USGS
science for a changing world

Loads, Trends, and Indicators:

Results from Non-tidal Monitoring, Chesapeake Bay Watershed, 1985-2010

USGS
science for a changing world

Results from Non-tidal Monitoring

- Nontidal network and its status
- Loads to Chesapeake Bay
- Long-term progress (trends)
- Indicators of watershed condition
  - Recent conditions
  - Recent progress (trends)
- Summary

USGS
science for a changing world

Nontidal Network Partners

Delaware Department of Natural Resources and Environmental Control
District of Columbia Department of the Environment
Environmental Protection Agency CBPO
Environmental Protection Agency Region 3
Interstate Commission on the Potomac River Basin
Maryland Department of Environment
Maryland Department of Natural Resources
New York Department of Environmental Conservation
Pennsylvania Department of Environmental Protection
Susquehanna River Basin Commission
United States Geological Survey
University of Maryland Center for Environmental Science
Virginia Department of Environmental Quality
West Virginia Department of Environmental Protection
West Virginia Department of Agriculture

Data Analysis Team–

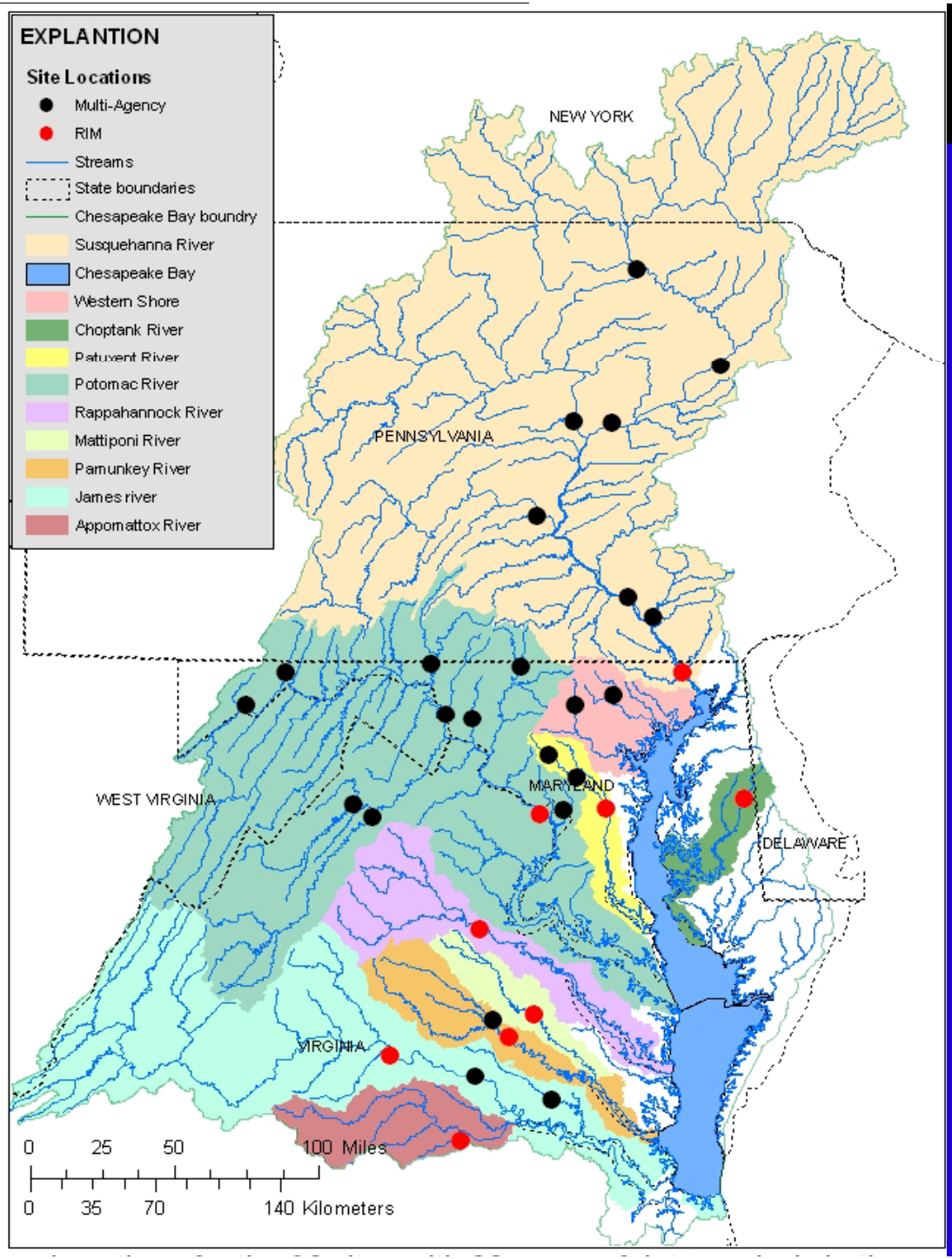
Mike Langland –USGS, PA
Ken Hyer – USGS, VA
Joel Blomquist – USGS, MD
Doug Moyer – USGS, VA

USGS
science for a changing world

Nontidal Network

- 31 long-term stations in Bay Watershed
- 1985*-to present
- 9 River Input Stations
- 22 Upstream Stations

*some stations have records prior to 1985



USGS
science for a changing world

Nontidal Network

64 “Mature” sites supporting loads or trend analysis:

5 years for loads,

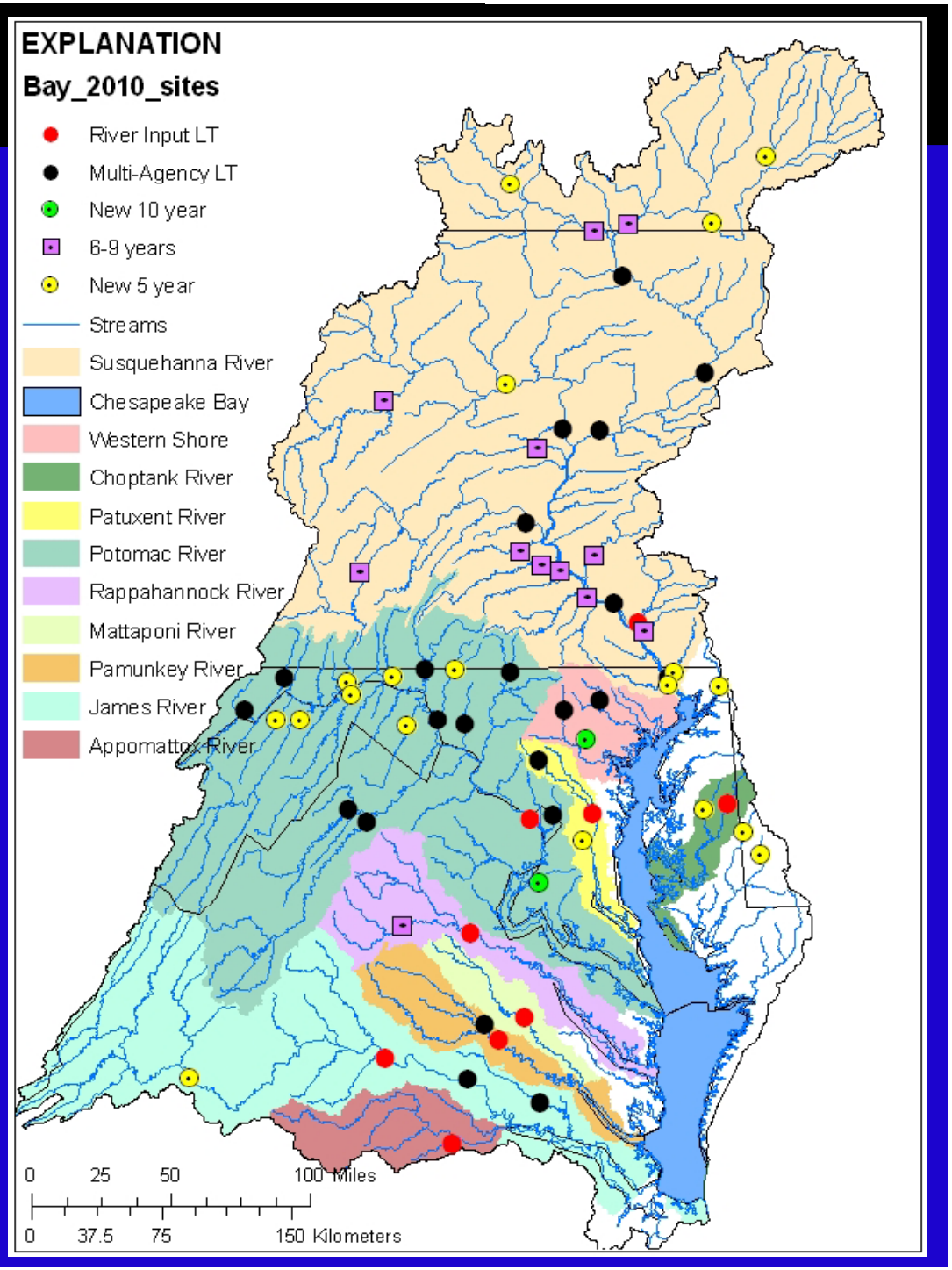
10 years for trends

2010 Summary

2 sites added with +10 years (green)

11 sites with 6-9 years (purple)

20 new sites with 5 year (yellow)



USGS
science for a changing world

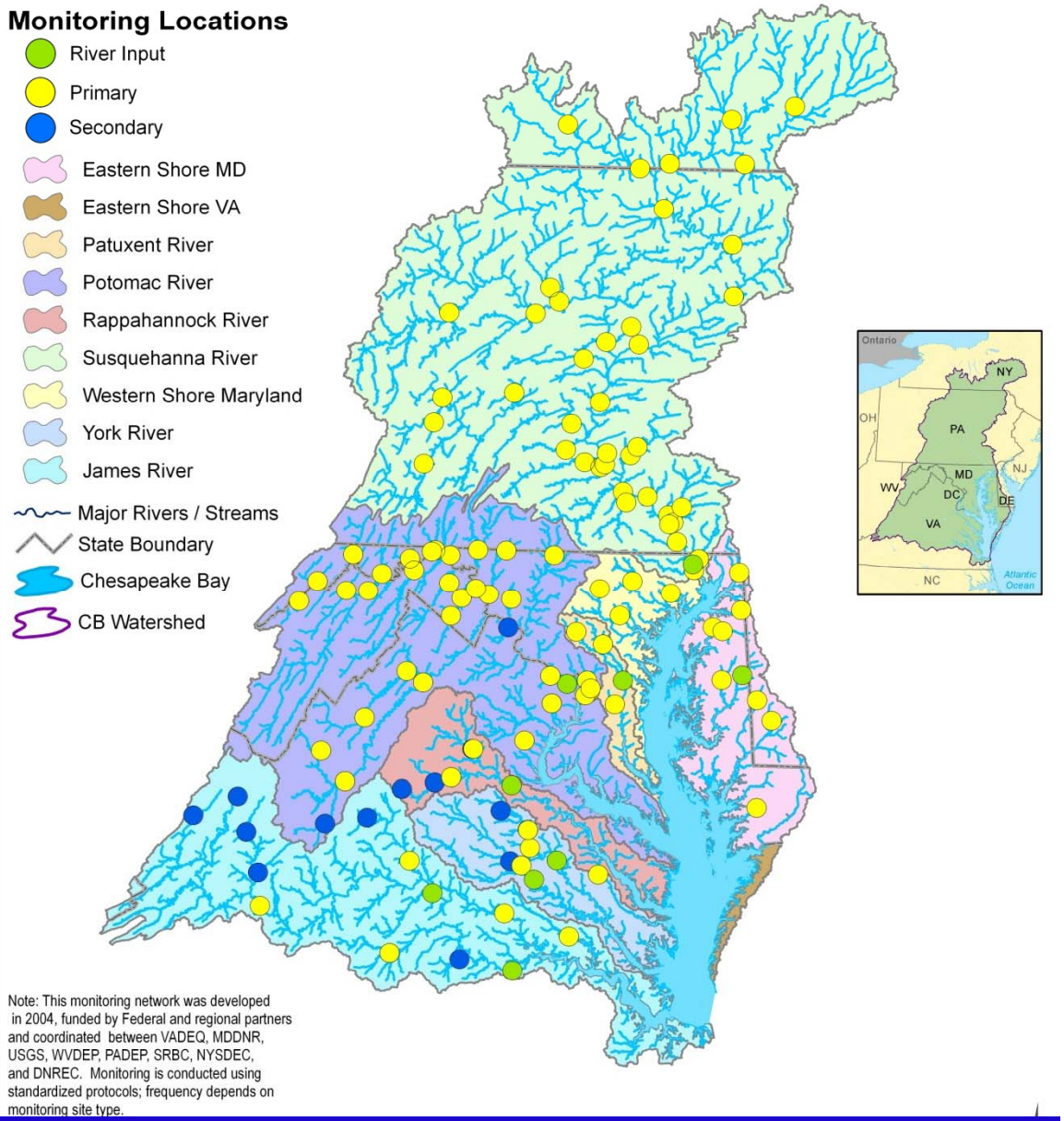
Expanded Nontidal Network

122 Sites

Nontidal Water Quality Monitoring Network

Chesapeake Bay Watershed

Chesapeake Bay Program
A Watershed Partnership



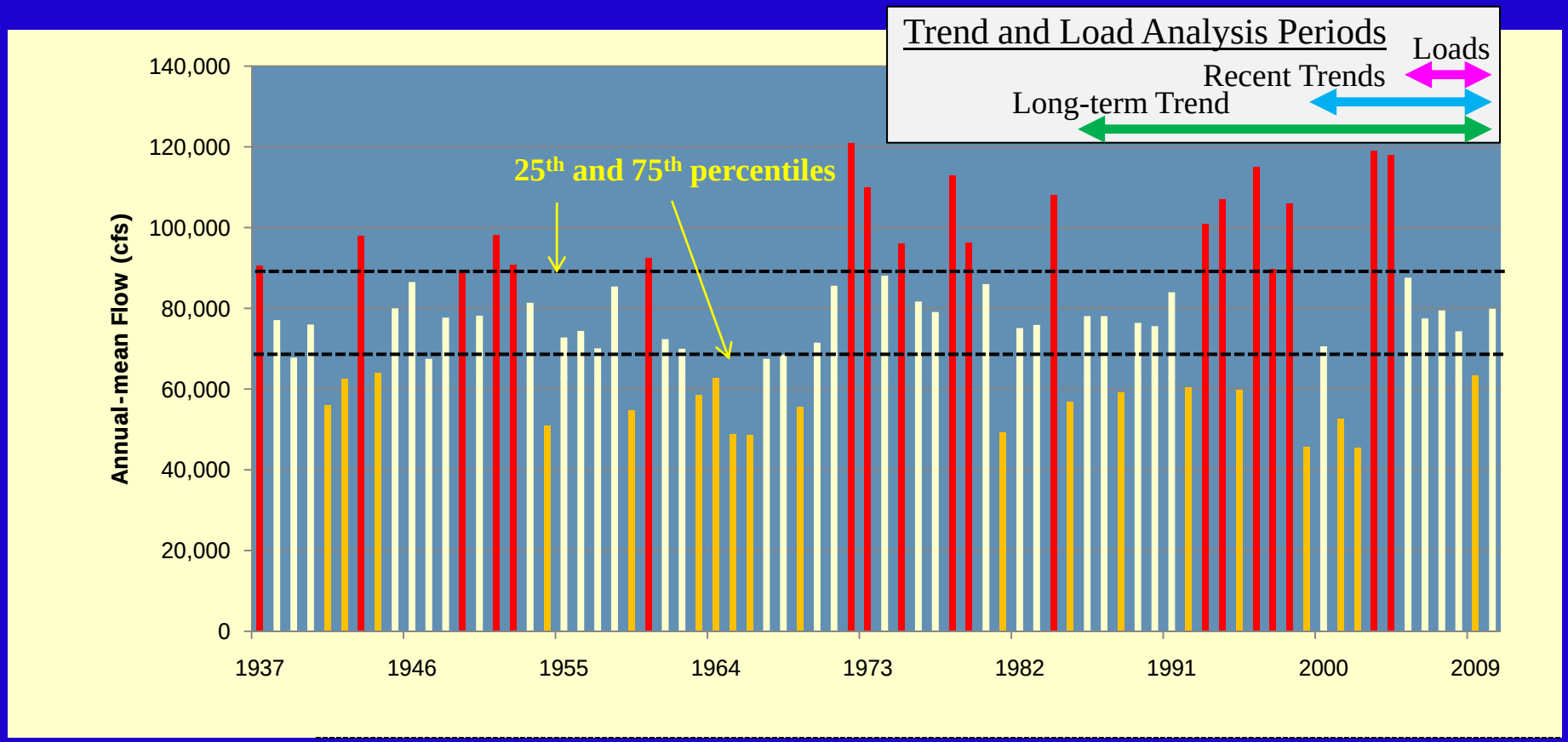
Note: This monitoring network was developed in 2004, funded by Federal and regional partners and coordinated between VADEQ, MDDNR, USGS, WVDEP, PADEP, SRBC, NYSDEC, and DNREC. Monitoring is conducted using standardized protocols; frequency depends on monitoring site type.

Nontidal Network Results-1985-2010

Number of stations available to support results

Time period	Length of Record	Type	Number of sites
1985-2010	25 yrs	Load/tend	31
2001-2010	10 yrs	Load/tend	33
2006-2010	5 yrs	Loads only	64

Trend and Load Analysis periods relative to Historical Streamflow



- WY2010 79,900 cfs (normal year)
  - 2010– Most unusual "normal" year
- 5 of last 6 years annual "normal" flow
- 2011 floods-not included in results

Load and Trend analysis Methods

- Methods are well documented and peer reviewed.
  - Indicators vetted through Management board.
  - New publication is expected in late 2011 early 2012.
- Data from each site undergoes a rigorous QC process.
- Continuing to evolve data-analysis approach utilizing state-of-the-art techniques.
- Testing approaches to address 2-year milestones with monitoring data.

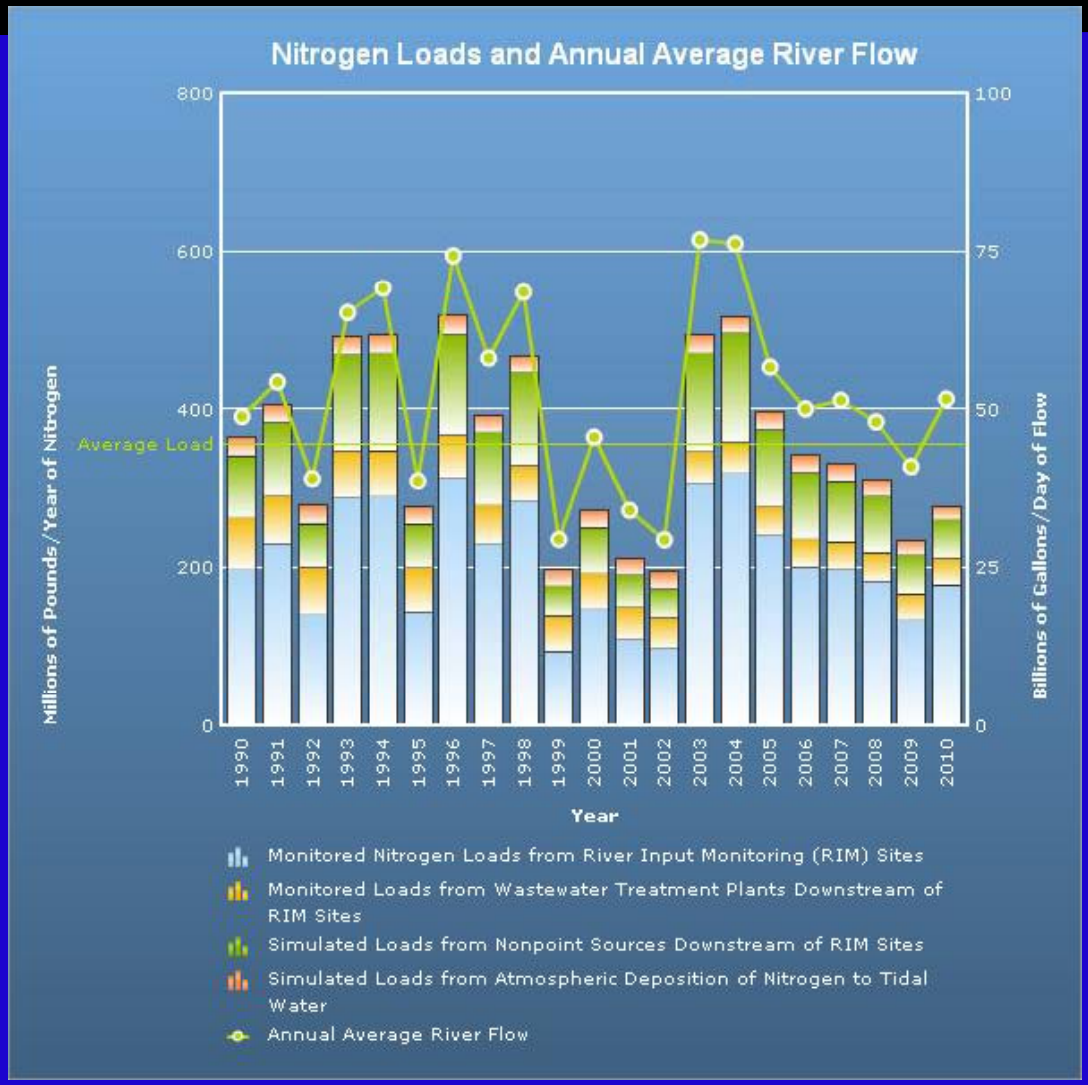
USGS
science for a changing world

Nitrogen Loads: Reporting level indicator

TN – 33% increase in combined RIM loads

First increase in TN loads since 2004

All 9 RIM sites loads increased vs. 2009



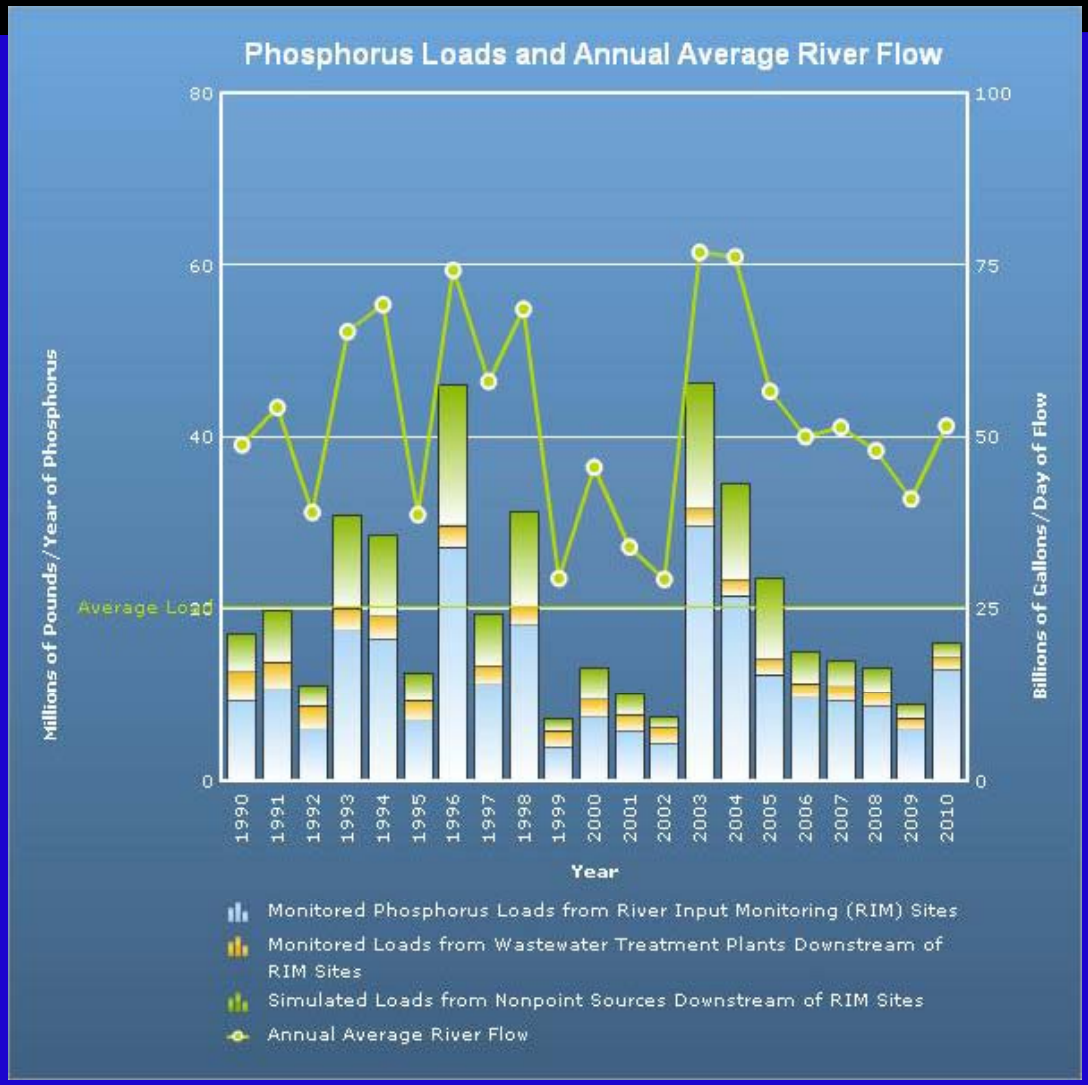
USGS
science for a changing world

Phosphorus Loads: Reporting level indicator

TP – 120% increase in combined RIM loads

First increase in TP loads since 2003

All 9 RIM sites increased vs. 2009

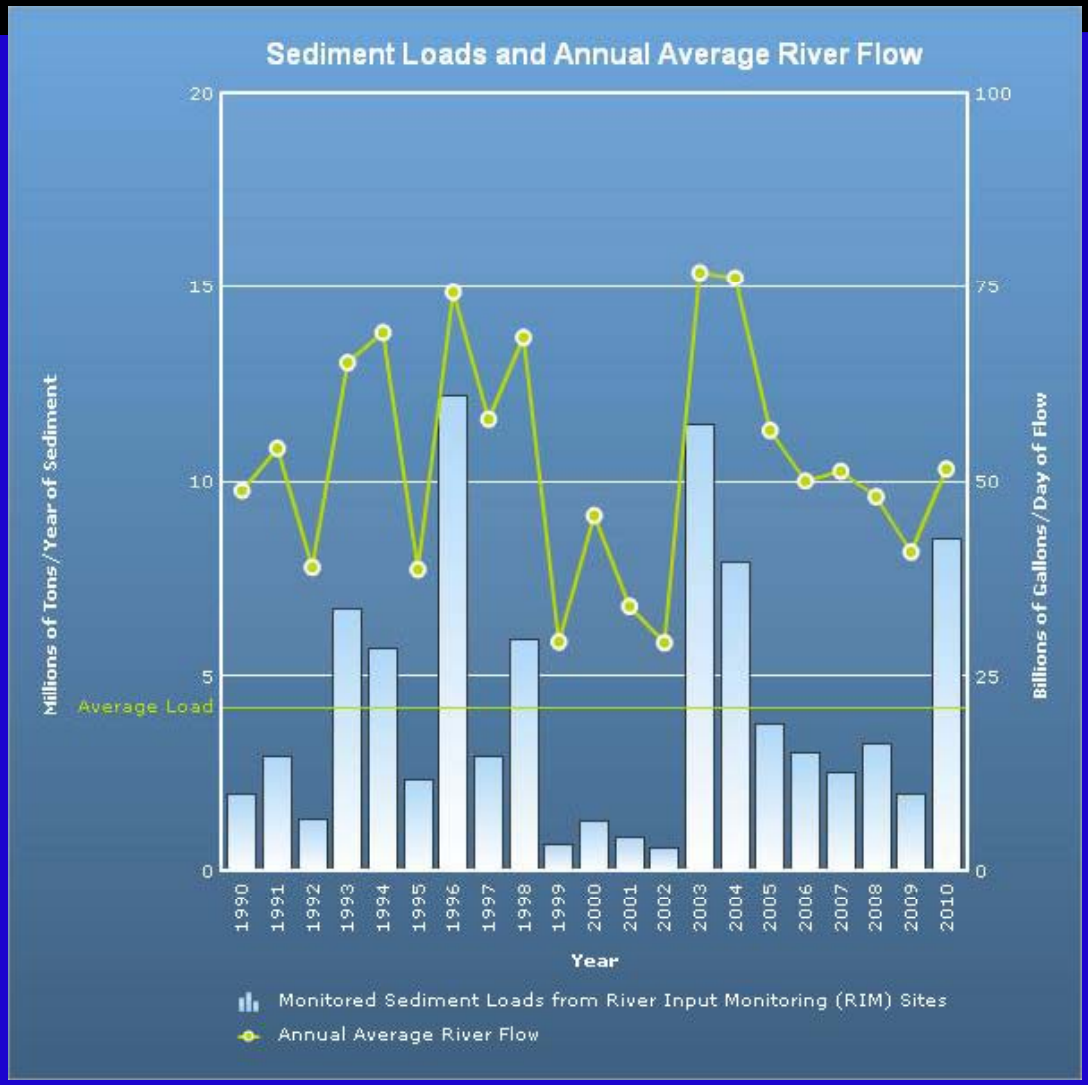


USGS
science for a changing world

Suspended Sediment Loads: Reporting level indicator

SED – 330% increase in combined RIM loads

All 9 RIM sites increased vs. 2009



USGS science for a changing world

Long-term Trend Approach

Flow-adjusted concentration

- Useful for examining effects of management actions
- Uses the slope coefficient (b), time (t), and time (t2) for non-linear trend from ESTIMATOR model
- Adjusts for the “effects” of hydrology and season
- Expressed in percent over time

USGS
science for a changing world

Total Nitrogen

Flow Adjusted Concentration 1985-2010

19 of 31 sites (~65%) down, 2 sites up

4 of 9 RIM sites downward

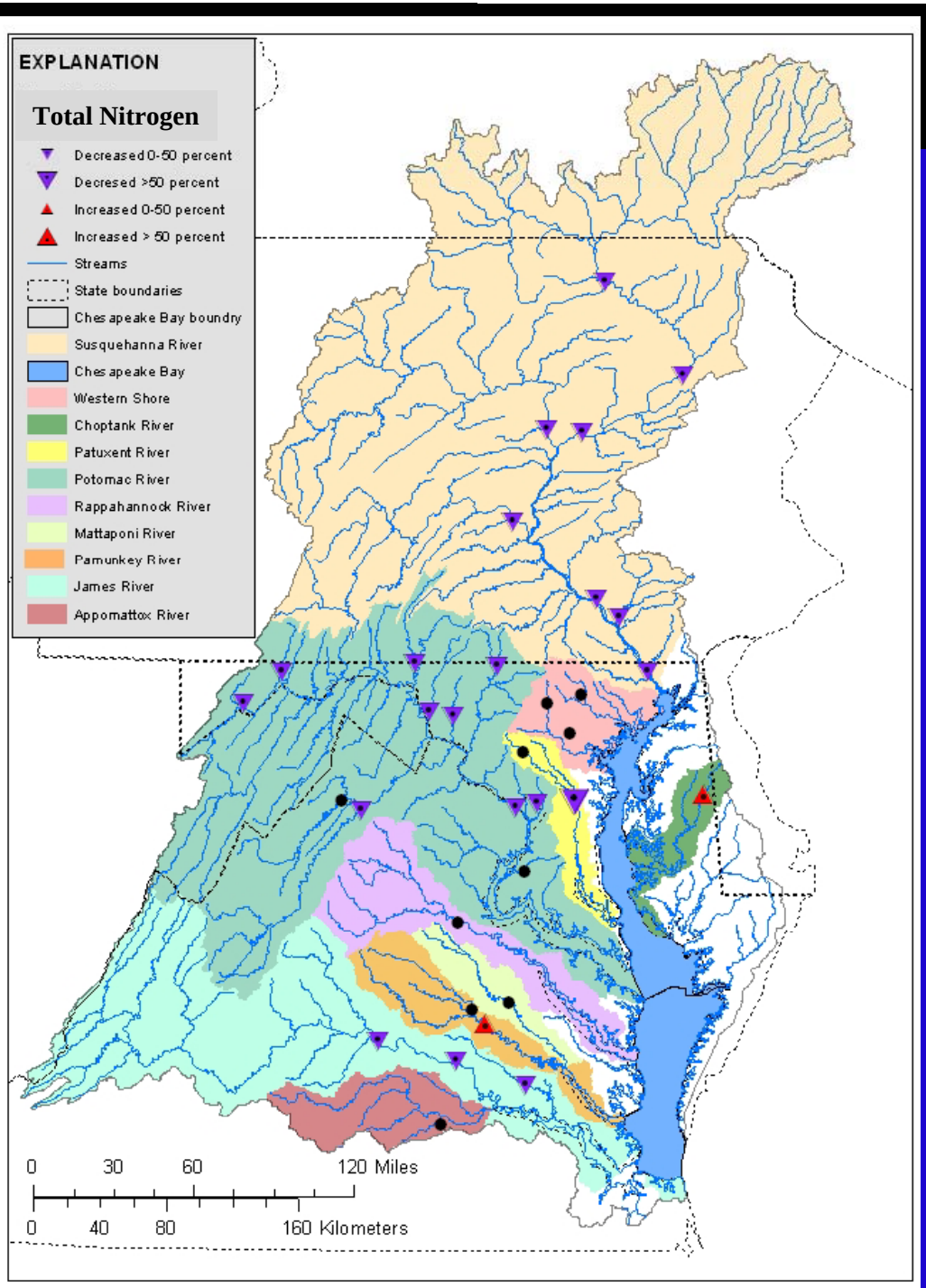
Previous results:

2009 - 22 DN, 2 UP

2008 - 22 DN, 2 UP

2007 – 22 DN, 2 UP

2006 – 25 DN, 4 UP



USGS
science for a changing world

Total Phosphorus

Flow Adjusted Concentration 1985-2010

21 of 31 sites (~70%) down, 4 sites up

2 of 9 RIM sites downward, 3 upward

13 sites exceed 50% reduction

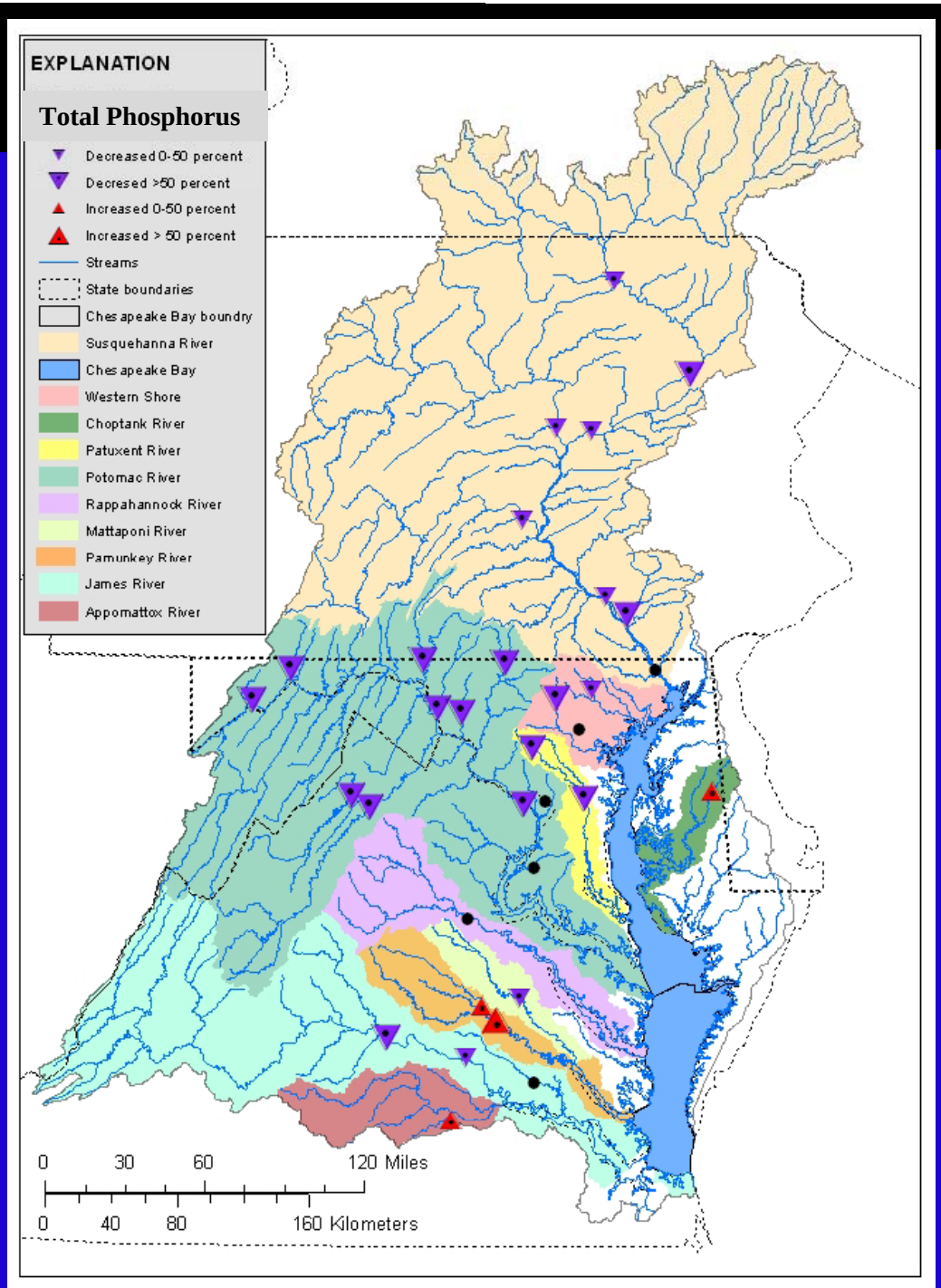
Previous results:

2009 - 21 DN, 4 UP

2008 - 22 DN, 3 UP

2007 – 22 DN, 3 UP

2006 – 23 DN, 4 UP



USGS
science for a changing world

Suspended Sediment

Flow Adjusted Concentration 1985-2010

10 sites down, 7 sites up

5 sites > 50% up

17 of 31 sites not significant

4 of 9 RIM sites downward, 2 upward

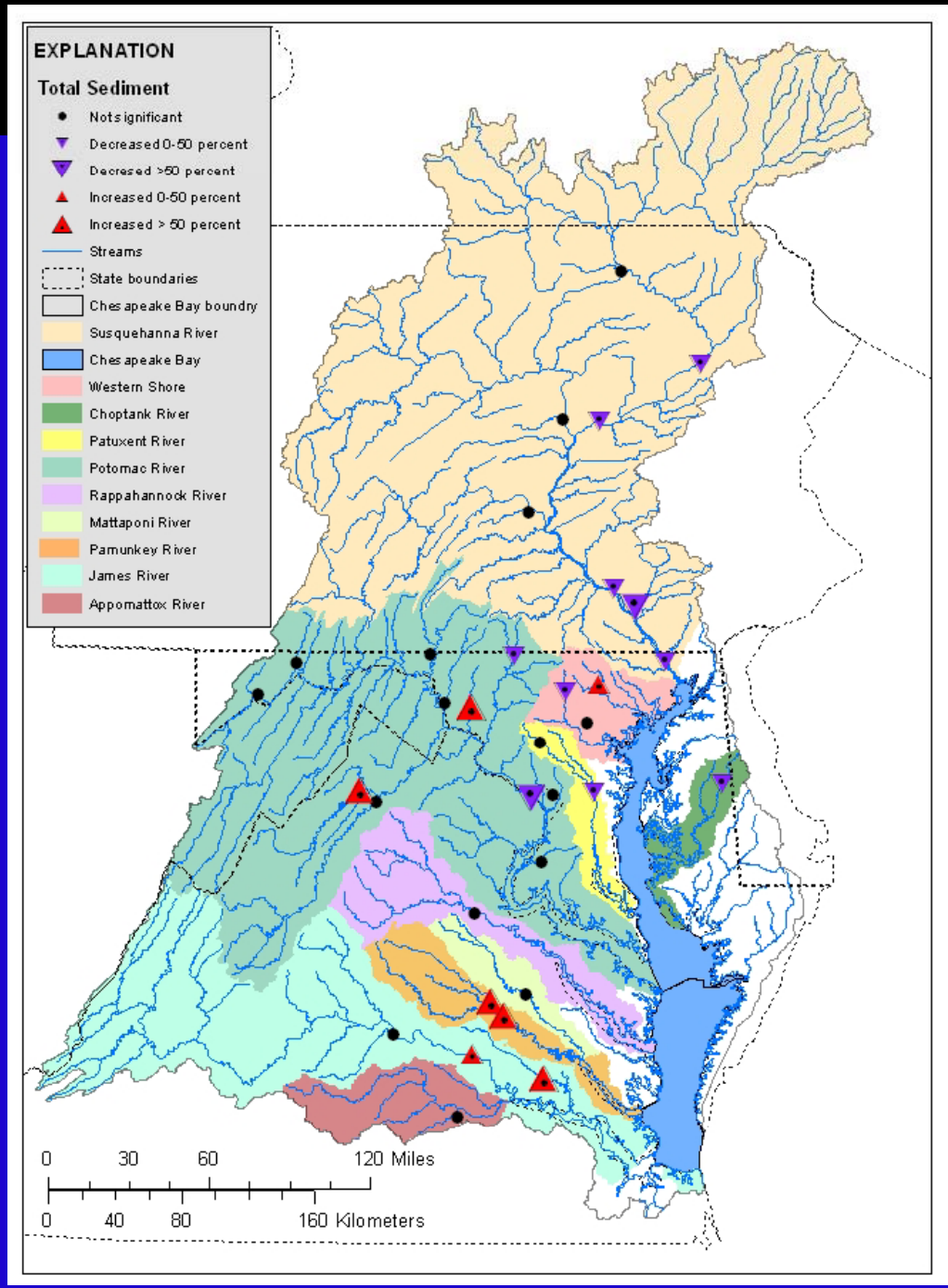
Previous results:

2009 – 12 DN, 4 UP

2008 – 15 DN, 2 UP

2007 – 15 DN, 2 UP

2006 – 11 DN, 2 UP



Watershed Indicators

- Approach for network sites
  - Relative status indicator:
    - Mean yield 2006-2010
    - Yield = load / watershed area;
    - 3 equal sized classes
      - Low Medium High
  - Short term trends (10 years)
    - Balances need for
      - “recent” assessment
      - Statistical Power
      - Hydrologic variation

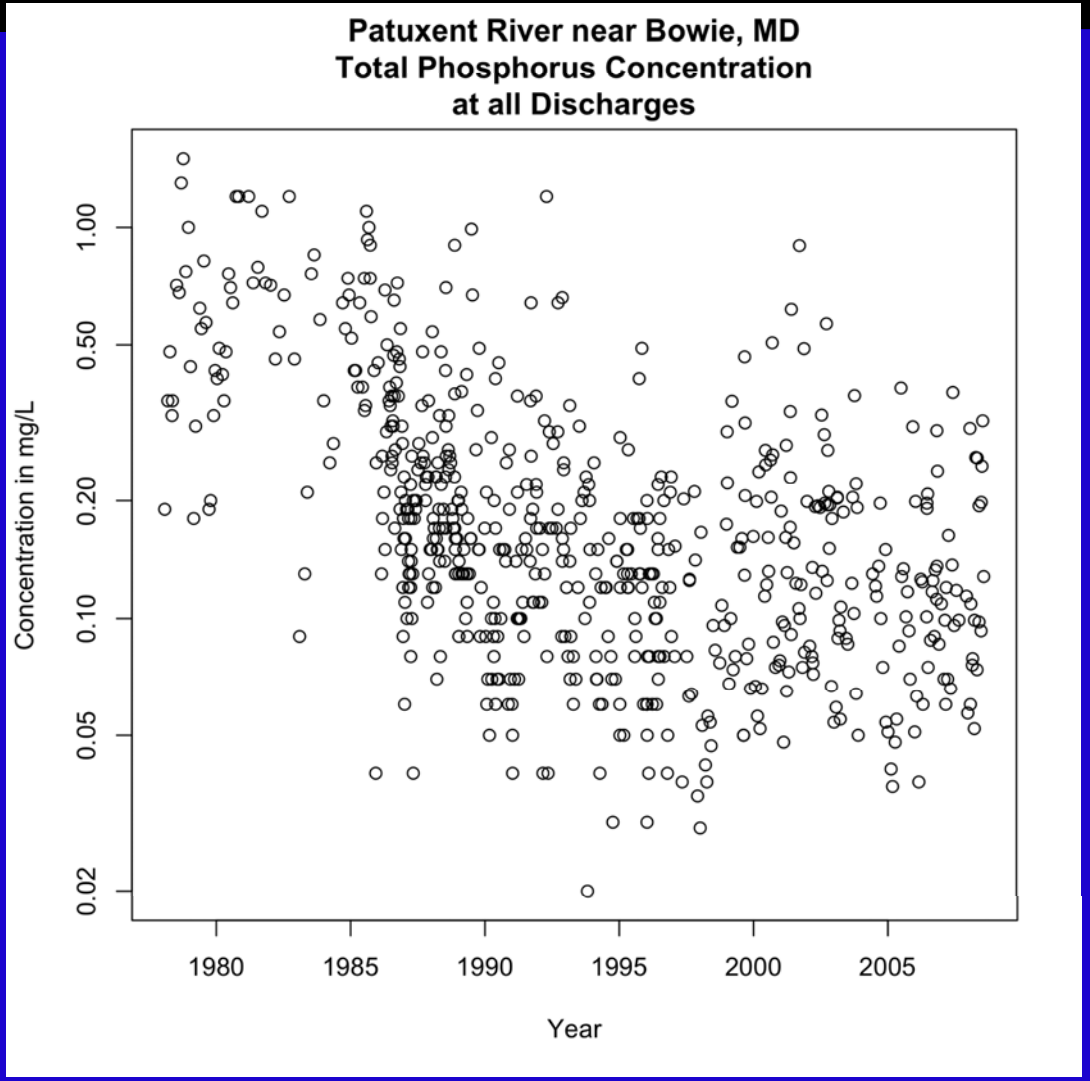
USGS
science for a changing world

Basis for short and long term trends

Restoration and monitoring periods are sufficiently long that observed changes may include:

- Step trends
- Increases
- Decreases
- Fluctuations

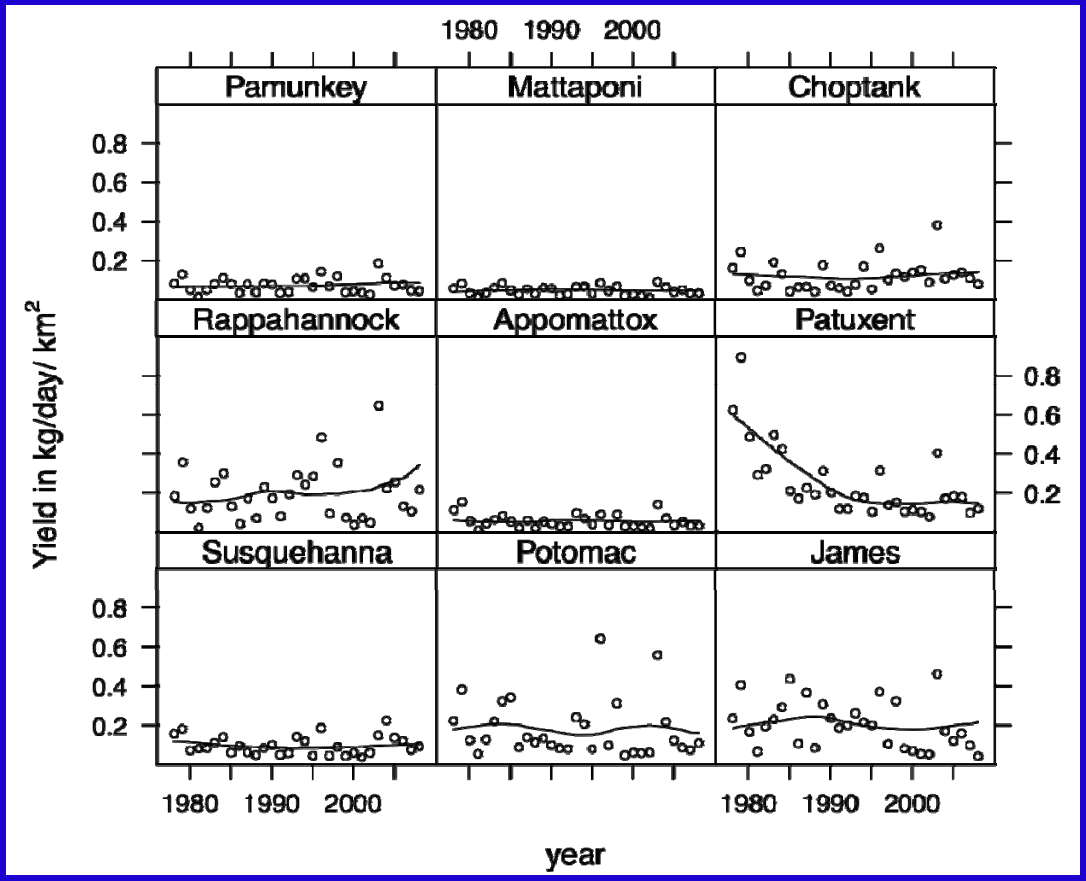
Long-term trends may mask more recent patterns



USGS
science for a changing world

Observed Patterns at RIM stations

Graphic from Hirsch and others,



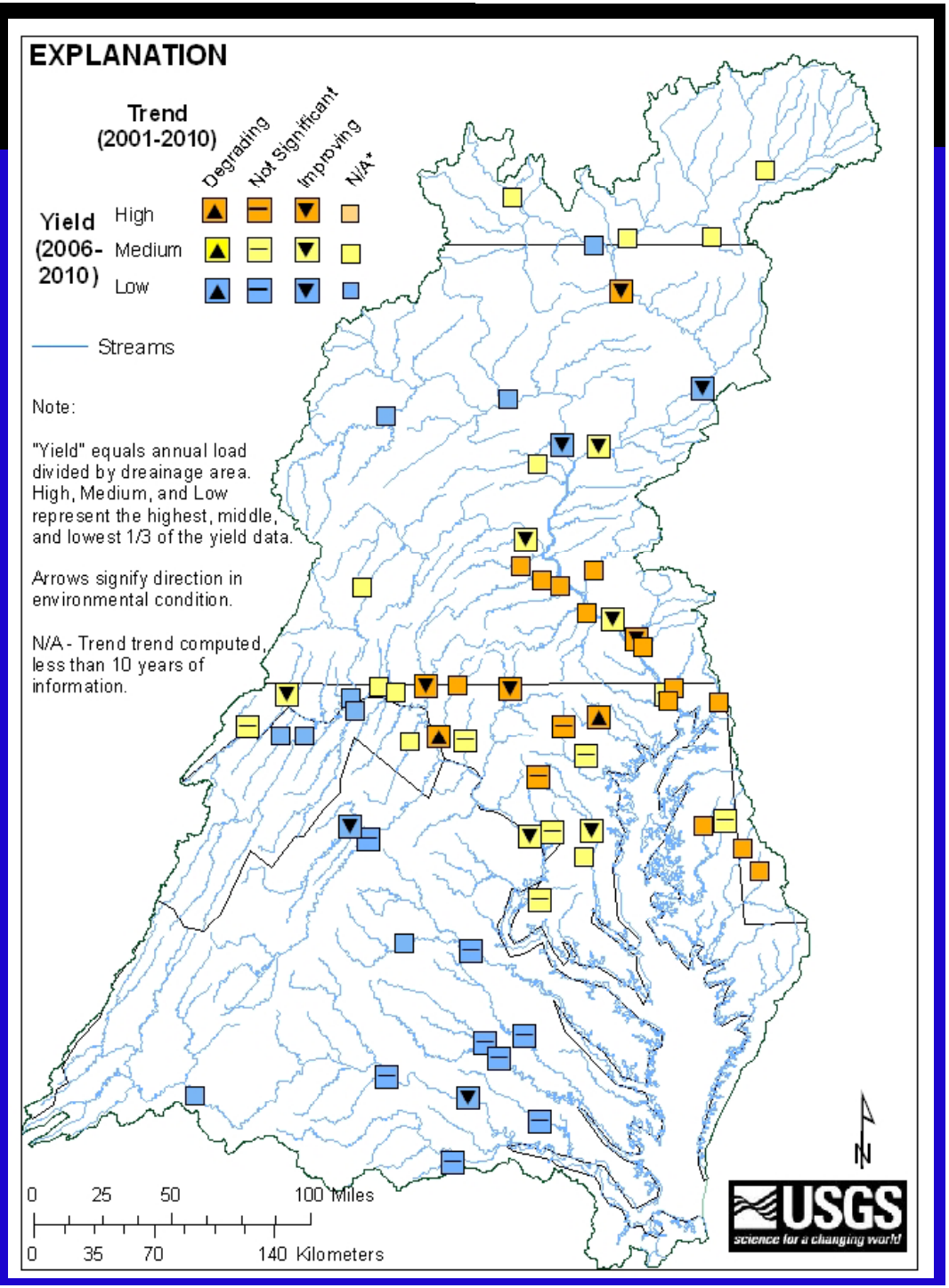
USGS
science for a changing world

Total Nitrogen Indicator

10 yr trend (33 sites)
5-yr TN Yields (tons/mi^2) at 64 sites

14 of 31 sites indicate improving trends

Spatially, higher yield distribution in middle of Bay watershed, lower yields in lower Bay watershed



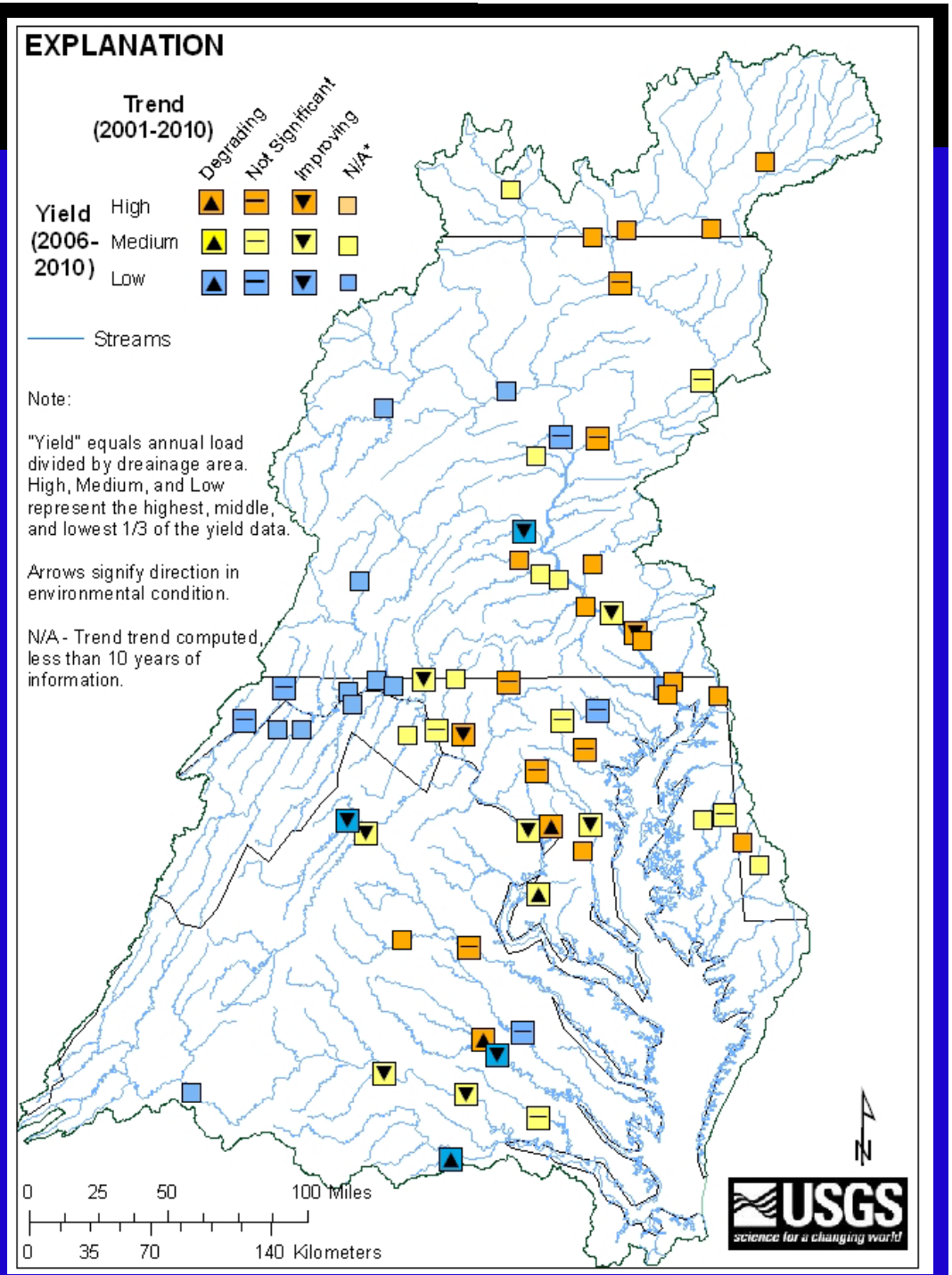
USGS
science for a changing world

Total Phosphorus Indicator

10 yr trend (33 sites)
5-yr TN Yields (tons/mi^2) at 64 sites

12 of 31 sites indicate improving trends

3 sites show degrading trends

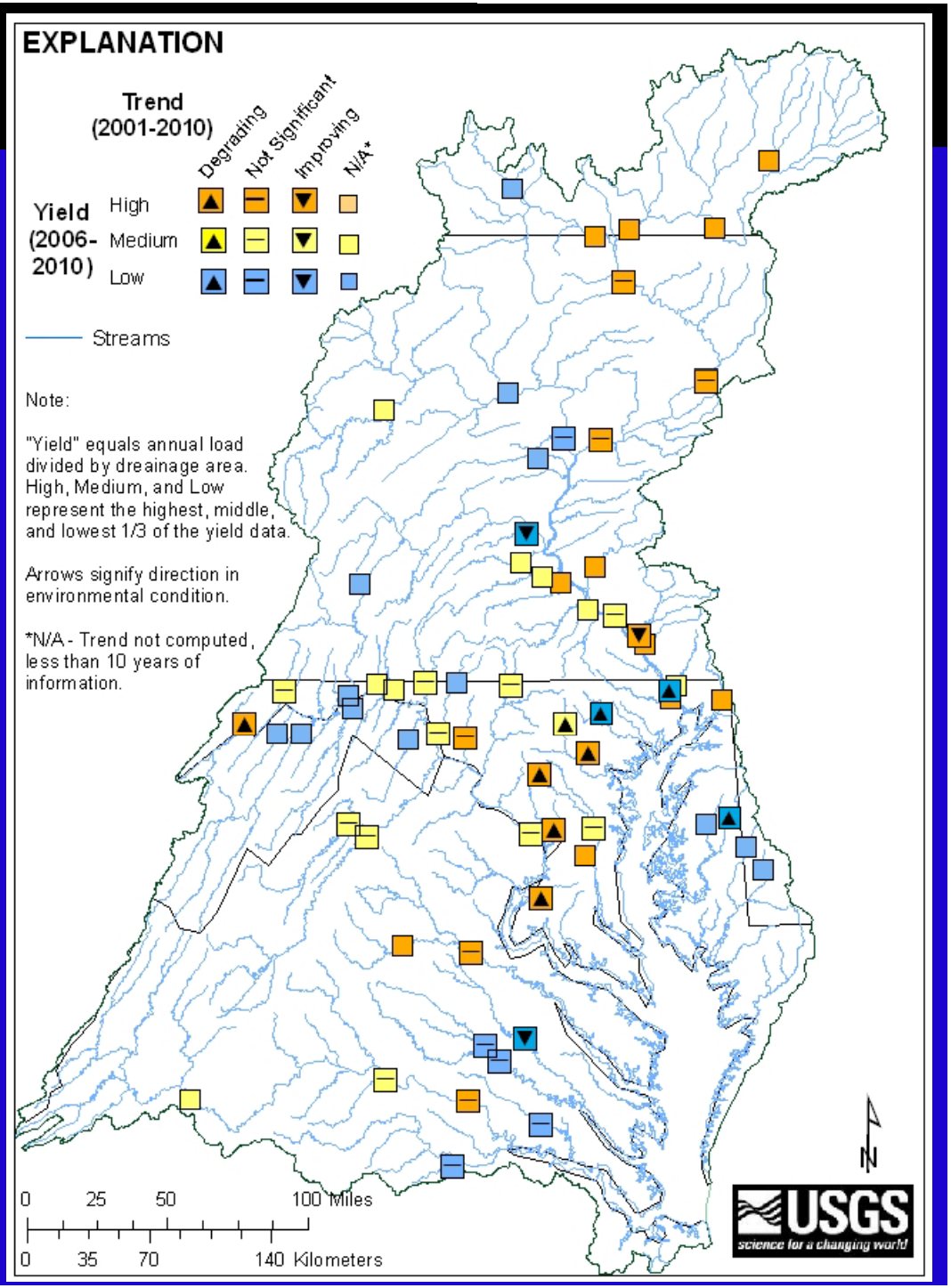


USGS
science for a changing world

Suspended Sediment Indicator

10 yr trend (33 sites)
5-yr TN Yields (tons/mi^2) at 64 sites

3 of 31 sites indicate improving trends, 9 degrading trends



USGS science for a changing world

Indicator Summary

		10-year flow-adjusted trend (2001-2010)			
Total Nitrogen 5-year Yields (2005-2010)	Yield	Degrading (upward)	Not significant	Improving (downward)	Trends not available
	high	2	4	2	13
	medium	0	6	7	10
	low	0	4	8	8
Total Phosphorus 5-year Yields (2005-2010)	Yield	Degrading (upward)	Not significant	Improving (downward)	Trends not available
	high	2	2	6	14
	medium	1	7	5	7
	low	1	3	6	10
Sediment 5-year Yields (2005-2010)	Yield	Degrading (upward)	Not significant	Improving (downward)	Trends not available
	high	5	6	1	11
	medium	1	10	0	8
	low	3	5	2	13

Table can be used to identify “best and worst” conditions along with associated trend direction

USGS
science for a changing world

Summary

- Loads
  - Sediment and Phosphorus loads in 2010 showed effects of unusual “normal” hydrologic conditions
- Long-term trends
  - The majority of the sites showed improving conditions:
  - Some long-term challenges remain for N, P, and S
- Load and short term trend indicator
  - Fewer improving trends as time period is shortened
  - More better cases than worse cases scenarios nitrogen and phosphorus.
  - Suspended sediment shows more problem sites.

USGS
science for a changing world

Directions

- Continuing to improve trends and loads techniques (WRTDS)
  - 2-year milestones
  - Comparison with WSM output
- Greater use of new web sites for information and data dissemination (USGS, CBP)
- Continued improvement to indicators,
- Expanded network data resources will increase power to see patterns.
  - Thanks for your continued investment in monitoring!

- Contact STAR, NTWG members, and Data Analysis team for specific questions