Water-Quality Trends in the Chesapeake Bay and Potomac River Basin 1985 - 2004

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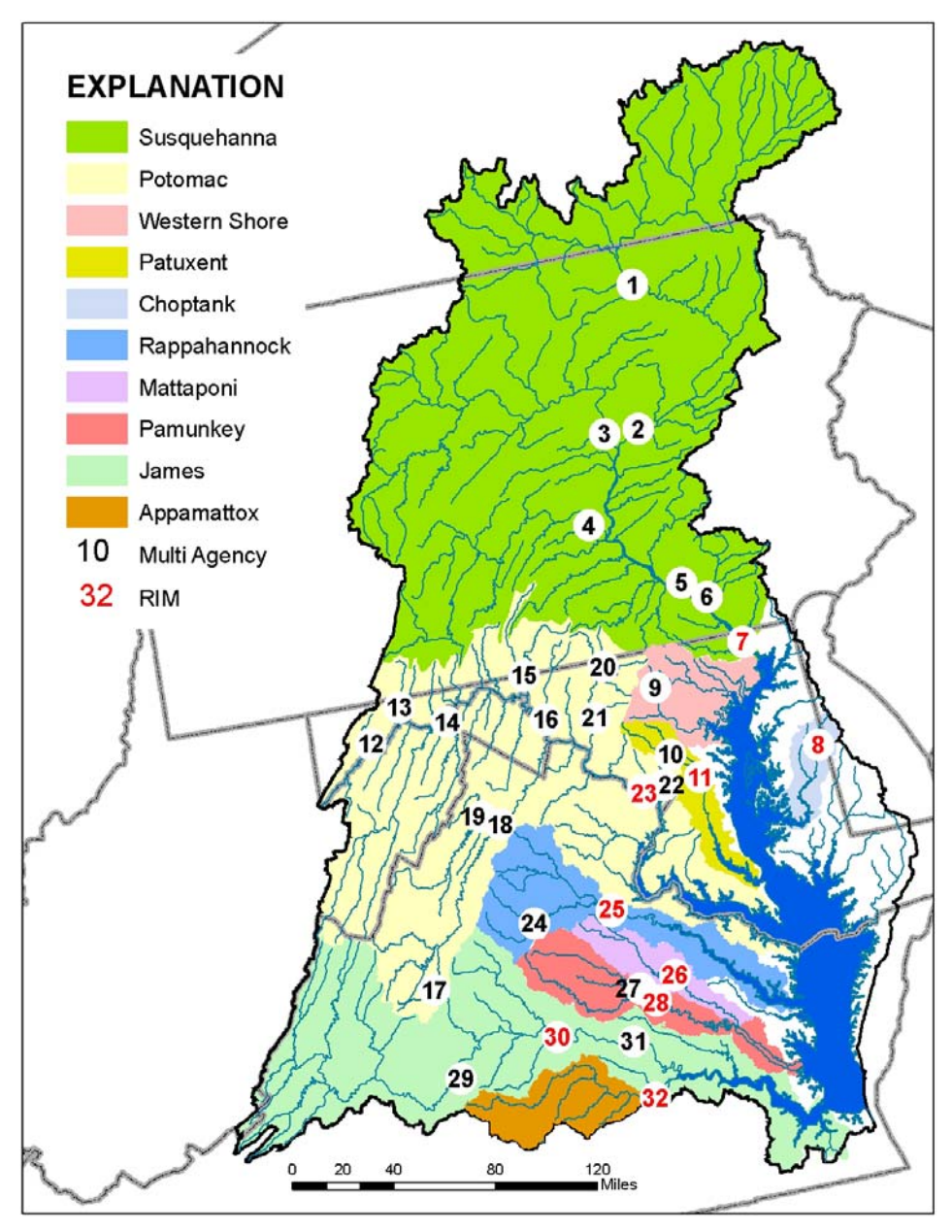
Nontidal Water-Quality Monitoring Network

OBJECTIVES

- Monitor Nutrient and Sediment Conditions
- Quantify Nutrient and Sediment Loads
- Identify Long-Term Trends
  - SRBC
  - MDDNR
  - DNREC
  - VADEQ
  - WVDA



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Data Collection

Sampling Goals

Collect 20 water-quality samples per year
- 12 Routine Samples
- 8 Storm-Impacted Samples
  (required for load quantification)

Water-Quality Measurements

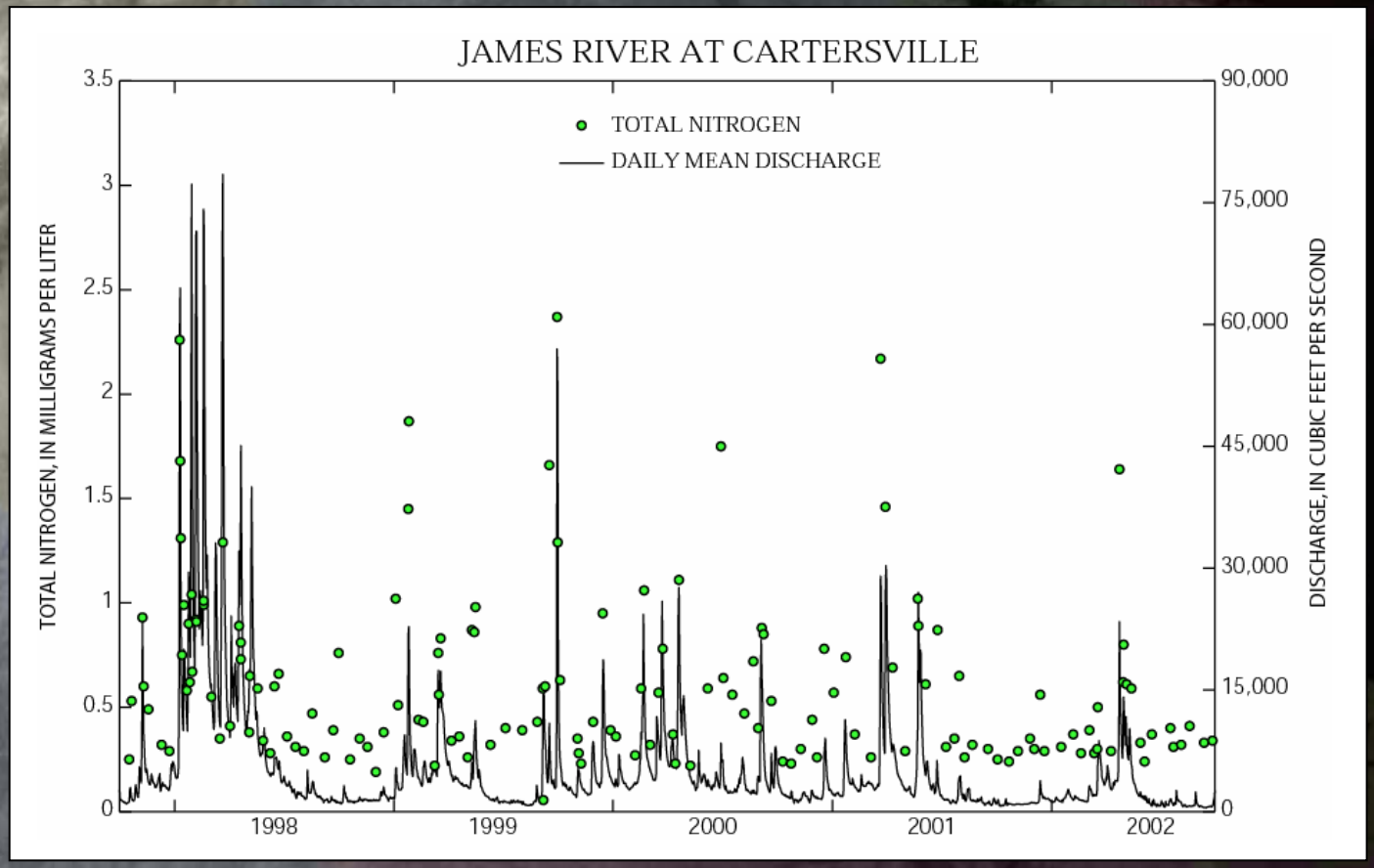
Streamflow
Field parameters
Nitrogen (TN, DN, PN, NOx, NH_4^+)
Phosphorus (TP, DP, PP, SRP)
Sediment (SSC, TSS, VSS, FSS)

LOAD ESTIMATION

RIM Primary Ojective:

1) Quantify nutrient and sediment loading from each basin

Daily Load = Daily Concentration * Mean Daily Discharge



LOAD ESTIMATION

ESTIMATOR (Cohn and others, 1989)

$\ln(C) = \beta_0$	Constant
$+\beta_1\left[\ln\left(\frac{Q}{\tilde{Q}}\right)\right]+\beta_2\left[\ln\left(\frac{Q}{\tilde{Q}}\right)\right]^2$	Flow
$+\beta_3\left[T-\tilde{T}\right]+\beta_4\left[T-\tilde{T}\right]^2$	Time
$+\beta_5\sin(2\pi T)+\beta_6\cos(2\pi T)$	Seasonality
$+\varepsilon$	Error

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Trend Questions

1. What changes have occurred in concentrations and loads delivered from each basin?

Types of Trend Analyses used to Address this Question

A. Trend in Streamflow
B. Trend in Observed Concentration
C. Trend in Modeled Concentration and Load (Non-Flow Adjusted)

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Trend Questions

2. What have been the effects of management actions on water-quality conditions in each basin?

Type of Trend Analysis used to Address this Question

A. Trend in Model Concentration - Flow-Adjusted Concentration

- Flow-adjusted trends provide our best estimate of changes that have occurred due to a variety of actions, independent of variation in streamflow.

FLOW ADJUSTED TREND

ESTIMATOR (Cohn and others, 1989)

$$\ln(C) = \beta_0$$ Constant

$$+\beta_1\left[\ln\left(\frac{Q}{\tilde{Q}}\right)\right]+\beta_2\left[\ln\left(\frac{Q}{\tilde{Q}}\right)\right]^2$$ Flow

$$+\beta_3\left[T-\tilde{T}\right]+\beta_4\left[T-\tilde{T}\right]^2$$ Time

$$+\beta_5\sin(2\pi T)+\beta_6\cos(2\pi T)$$ Seasonality

$$+\varepsilon$$ Error

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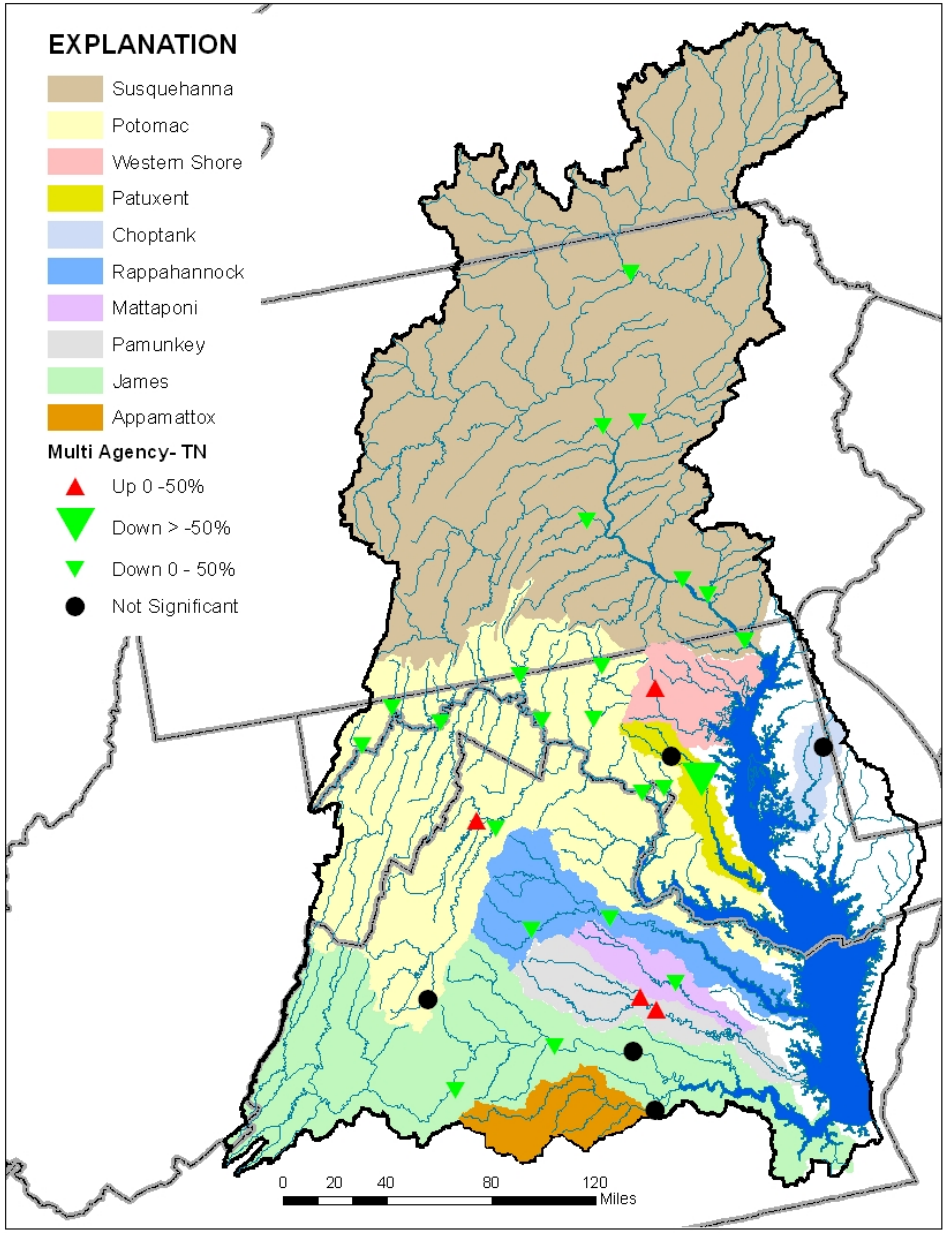
Flow Adjusted Trends: NT Stations



Total Suspended
Total Nitrogen
Total Phosphorus

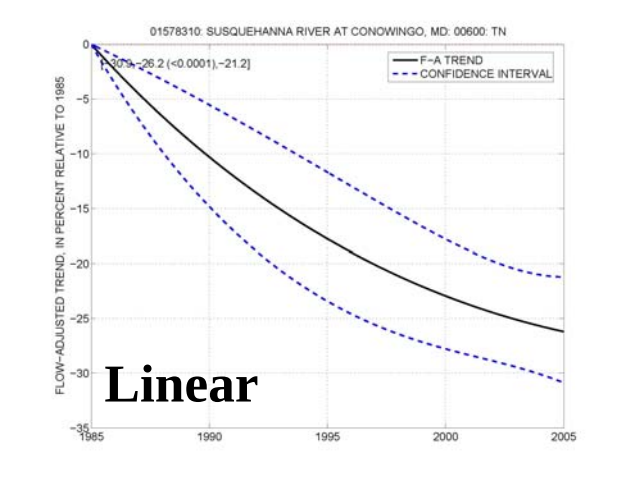
▲ = 4

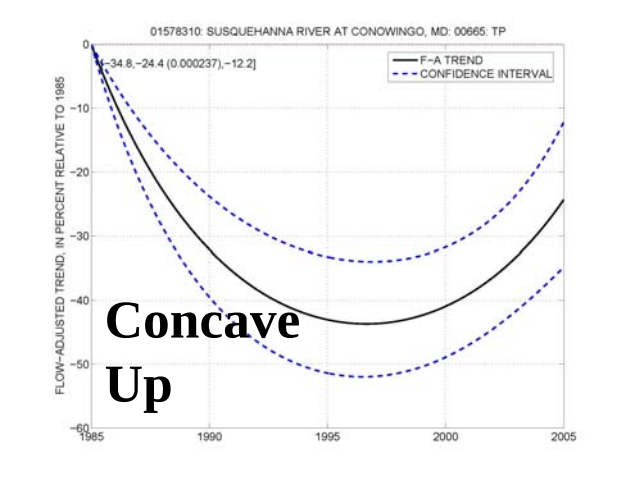
▼ = 1

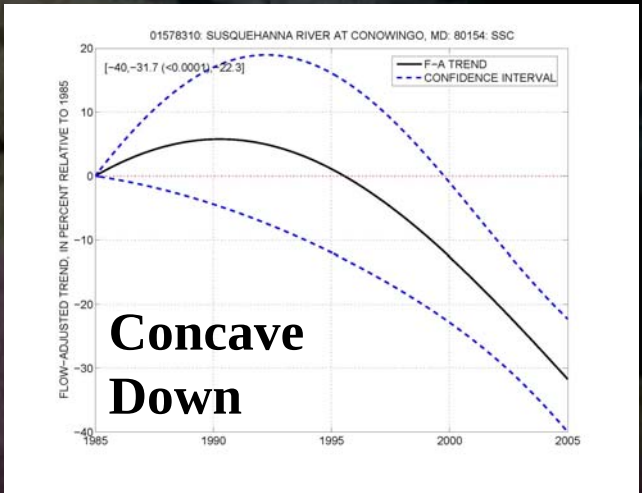
▼ = 22

● = 5

Flow Adjusted Trends: Temporal Patterns







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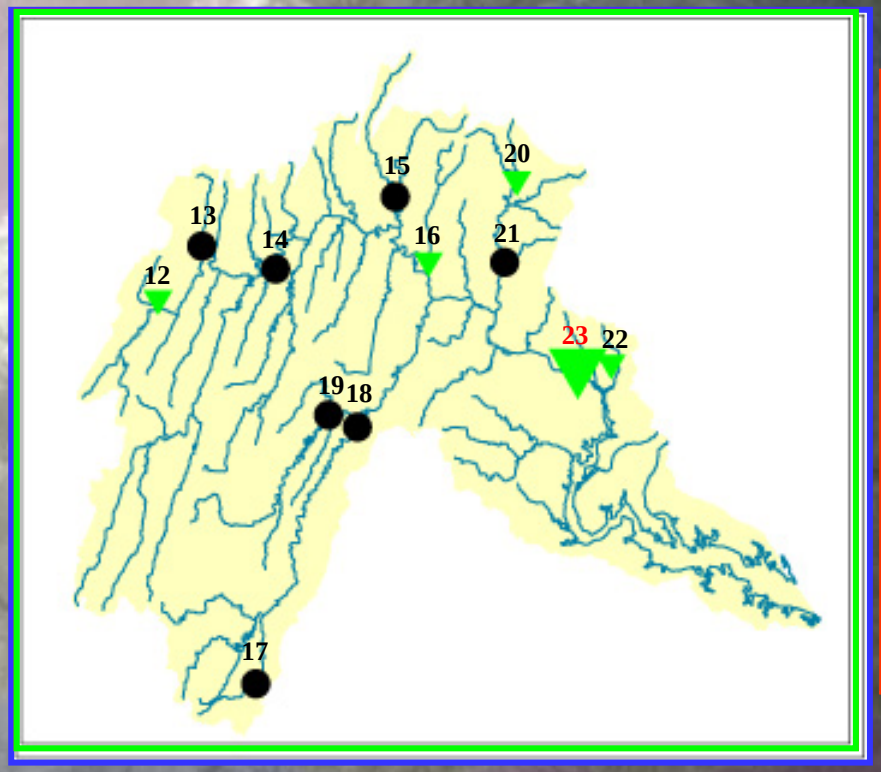
Potomac River: Flow Adjusted Trend



Trend	Total Suspended Sediment	Total Nitrogen	Total Phosphorus
	Total	Linear	Curve Up	Curve Down
SIG-UP	2		2	
SIG-DN	10	6	1	3
NS	1			

Basins of Concern: Total Phosphorus
Basins of Concern: Total Nitrogen

- NF Shenandoah River nr Strasburg
- NF Shenandoah River nr Strasburg
- Potomac River at Chain Bridge
- Conococheague Creek at Fairview
- Moncacy River at Bridgeport
- Monocacy River near Bridgeport

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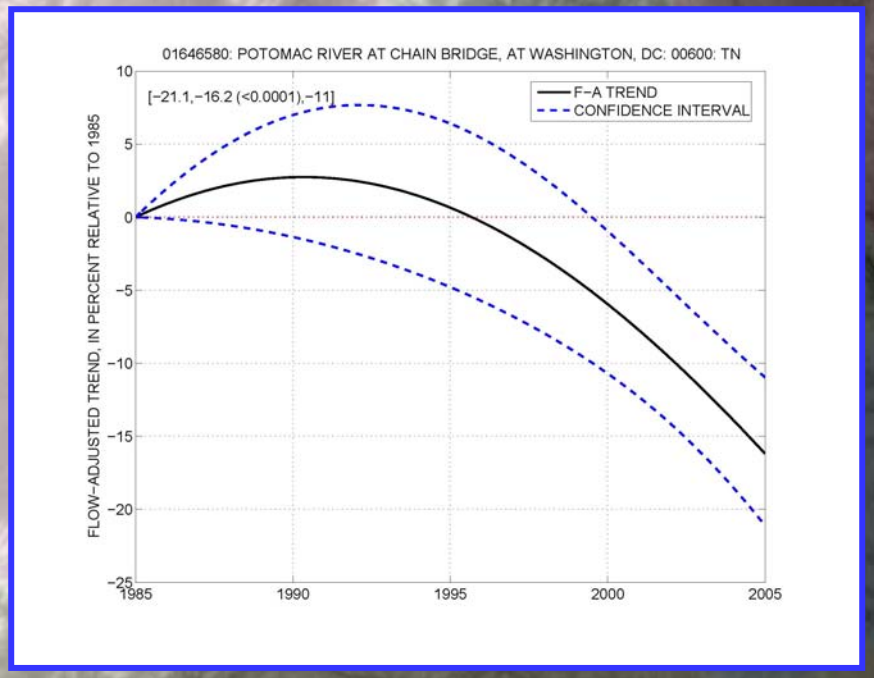
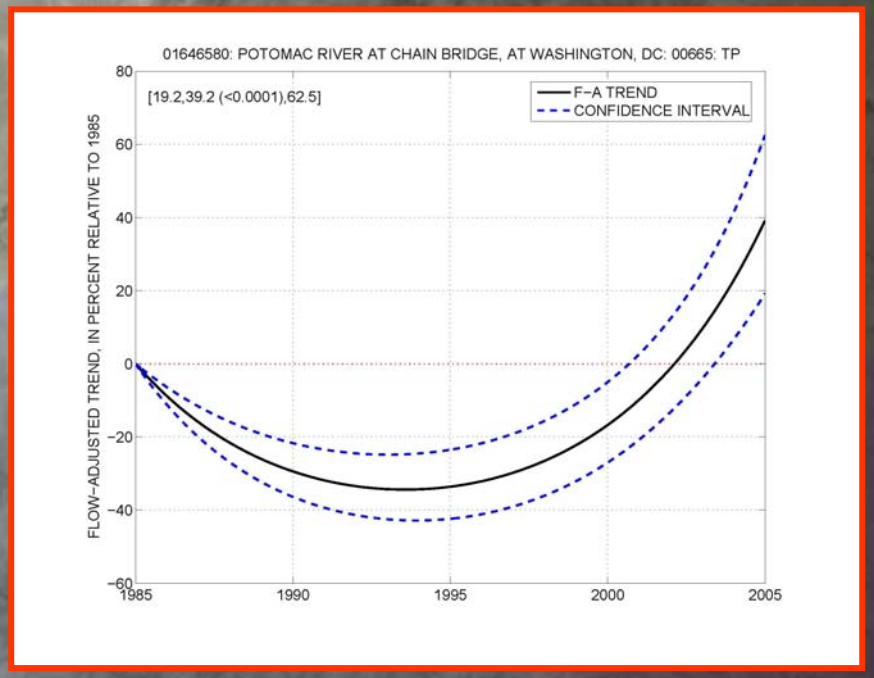
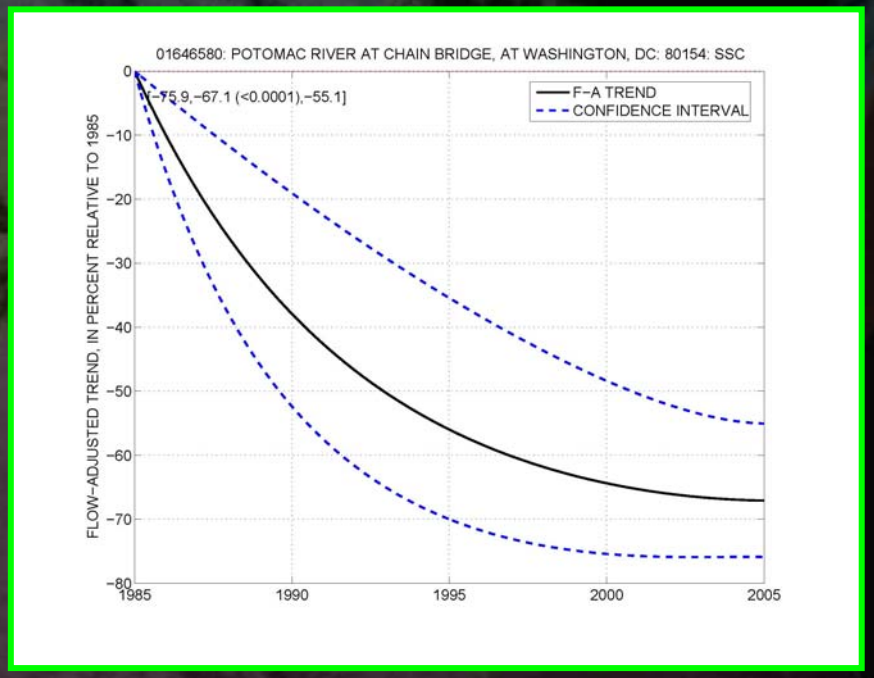
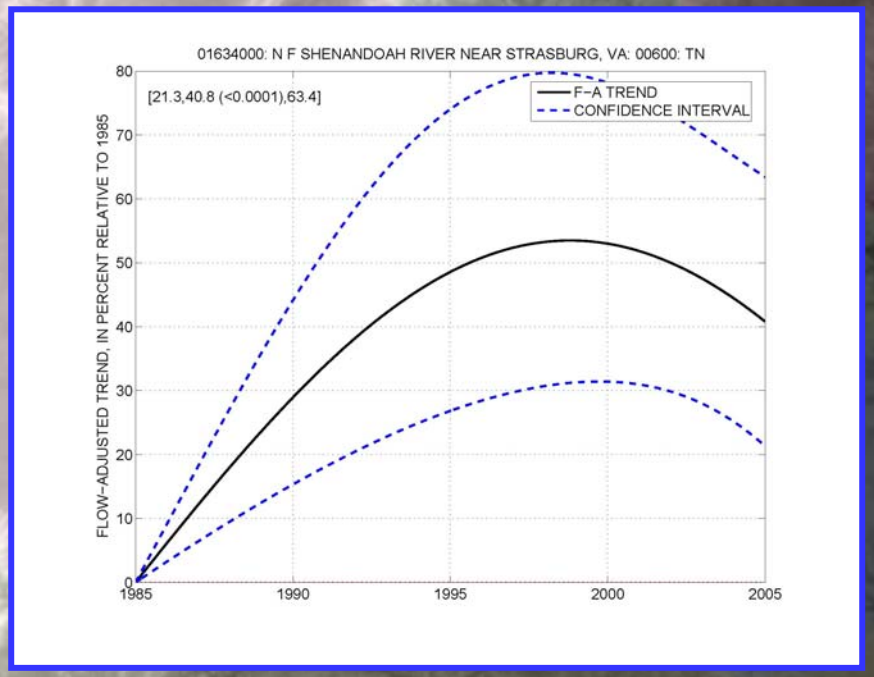
Potomac River: Flow Adjusted Trend TN, TP, & SSC

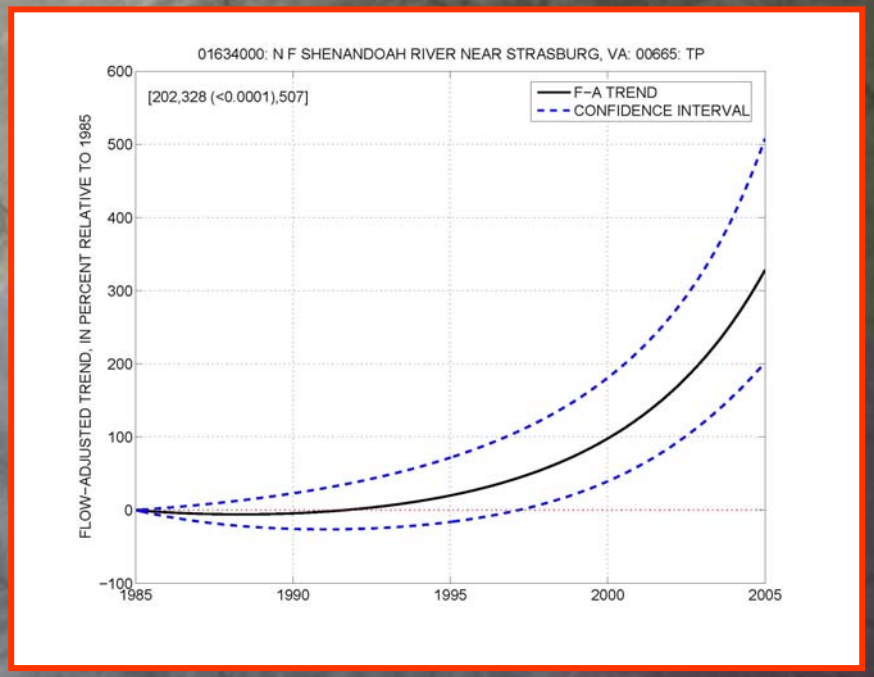


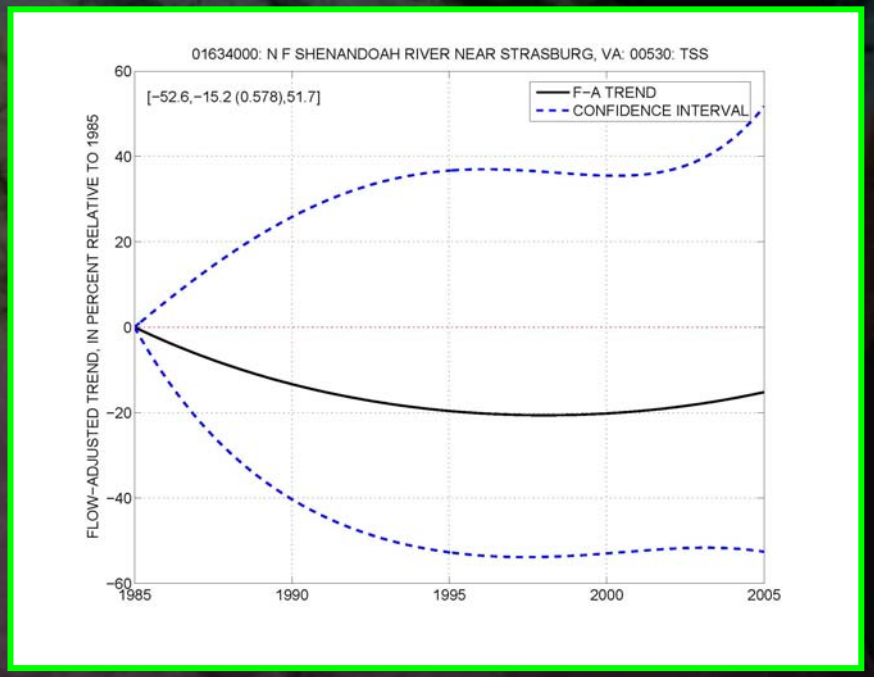




NF Shenandoah: Flow Adjusted Trend TN, TP, & TSS



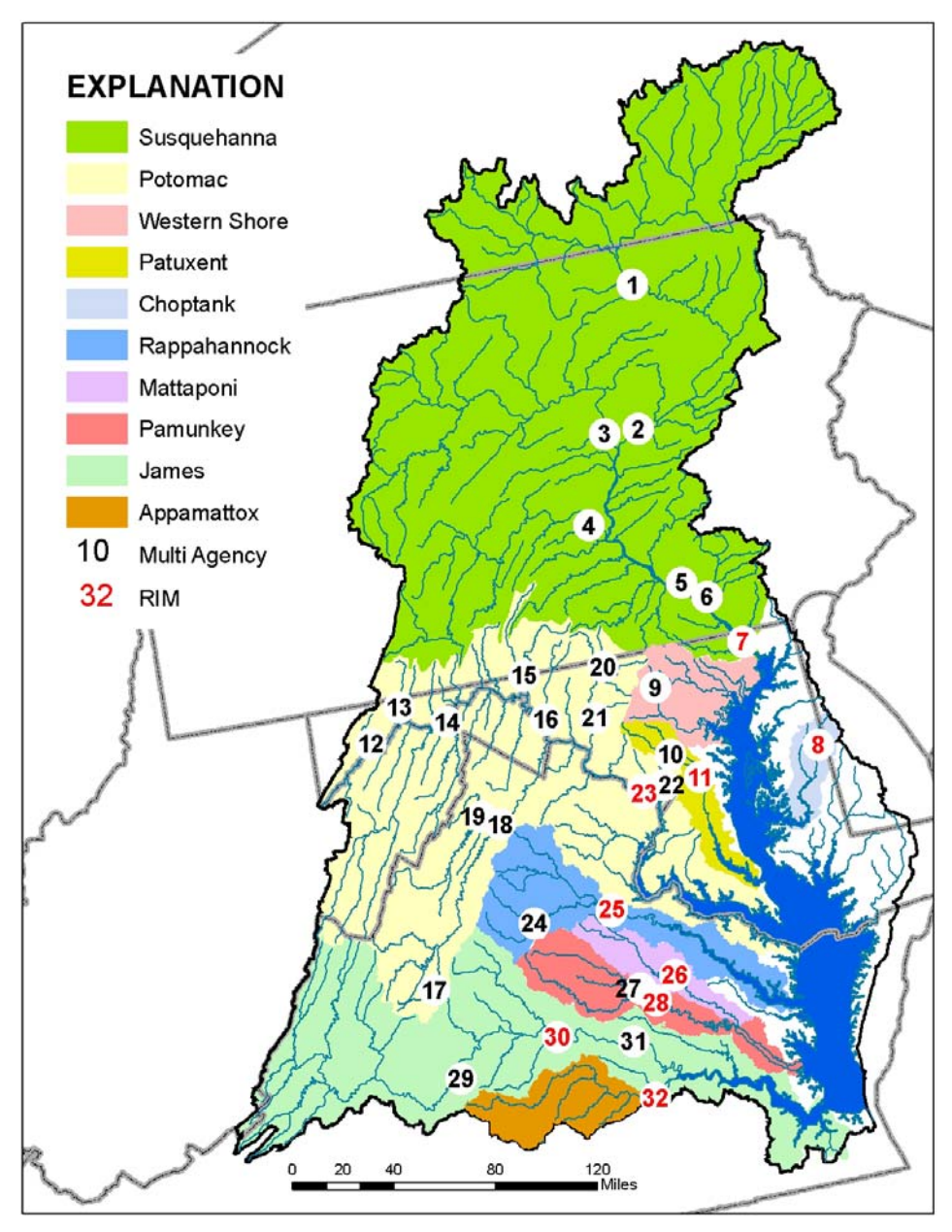




Nontidal Water-Quality Monitoring Network

ISSUES

- Small Scale Basins are under represented (<50 mi^2)
  - Process oriented studies
  - BMP efficacy
- Urban-dominated or rapidly developing basins.
  - Process oriented studies
  - BMP efficacy
  - Nutrient and sediment transport



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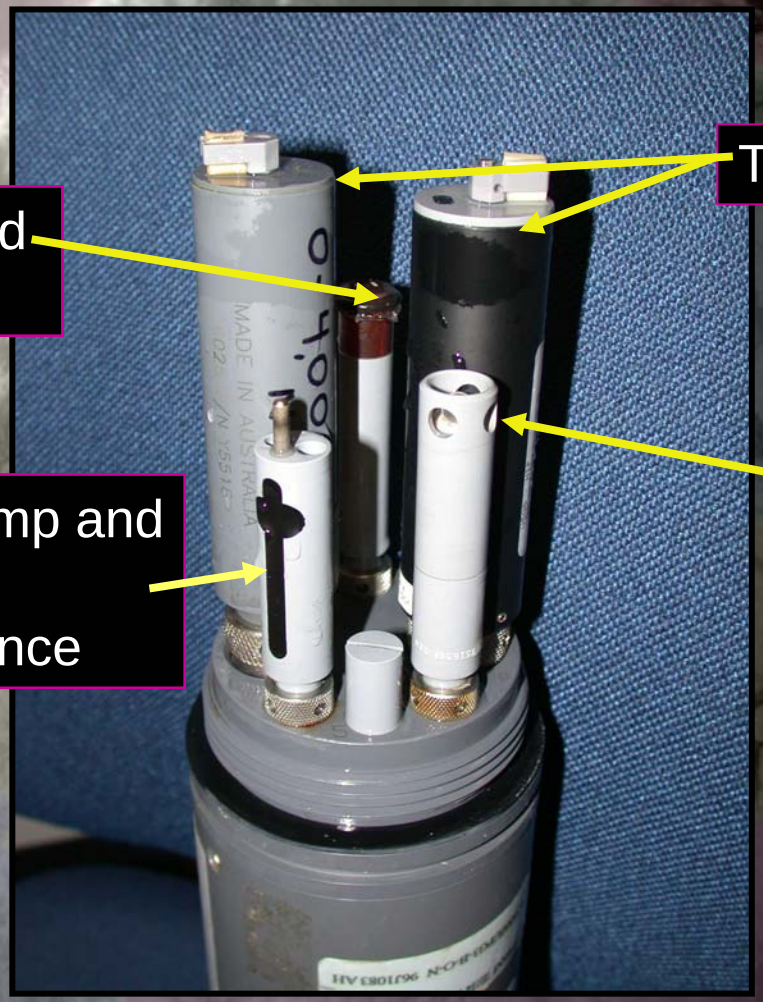
Urban Dominated Watersheds

Continuous Water-Quality Monitoring



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Why Continuous Water Quality Monitoring?

- Typically, relatively few discrete samples (20 per year) are collected and used to develop QW interpretations.
- Detailed understanding of the river is almost never developed if discrete sampling is used.
- Continuous data are extremely detailed (every 15 minutes), which allow them to be applied very broadly.
- Delay between sample collection and lab analysis may be critical.
- Time and costs associated with manual sampling.
- Existing approaches for estimating a constituent time-series generally involves regressions to discharge. Use water-quality data to predict water-quality data!

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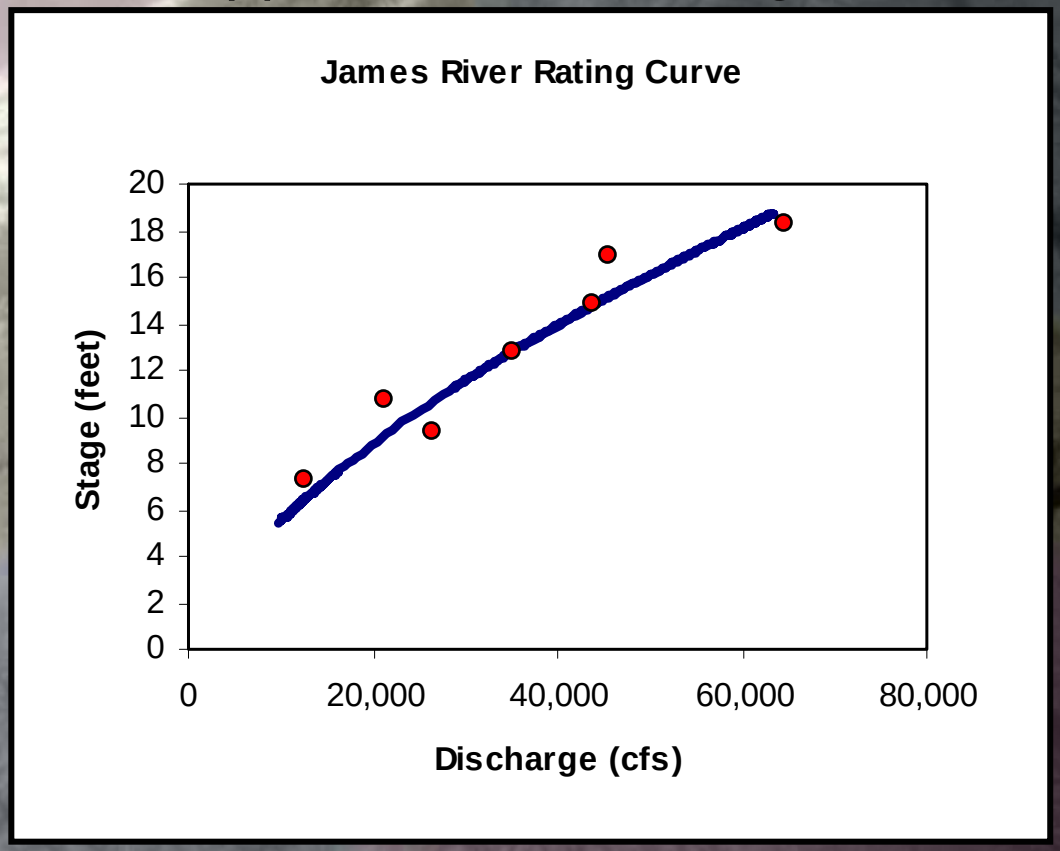
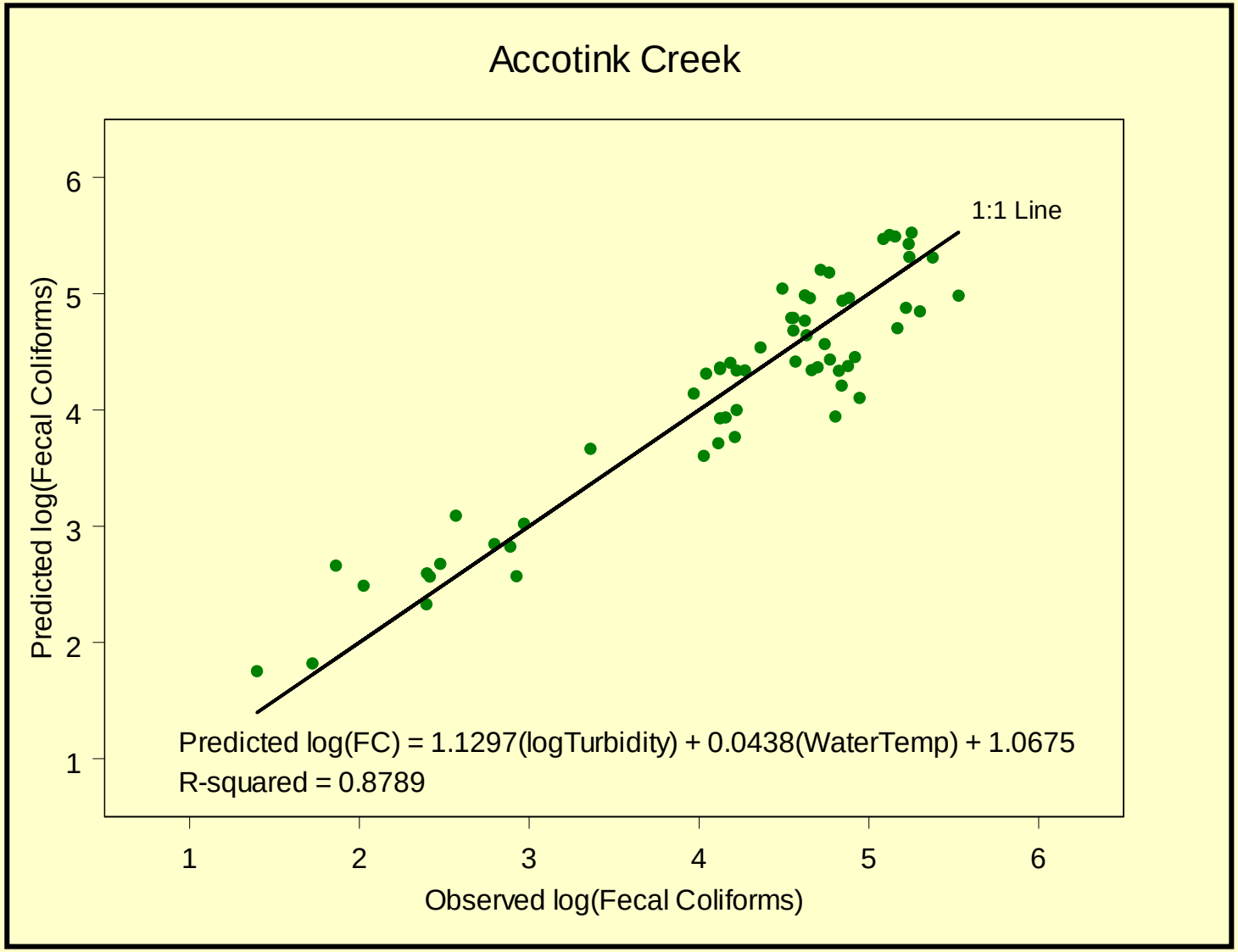
Surrogate estimation through the Rating Curve Approach

Stream discharge is determined on the basis of a continuously measured record of water level and the application of a rating curve.

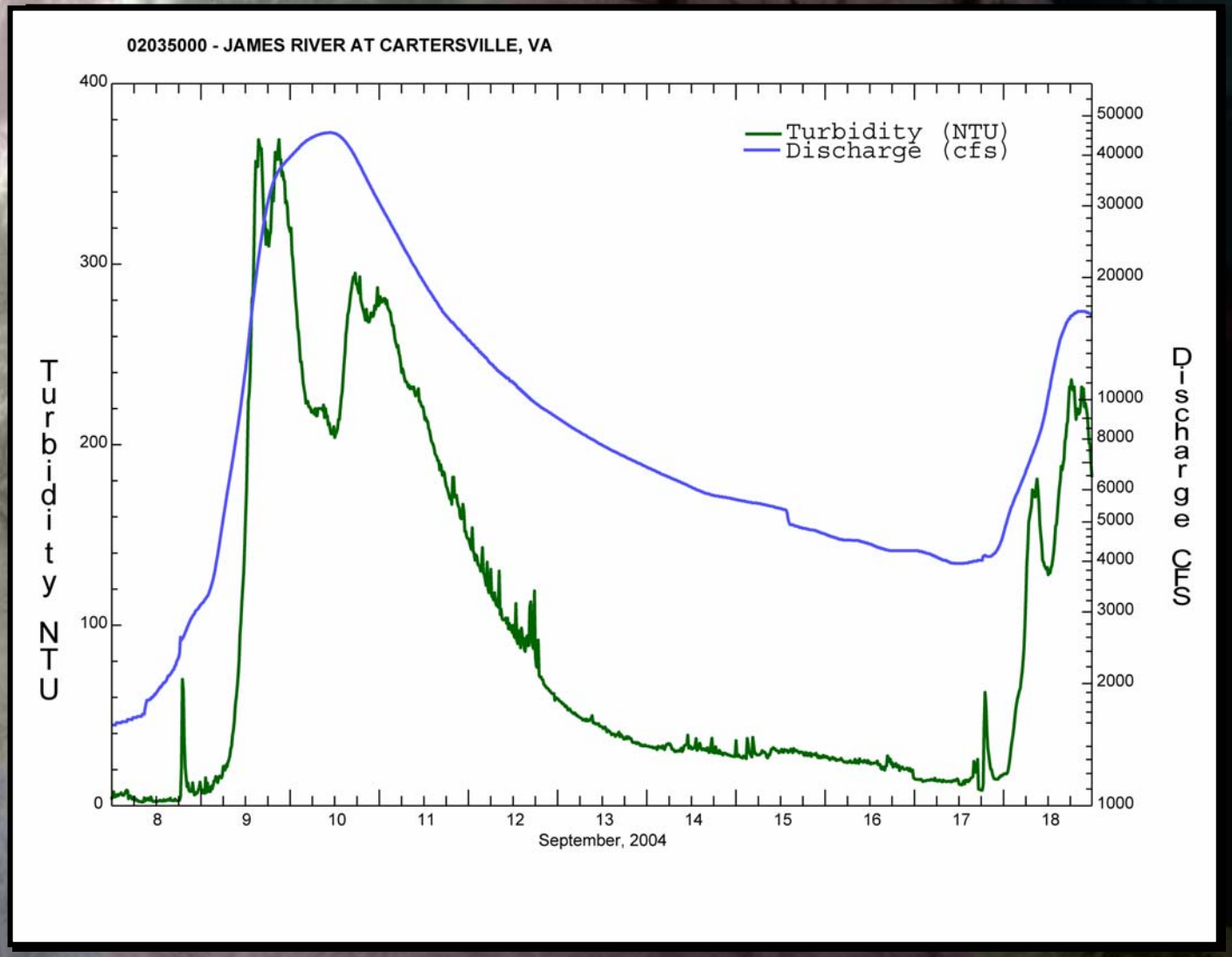


An analogous approach can be used to determine other QW constituent concentrations (sediment, bacteria, nutrients, metals, organics) from continuous parameters .

EXAMPLE WATER-QUALITY RATINGS



Resulting Data



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Efficacy of urban BMP implementation

Objective:
Evaluate the utility of continuous water-quality monitoring to detect water-quality improvements that are related to BMP activities at the watershed scale?

Hypothesis:
More robust data improves The ability and rate with Which change can be detected.

Cooperator:
US EPA
Fairfax City

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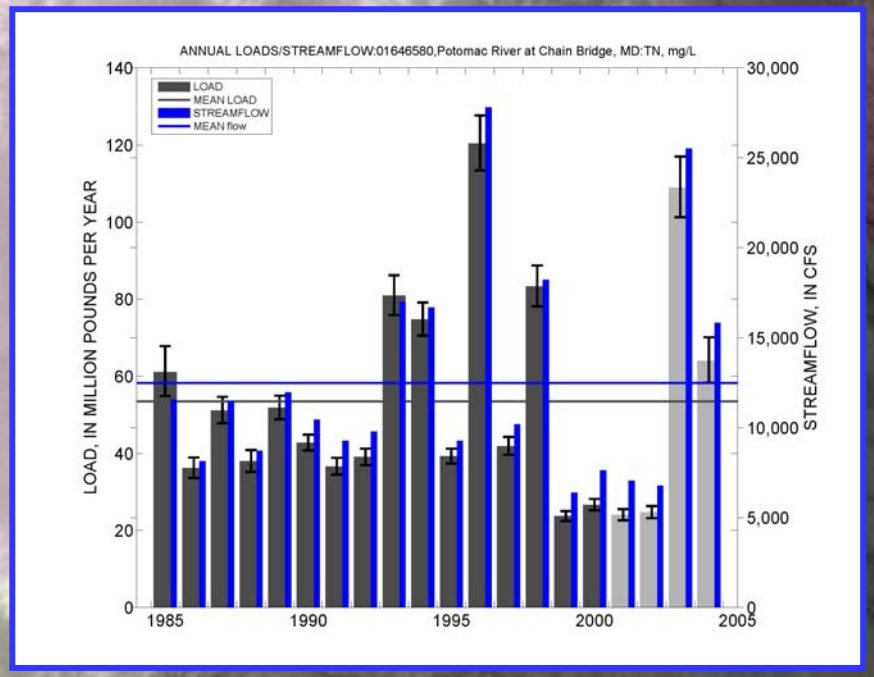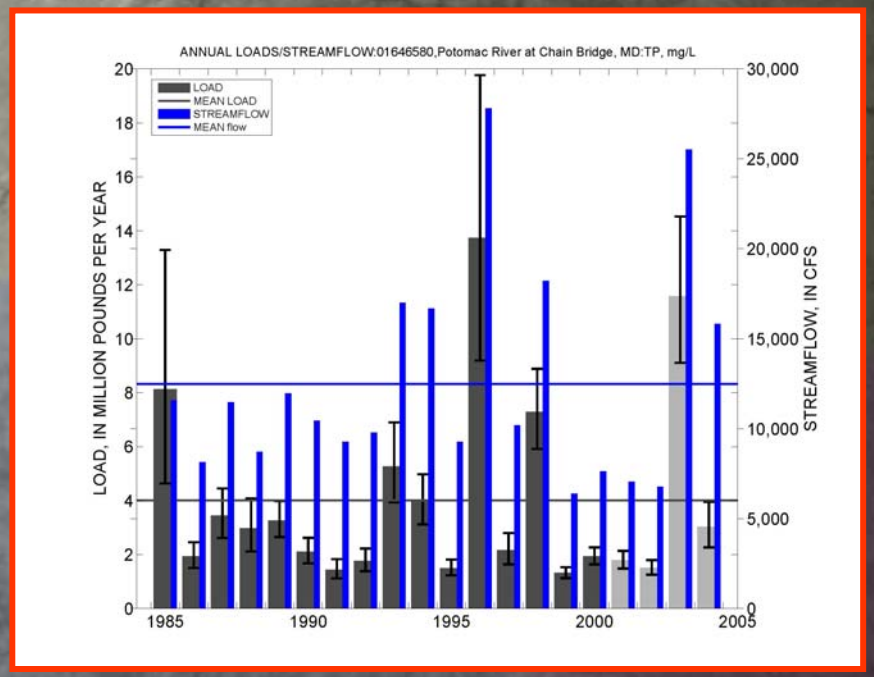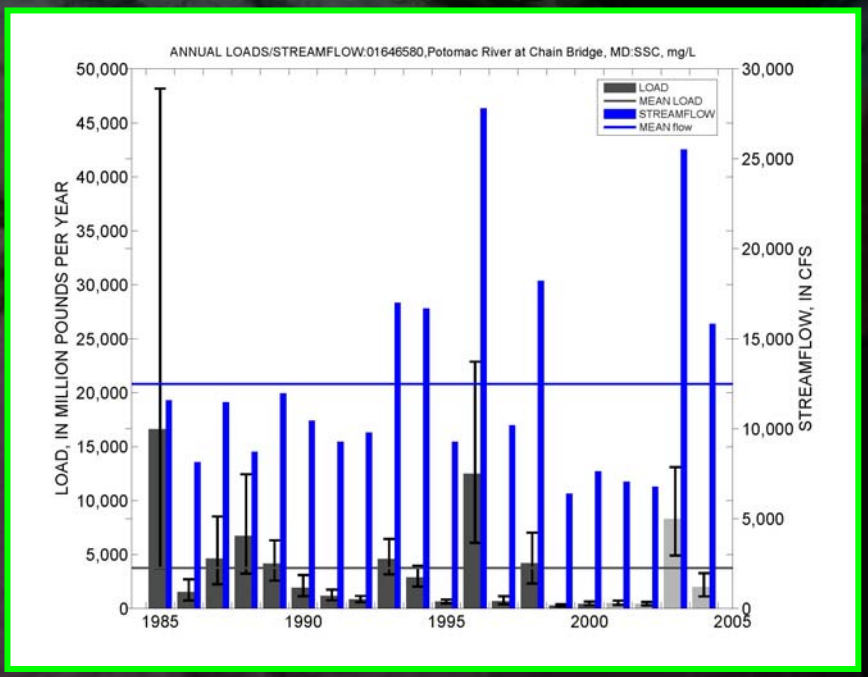
Potomac River: Annual Loads TN, TP, & SSC