A Spatially Detailed Assessment of Total Nitrogen Loads in the Delaware River Basin

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

Today's Objective

- **Overview of SPARROW Nutrient Model Developed for Northeastern US**

- **How to Obtain Data on the Web**

- **Selected Nitrate Results for the Delaware Estuary**

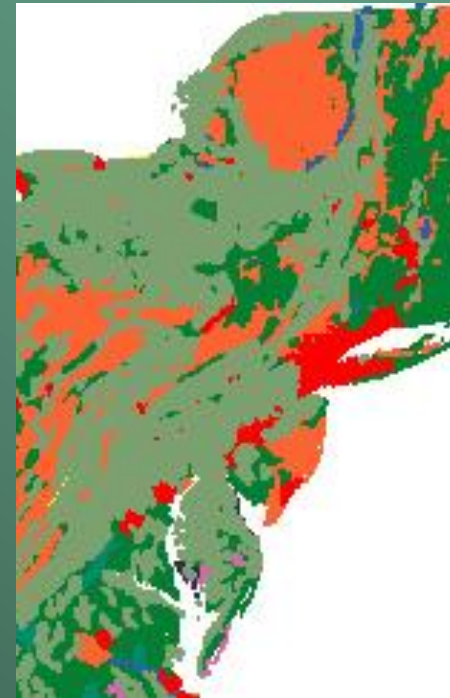- **(Phosphate results are also available, but will not be shown today)**

SPARROW* uses a stream network to relate loads at monitoring stations to sources and stream or land attributes

*Spatially Referenced Regression On Watershed Attributes

Stream Network
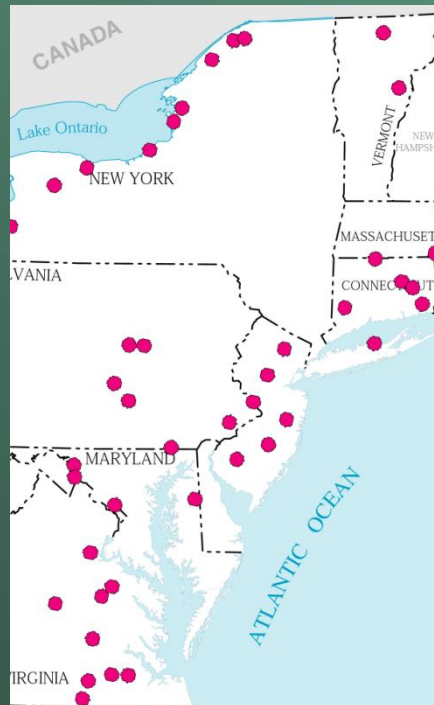
Monitoring Data

Sources

Atmospheric, Agricultural, & Urban

Landscape Features

Geology, Topography, Land Use, and others

Model predictions are made for every reach

(not just monitored reaches)

- **Load, yield, concentration**
- **Contribution from each source**
- **In-stream losses**
- **Statistical measures of uncertainty**

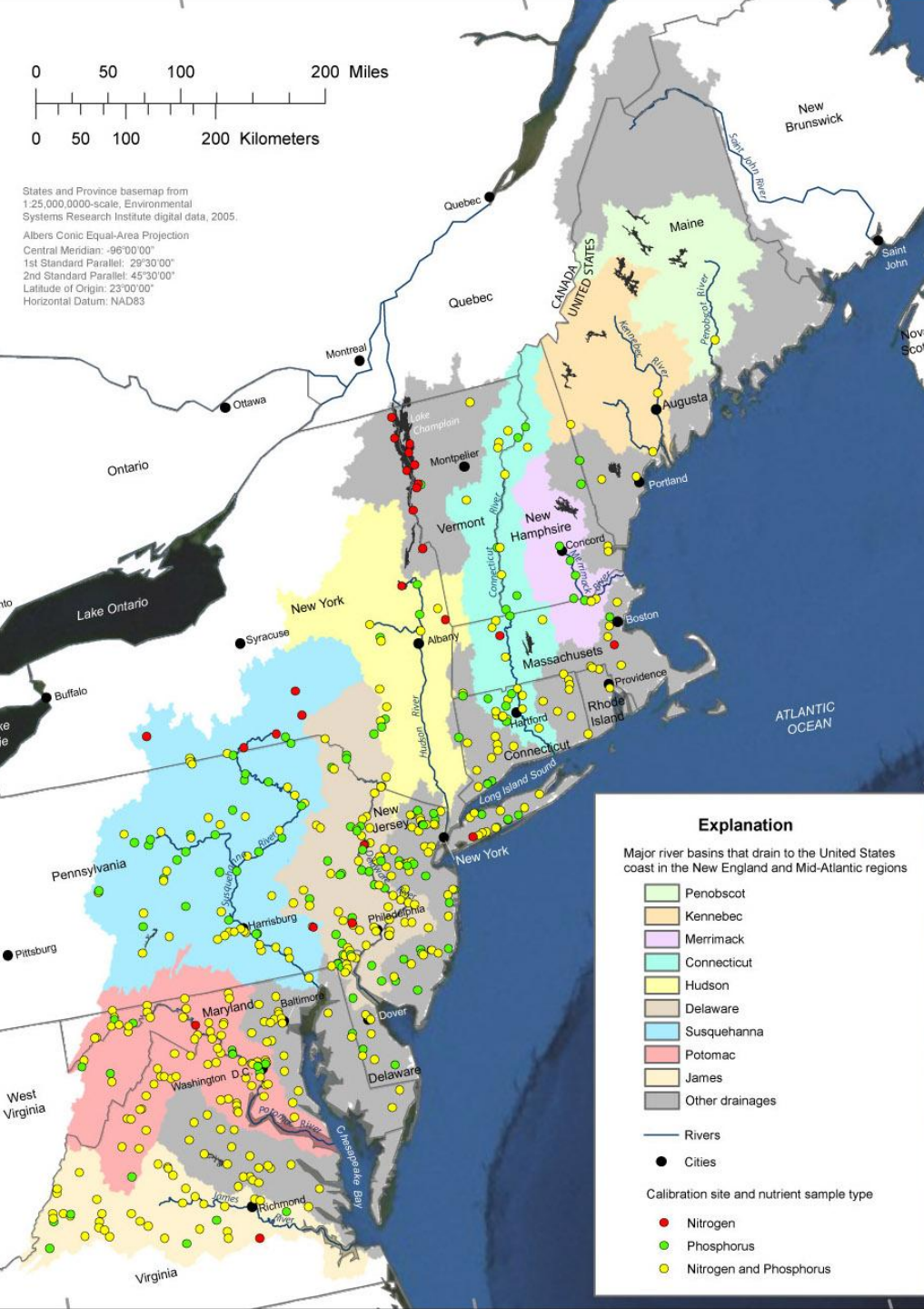# Northeast SPARROW Nitrogen Model

Calibrated to 363 nitrogen monitoring sites
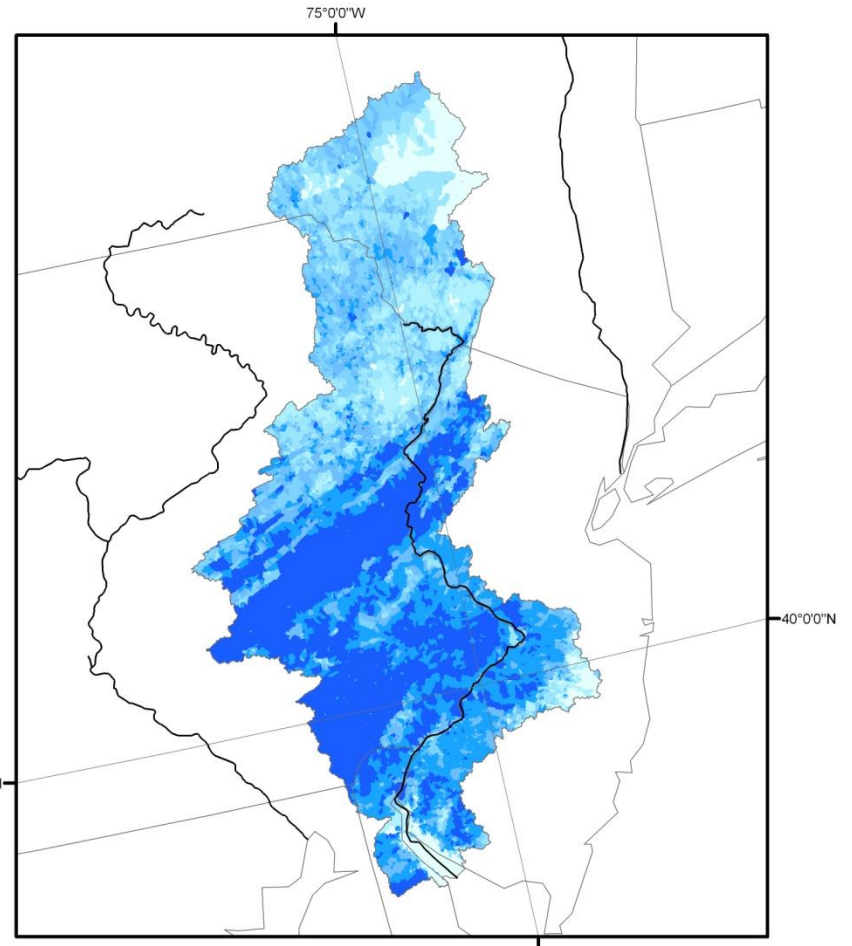
6 source terms
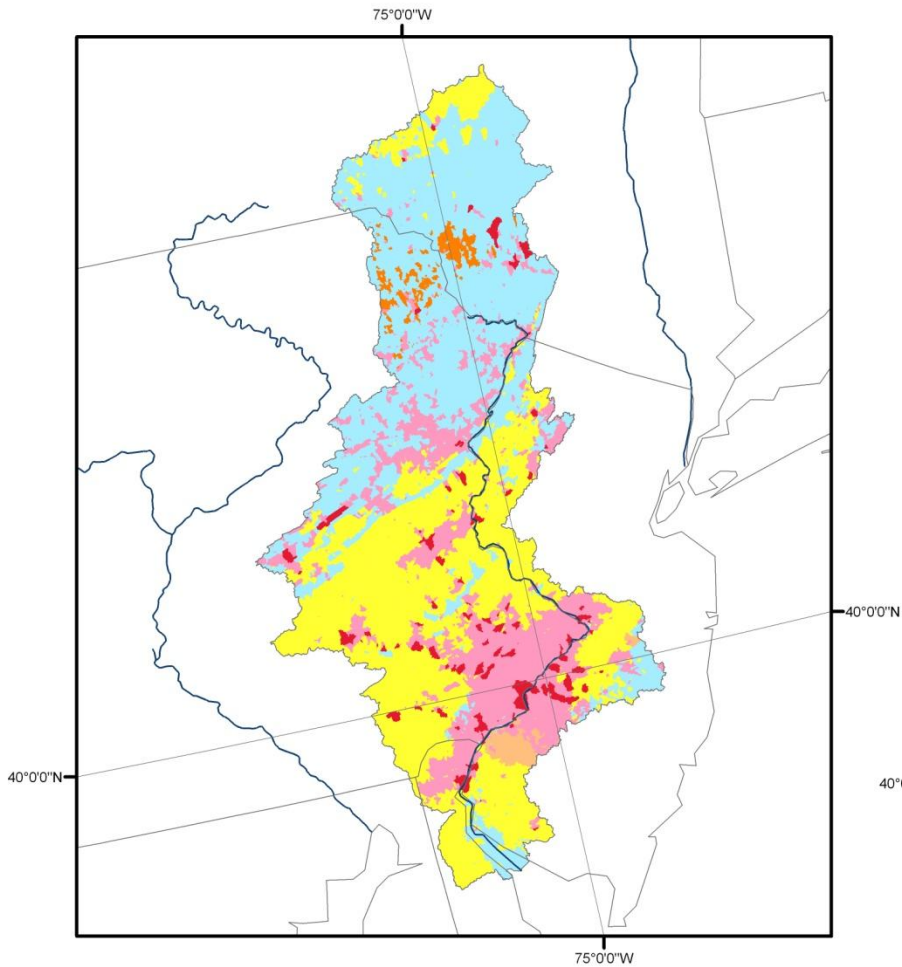
5 land-to-water delivery

1 stream loss term

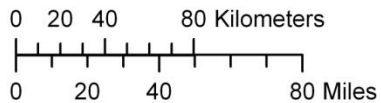Predictions made for 187,171 stream path segments (plus 6,156 coastal segments)

Primary Sources

Yield

Agriculture
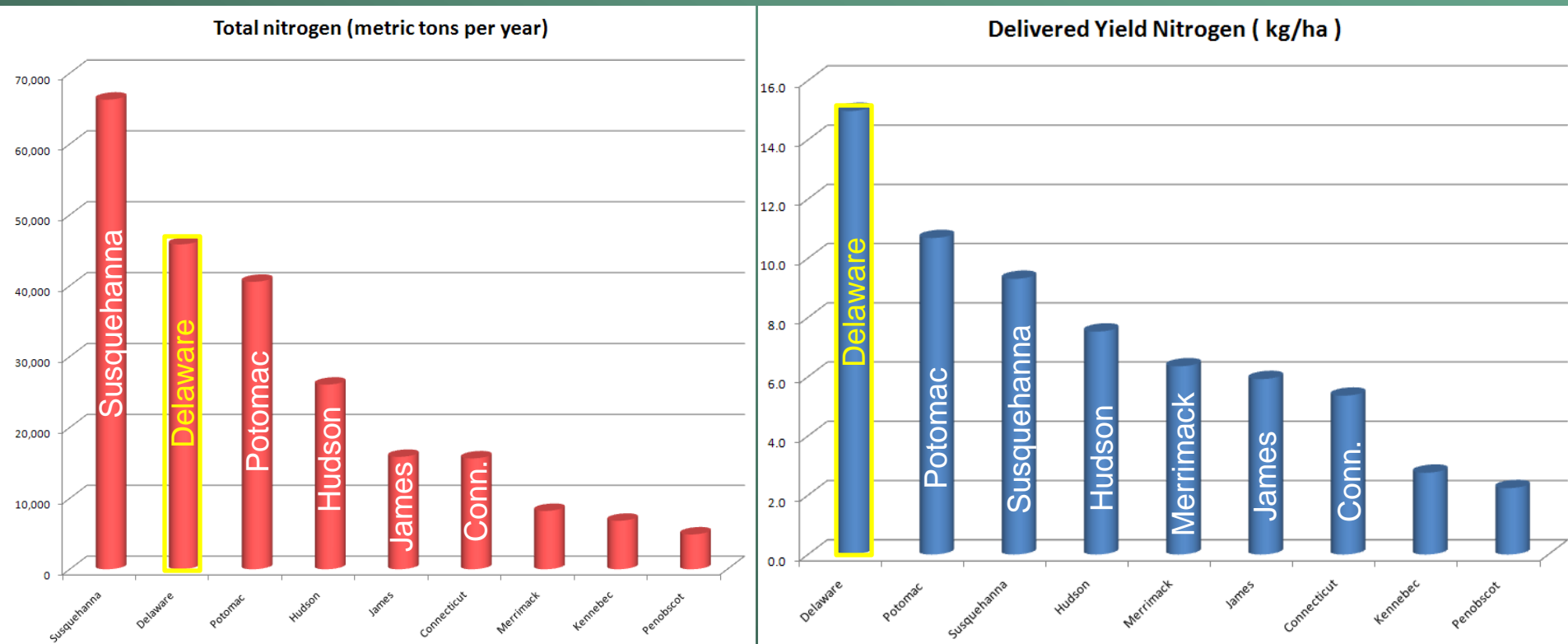
- Atmospheric
- Developed
- Point Source
- Corn, Soy, Alfalfa
- Fertilizer Other
- Manure

Delivered nitrogen yield
in kilograms per hectare per year

- Less than 1.6
- 1.6 to 2.1
- 2.1 to 2.8
- 2.8 to 4.0
- 4.0 to 6.0
- 6.0 to 9.8
- Greater than 9.8

0   20   40   80 Kilometers

0   20   40   80 Miles

6

How does the Delaware compare to other estuaries in the northeast?

It has the highest yield (nitrogen delivered per unit area) for estuaries in the northeast.

SPARROW Webpage
http://water.usgs.gov/nawqa/sparrow

USGS science for a changing world

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SPARROW Surface Water-Quality Modeling

NAWQA Home | Model Description | Fact Sheet | Decision Support System | FAQs | Documentation | Software | Publications | Contacts | Training

Regional MRB Studies

SPARROW, a modeling tool for the regional interpretation of water-quality monitoring data. The model relates in-stream water-quality measurements to spatially referenced characteristics of watersheds, including contaminant sources and factors influencing terrestrial and aquatic transport. SPARROW empirically estimates the origin and fate of contaminants in river networks and quantifies uncertainties in model predictions.

Mississippi/Atchafalaya River Basins

Phosphorus yield delivered to local waters
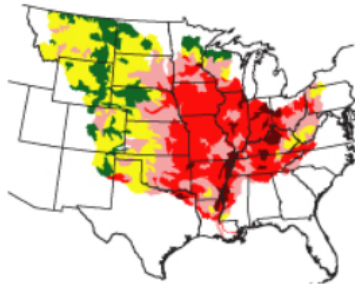
Phosphorus yield delivered to the Gulf of Mexico
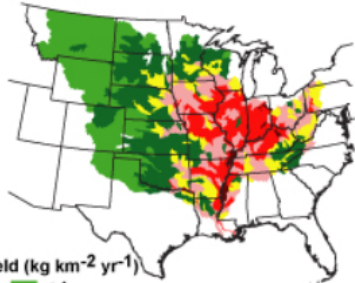
Yield (kg km^{-2} yr^{-1})
- < 1
- 1 to 25

RECENT ACTIVITIES

Accessing the on-line tool

- NEW Regional SPARROW model assessments for the United States
- NEW SPARROW Online Decision Support System
- NEW SPARROW Featured Collection in the Journal of the American Water Resources Association
- A model of organic carbon in streams of United States
- Sources of suspended sediment in streams of the Chesapeake Bay watershed

APPLICATIONS

The National Models
- Organic carbon in U.S. streams
- Suspended sediment in U.S. streams
- Natural background concentrations of nutrients in U.S. streams
- Atmospheric sources of nitrogen to estuaries of the United States

Publications and data used in models

The Regional Models
- Summary of the major results and enhanced modeling capabilities
- Regional SPARROW model assessments for the United States
- SPARROW Featured Collection in the Journal of the American Water Resources Association

Using the Decision Support Tool

The DSS Map Interface

1. **Select Data Series**
2. **Select Source Type**
3. **Update Map**

1. Selecting Data

SPARROW Decision Support System MRB01 Nitrogen

Display Results | Downstream Tracking | Change Inputs | Find a reach... | Export Data... | Session ▾ | Layers | Hide Header/Foote
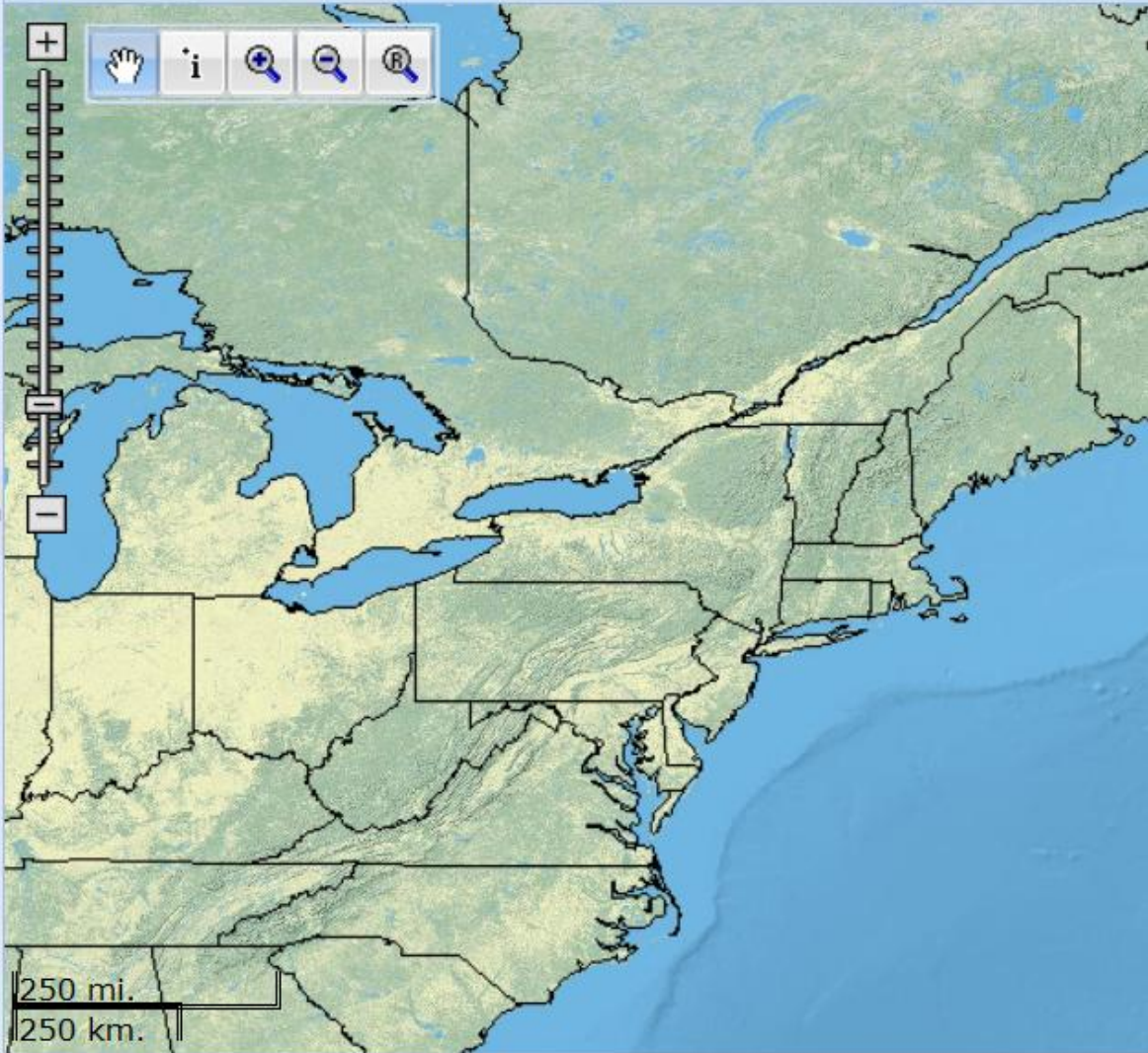
Map the model results by reach or catchment.

1. Select a Data Series
Data Series

Total Load ▾

Model Estimates
Total Load
Incremental Load
Flow-weighted Concentration
Total Yield
Incremental Yield

Model Inputs
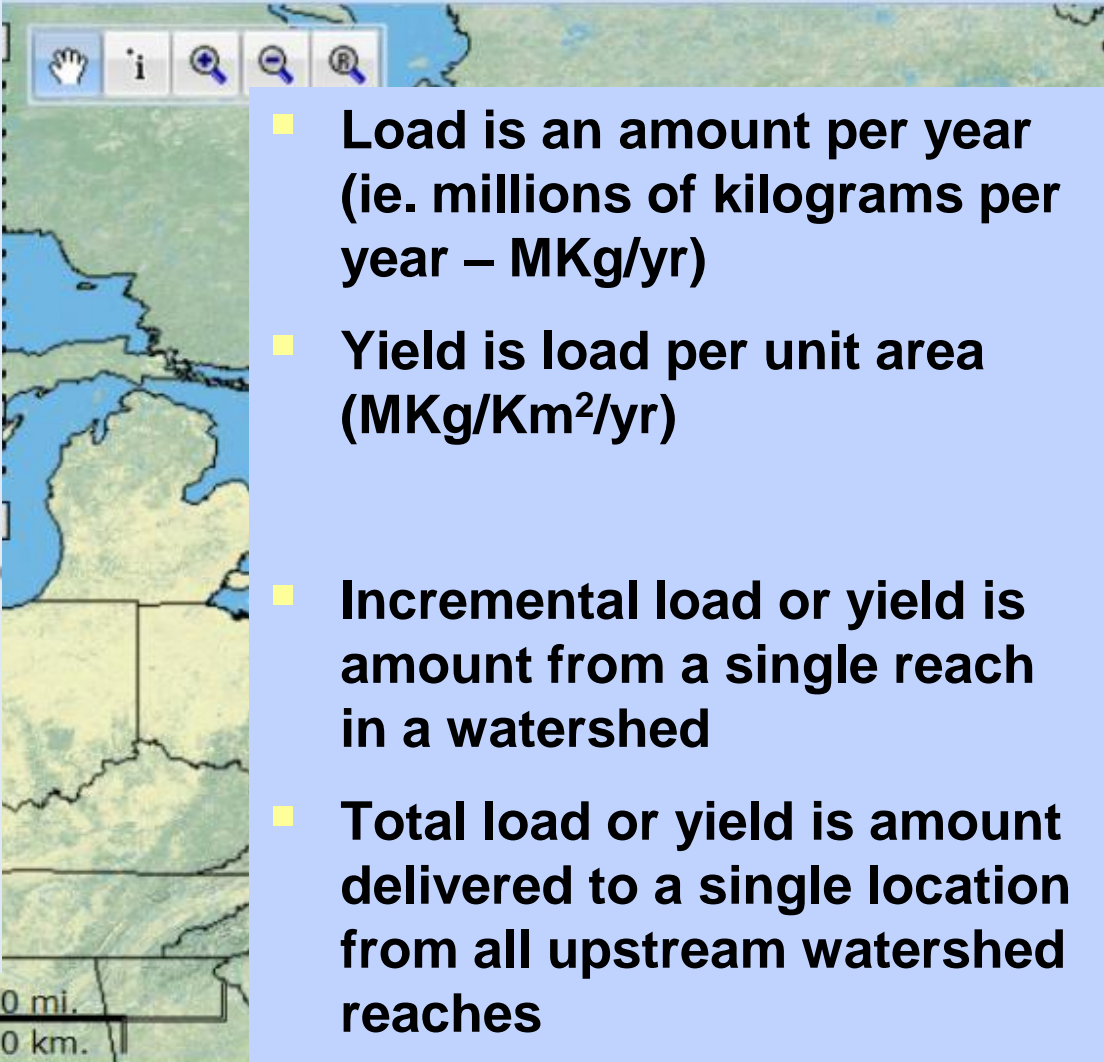Model Input Sources

Stream Network
Streamflow

Model Uncertainty
Standard Error of Total Load
Standard Error of Incremental Load

Downstream Tracking

Update Map

250 mi.
250 km.

- **Load is an amount per year (ie. millions of kilograms per year – MKg/yr)**

- **Yield is load per unit area (MKg/Km^2/yr)**

- **Incremental load or yield is amount from a single reach in a watershed**

- **Total load or yield is amount delivered to a single location from all upstream watershed reaches**

2. Selecting Sources

SPARROW Decision Support System MRB01 Nitrogen

Display Results | Downstream Tracking | Change Inputs | Find a reach... | Export Data... | Session ▾ | Layers | Hide Header/Foote

Map the model results by reach or catchment.

1. Select a Data Series
Data Series
Total Load ▾
Comparison To Original Model
Do Not Compare ▾

2. Select a Model Source
Model Source
All ▾
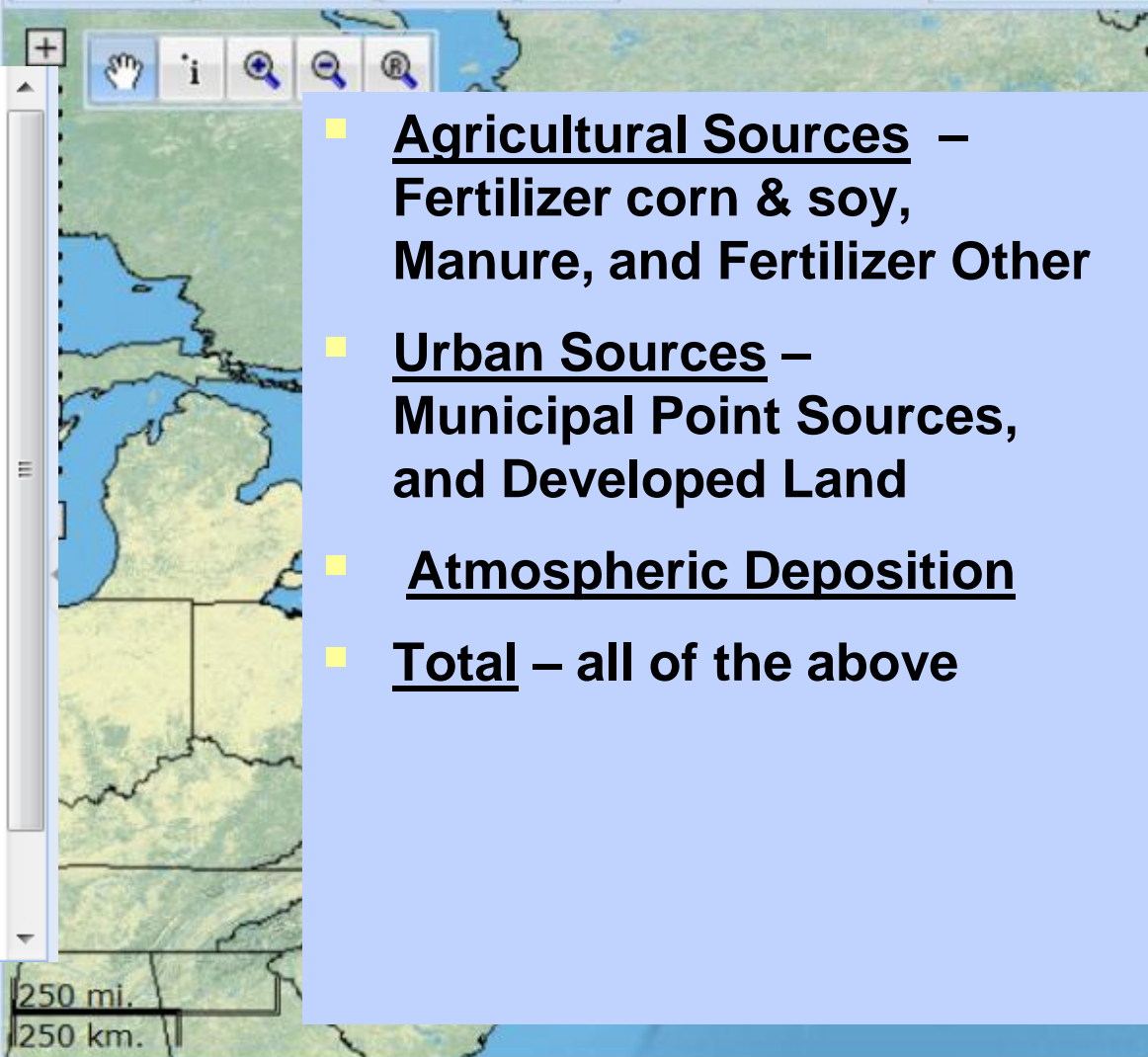- All
- Municipal Point Source
- Fertilizer Corn Soy
- Atmospheric TIN
- Manure
- Developed Land
- Fertilizer Other

Binning for Map Color and Legend
5 Equal Count Bins

Update Map

250 mi.
250 km.

- **Agricultural Sources** – **Fertilizer corn & soy, Manure, and Fertilizer Other**

- **Urban Sources** – **Municipal Point Sources, and Developed Land**

- **Atmospheric Deposition**

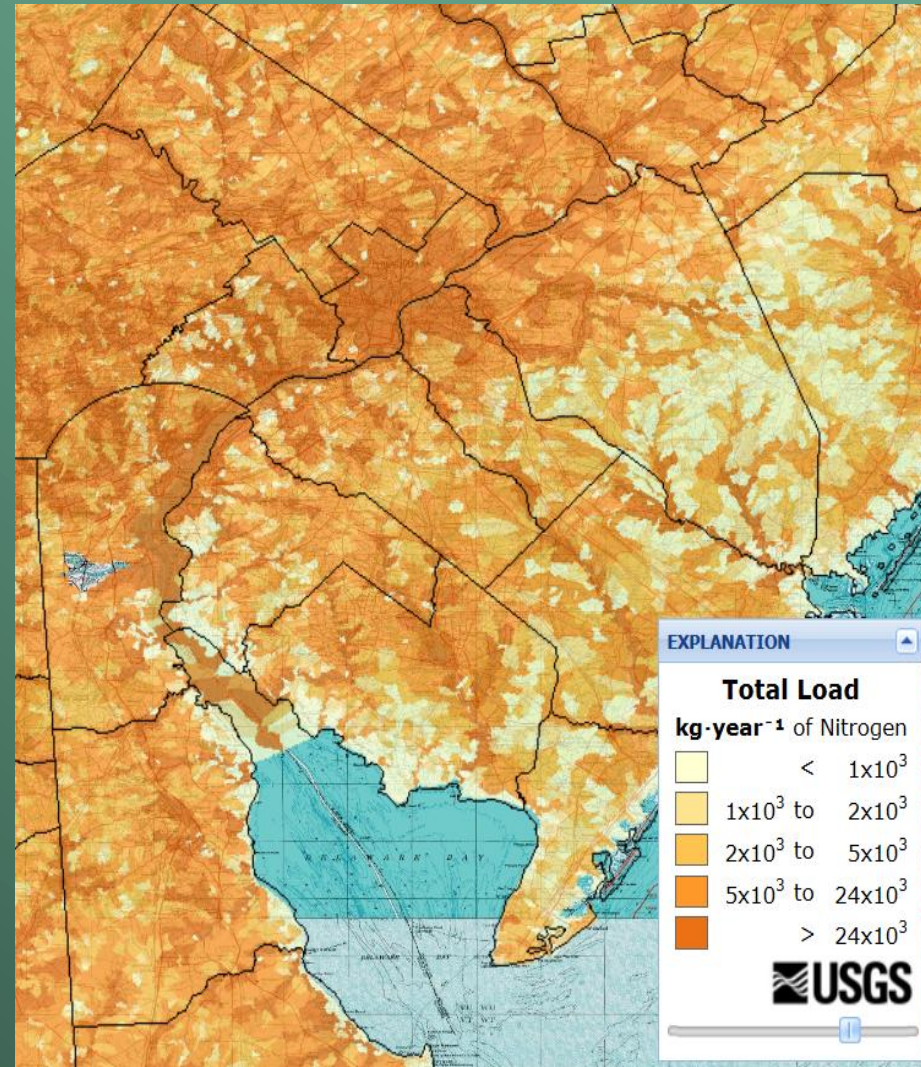- **Total** – **all of the above**

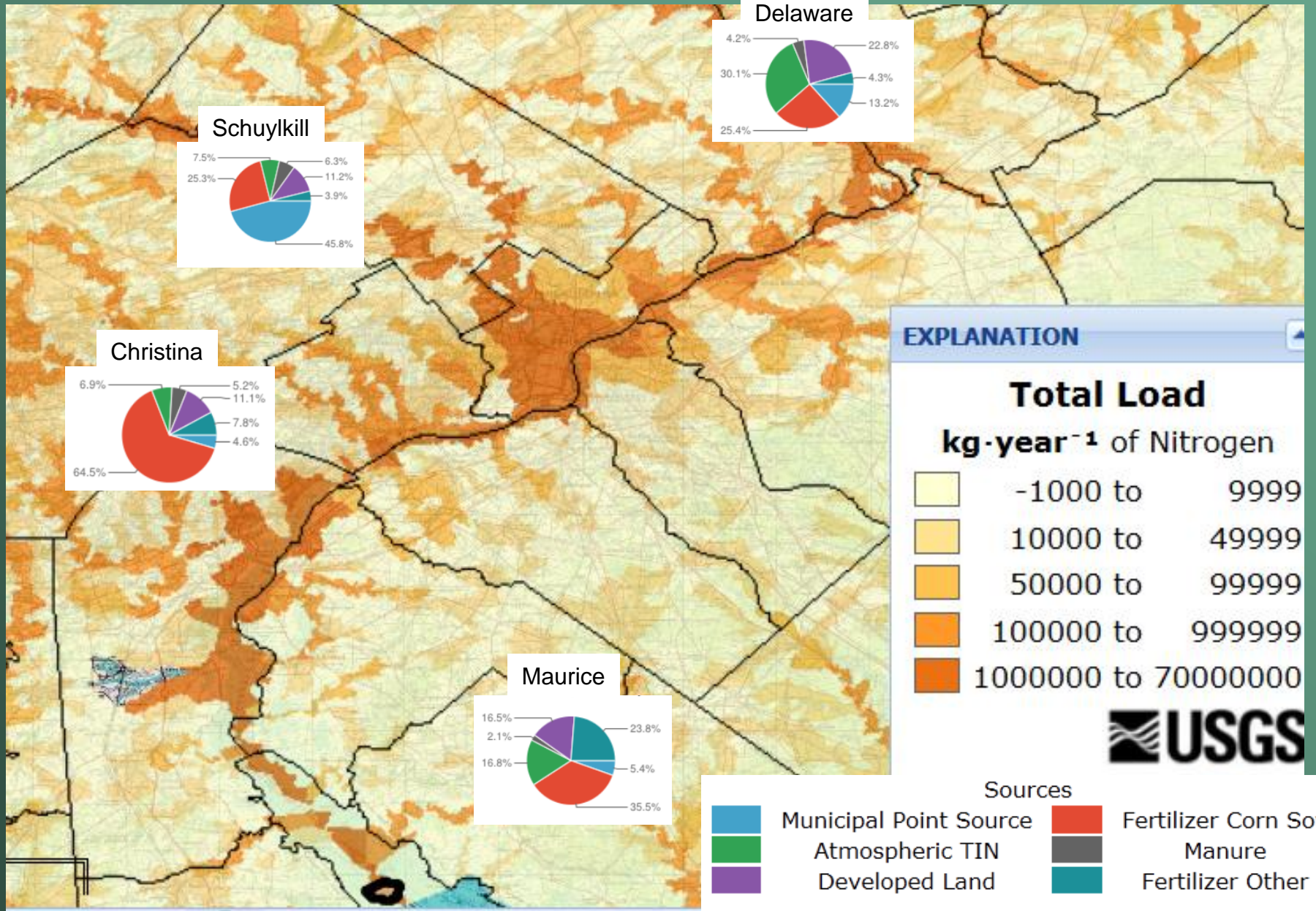# Updating Map – Total Nitrogen Load
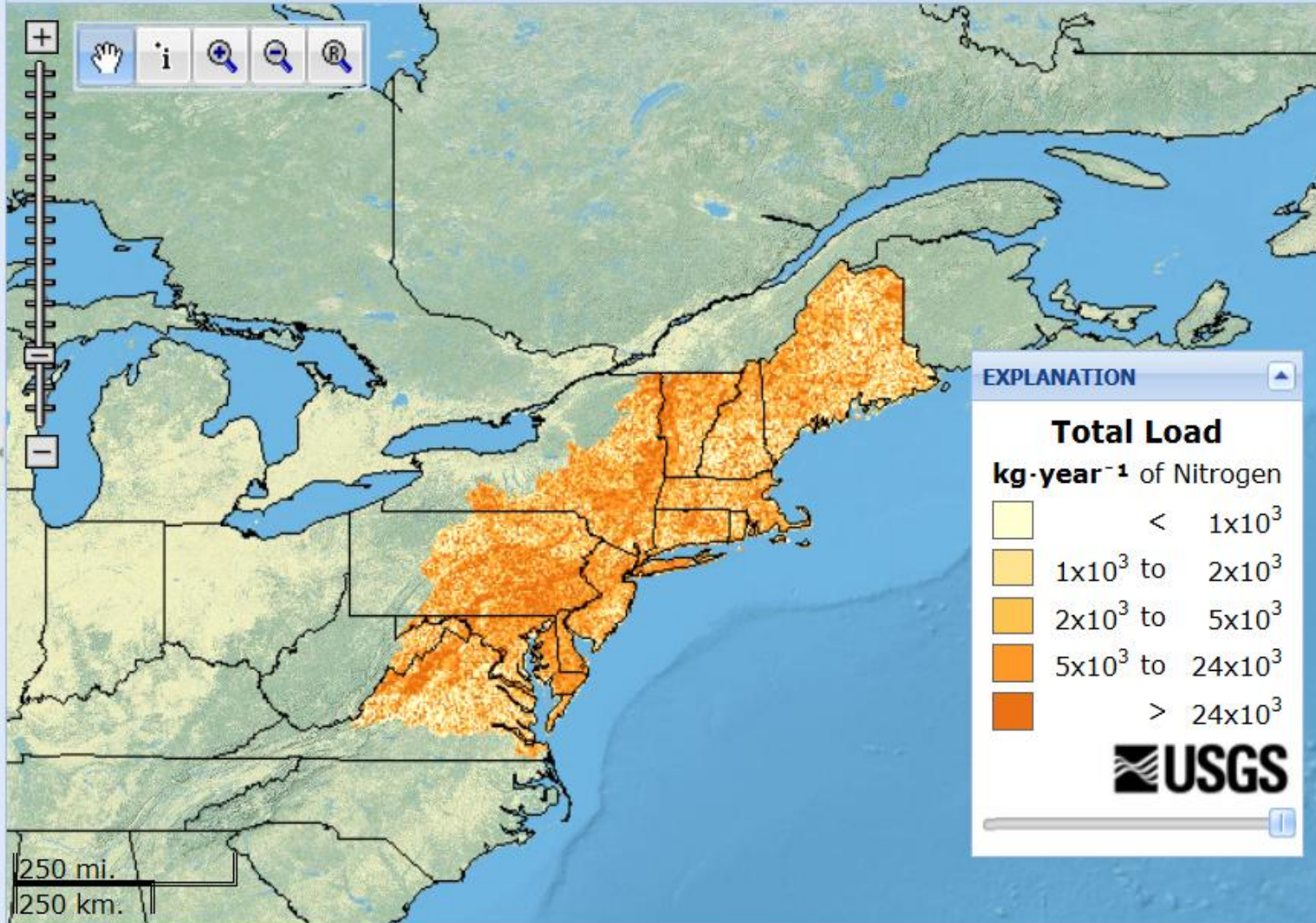
Using SPARROW in the Estuary

- **Model is calibrated for all non-tidal streams and makes predictions of loads and decay.**

- **Model is not calibrated in estuary and only accumulates inputs, but makes no predictions of losses (decay)**
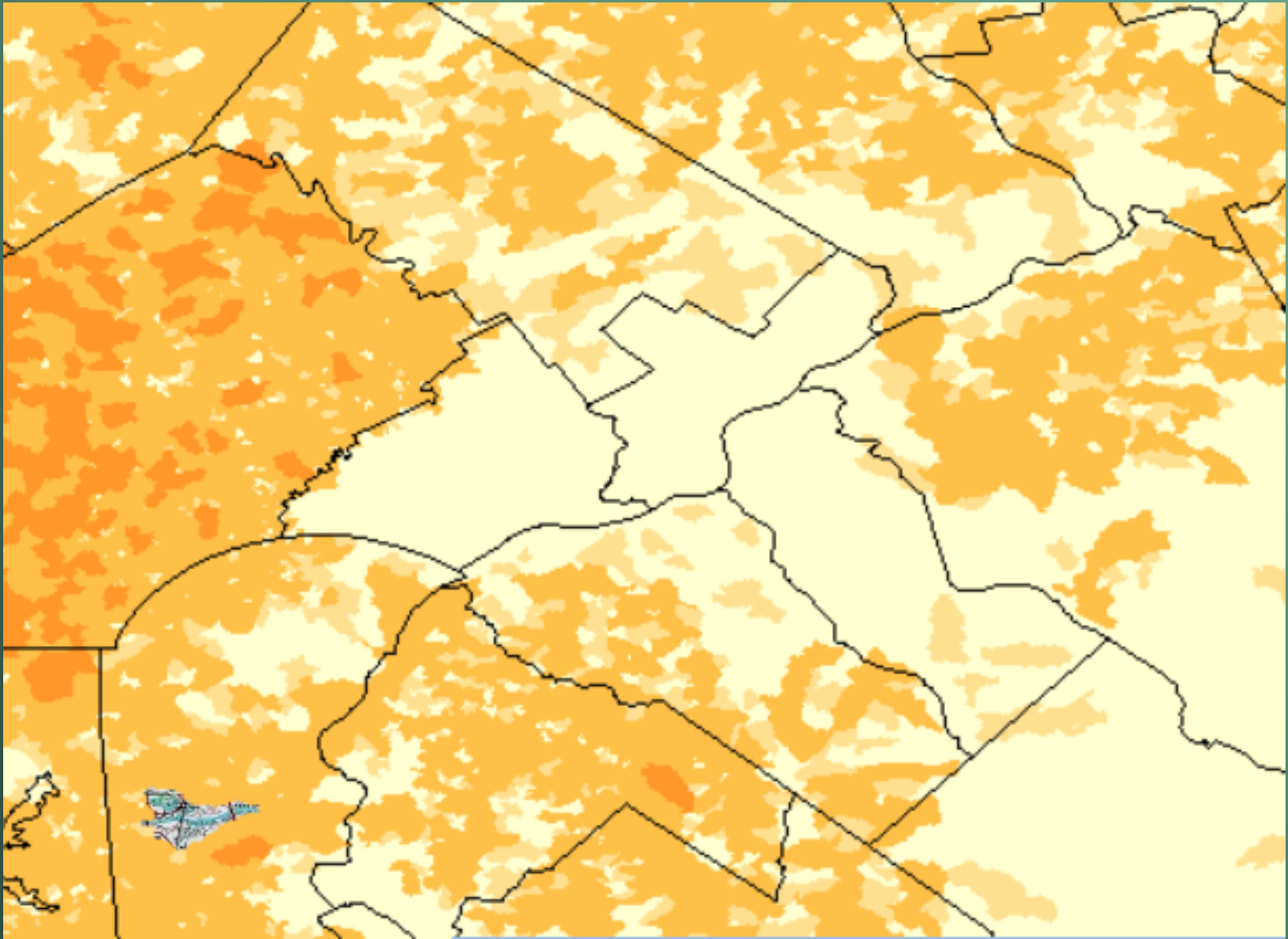
- **Data is not accumulated in lower bay**

EXPLANATION

Total Load
$kg \cdot year^{-1}$ of Nitrogen

	$< \quad 1 \times 10^3$
	1×10^3 to 2×10^3
	2×10^3 to 5×10^3
	5×10^3 to 24×10^3
	$> \quad 24 \times 10^3$

USGS

Estuary Total Nitrogen – all Sources

Incremental Yields from Corn and Soy Fertilizer

Incremental Yields from Point Sources
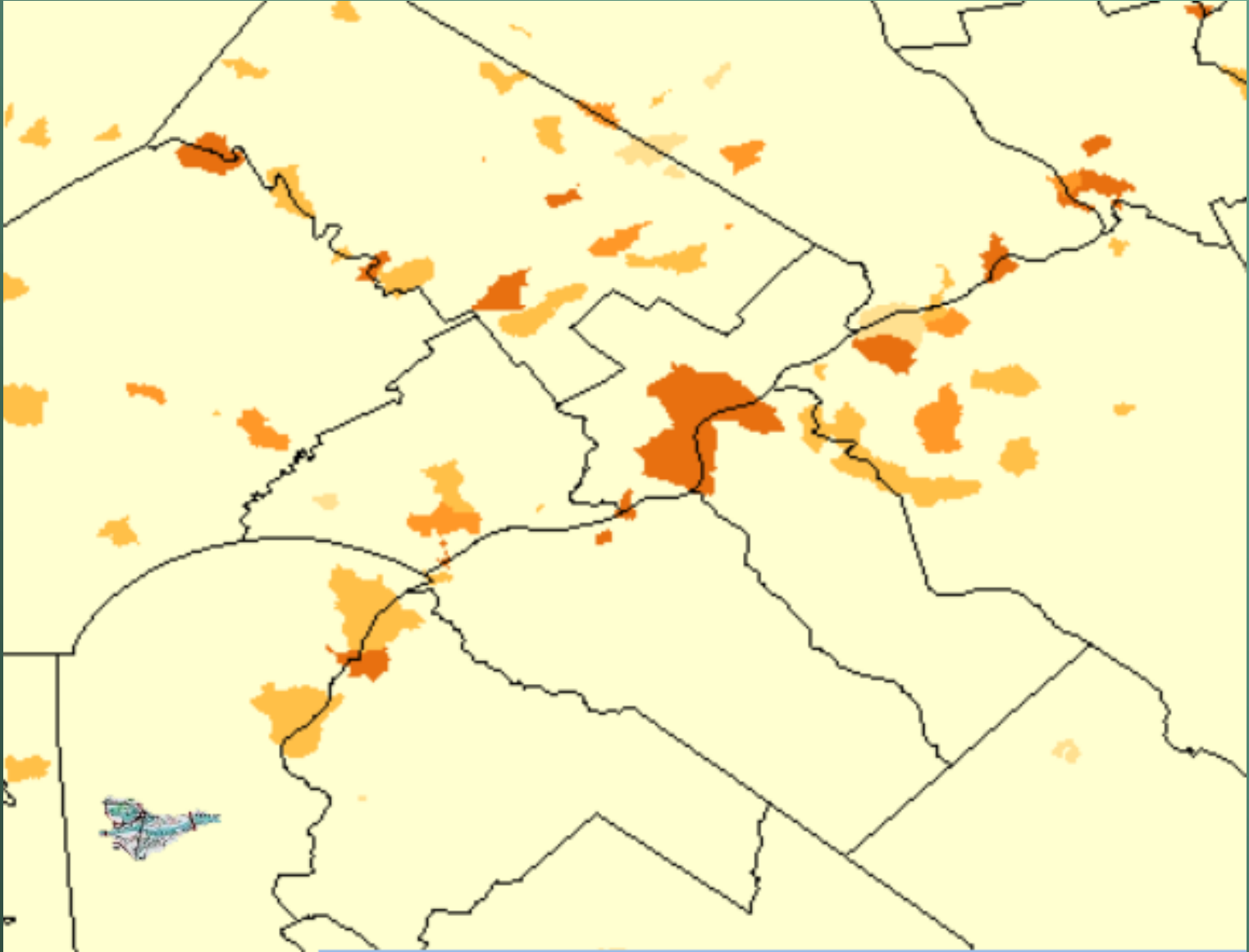
Selecting Reach Provides Information

Exporting Data

Predicted Nitrate Loads to Upper Delaware Estuary
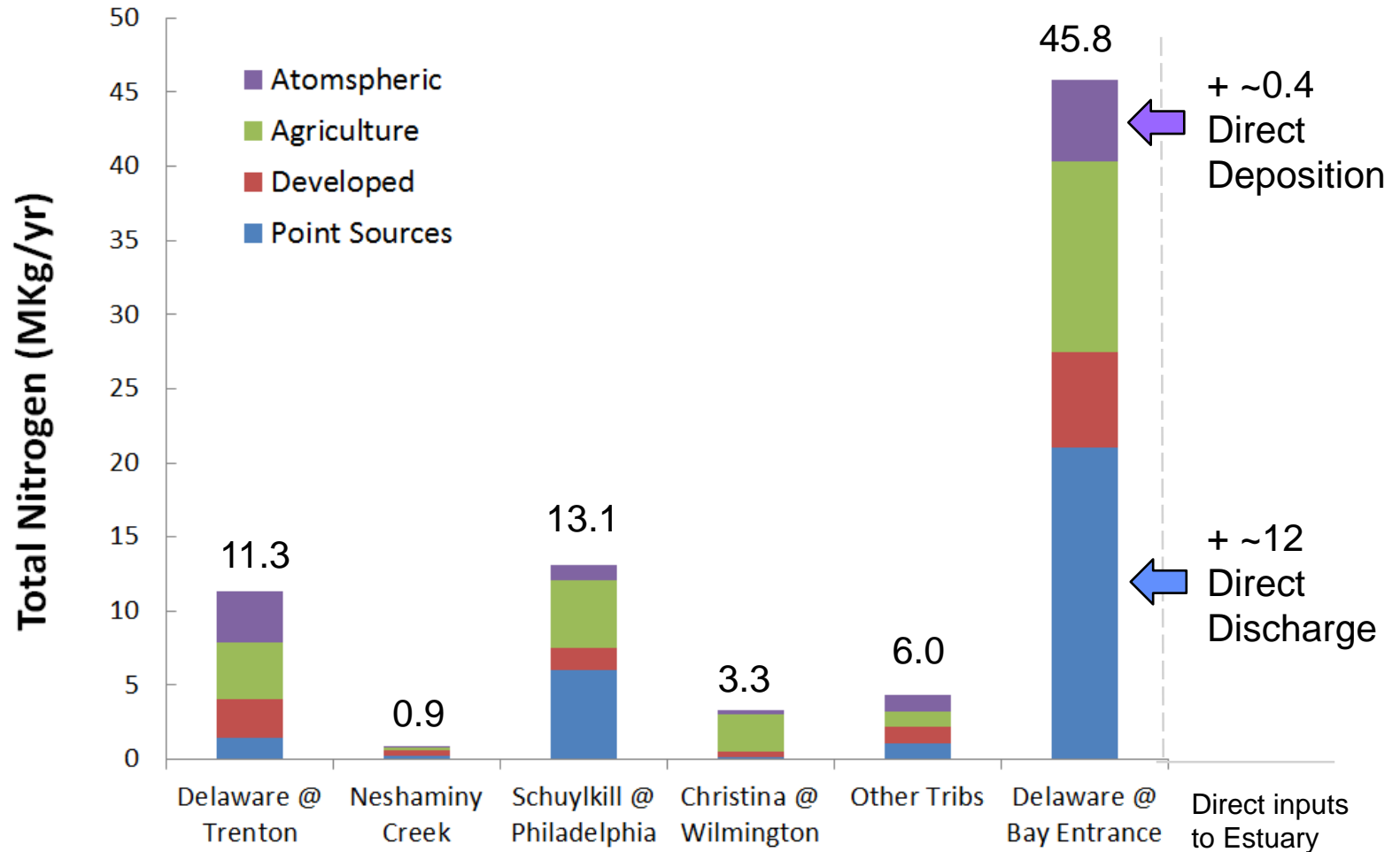
Total Nitrate Budget for Delaware Estuary

- **~28 MKg/yr from Major tribs (Del R, Schuylkill, & Christina)**
- **~12 MKg/yr from direct point-source discharge to estuary**
- **~7 MKg/yr from smaller tributaries**
- <u>**<1 MKg/yr from direct atmospheric depostion to estuary**</u>

- **~48 MKg/yr TOTAL**

Percent Contributions of Nitrate to the Estuary

Total Nitrate Loads from Smaller Tributaries (in MKg/yr)
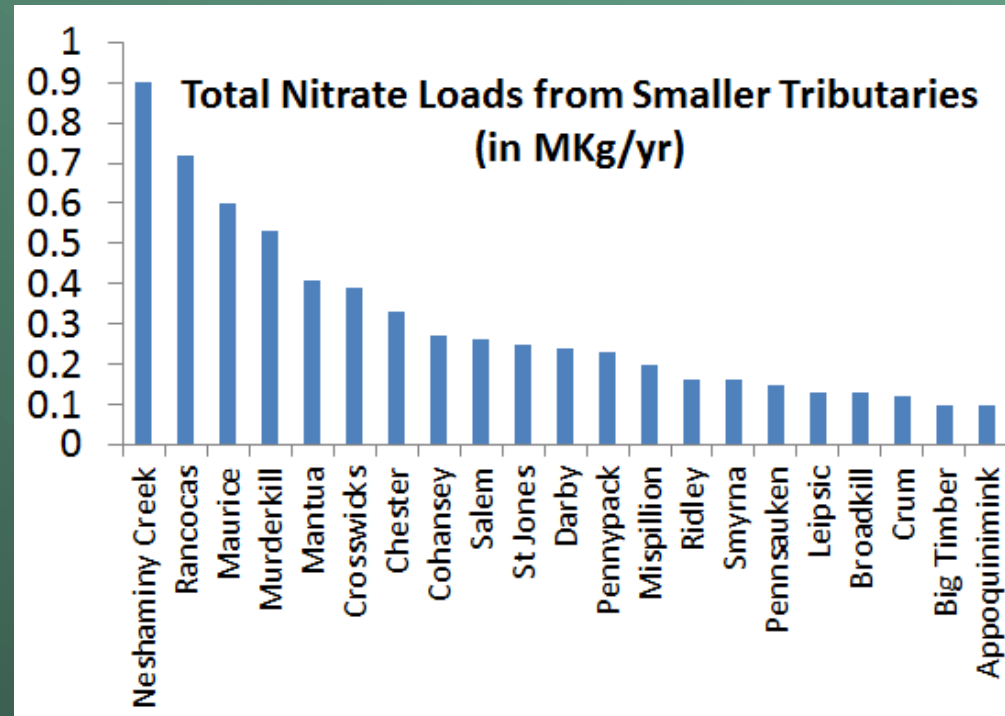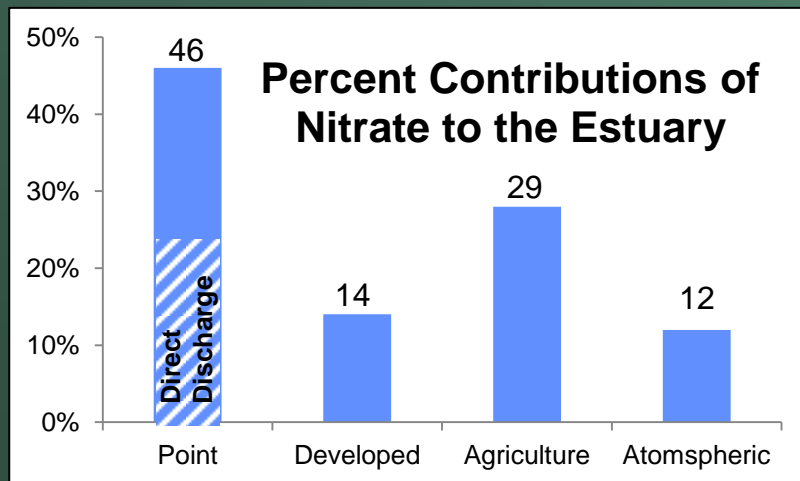
Summary

- **SPARROW nitrate and phosphorus models developed for northeastern US at 1:100,000 scale.**

- **On-line DSS allows user to explore and download data on loads and yields from varying sources for watersheds of interest.**

- **Examples were shown for nitrate in the Delaware Estuary, but similar analyses could be conducted at large or small watersheds throughout the basin.**

- **Phosphorus model not shown, but available.**

For More Information

SPARROW Webpage
http://water.usgs.gov/nawqa/sparrow

- **Publications and input data for N and P models**
- **On-line DSS tool**

Contacts

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- **rmoore@usgs.gov, 603-226-7825**

Jeff Fischer

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