

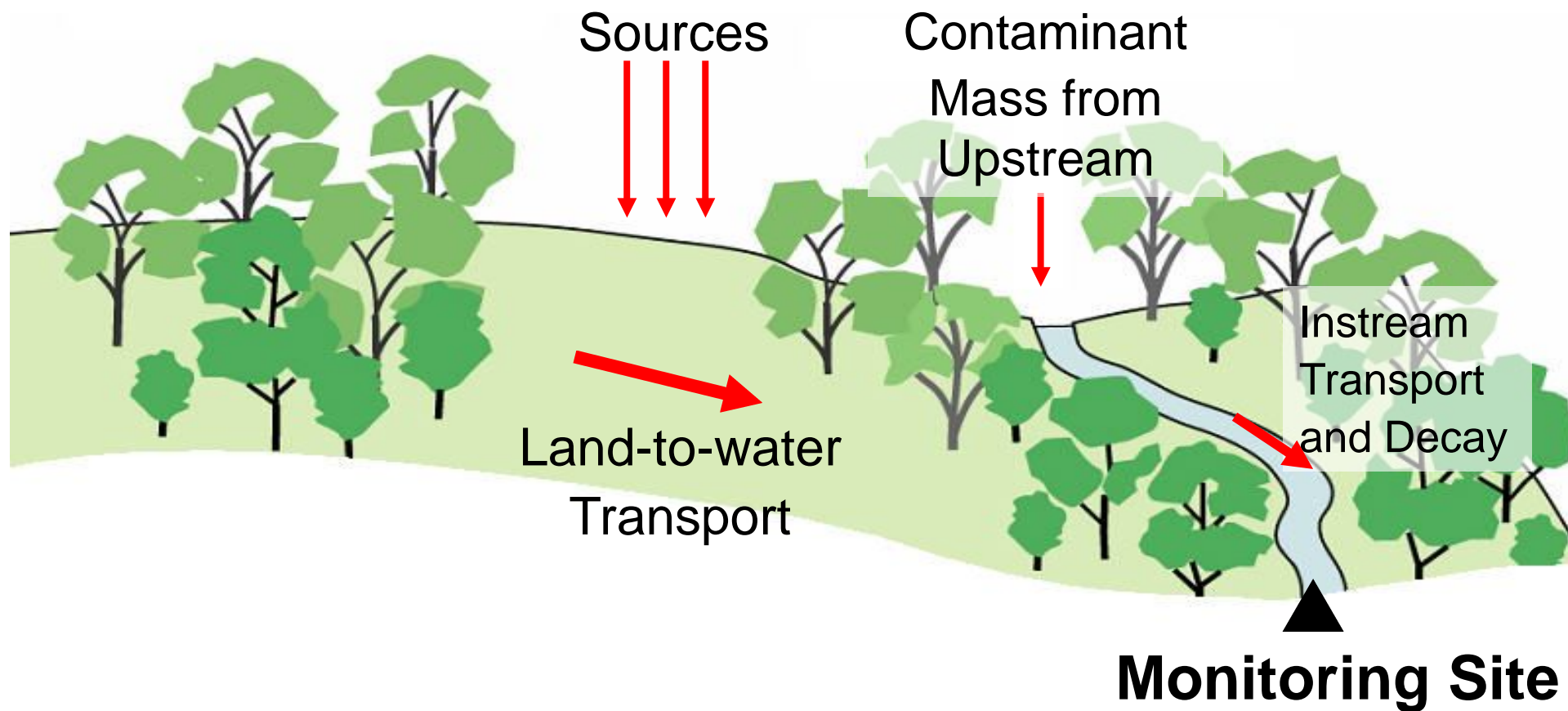
# Spatially Explicit Modeling to Extend Monitoring Information in Major Regions of the Conterminous United States

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National Water Quality Assessment Program  
U.S. Geological Survey



# SPARROW Model Description

## Basic Mass Balance Approach



# SPARROW's Reach-Scale Mass Balance

Reach network relates watershed data to monitored loads

$$LOAD_i = \left\{ \sum_{j \in J(i)} \left[ \sum_{n=1}^N S_{n,j} \beta_n \exp(-\alpha' Z_j) \right] \prod_m \exp(-\delta_m^s T_{i,j,m}) \prod_l 1/(1 + \lambda^r q_{i,j,l}^{-1}) \right\} \exp(\varepsilon_i)$$

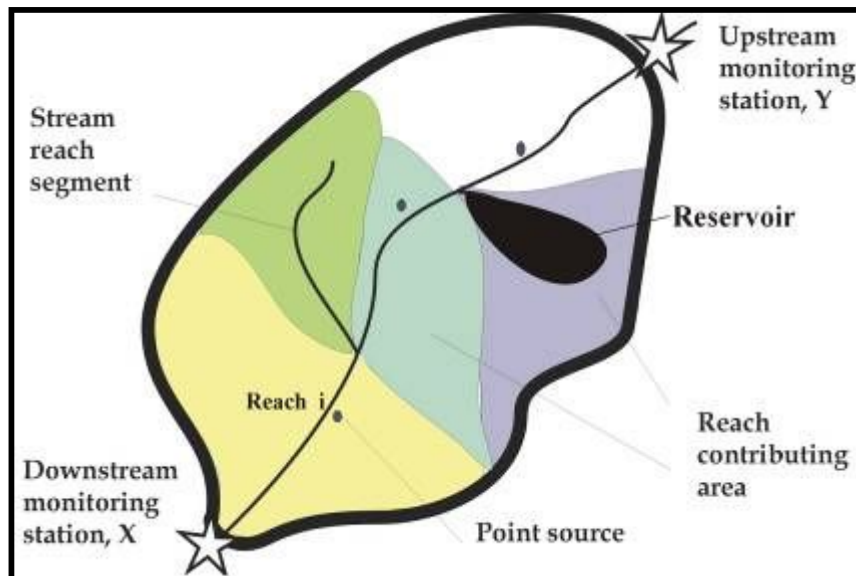
Monitored  
Stream Load

Sources

Land-to-water  
transport

Aquatic  
transport

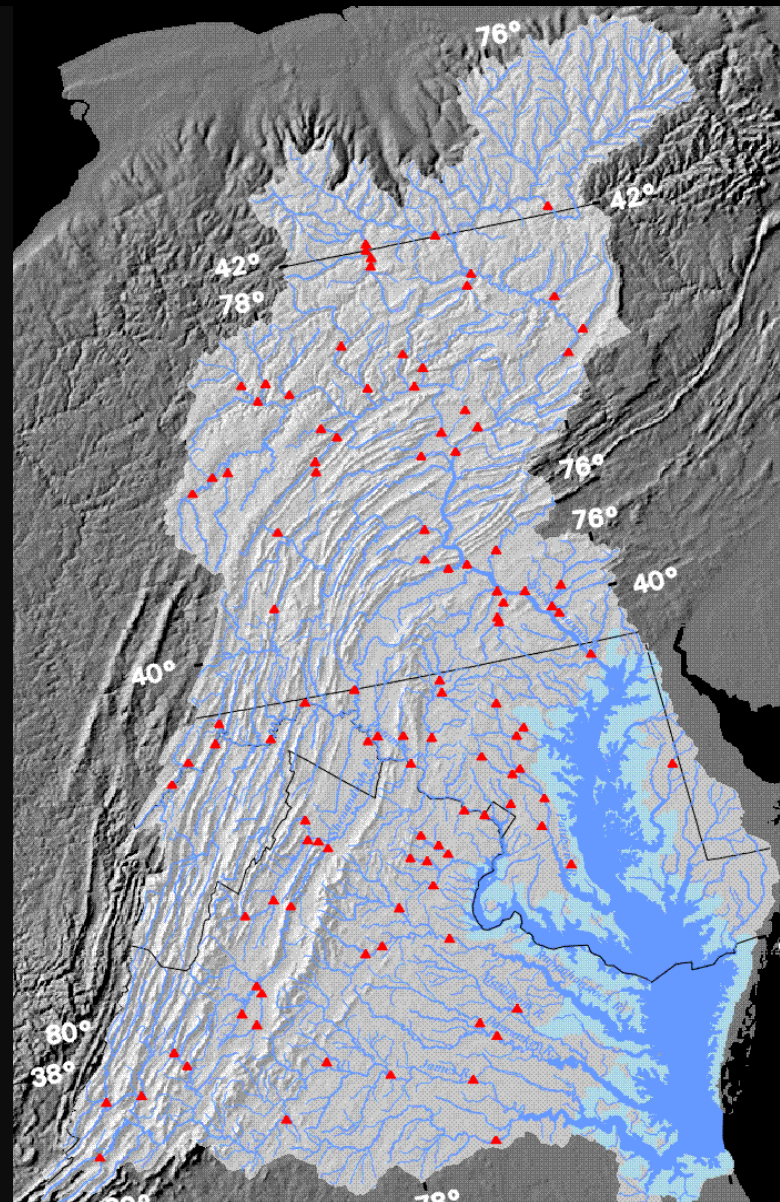
Error



- Spatial reference frame is stream network, coupled to DEM
- Fundamental spatial element is stream reach and associated incremental drainage area
- SPARROW estimates the optimal set of rate coefficients that balance material mass (source inputs, stream loads, and storage/loss)

# Importance of Large Numbers of WQ Sites

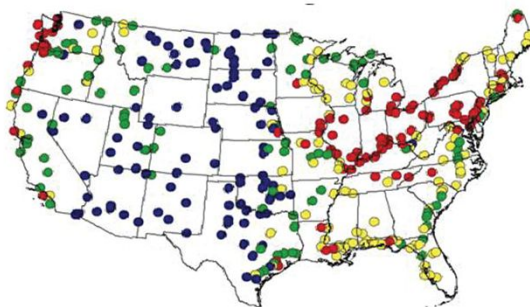
## *Chesapeake Bay Example*



# SPARROW Water-Quality Model

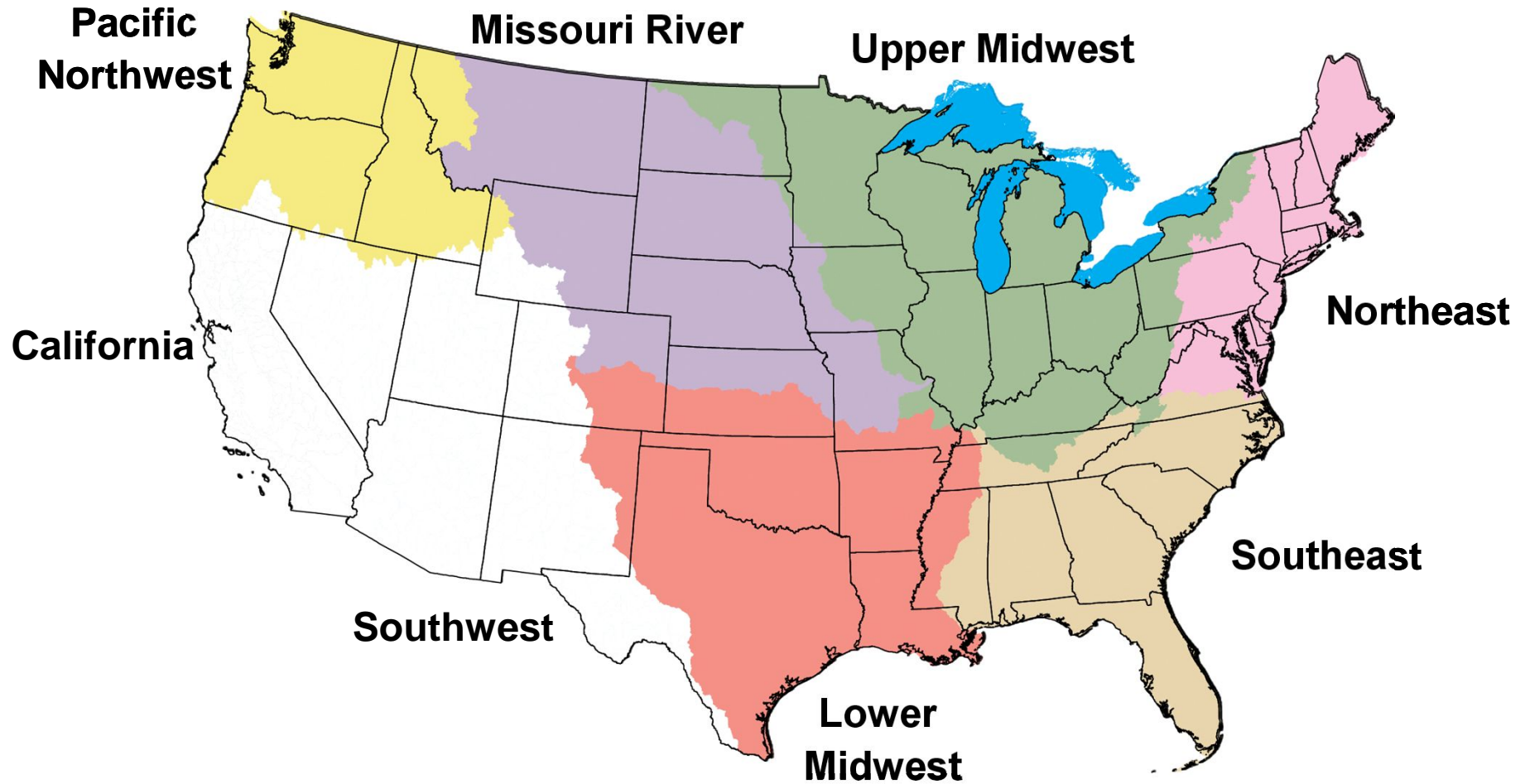
*SPAtially Referenced Regression on Watershed Attributes)*

Monitoring Data

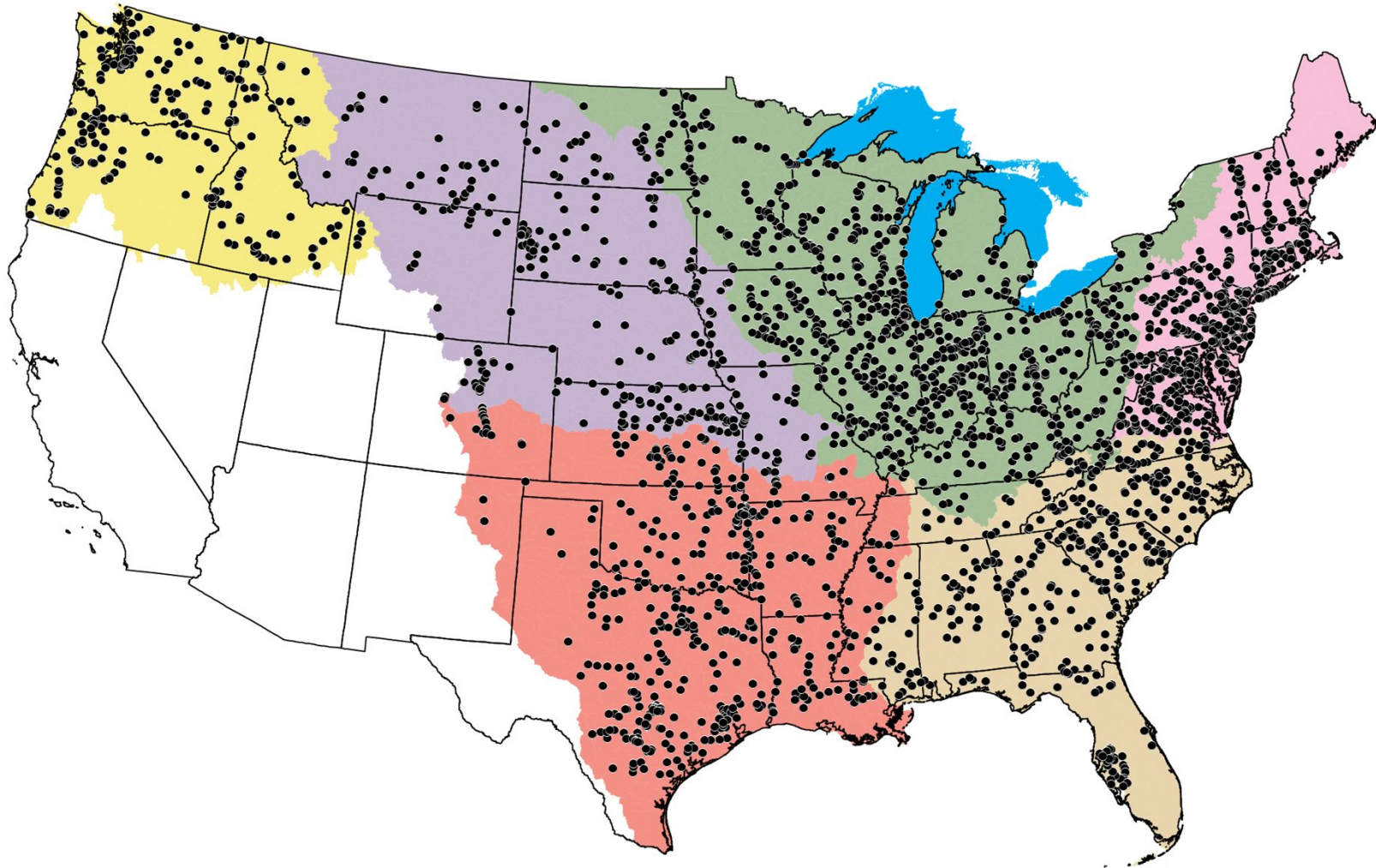


# National Water Quality Assessment Program

## *Surface Water Status and Trends Regions*

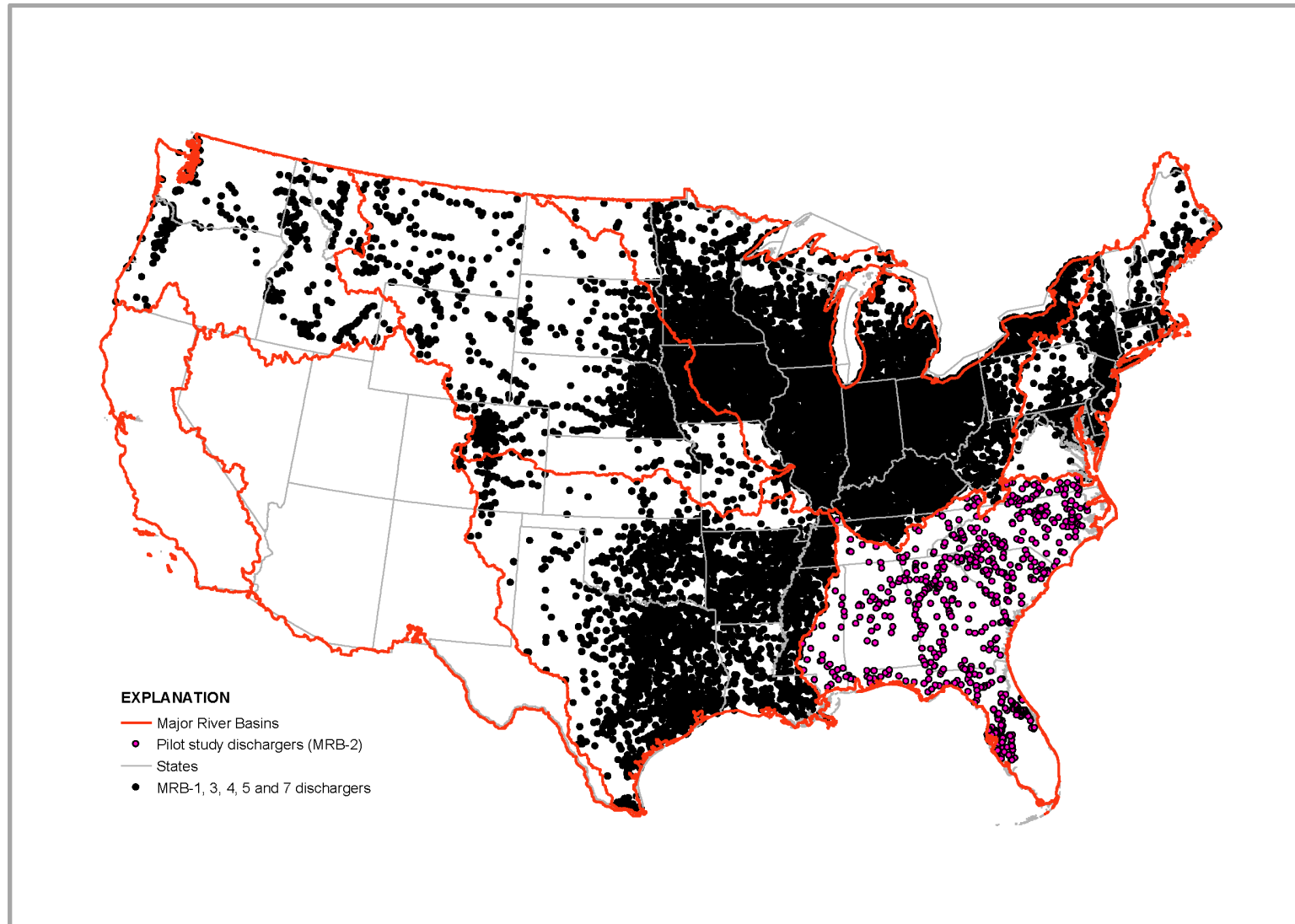


# Monitoring Data Are Critical for Modeling



**2,700 calibration sites with data from 73 agencies**

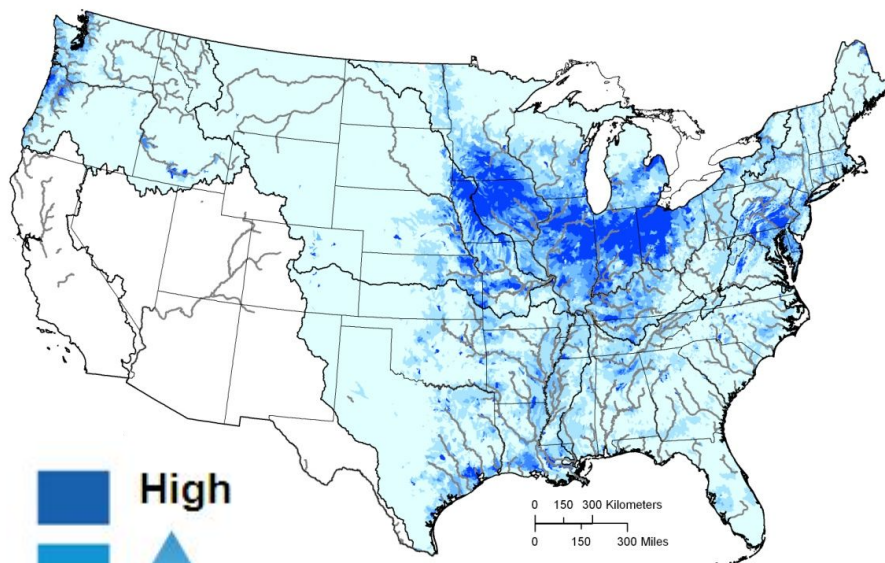
# Nutrient Source Data – Point Sources



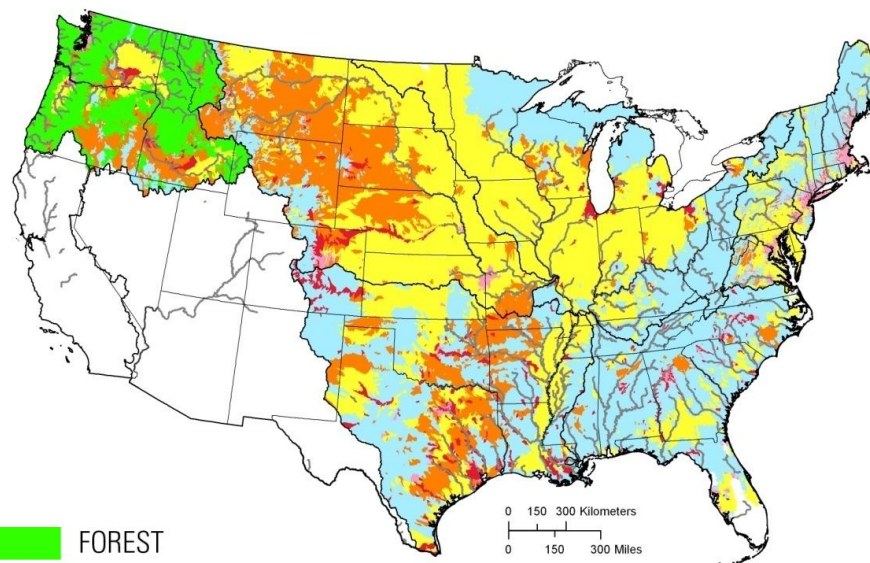


# Total Nitrogen Yields and Sources

## Yields

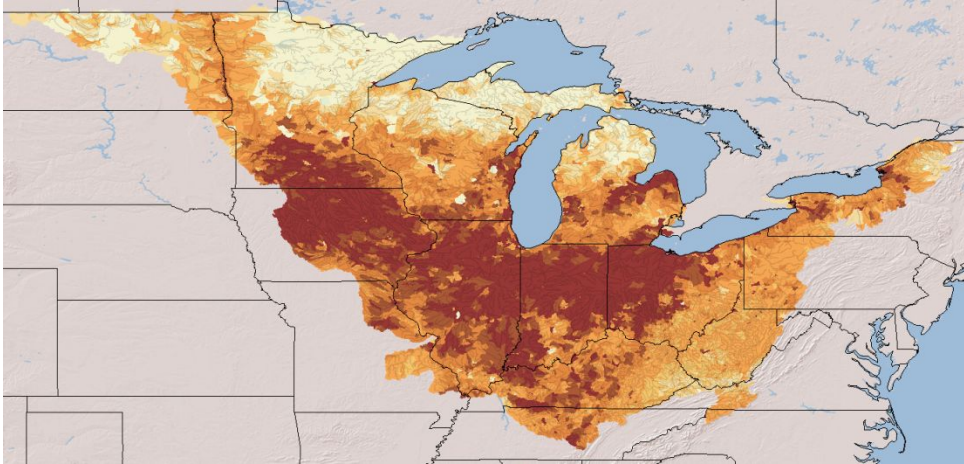


## Largest Sources

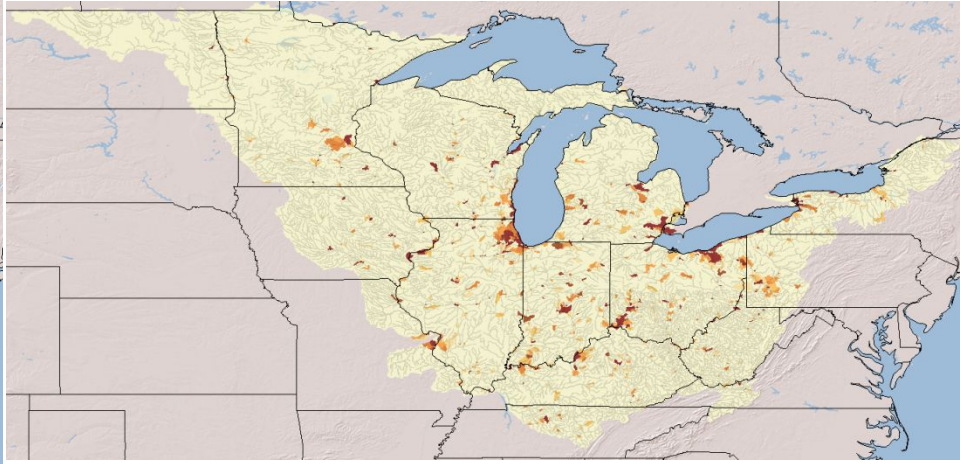


# Amounts and Sources of Nitrogen to Streams in the Upper Mississippi/Great Lakes Basin

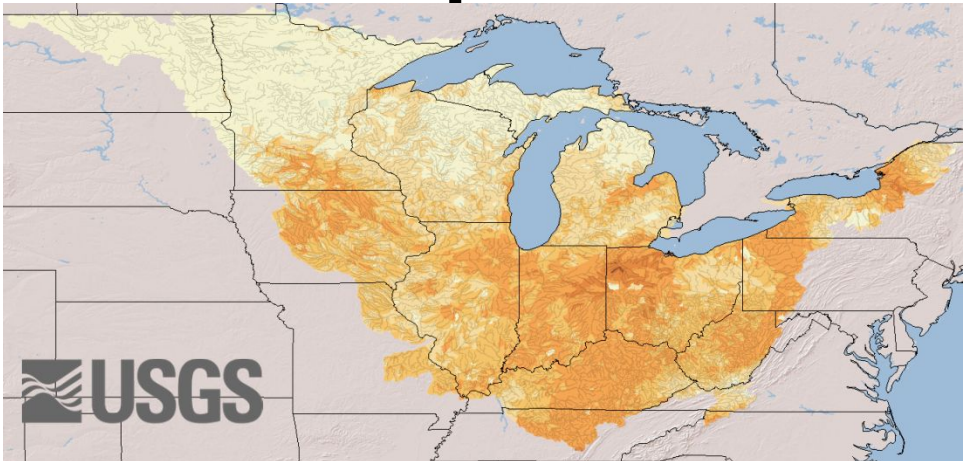
## All Sources



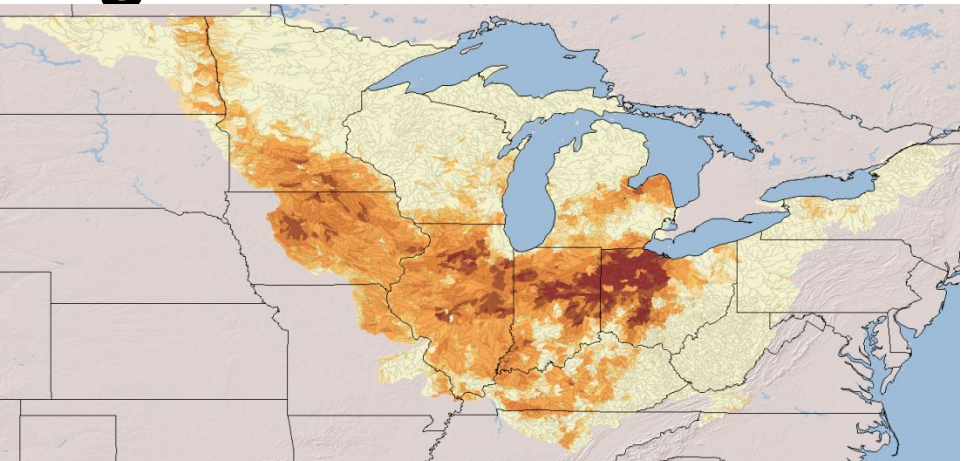
## Point Sources



## Atmosphere



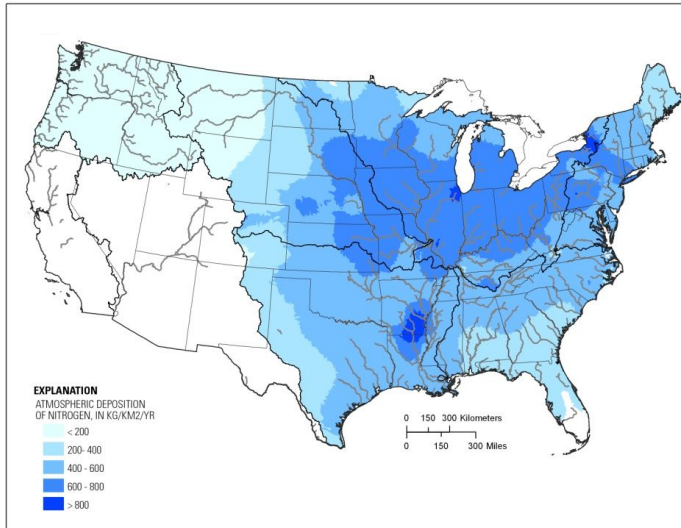
## Agricultural Fertilizers



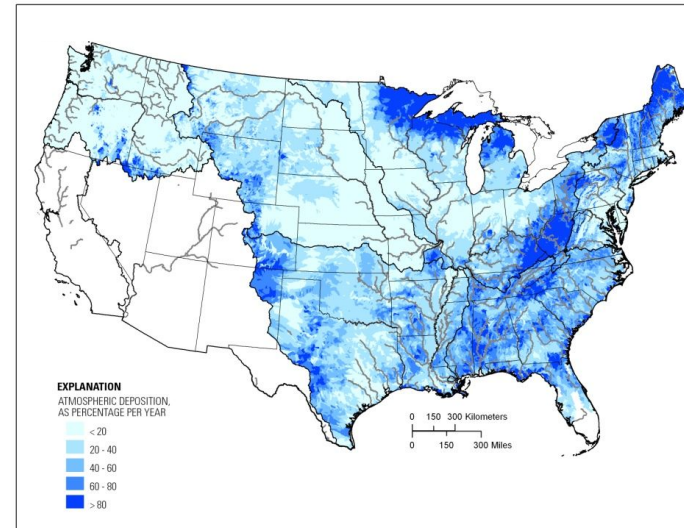
# SPARROW Perspectives on Source Input

## *Atmospheric Deposition Example*

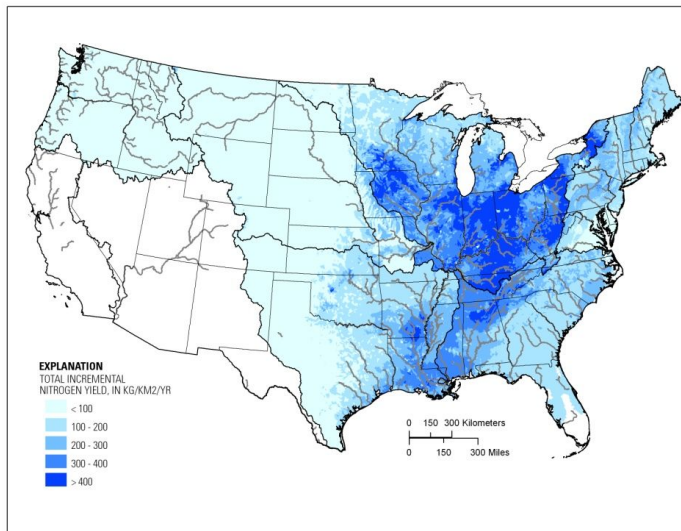
**Nitrogen Deposition to the Land Surface**  
(kg/km<sup>2</sup>/yr)



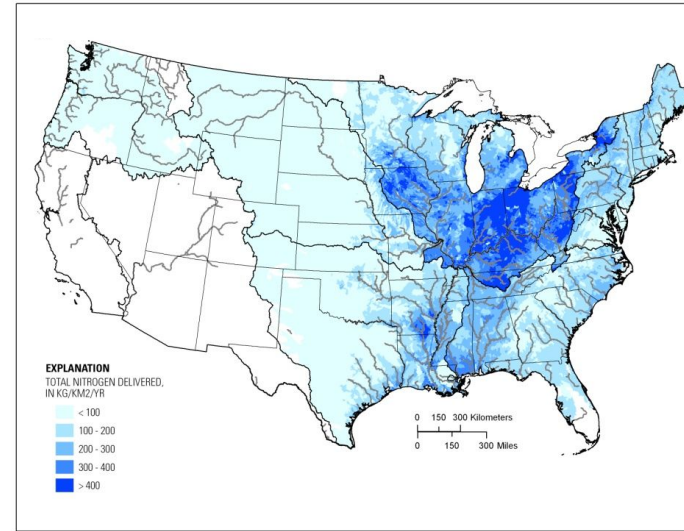
**Percentage of Nitrogen Source Input from Deposition**  
(%)



**Nitrogen Yield from Incremental Catchments**  
(kg/km<sup>2</sup>/yr)



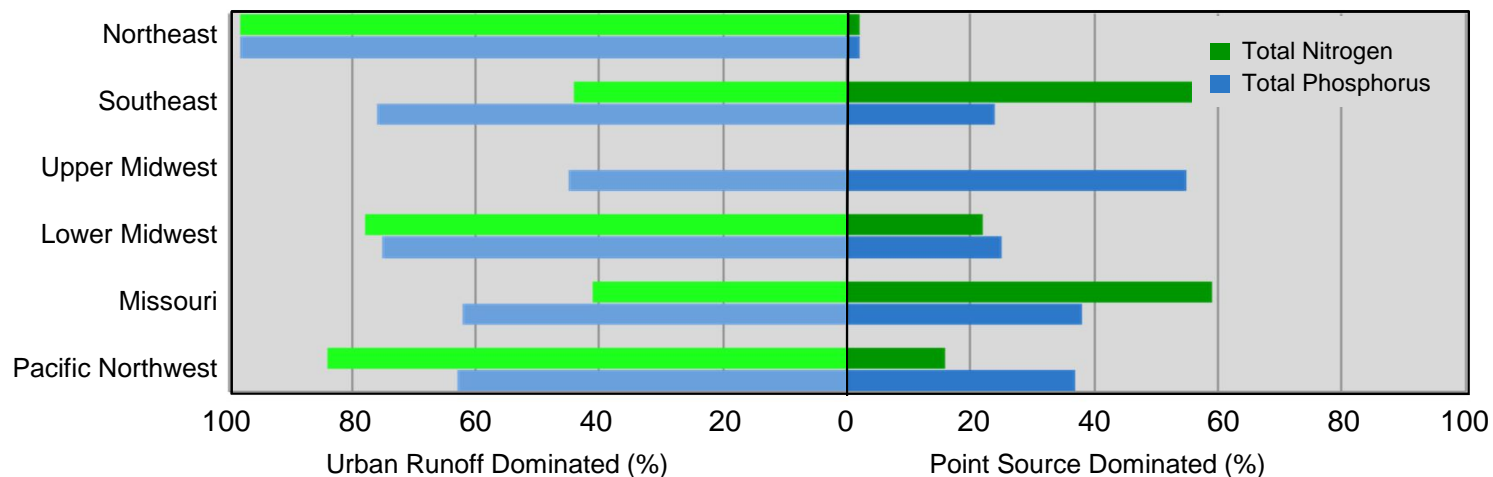
**Nitrogen Yield from Delivered Downstream**  
(kg/km<sup>2</sup>/yr)



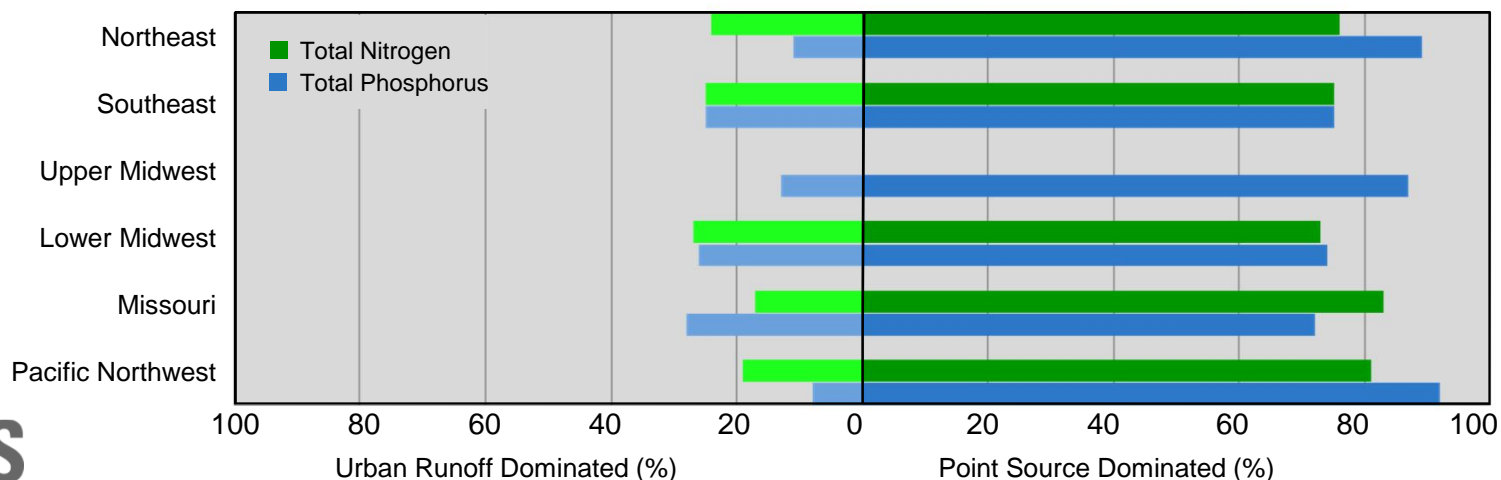
# Regional Importance of Source Contributions

## *Relative Importance of Urban Sources*

**Percentage of Urban Streams Dominated by Runoff vs Point Sources**



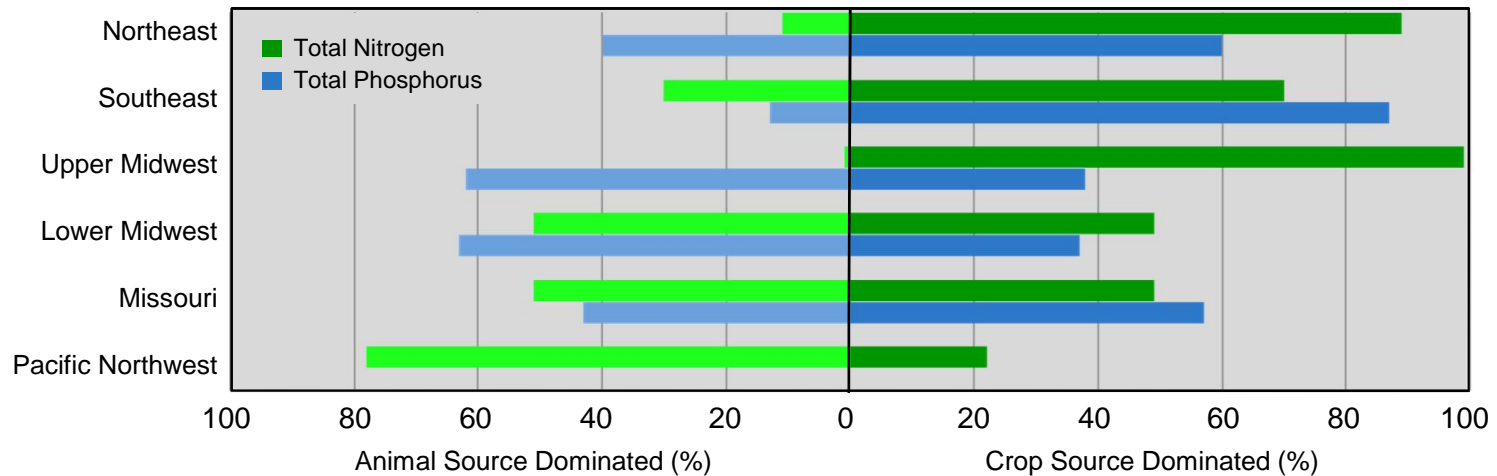
**Percentage of Regional Nutrient Mass Dominated by Runoff vs Point Sources**



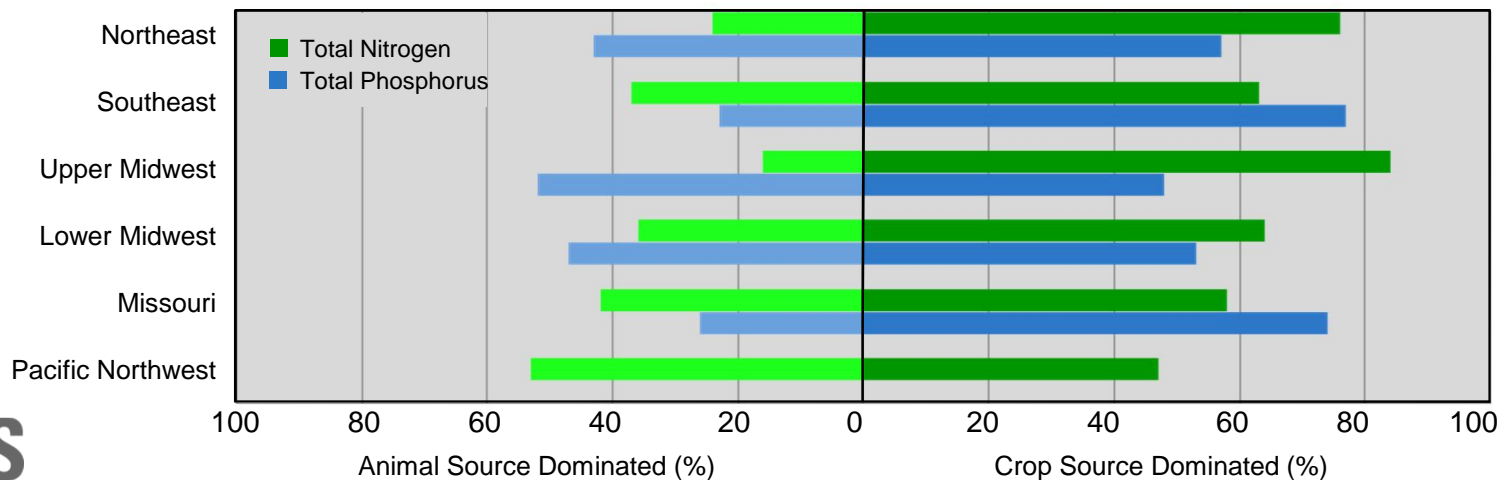
# Regional Importance of Source Contributions

## *Relative Importance of Agricultural Sources*

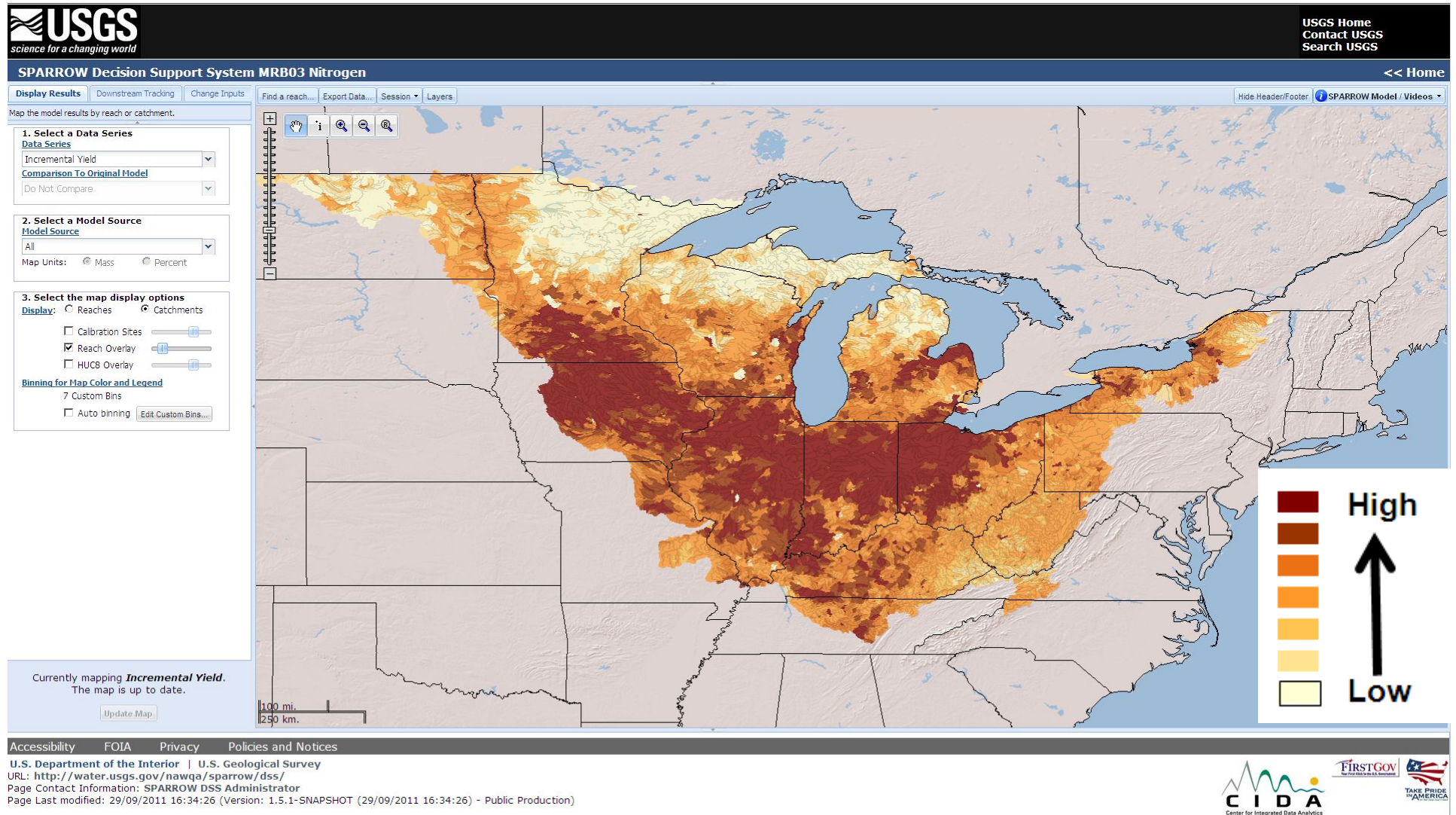
**Percentage of Agricultural Streams Dominated by Crop vs Animal Sources**



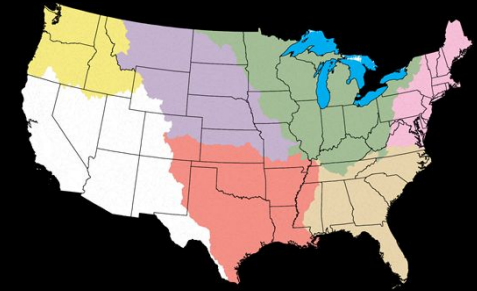
**Percentage of Regional Nutrient Mass Dominated by Crop vs Animal Sources**



# New SPARROW Decision Support System



# Additional Information



Further Details of SPARROW:

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

Regional Model Web Pages:

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

Decision Support System:

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

Contact Information:

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