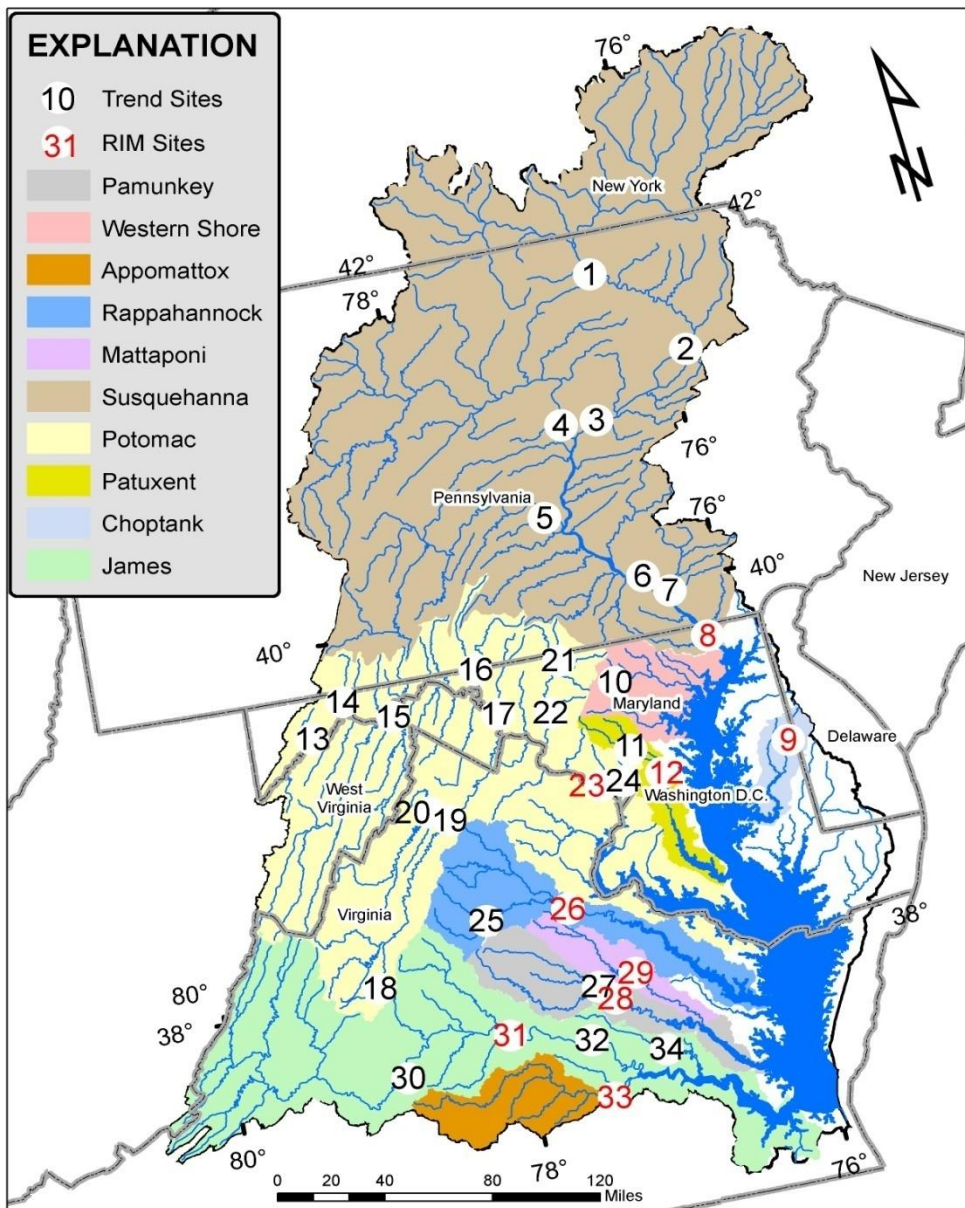
Total nitrogen, in kilograms per hectare



(C) Delivered yield of total nitrogen due to urban lands

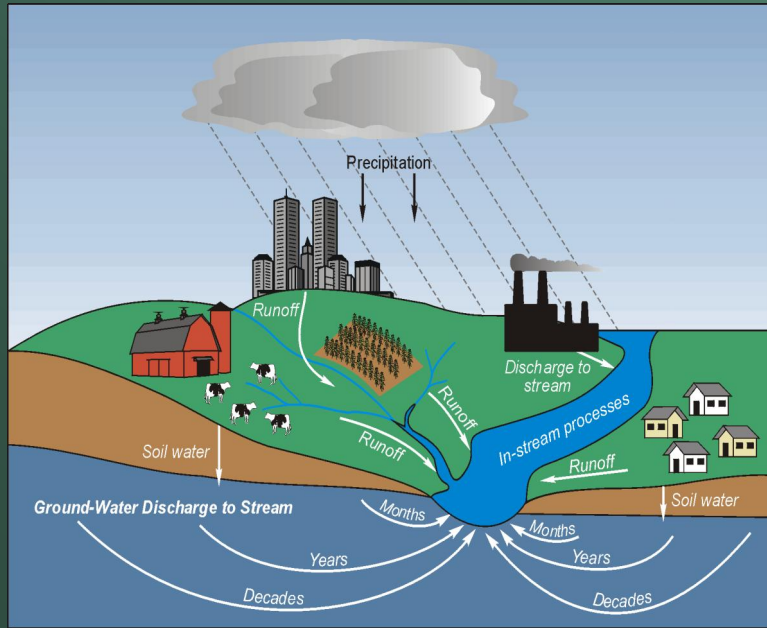
Monitoring

- Networks
 - Watershed
 - Estuary
- Used to calibrate CBP models
- Improvements



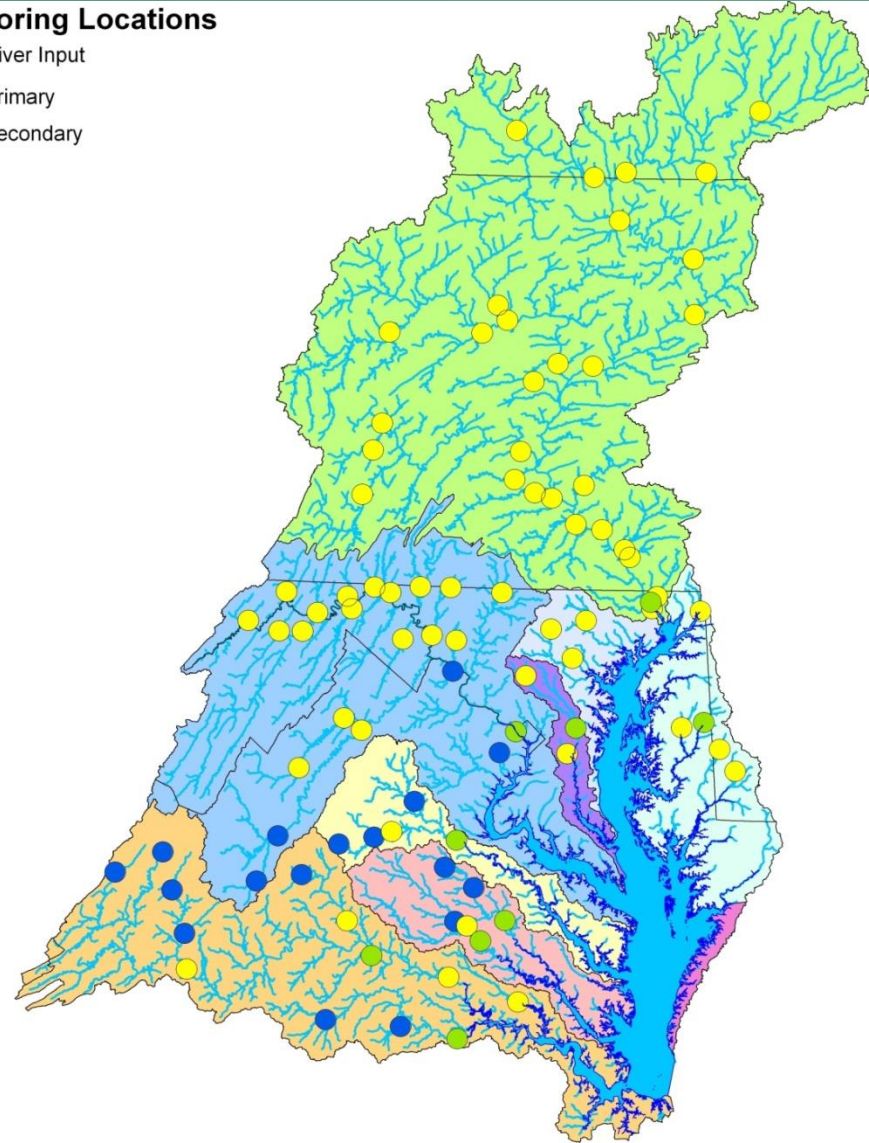
Monitoring Improvements

- Water quality
 - Ag and urban areas
- Small watershed research
- Implementation reporting



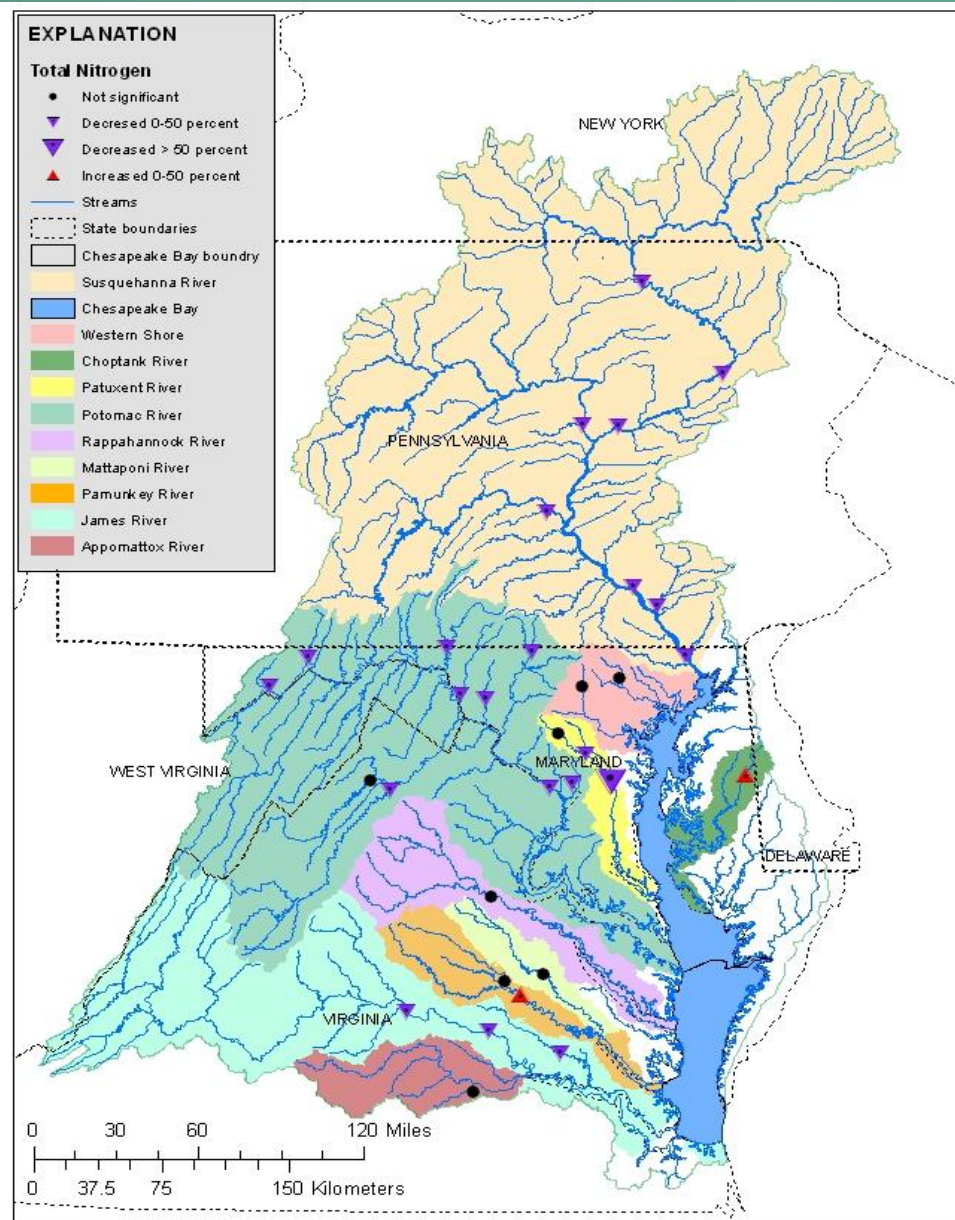
Monitoring Locations

- River Input
- Primary
- Secondary



Assess Performance and Evaluate

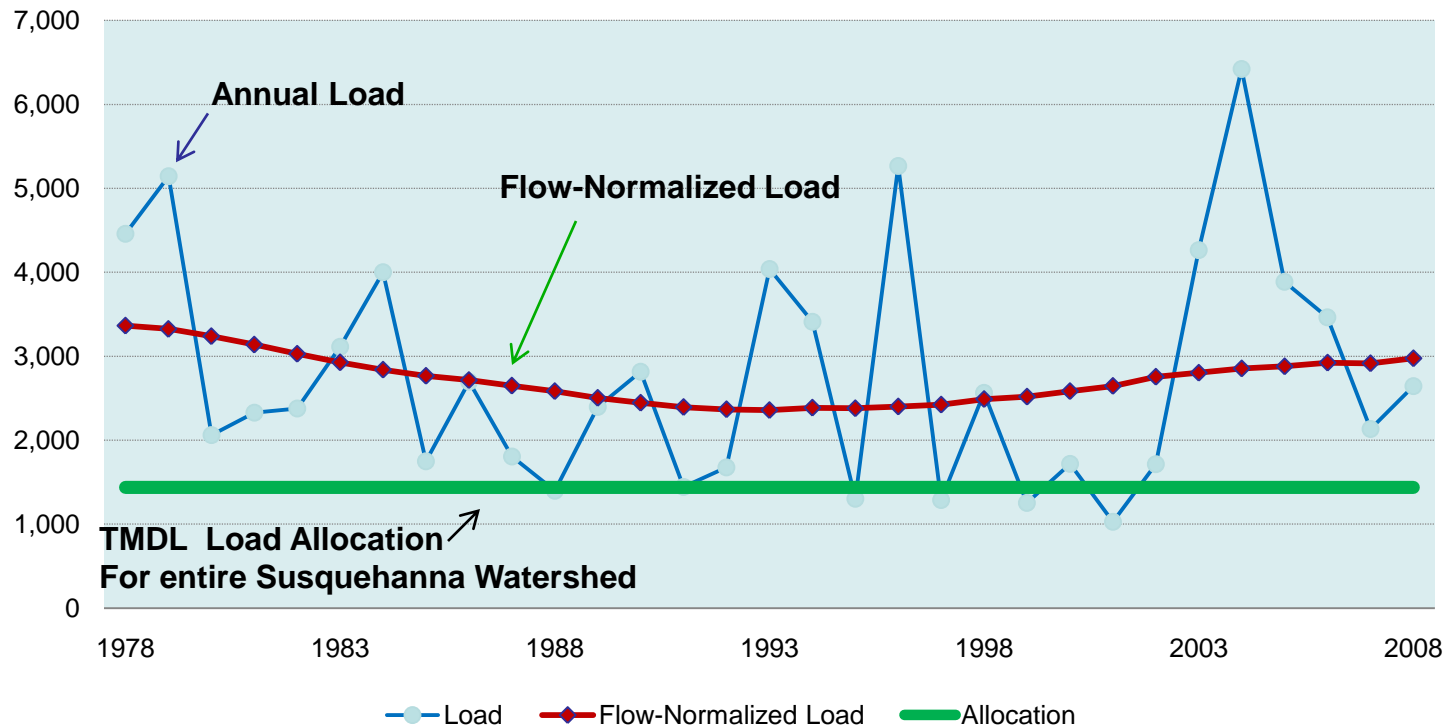
- Expected reductions
 - Model predictions
 - Two-year milestones
- Monitoring
 - Trends
 - Indicators
- Assess change
 - Better compare model and monitoring results



Progress Towards Nutrient Allocations

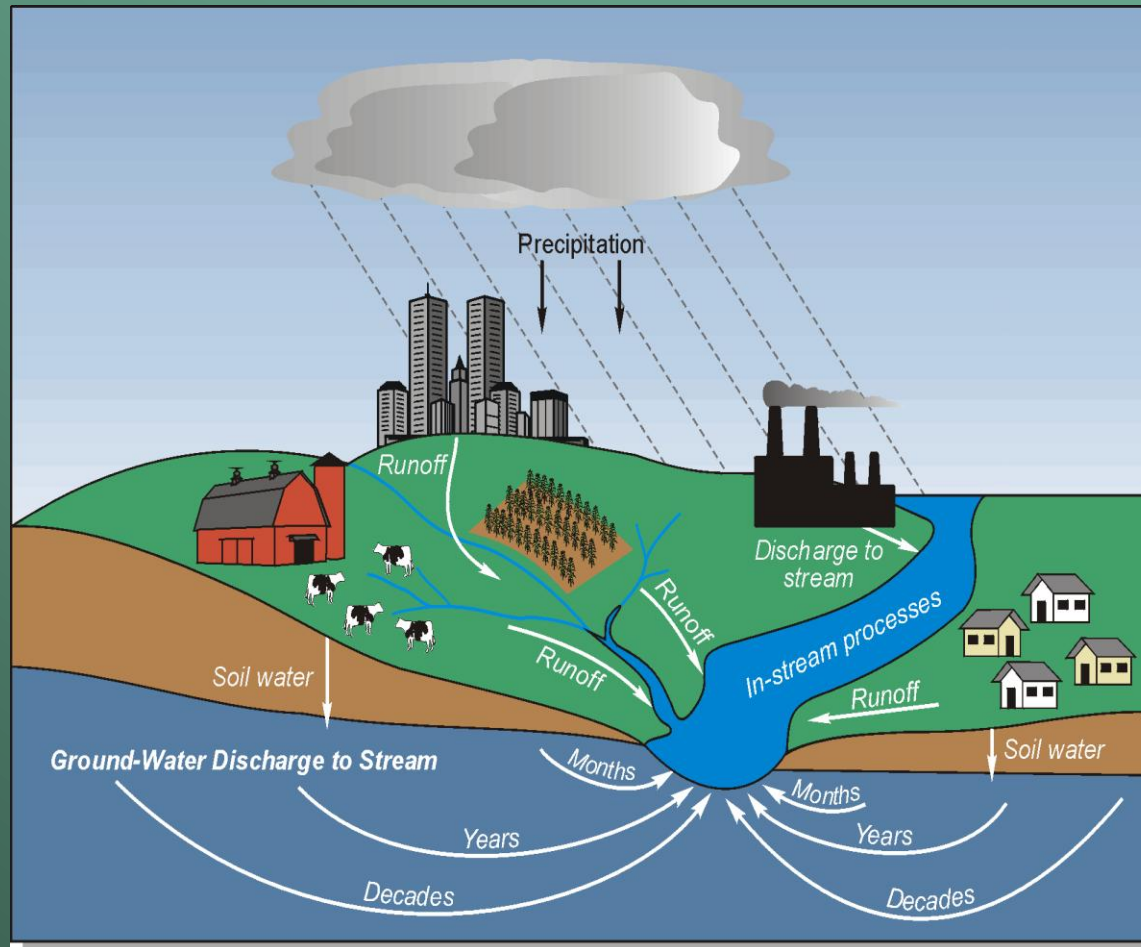
(modified from Hirsch and others, 2010)

Susquehanna River At Conowingo, Maryland Total Phosphorus Load (tons per year)



Explain Water-Quality Change

- Sources
- Management actions
- Streamflow variability
- Response times
- Implications
 - Effect of BMPs
 - Milestones
 - 2017 evaluation

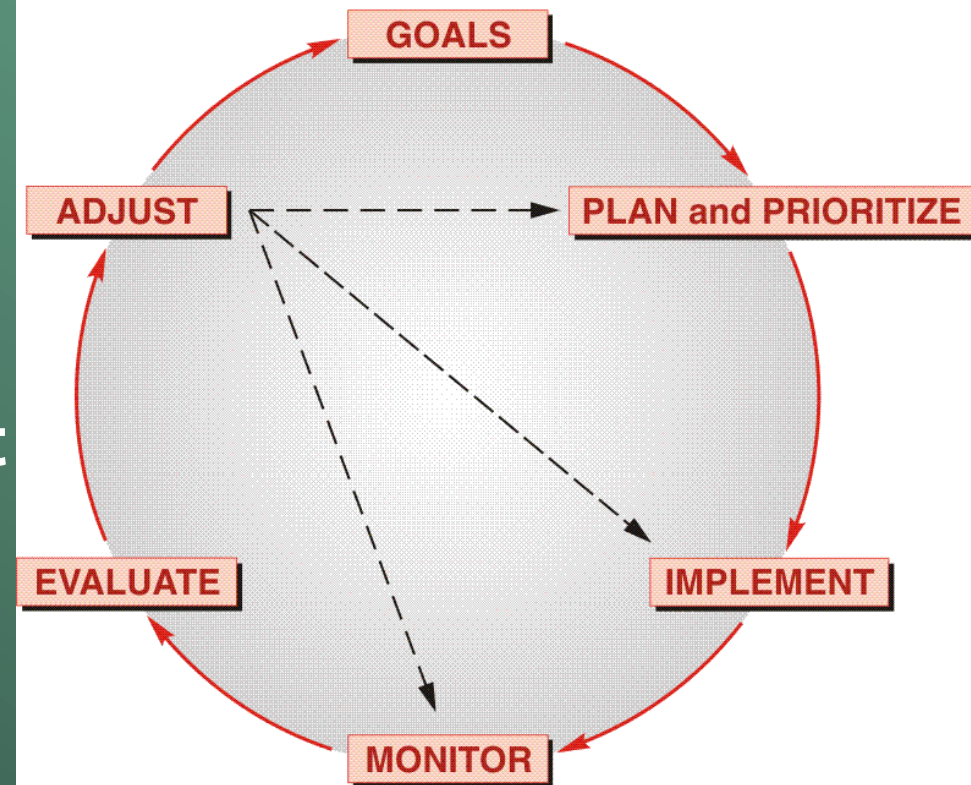


Manage Adaptively: Adjust

- Summarize and communicate
 - Improve understanding
 - Reduce uncertainty
- Short-term adjustments
 - Implementation
 - 2-year milestones
- Longer-term adjustment
 - TMDL allocations in 2017
 - Modeling and monitoring

ADAPTIVE MANAGEMENT FOR ECOSYSTEM DECISION MAKING

[Modified from Williams and others (2007)
and Levin and others (2009)]



Challenges and Summary

- Major estuaries
- Opposition to increased regulation
- Inadequate funding and policy
- Citizen involvement
- Economic considerations
- Population growth
- Science for improved decision making

