



Using Monitoring Data from Multiple Networks/Agencies to Calibrate Nutrient SPARROW* Models, Southeastern U.S.

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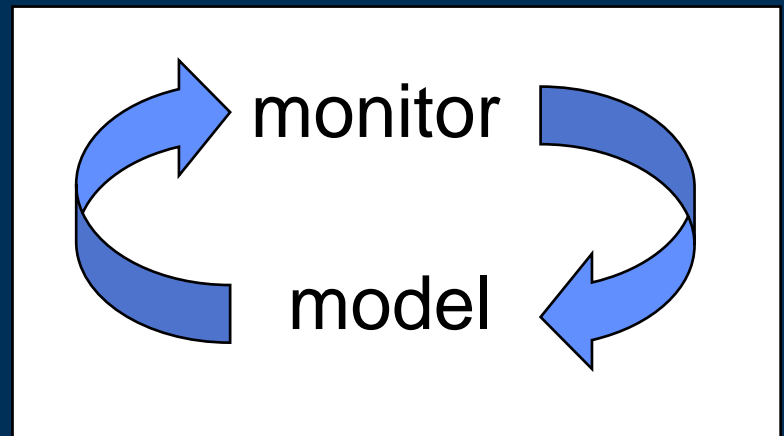
*SPatially Referenced Regression On Watershed Attributes

U.S. Department of the Interior
U.S. Geological Survey

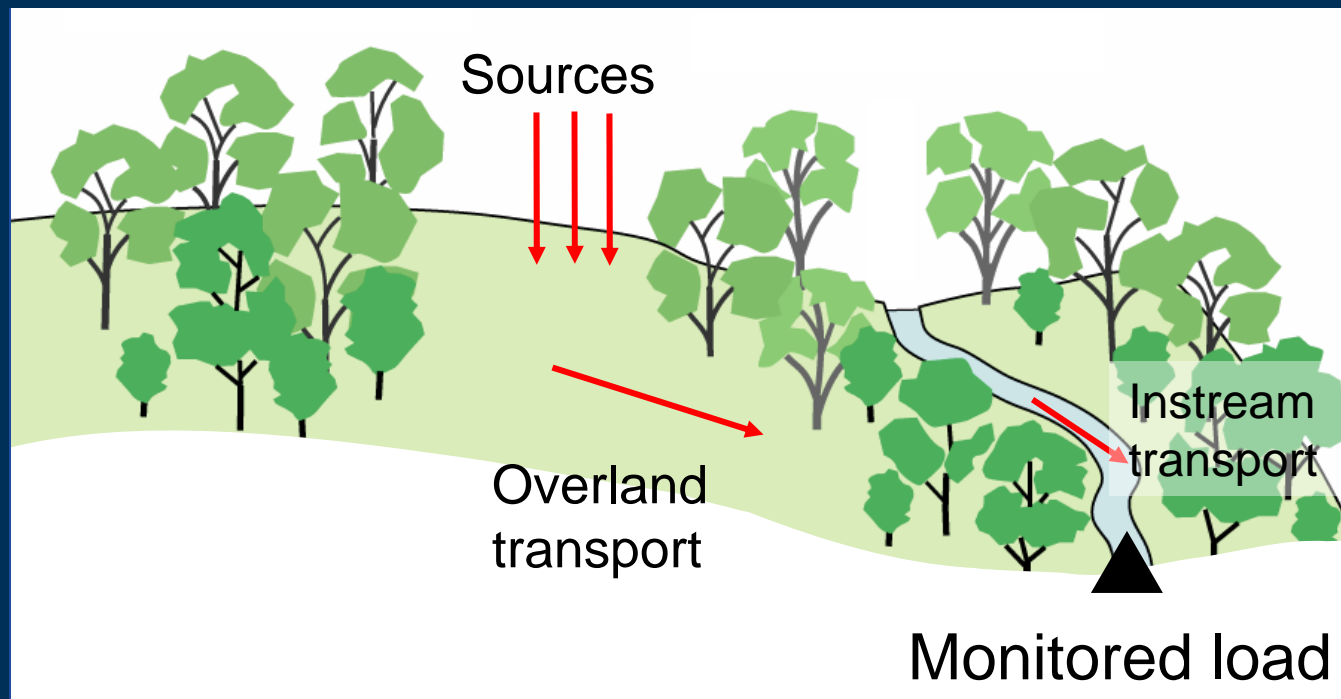
National Water-Quality Assessment Program

Presentation outline

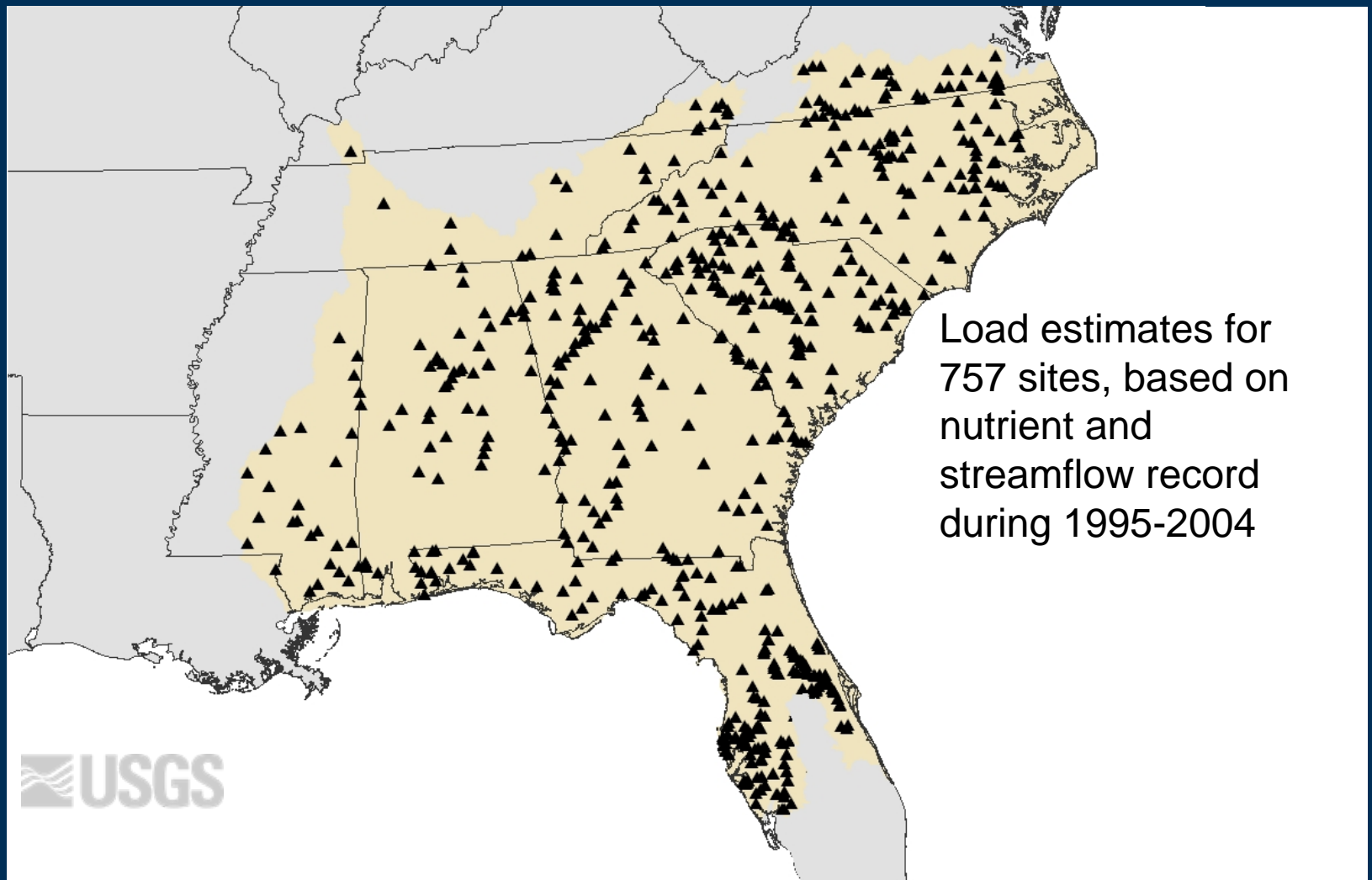
- **SPARROW model of the Southeastern U.S. – preliminary results and planned applications**
- **Use of monitoring networks from many different State and federal programs**
- **Implications of model results for monitoring programs**



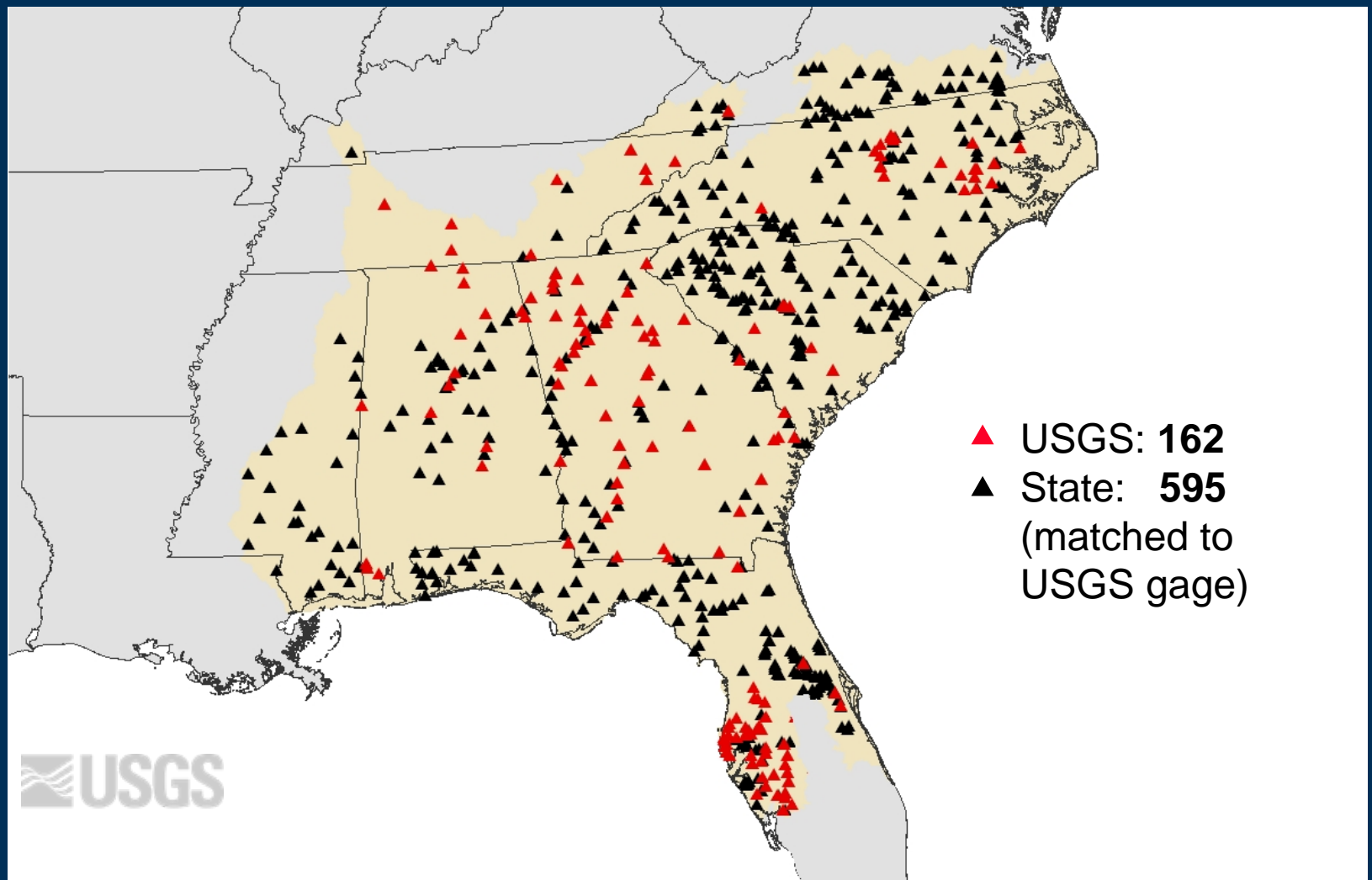
SPARROW model approach: Regress water-quality conditions (monitored load) on upstream sources and factors controlling transport



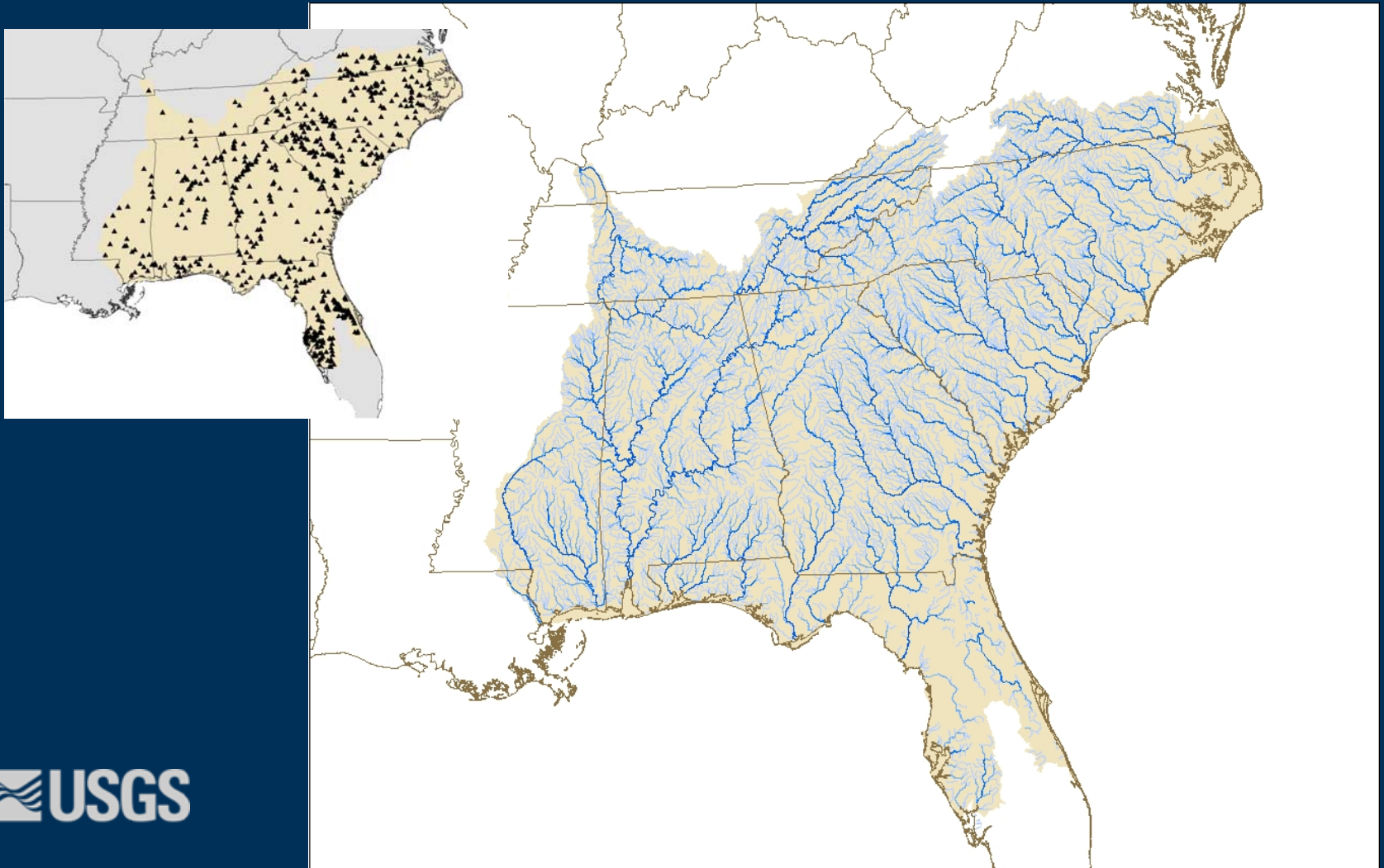
SPARROW model of nitrogen and phosphorus transport in Southeastern U.S. streams, 2000



SPARROW model of nitrogen and phosphorus transport in Southeastern U.S. streams, 2000



First round of modeling uses RF1 reach network (1:250,000 scale)



Calibration results for the preliminary (RF1) nitrogen SPARROW model, Southeastern U.S.

R-squared = 0.95, MSE = 0.15

<i>Source Variables</i>	Coefficient	
	Estimate (p<.05)	Unit
Wastewater effluent load (kg TN)	0.83	kg/kg
Atmospheric deposition (kg NO ₃ , wet deposition)	1.3	kg/kg
Agricultural land area (km ²)	880	kg/km ²
Developed land area (km ²)	830	kg/km ²

Calibration results, continued

Factors controlling movement over land

**Coefficient
($p < 0.05$)**

Soil infiltration rate (rank)

-0.27

Soil organic matter (percent)

-0.18

Water holding capacity (cm/cm)

4.6

in streams / reservoirs

**Travel time (days) in small streams
(<100) cfs**

0.47

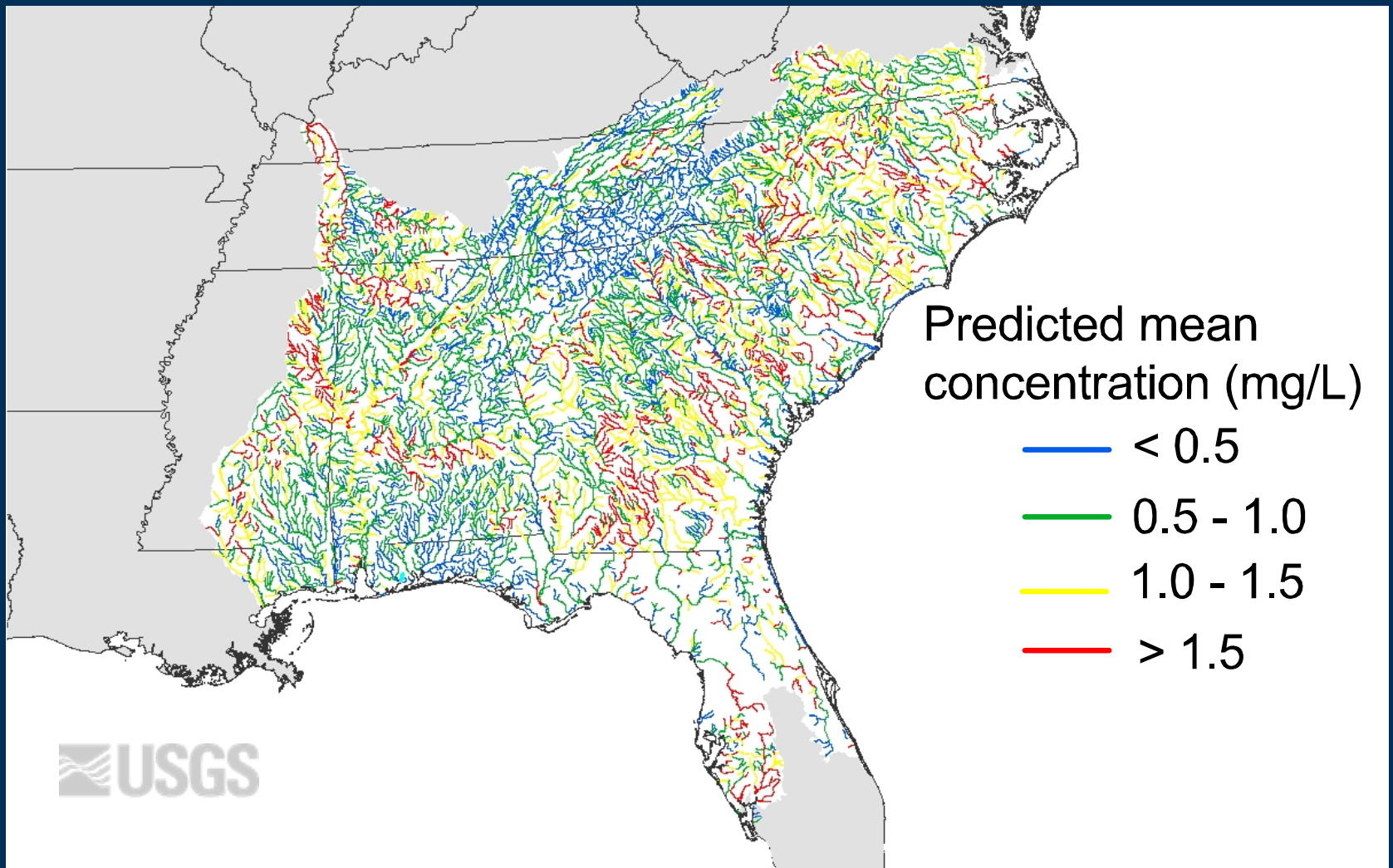
**Travel time (days) in 'medium' streams
100-1000 cfs**

0.19

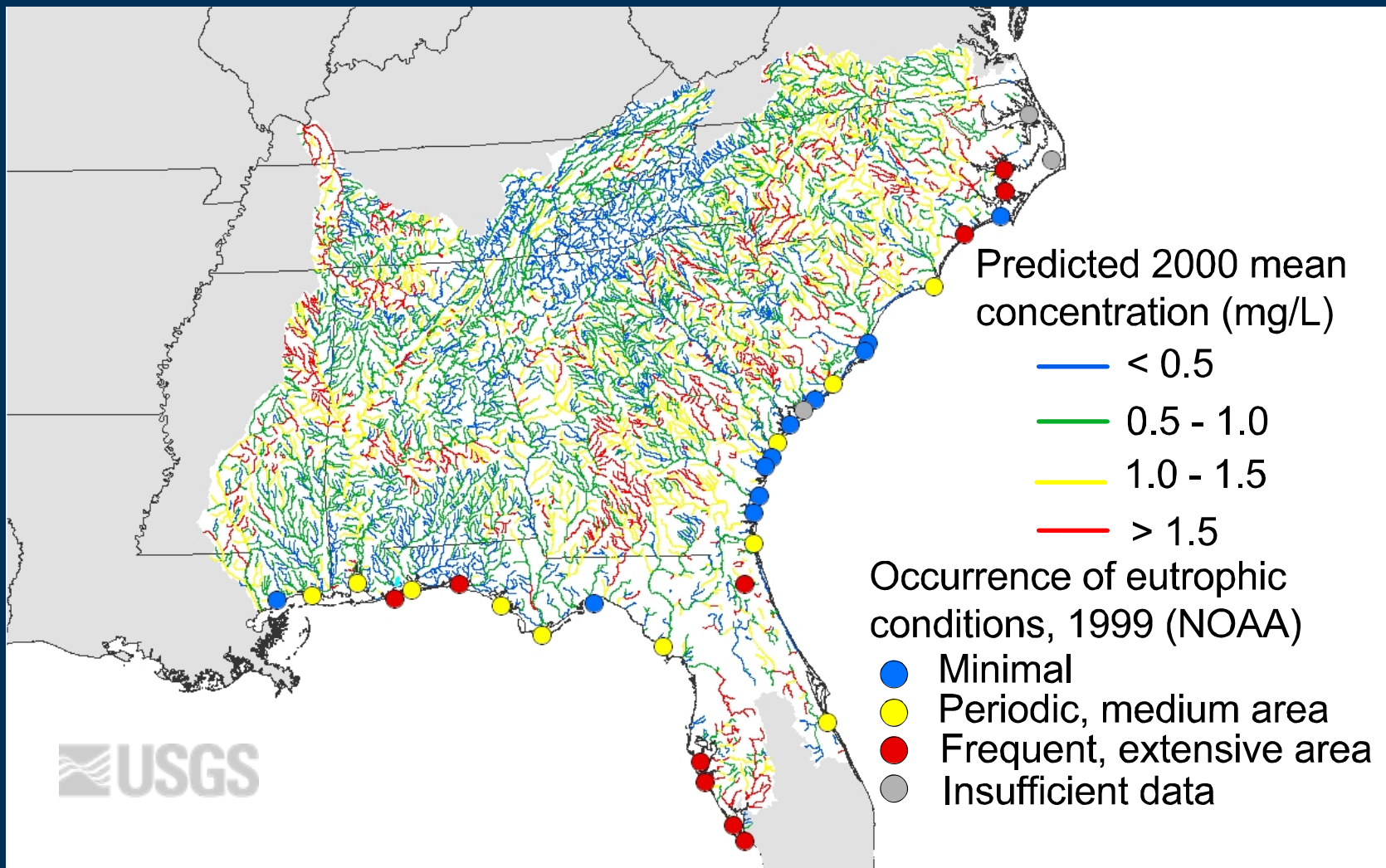
Reservoir hydraulic load, inverse (yr/m)

15

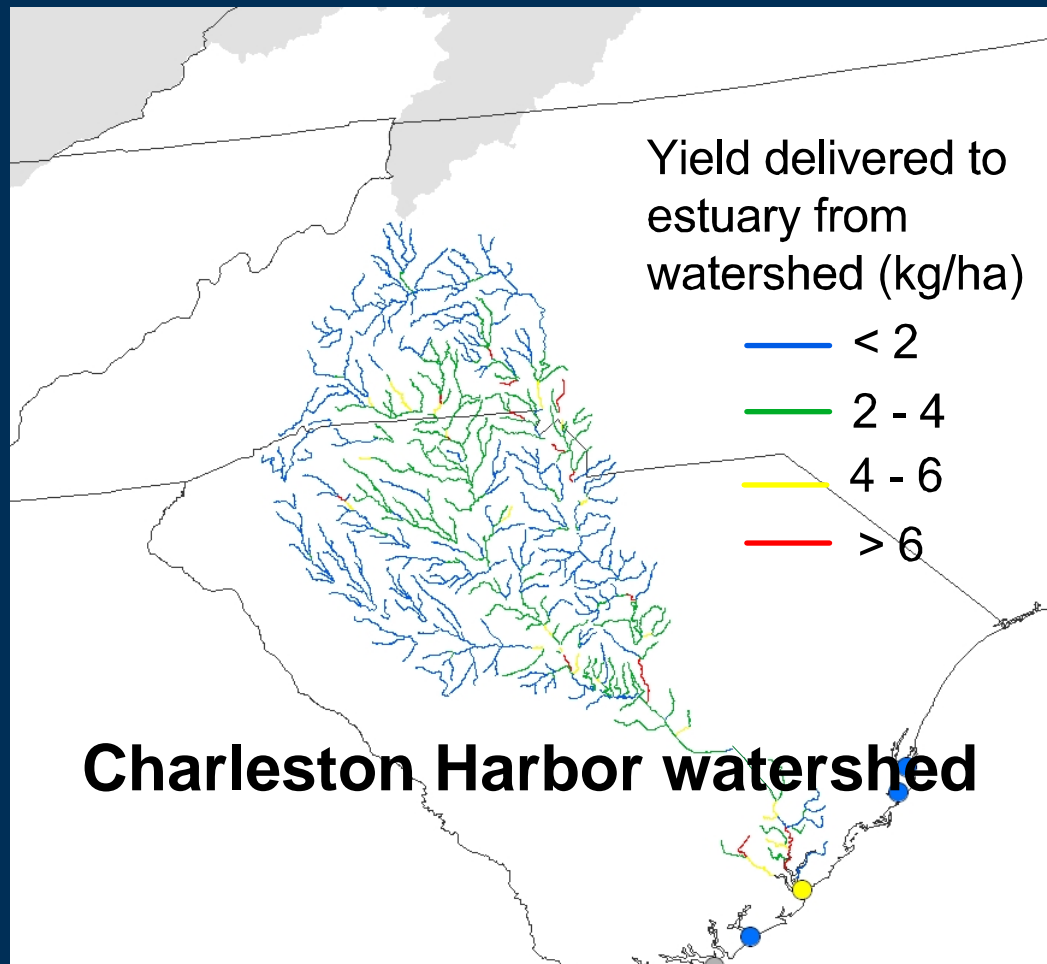
SPARROW model predictions of total-nitrogen concentration based on watershed conditions



SPARROW model predictions of total-nitrogen concentration based on watershed conditions



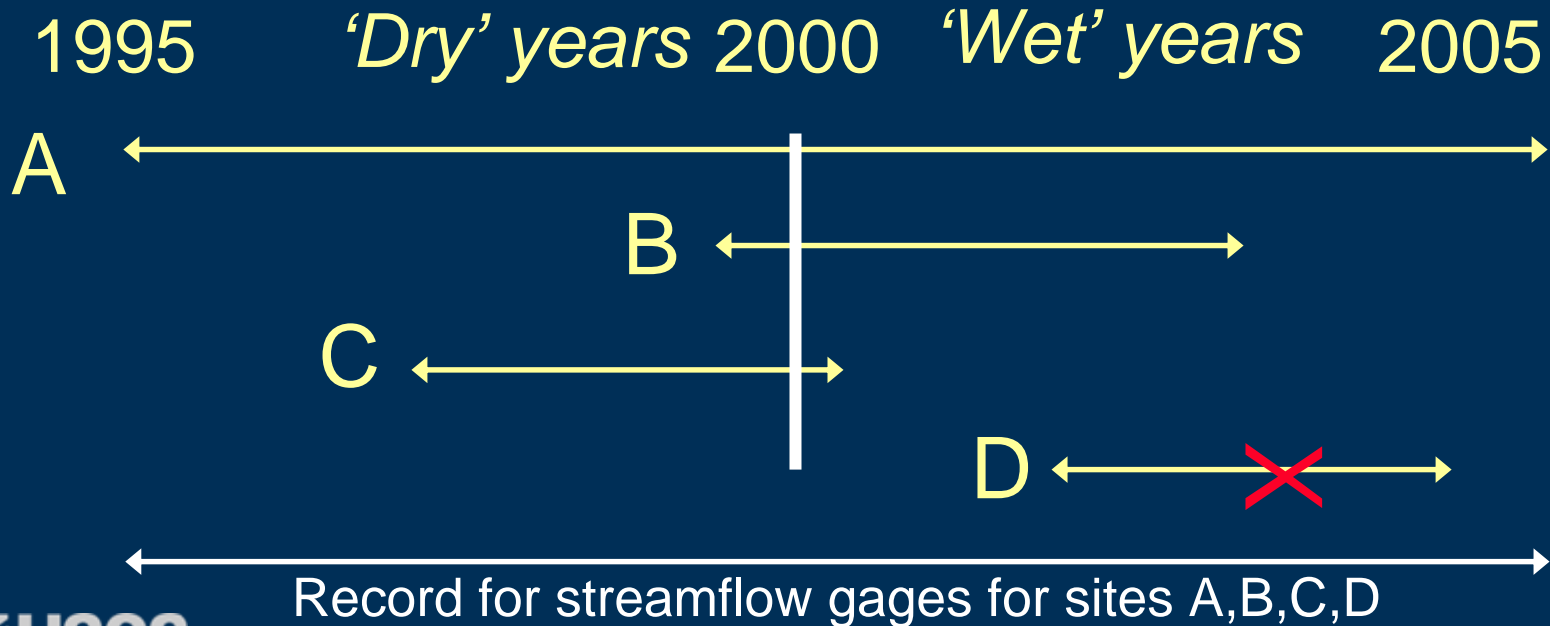
SPARROW model application – identify areas contributing highest loads to estuaries



- ✓ **SPARROW model of the Southeastern U.S. – preliminary results and planned applications**
- **Model uses monitoring networks from many State and federal programs**

Challenges to producing comparable load estimates from multiple networks

1. Multiple monitoring objectives and design : variable record length



Challenges - continued

1. **Multiple monitoring objectives and design :
variable record length**
2. **Multiple monitoring networks for water
quality,
single network for streamflow :

pair USGS gage with monitoring site**

“Shakedown” of monitoring data for load estimation

- Nutrient data retrieved for 21,500 sites
- Retain sites (3,422) with ≥ 20 samples, sampling frequency $\geq 4X$ / year
- Of the 3,422 sites:

Load est. for nitrogen:

No organic
nitrogen: 155

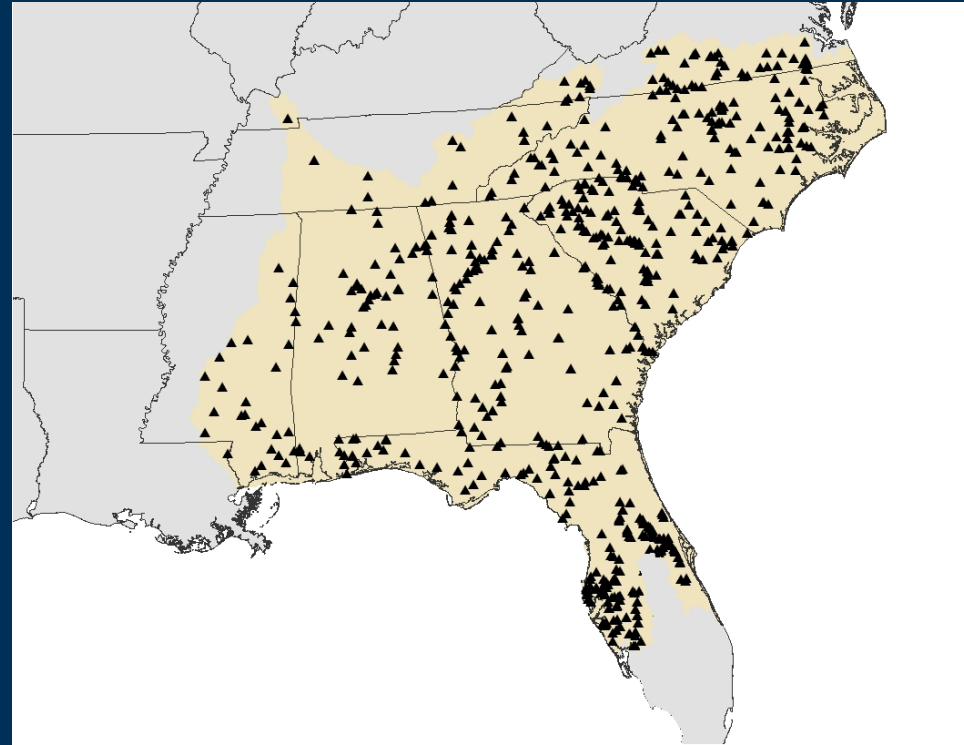
598

No gage
nearby: 1824

< 20 samples
in WQ & gage
overlap: 845

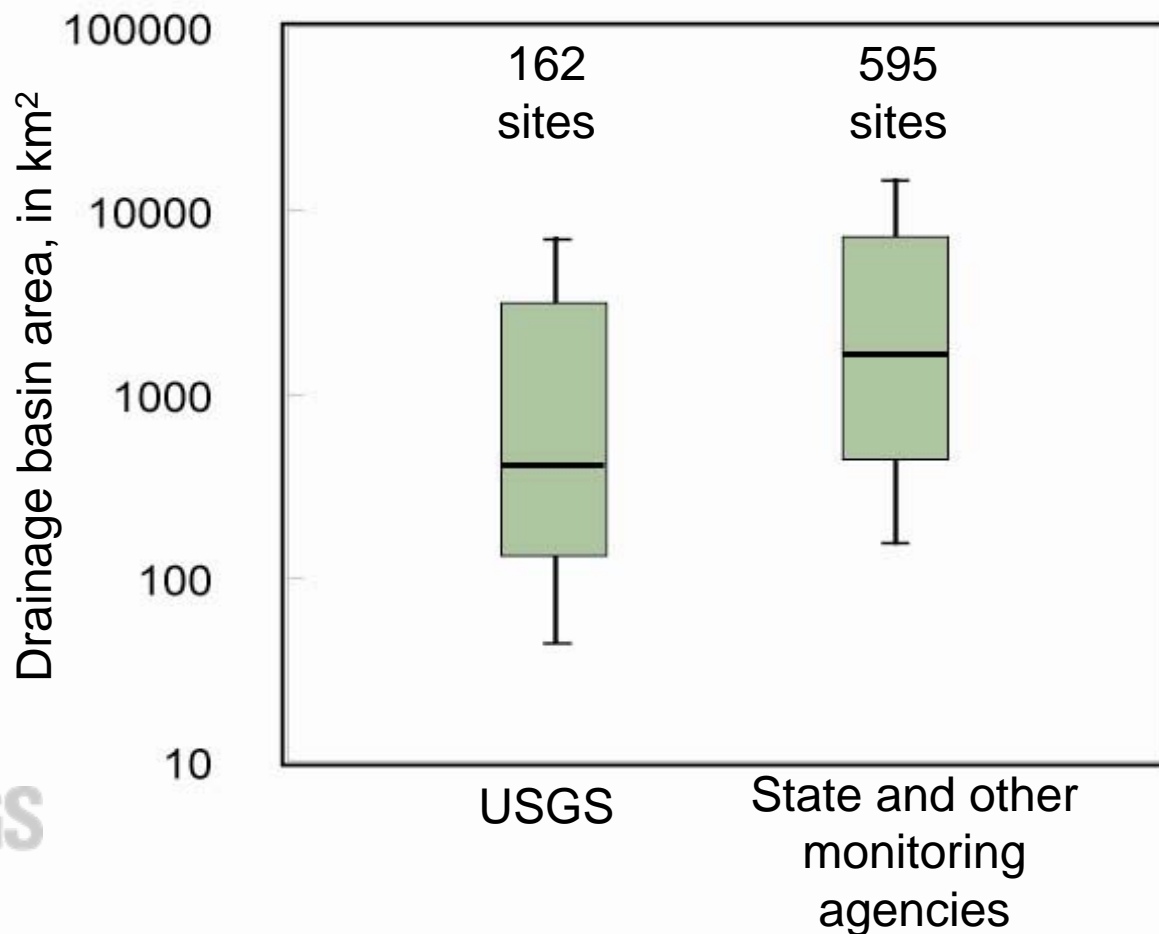


Measurement density:
598 sites/ 880,000 km²
model area
1 site / 1500 km²
(compare to national
model:
1 site / 16,600 km²)

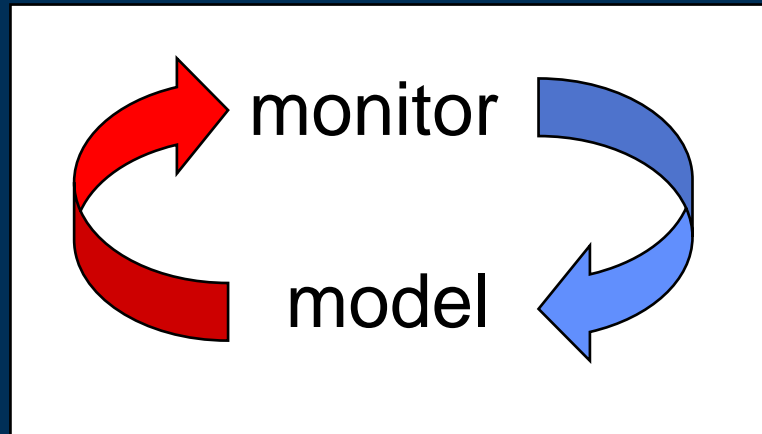


- The water-quality and streamflow-gaging networks have enough overlap (spatially, temporally) to allow estimating load, normalized to the year 2000, at a large number of sites

The combination of networks provides a broader sample of water-quality and watershed conditions



- ✓ **SPARROW model of the Southeastern U.S. – preliminary results and planned applications**
- ✓ **Model uses monitoring networks from variety of State and federal networks**
- **Implications of model results for monitoring programs**



SPARROW model residuals are larger for sites with shorter streamflow record

<i>Monitoring site characteristic</i>	<i>Significant (.05) predictor of SPARROW model residual</i>
Length of streamflow record	Yes (-)
Length of water-quality record	No
Number of concentration observations	No
Standard error of load estimate (percent)	No
Estimate of yield	Yes (+)
Upstream source inputs (per unit area)	No for all

SPARROW model residuals are larger for sites with shorter streamflow record

*Significant (.05) predictor
of SPARROW model
residual*

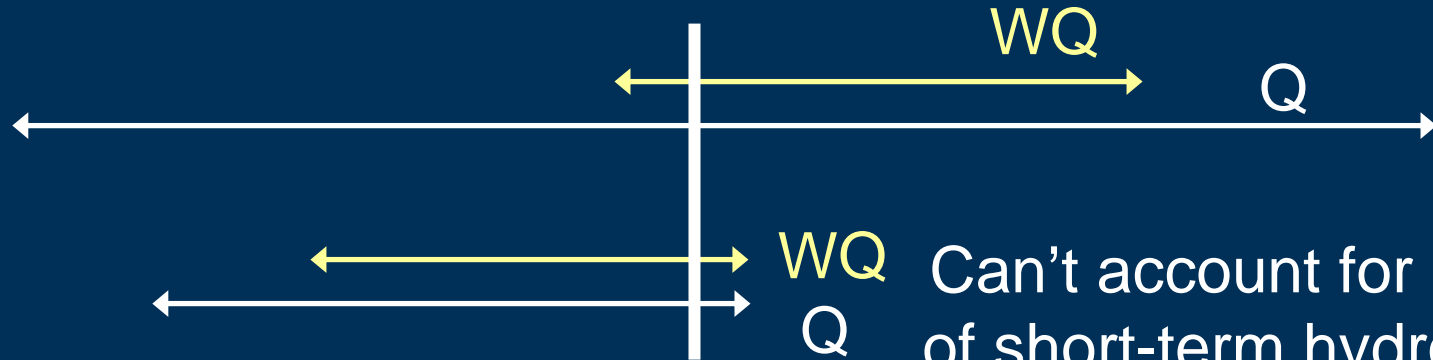
Monitoring site characteristic

Length of streamflow record

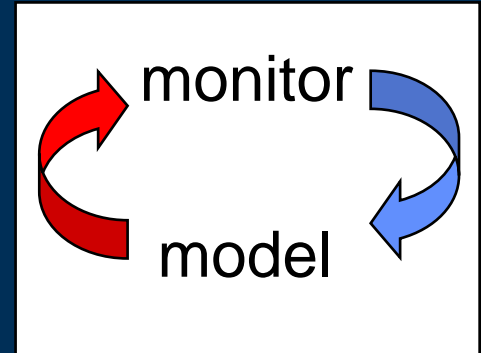
Y (-)

Why?

1995 'Dry' years 2000 'Wet' years 2005



Implications for monitoring design (for data used in spatial-comparison models):



- Load estimates from monitoring sites with short (<6 years) streamflow record may not be suitable for spatial comparisons across a region

Summary of main points, continued

- Including monitoring data from many sources and networks increased range of conditions in measurement set and increased model complexity
- Regional-scale SPARROW model for Southeastern U.S. gives improved prediction accuracy for region-specific applications

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<http://water.usgs.gov/nawqa/sparrow>