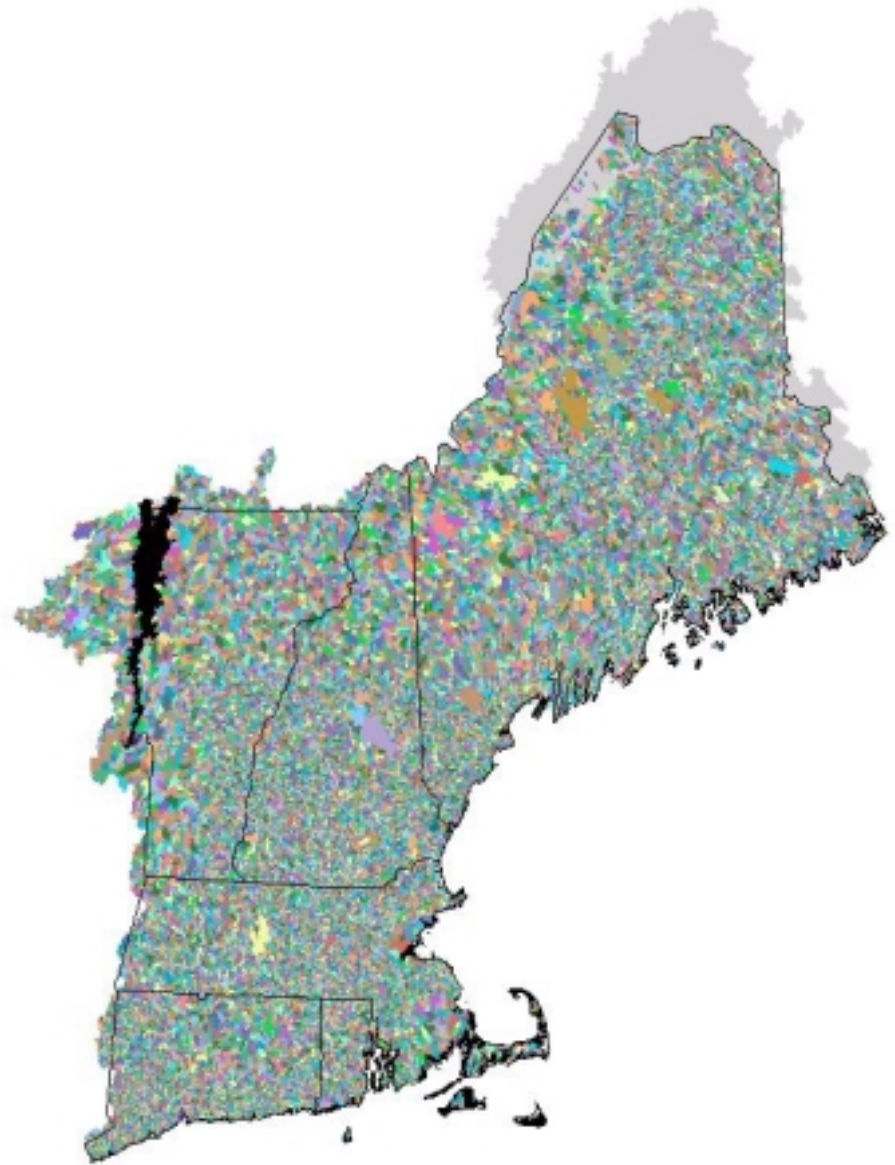


New England Regional SPARROW Water-Quality Model



Purpose of the New England Model is to support major water-quality management activities

•Nutrient Criteria Development

- expected ranges in concentrations
- variation by ecoregion
- relate concentrations to designated use attainment

•Total Maximum Daily Load Allocations

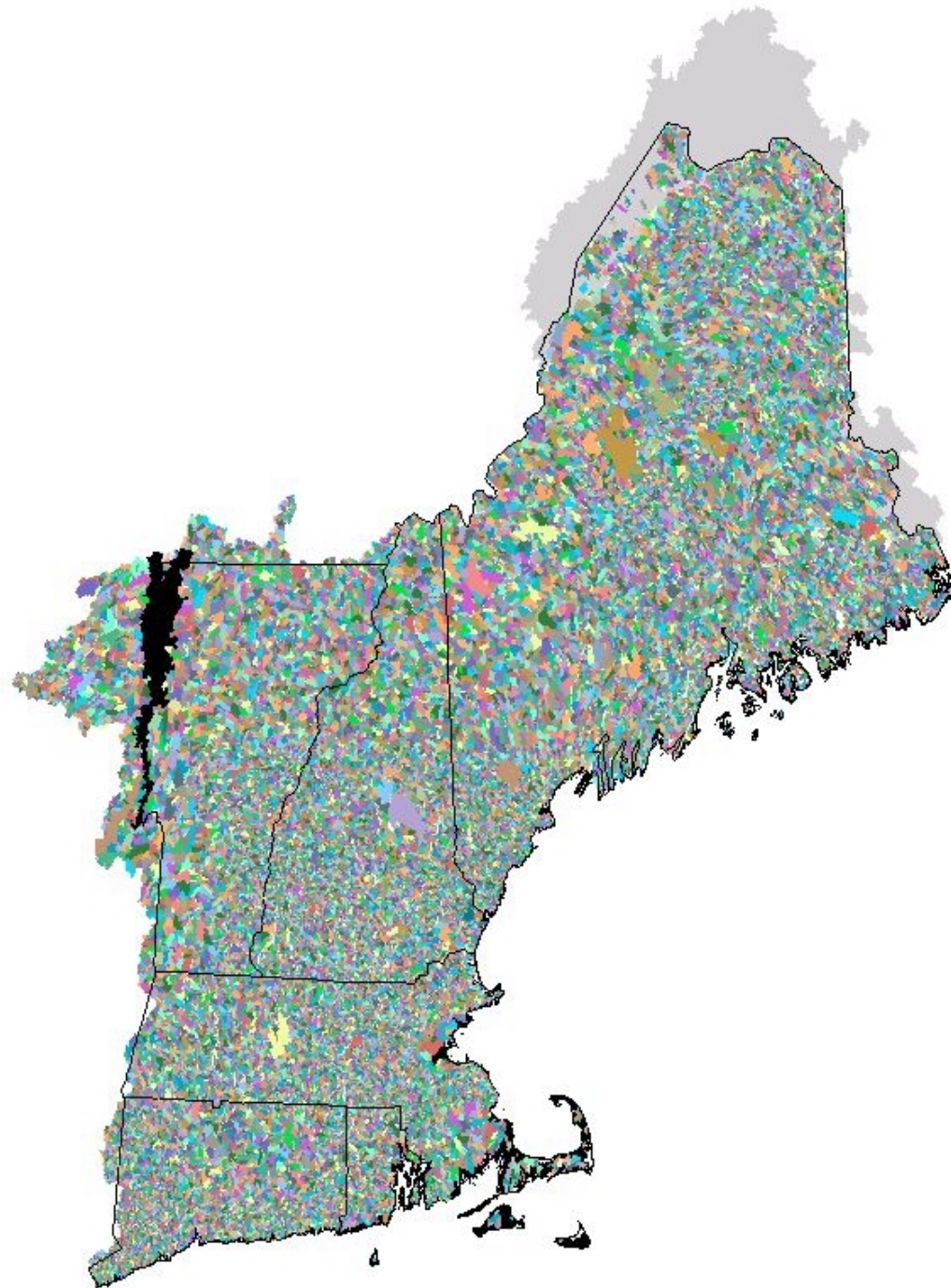
- magnitude and sources of loads
- load transport (especially interstate)

Design of the New England SPARROW Model

- 2 models: Total Nitrogen and Total Phosphorous
- Calibrating model for the early-mid 1990s time period
- Improve on national model by improved spatial detail and by additional local data sets
- Work began in 1999; now completing report summarizing results

New England Model Network of River Reaches and Reach Catchments

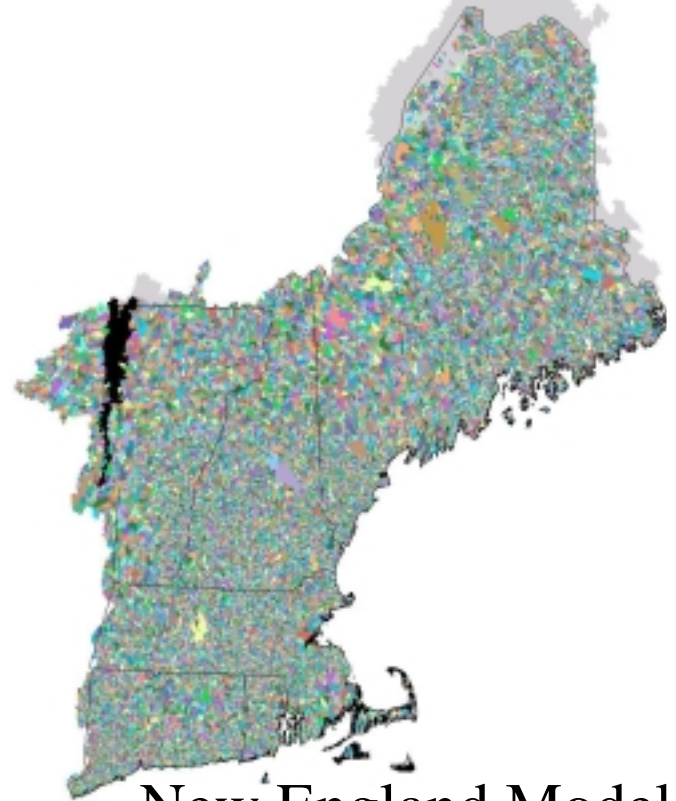
- **Based on the 1:100,000 scale National Hydrography Data Set (NHD)**
- **42,000 reaches in model**
- **Average size is 1.7 mi²**
- **Corrected to NRCS 12-digit watersheds**
- **Hydrologically connected**



Reach Watersheds/catchments



National Model
(2,462 watersheds
mean size 29.2 sq. mi.)



New England Model
(42,000 watersheds
mean size 1.7 sq. mi.)

Enhanced Predictor Variables being tested in the Model – Physical Watershed Features

- **Mean annual flow estimations**

 - based on Randall (1996) – regional runoff map

- **Time of travel/impoundment detention estimations**

 - time of travel based on Jobson (1996); function of drainage area size, streamflow and slope

 - settling factor for lakes/impoundments
(surface area / flow)

- **Wetlands from National Land Cover Data**

- **Climatic data (temperature and precipitation) from Oregon State PRISM program**

Nutrient Sources

- **Land use**

 - National Land Cover Dataset (11 classes)

- **Point Sources**

 - 1993 TN and TP discharge estimates provided by EPA;
~2600 in New England

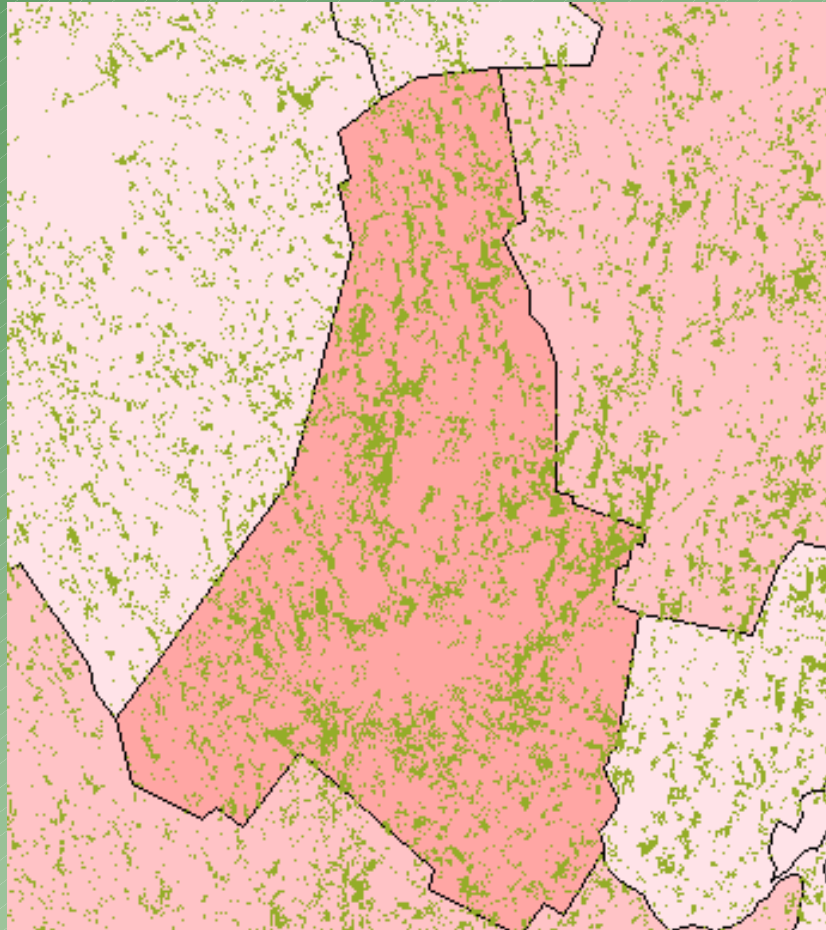
- **Agricultural fertilizer and manure applications**

 - USDA Natural Resource Inventory by county applied to
ag land use areas

- **Atmospheric Deposition of Total Nitrogen**

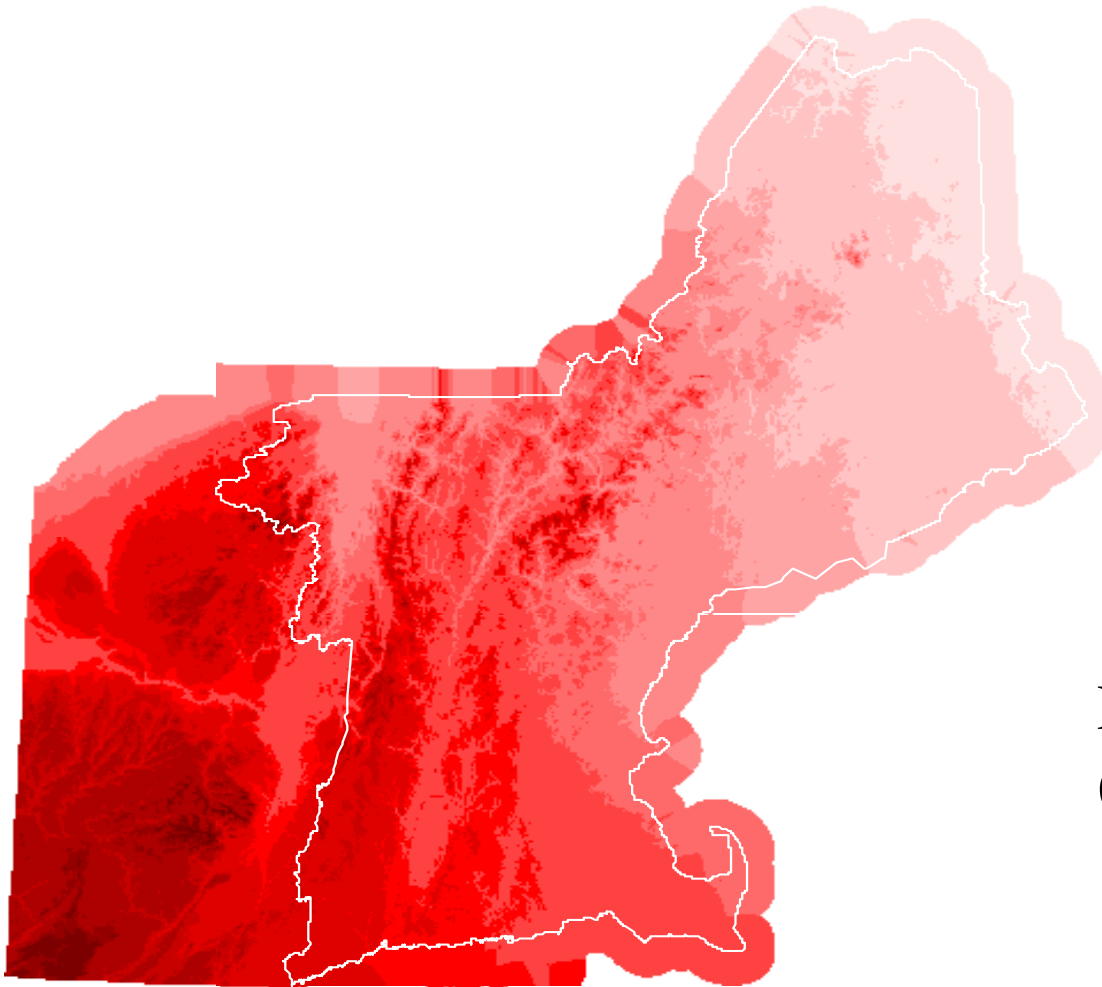
 - based on Ollinger and others (1993)

Nitrogen fertilizer use for Androscoggin County Maine



Green is crop land

Atmospheric Deposition of Nitrogen

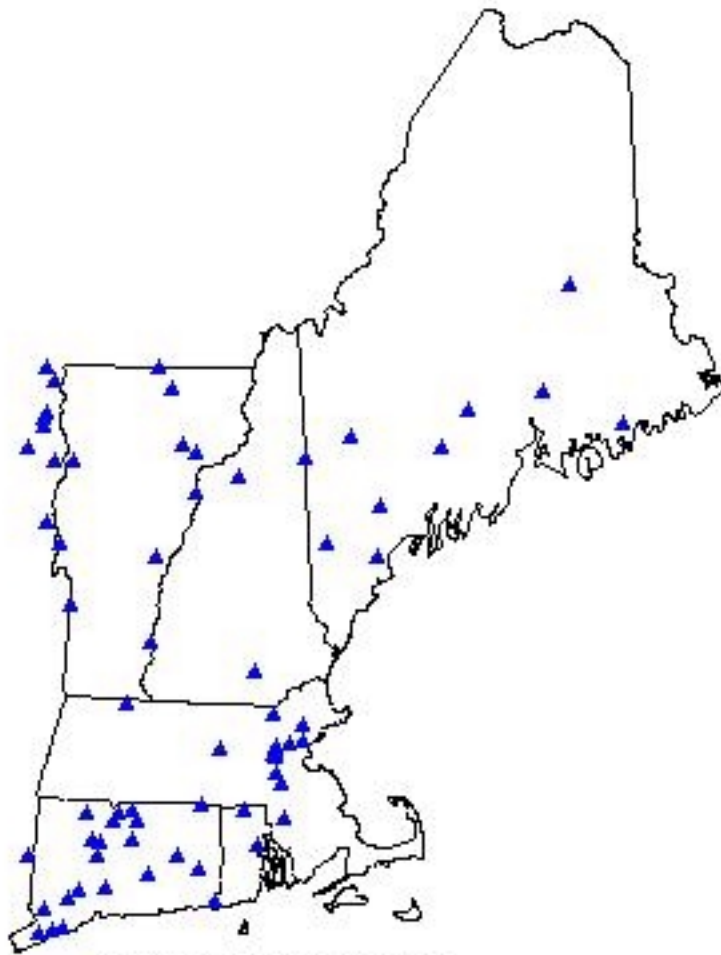


Range 3.2 to 12.0 kg/ha/yr
(Ollinger and others, 1992)

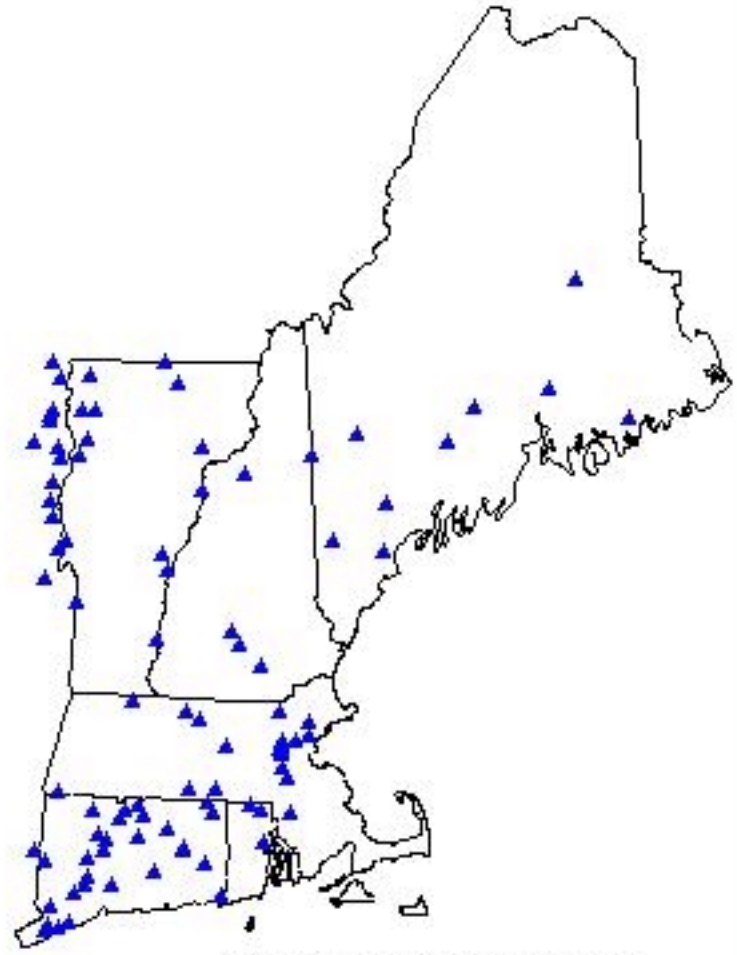
Nutrient Data (Dependent Variable) Used in the Model

- Collected data from USGS, STORET, States, research studies
- Calculated streamflow/nutrient relation to predict nutrient loads during all conditions of a hydrograph using the USGS Estimator Program.
- Loads are average over a period of record for streamflow data

Sites where Nutrient Loads Calculated



72 Nitrogen Sites
65 sites used in the model



95 Phosphorus Sites
67 sites used in the model

Model Results

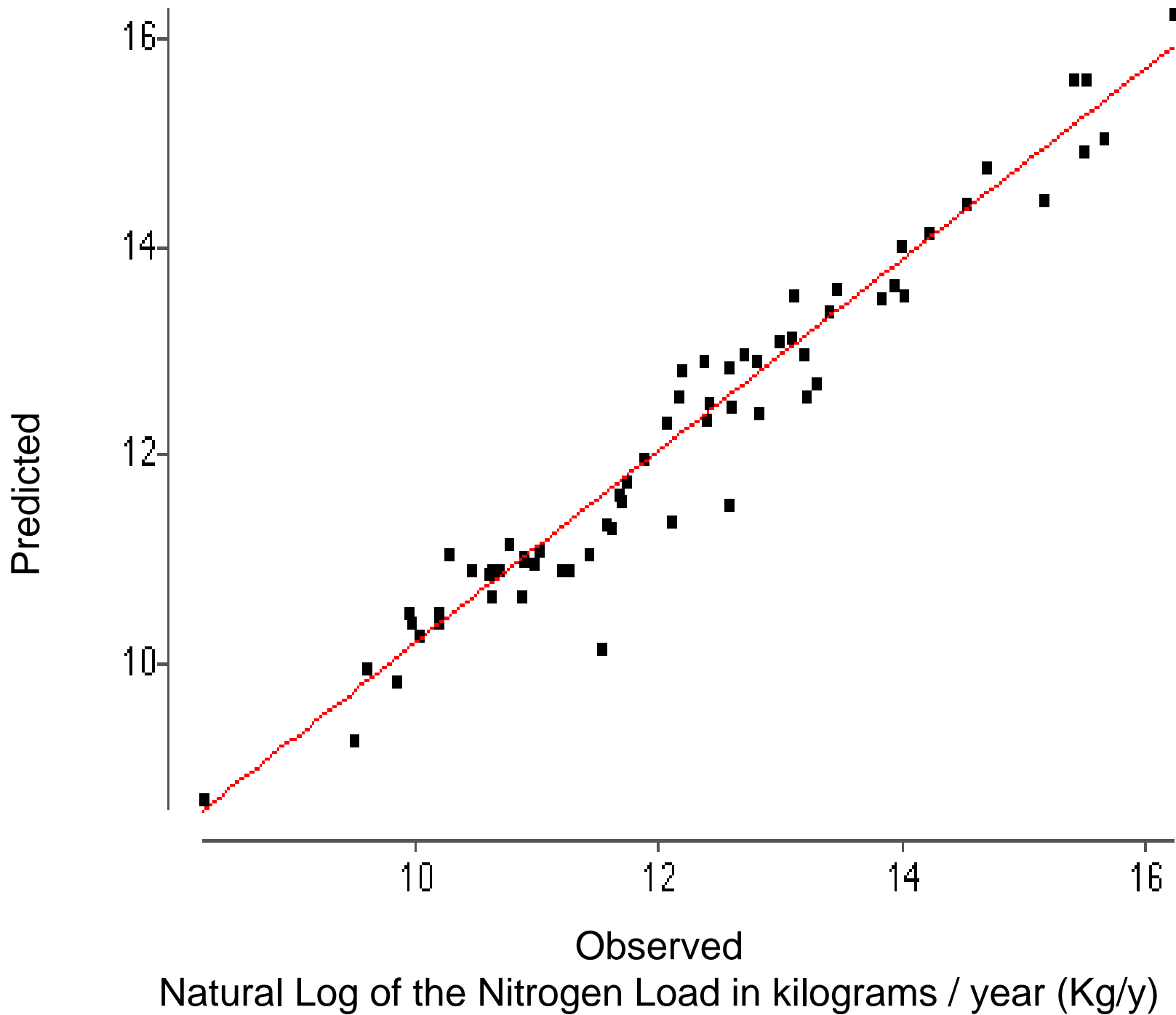
- Nitrogen and Phosphorous Models have been calibrated and bootstrap models have been run
- Writing report

Model Calibration Runs for the New England SPARROW Nitrogen Model

Significant Predictors:

Point Sources (municipal STPs),
Atmospheric Deposition,
agricultural land, and urban land
R-squared = .94, MSE = 0.18

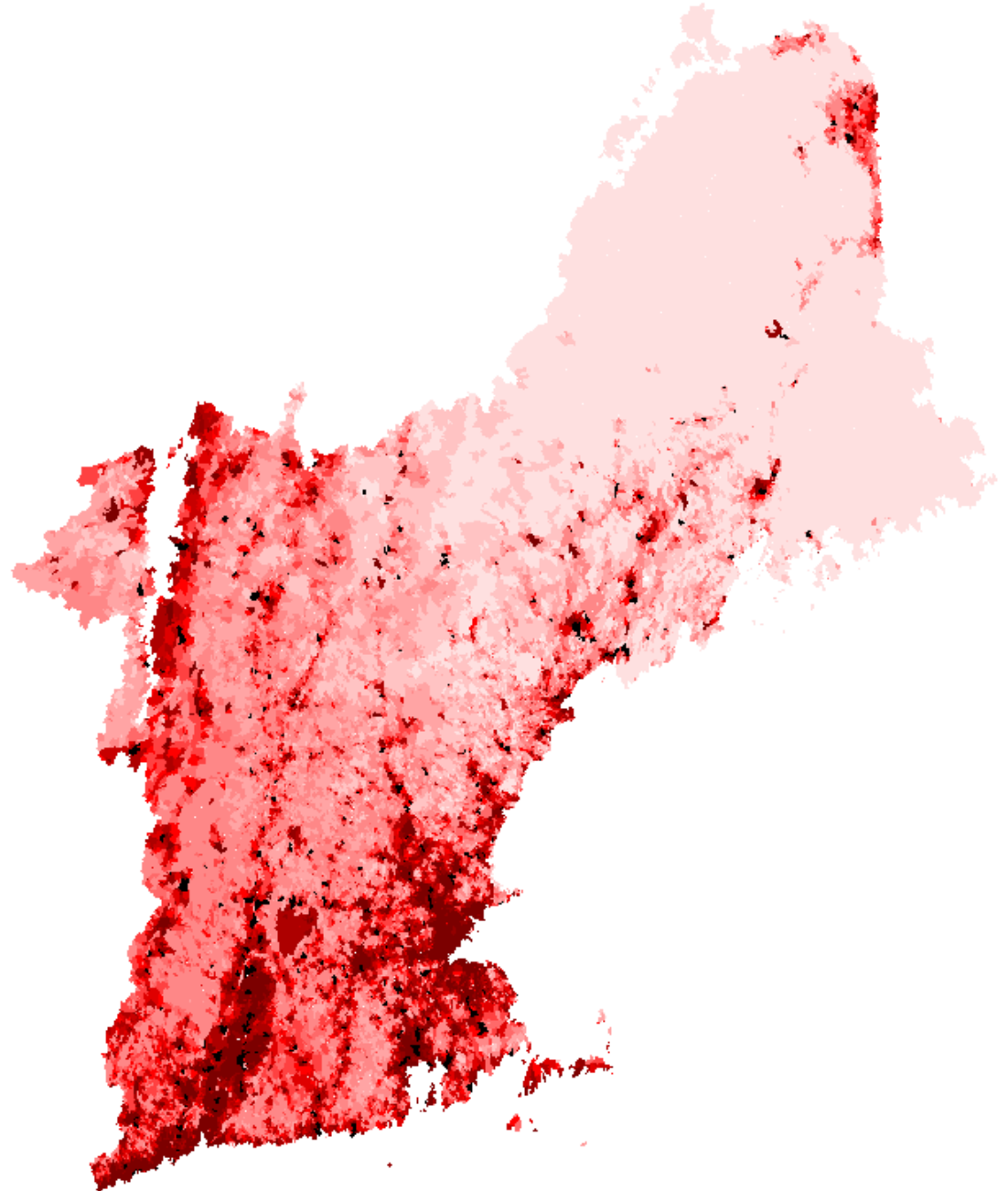
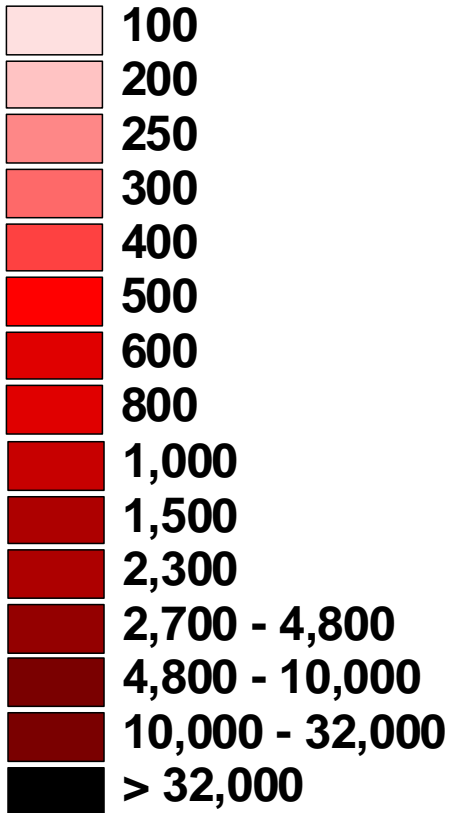
Variable	COEF	STD ERR	BOOTEST	BOOTSTD
• POINT	1.13	0.37	1.18	0.43
• ATMOS	0.33	0.03	0.34	0.04
• AG LAND	1114	506	1149	619
• URBAN	2409	584	2574	860



SPARROW

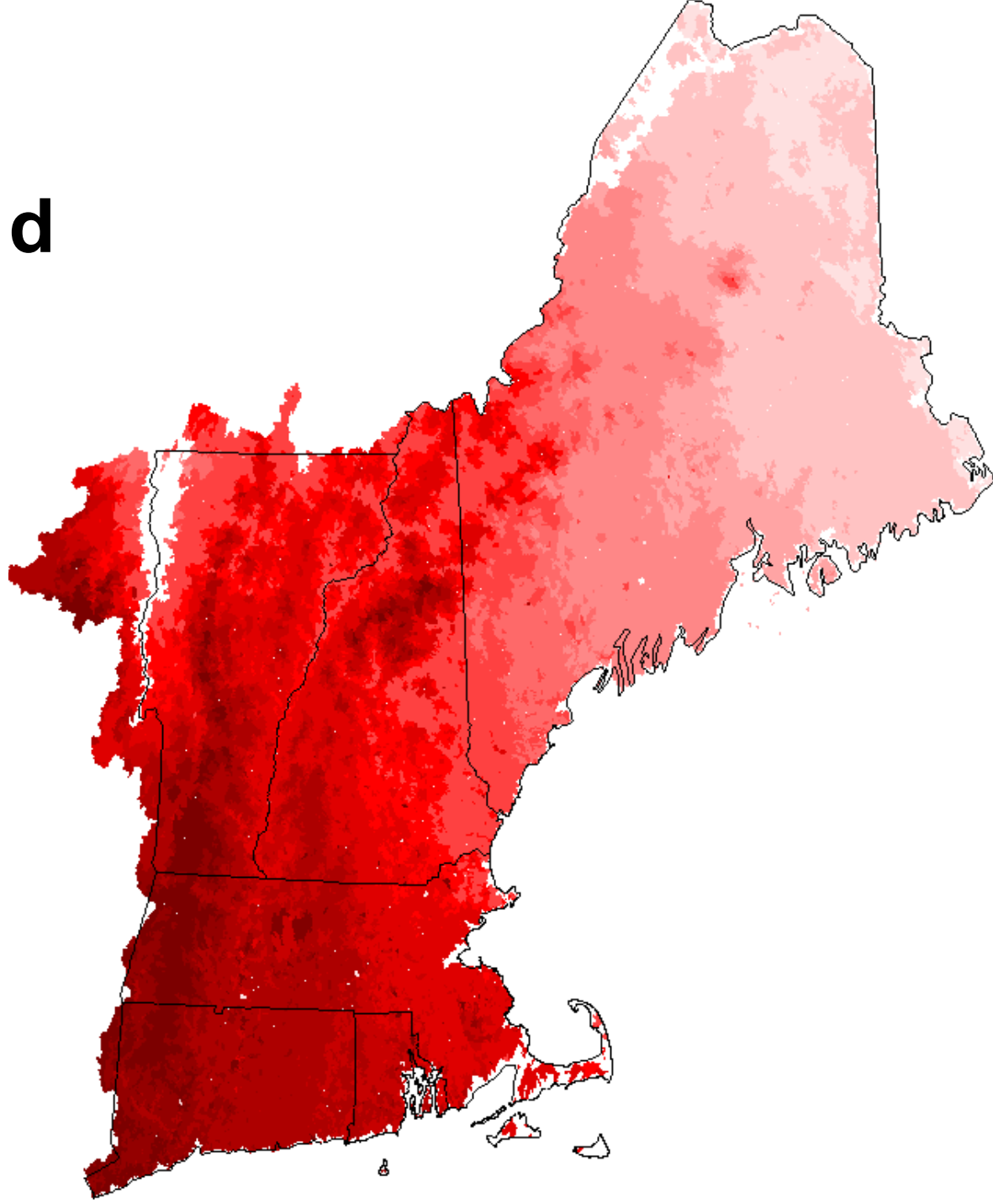
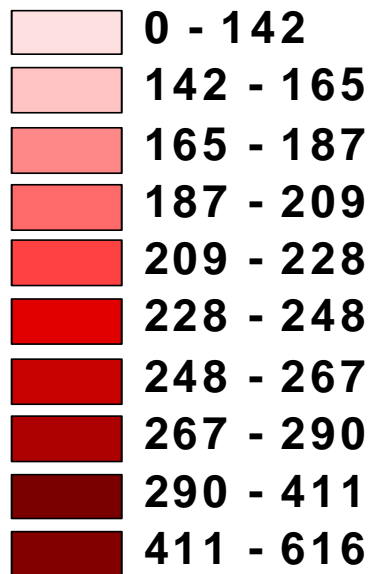
Predicted Nitrogen Yield

Catchment Yield (kg / sq km)



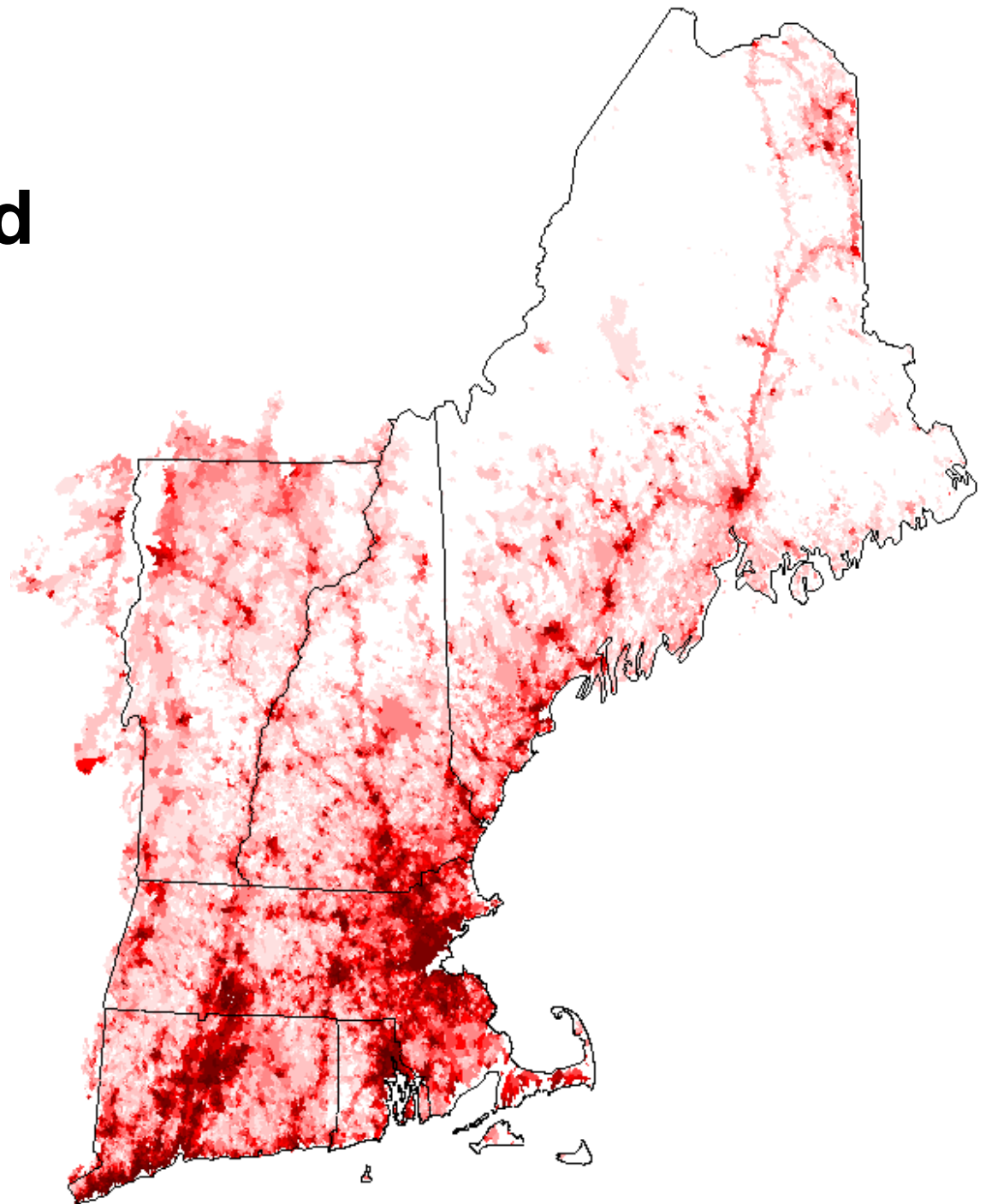
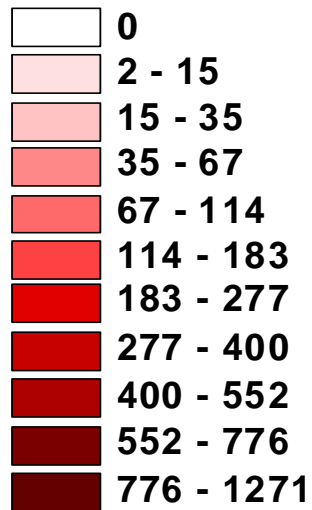
SPARROW Predicted Nitrogen Yield Atmospheric Deposition

Catchment Yield
(kg / sq km)

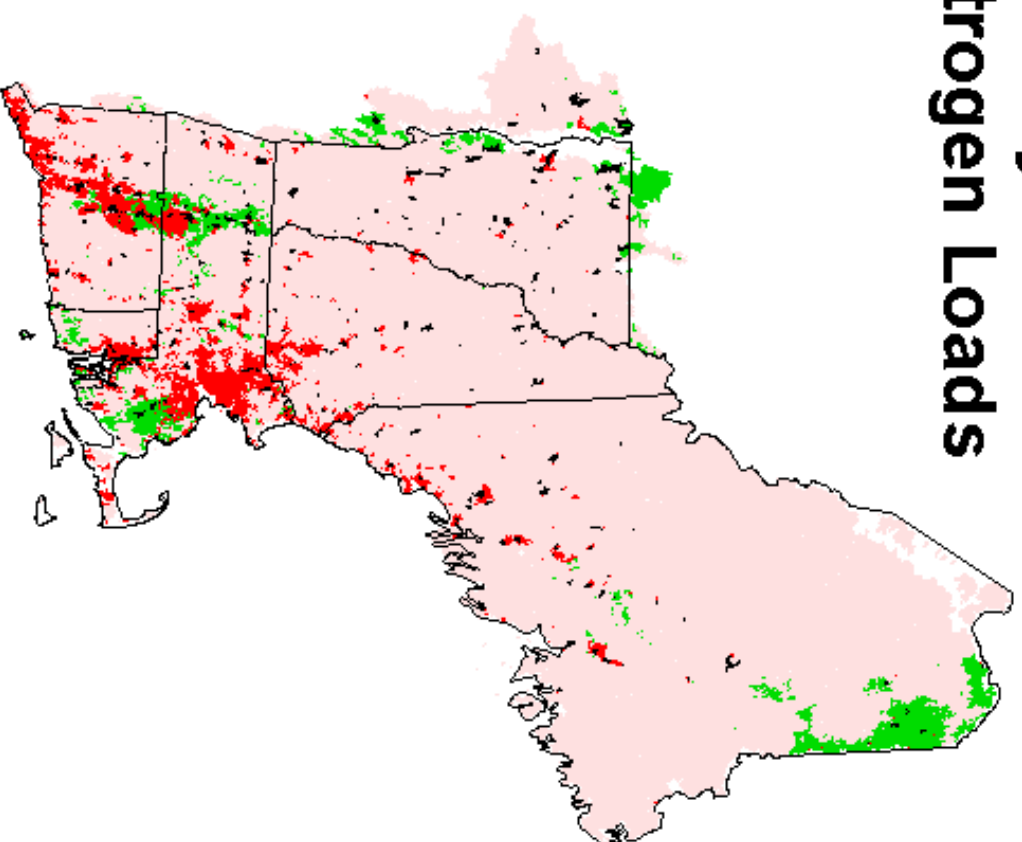


SPARROW Predicted Nitrogen Yield URBAN Sources

Catchment Yield
(kg / sq km)



Primary Sources of Nitrogen Loads



Primary Source

Atmospheric

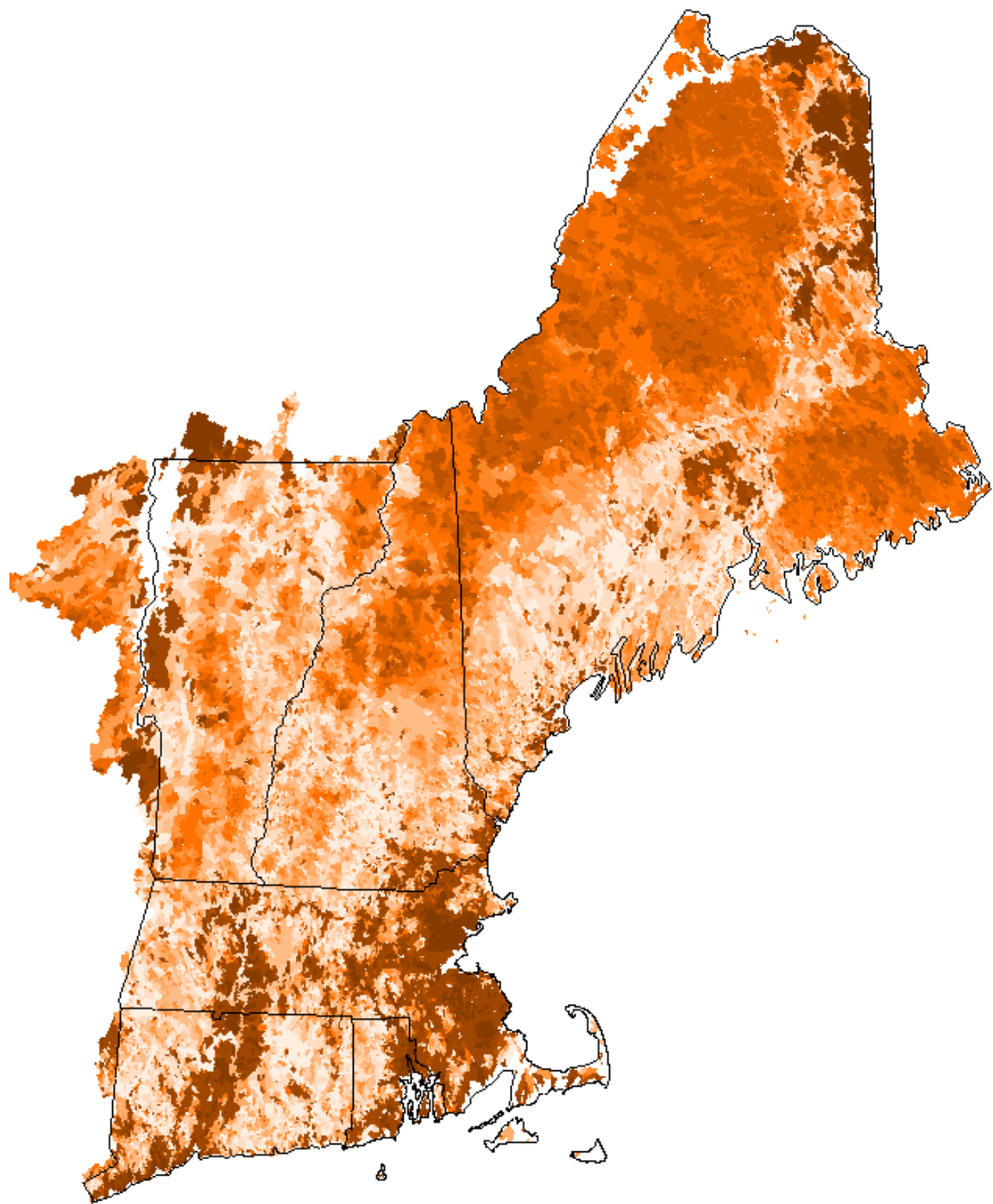
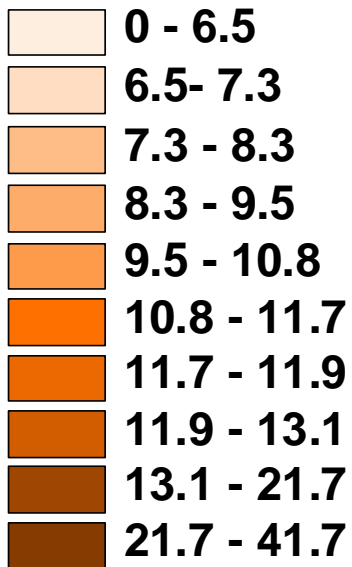
Urban

Agriculture (fertilizer)

Point Source (sewered)

Coefficient Error of Total Load

error in percent
(model error of about 34%
is in addition to these
percentages)



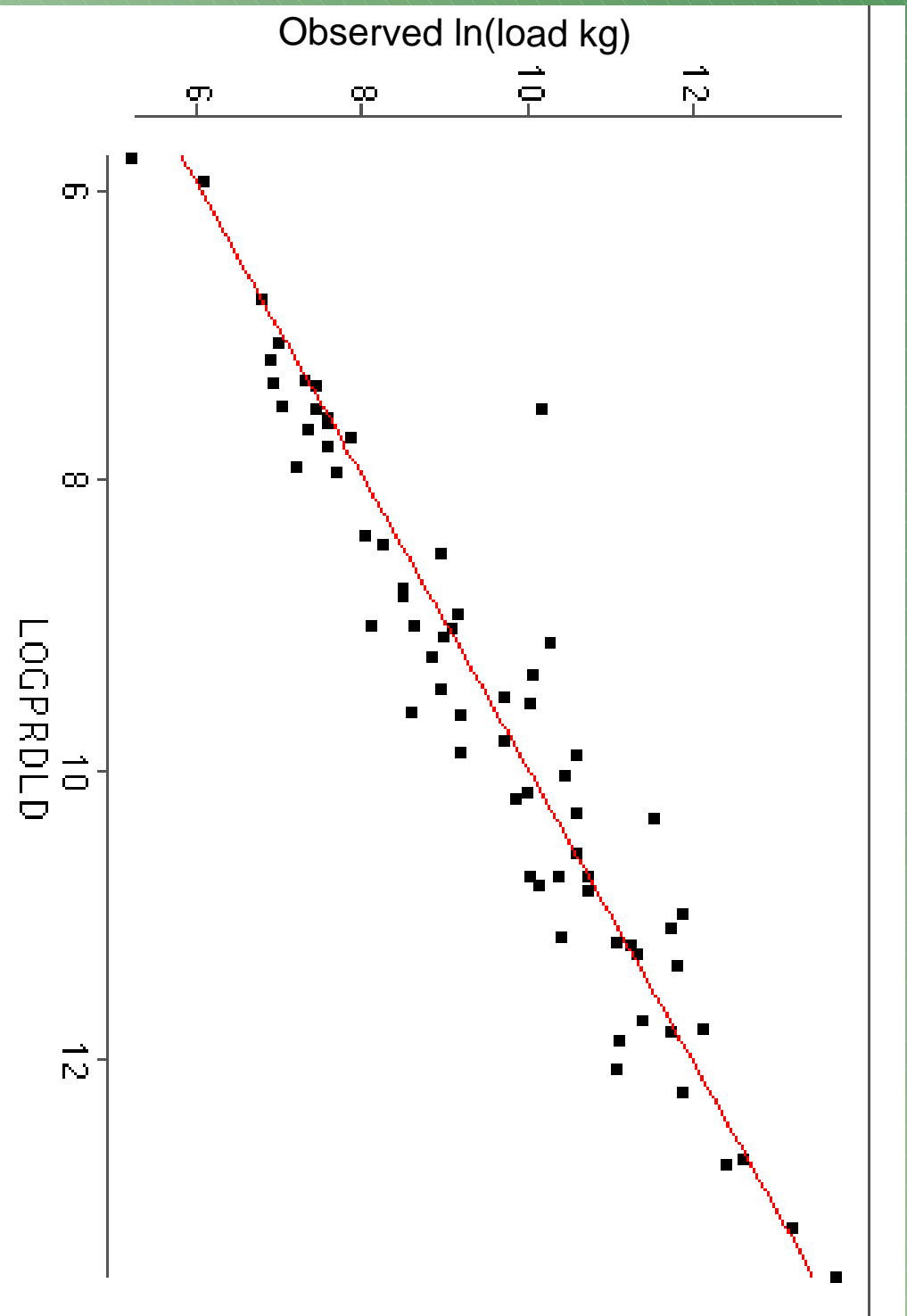
Model Calibration Runs for the New England SPARROW Phosphorous Model

Significant Predictors:

Point sources (municipal STPs and paper),
Forest land, agricultural land, urban land,
Attenuation in lakes with surface areas $\leq 10 \text{ km}^2$

R-squared = .91, MSE = .36

Variable	COEF	STD ERR	BOOTEST	BOOTSTD
• POINT	1.15	0.25	1.18	0.29
• ATMOS	26	9.4	28	8.5
• AG LAND	311	65	302	96
• URBAN	79	28	77	11

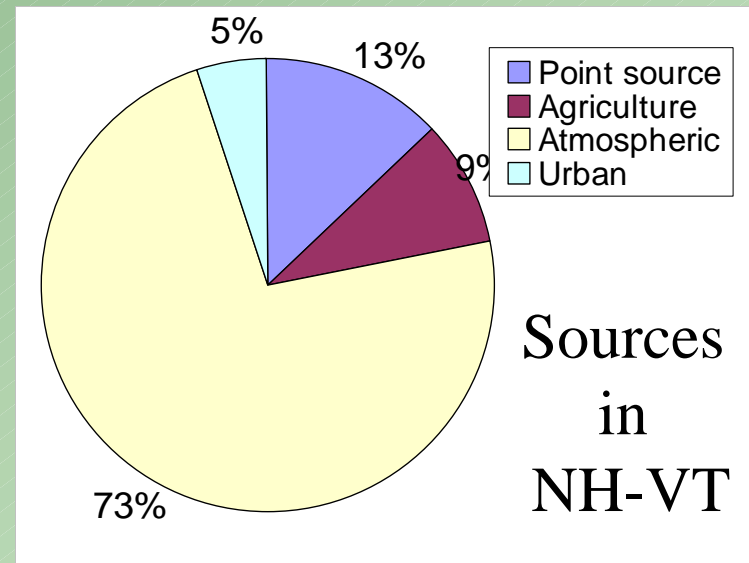
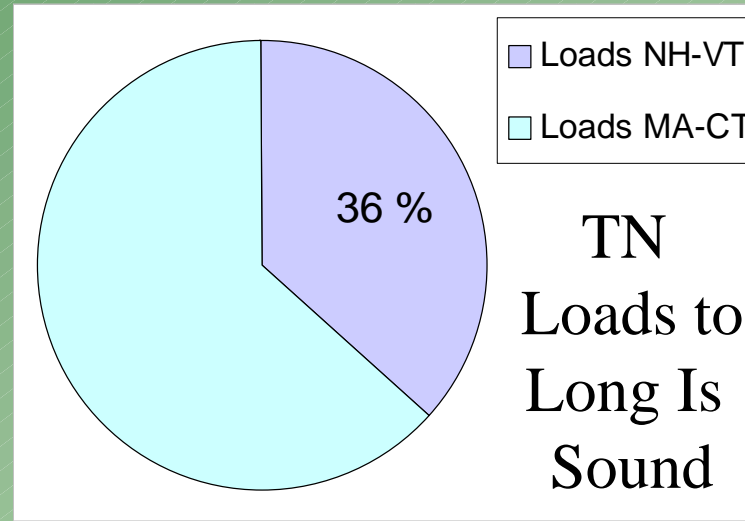
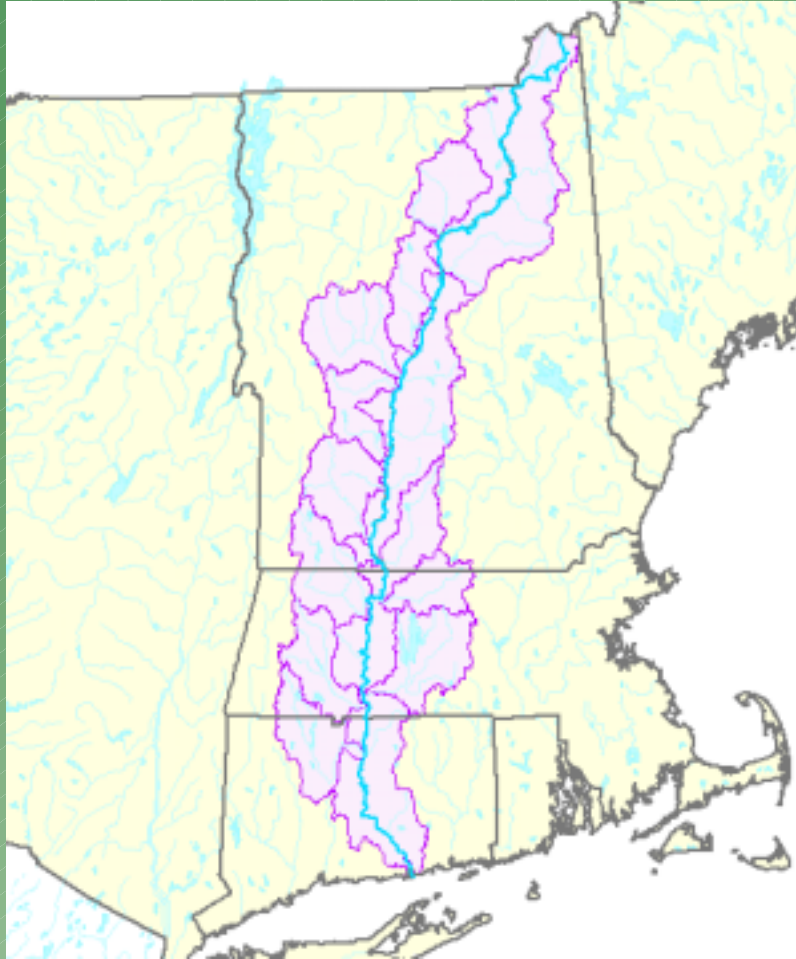


Using the New England SPARROW Model to Assist in the Upper Connecticut River TMDL Process

- Compare SPARROW results to other load estimates, modeling studies and professional judgment
- Use New England SPARROW model to determine loads, sources of loads, and errors
- Determine if additional/refined SPARROW modeling is needed
 - Nested model to assess attenuation
- Use SPARROW model to assist in design of monitoring network to better define loads
- Revised SPARROW model after additional data collection

Utility of New England SPARROW Model

Results for TMDL Applications – An Example from the Connecticut River Basin



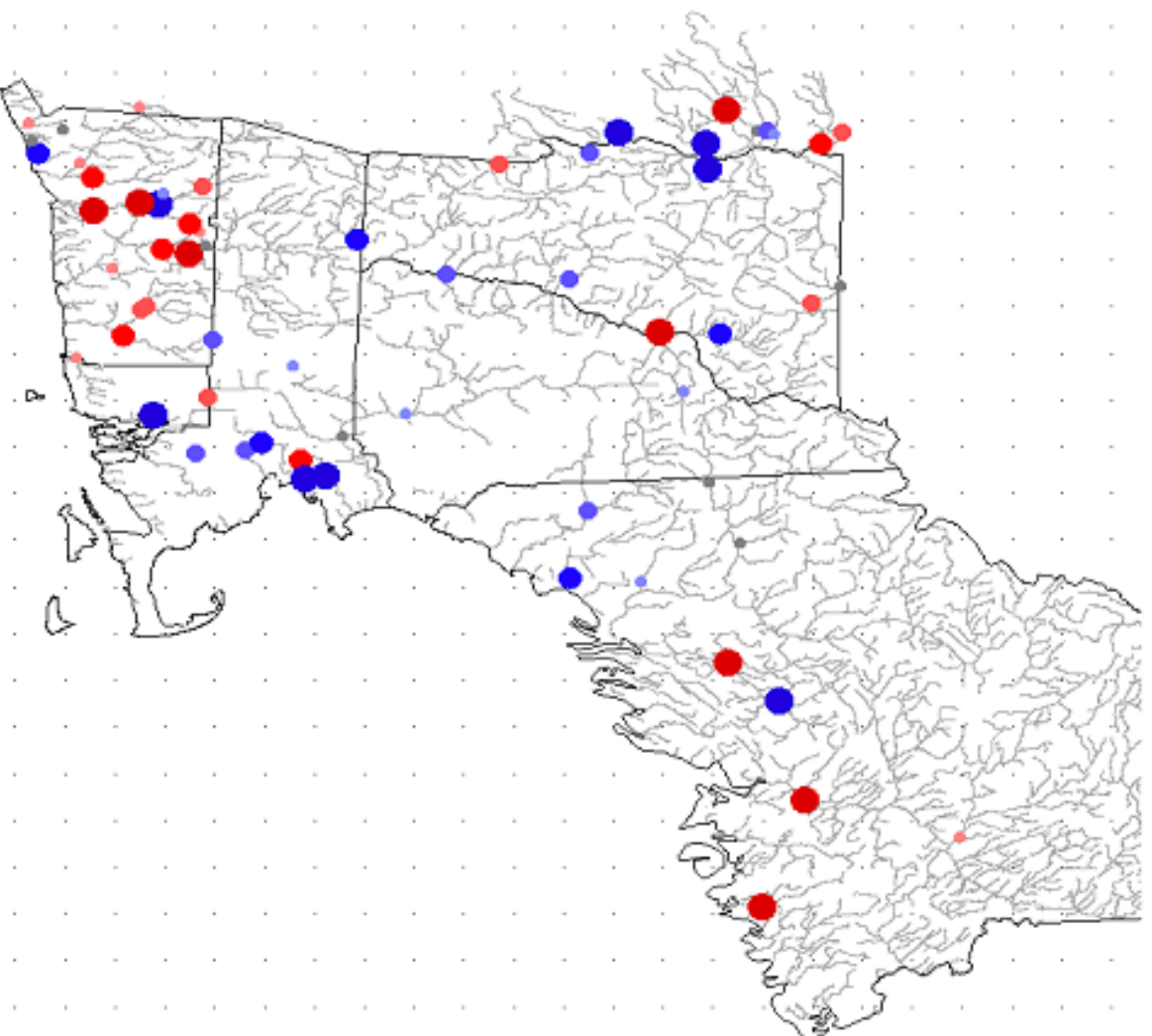
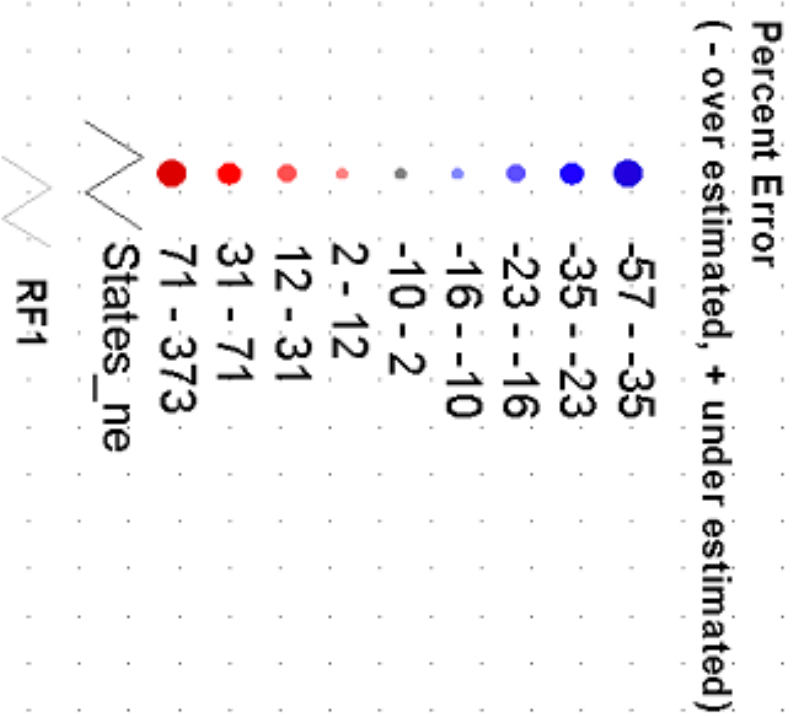
Mercury SPARROW Model

- Multivariate regression model (not true SPARROW)
 - dependent variable: Hg in tissue by species
 - independent variables: SPARROW-generated watershed characteristics, Hg deposition, other Hg sources, water chemistry, other variables shown to influence Hg in fish
- Data collection initiated
- Model development in 2003/04?
- EPA/NEIWPC/NEISCAUM/USGS cooperative study

Summary of Results

- 1:100,000 NHD needed work
- Quality point source data difficult to obtain
- New England TN and TP models are improvements over the national SPARROW model
- Packaged and documented SPARROW programs needed
- Significant interest and value in SPARROW products from EPA, NEIWPC, and state agencies

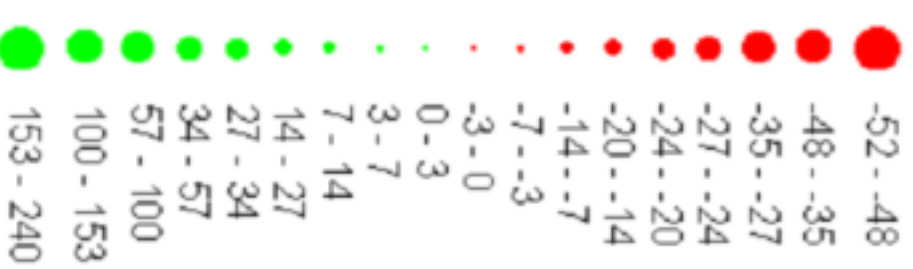
SPARROW Nitrogen Residual (percent)



SPARROW Phosphorous

Residual (percent)

Percent Error
(- over estimated, + under estimated)



Ne ft1 alb

