Recent Progress in SPARROW Watershed Modeling in the Great Lakes Basin

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Eutrophication Issues in the Great Lakes

Lake Erie

Pelee Island, Lake Erie

Manitowoc, Lake Michigan

Cladophora on Beaches

The Importance of Nutrient Loading to Lakes is Well Known
And is One of the Primary Reasons for Impairment Across the Country

Delavan Lake, Wisconsin

Typical Goals of SPARROW Modeling:

1. Determine P and N loading to various receiving waters over large spatial scales.

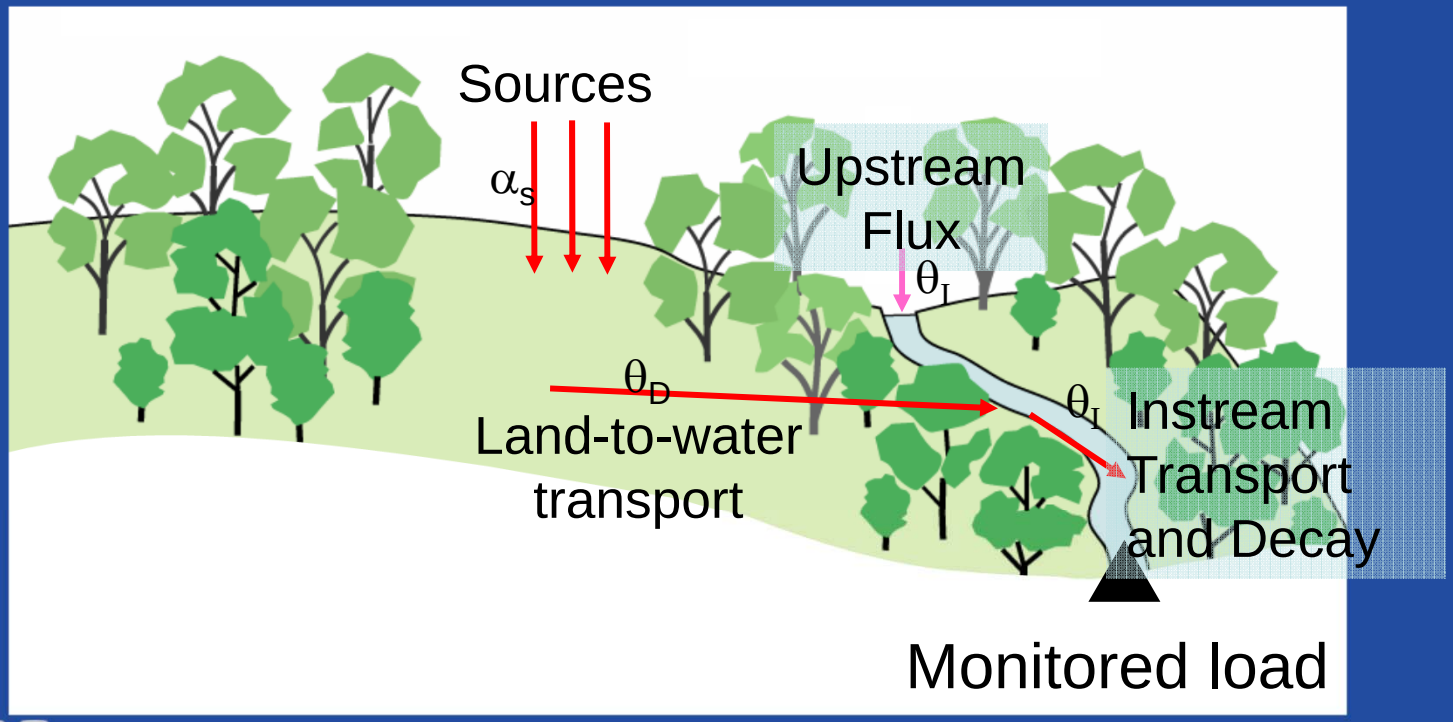
2. Determine where are the main contributing basins (Rank contributing basins based on loads and yields).

3. Determine what are the main causes of the high loads (Describe the relative importance of nutrient sources).

4. Provide information to various states and regional organizations to support regional interpretation and guide local, more indepth studies.

SPARROW Mass Balance modeling approach:

- Regress water-quality conditions (monitored load) on upstream sources and factors controlling transport
- Incorporates in-stream decay of nutrients



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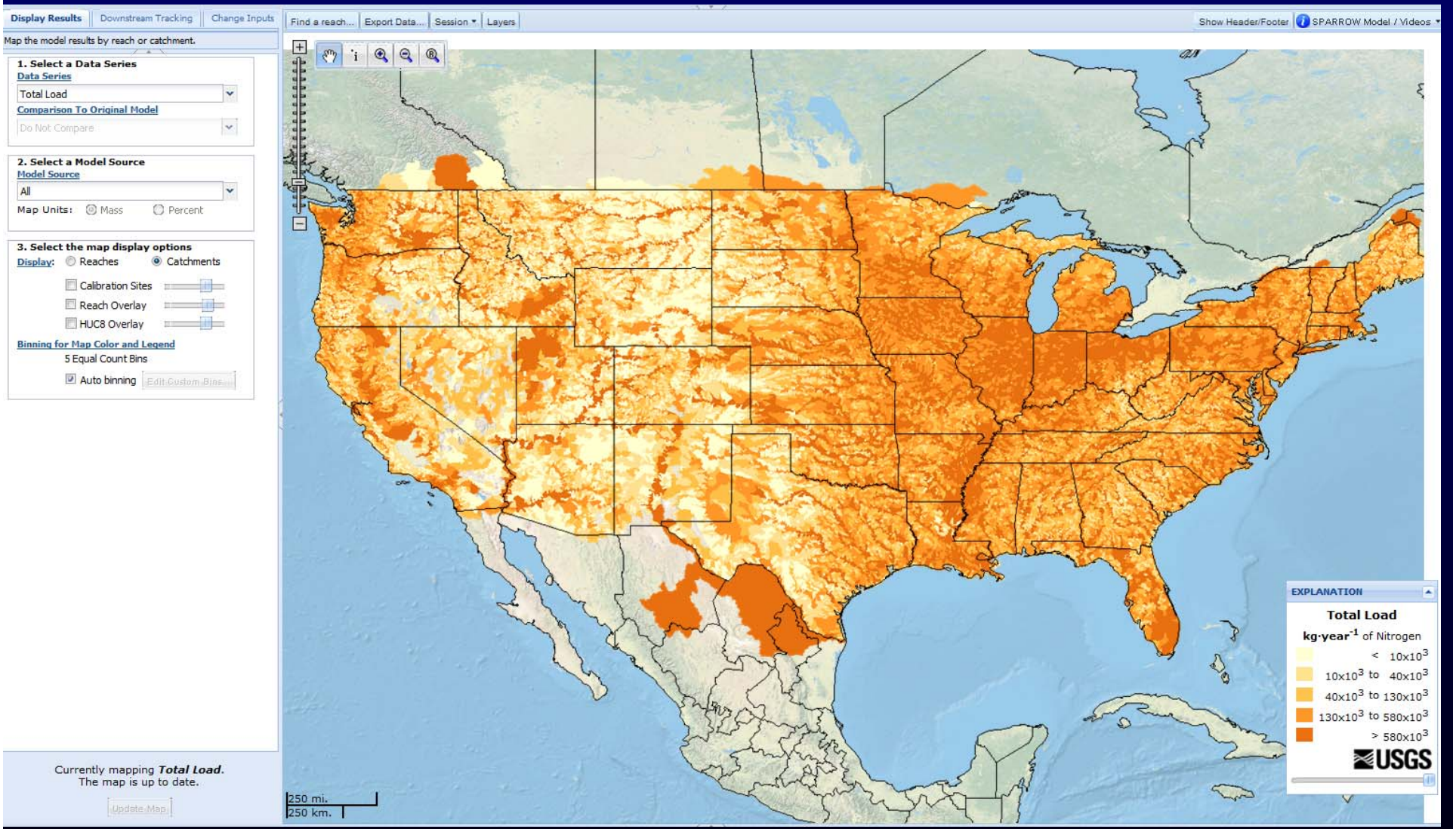
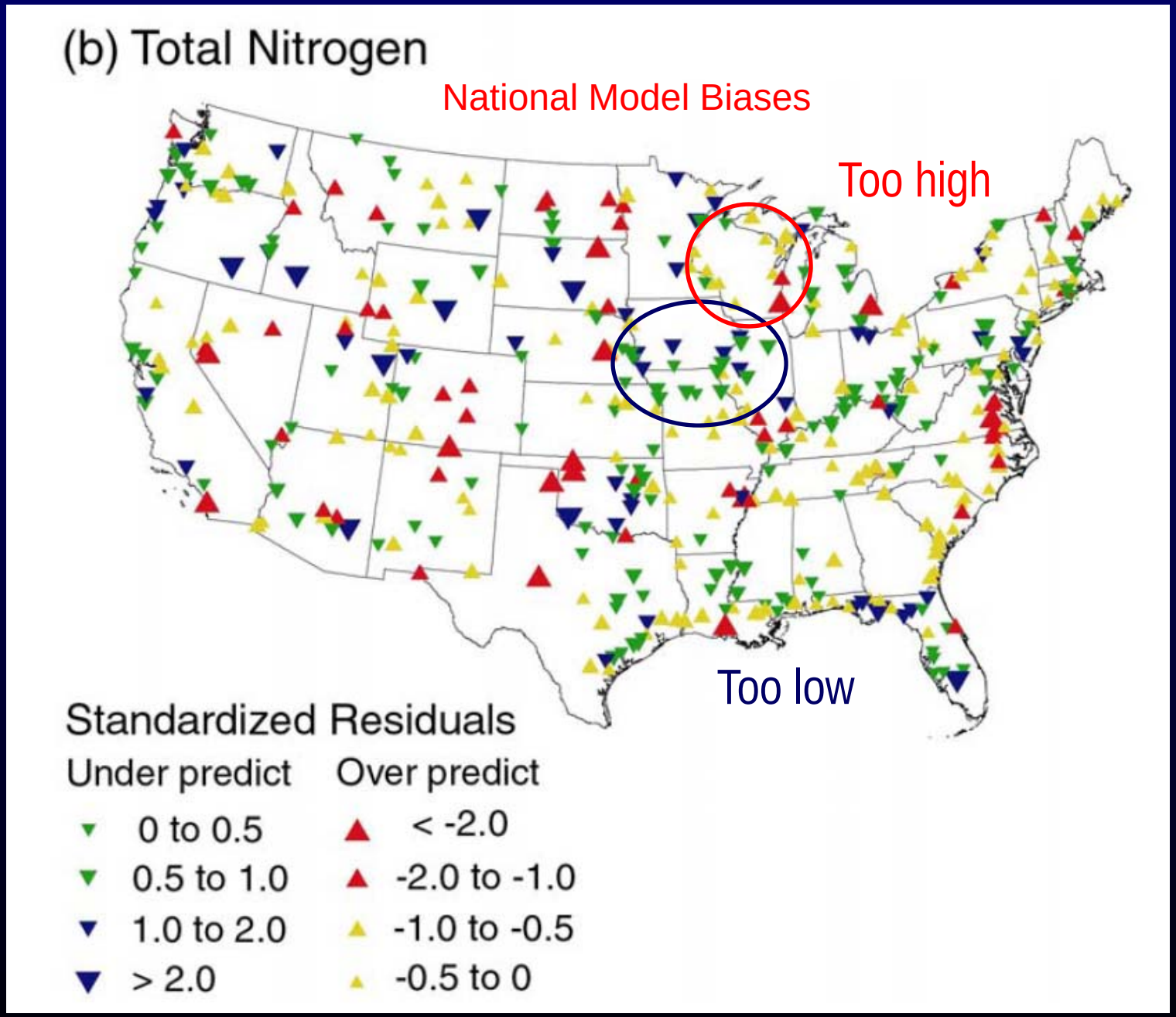
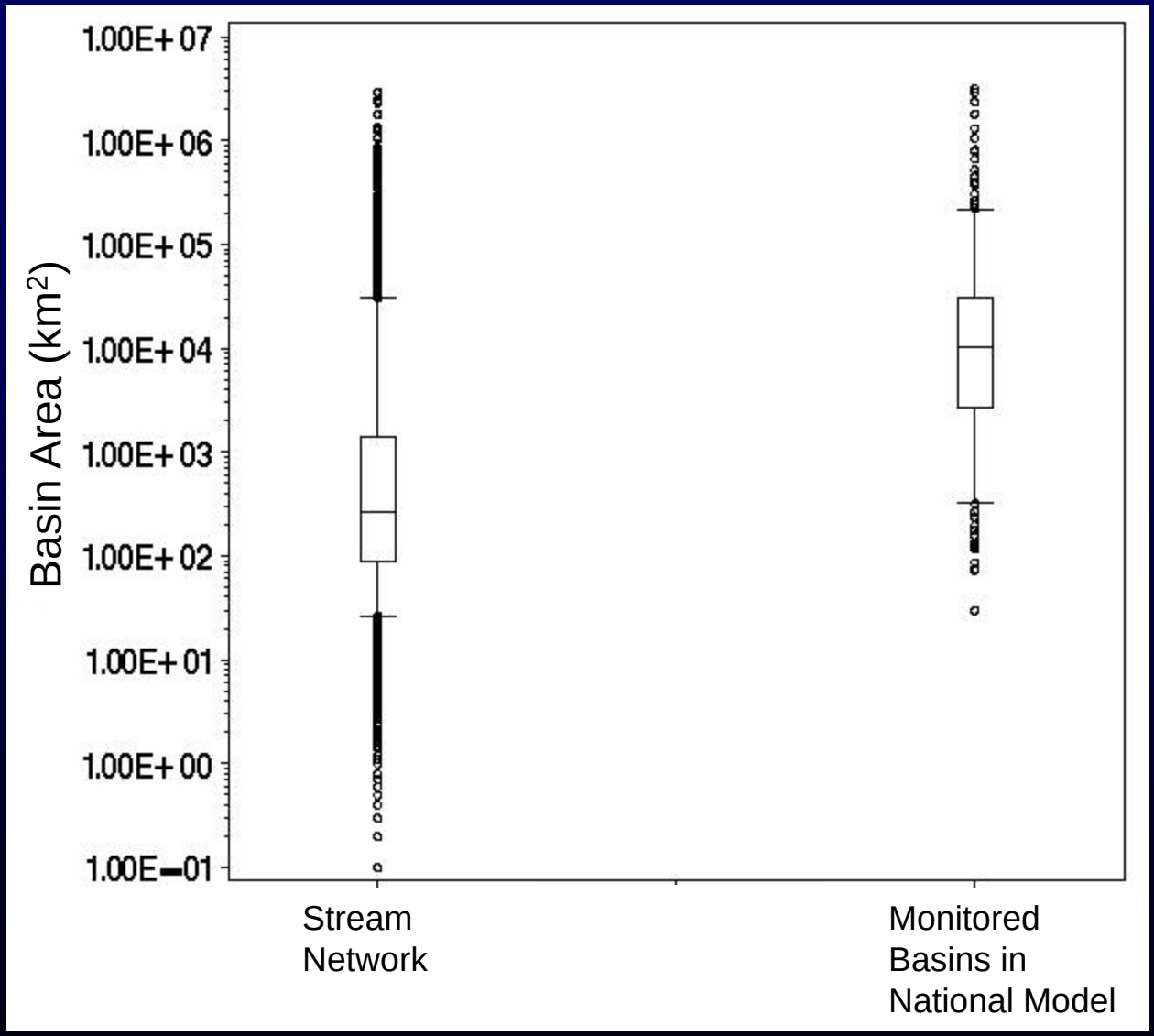
1992 National SPARROW Nitrogen Model

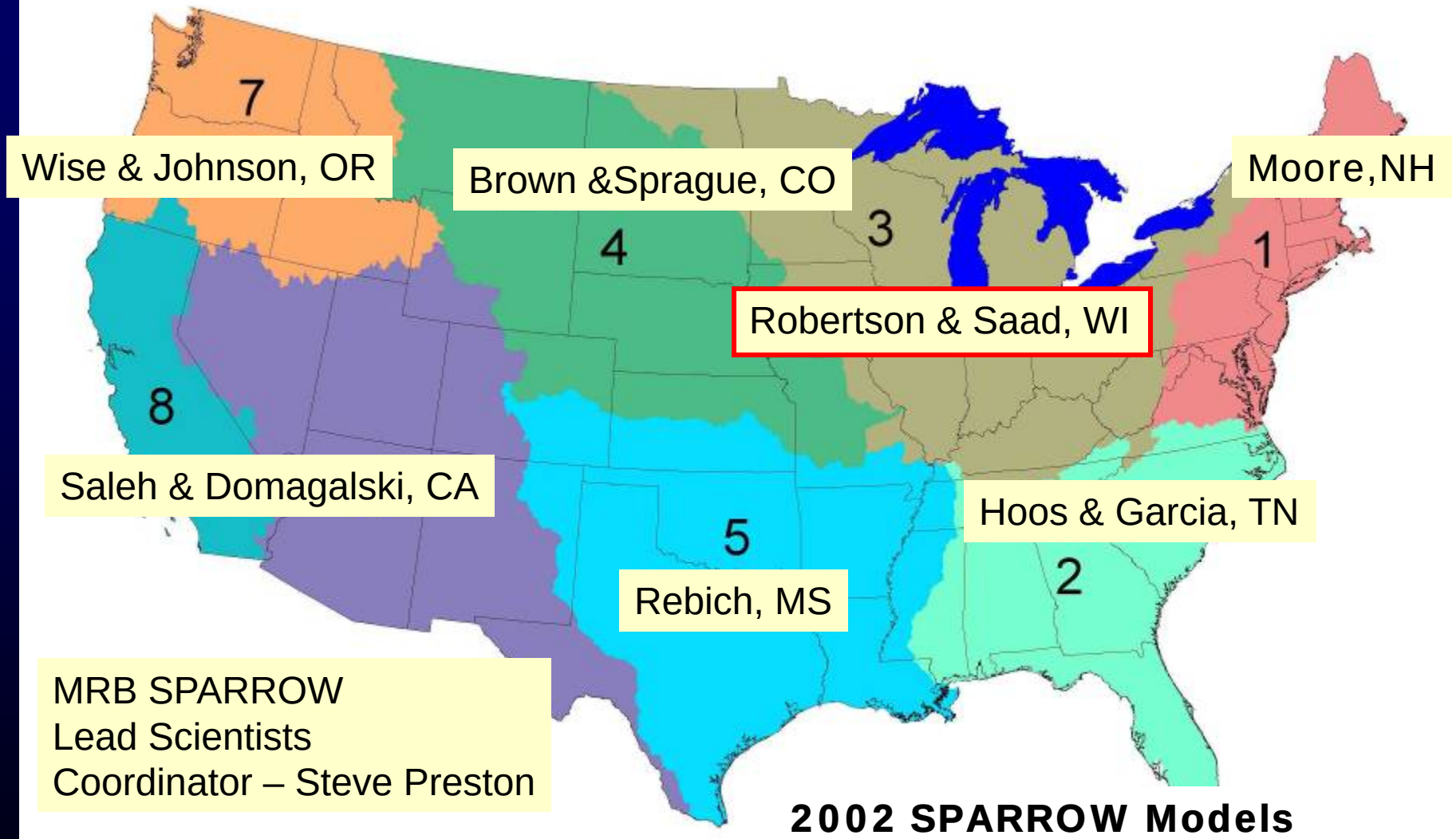



(b) Total Nitrogen
National Model Biases
Too high
Too low
Standardized Residuals
Under predict
Over predict
0 to 0.5
0.5 to 1.0
1.0 to 2.0
> 2.0
< -2.0
-2.0 to -1.0
-1.0 to -0.5
-0.5 to 0

Distribution of Basin Areas in the Model and Calibration Sites Used in the National Model



Regional Models

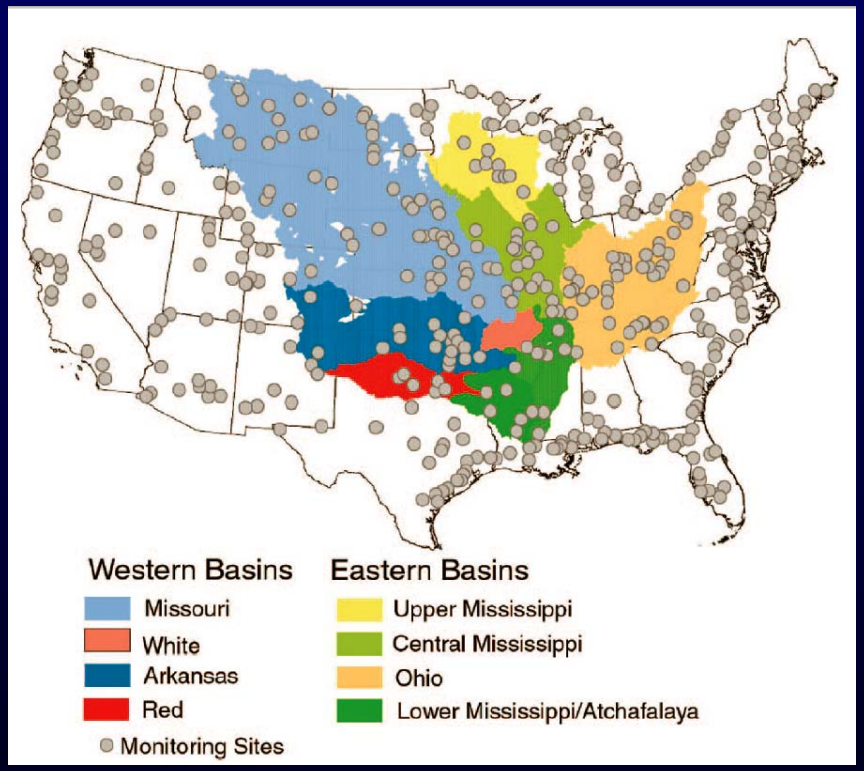


All published in 2011 in JAWRA

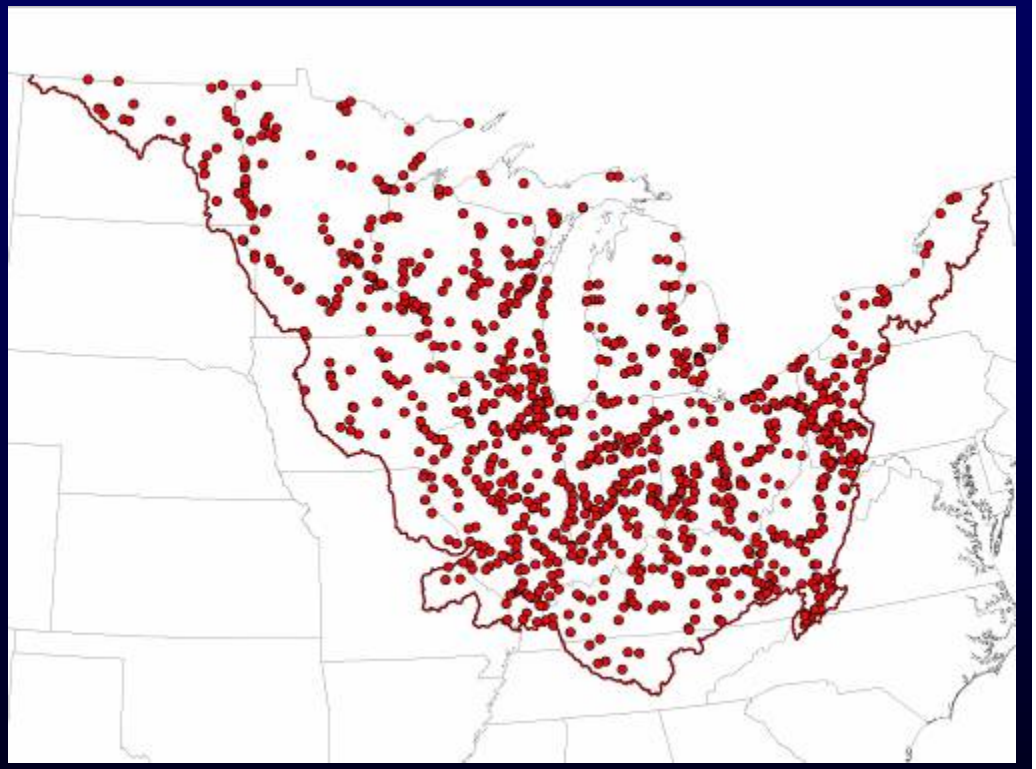
NAWQA Regional SPARROW Models

Take Advantage of Updated GIS Data and additional water-quality data from Other USGS and Other Agency Programs

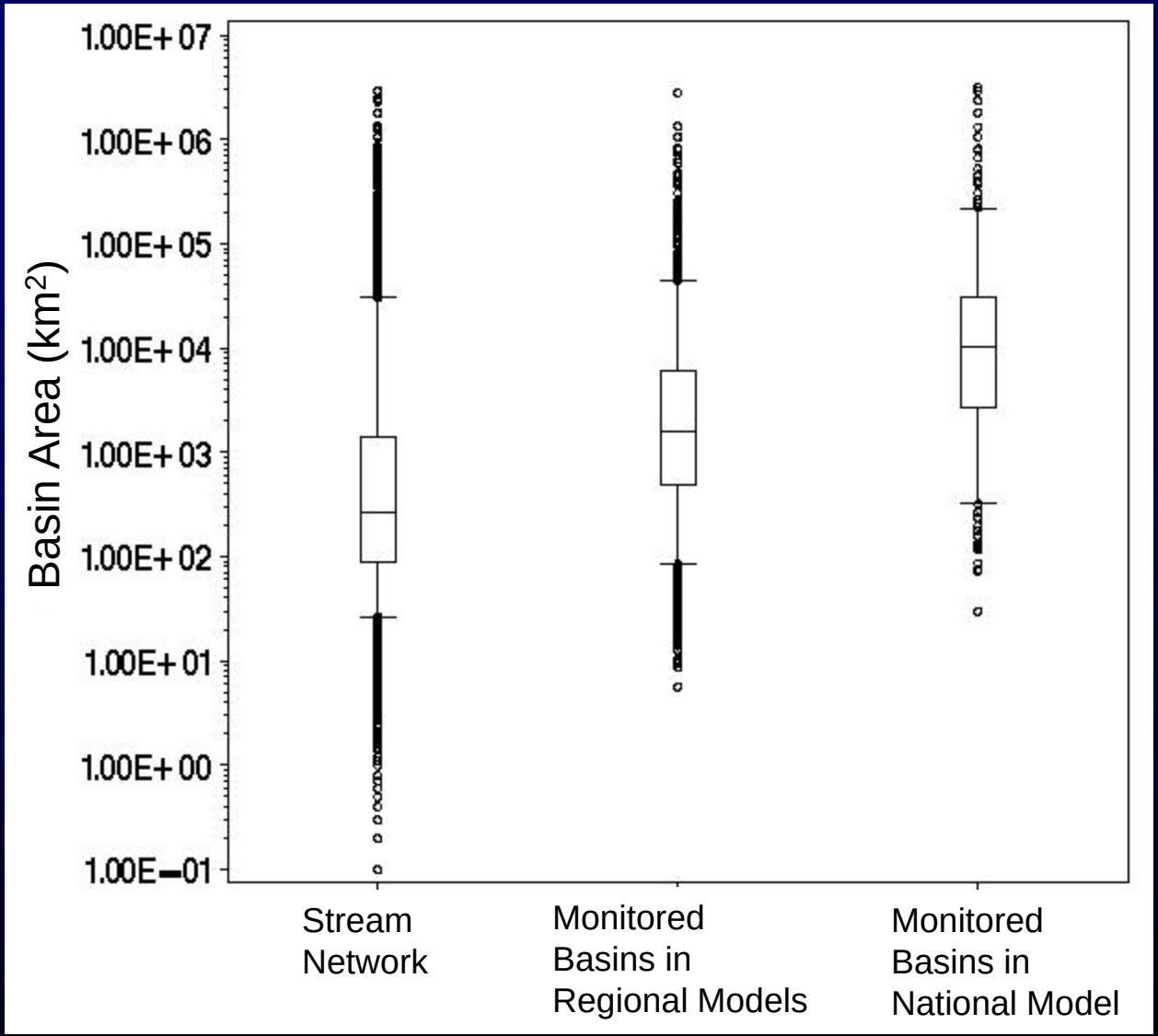
Sites used in National Models



Sites being used in Regional Models



Distribution of Basin Areas in the Model and Calibration Sites used in the SPARROW Models

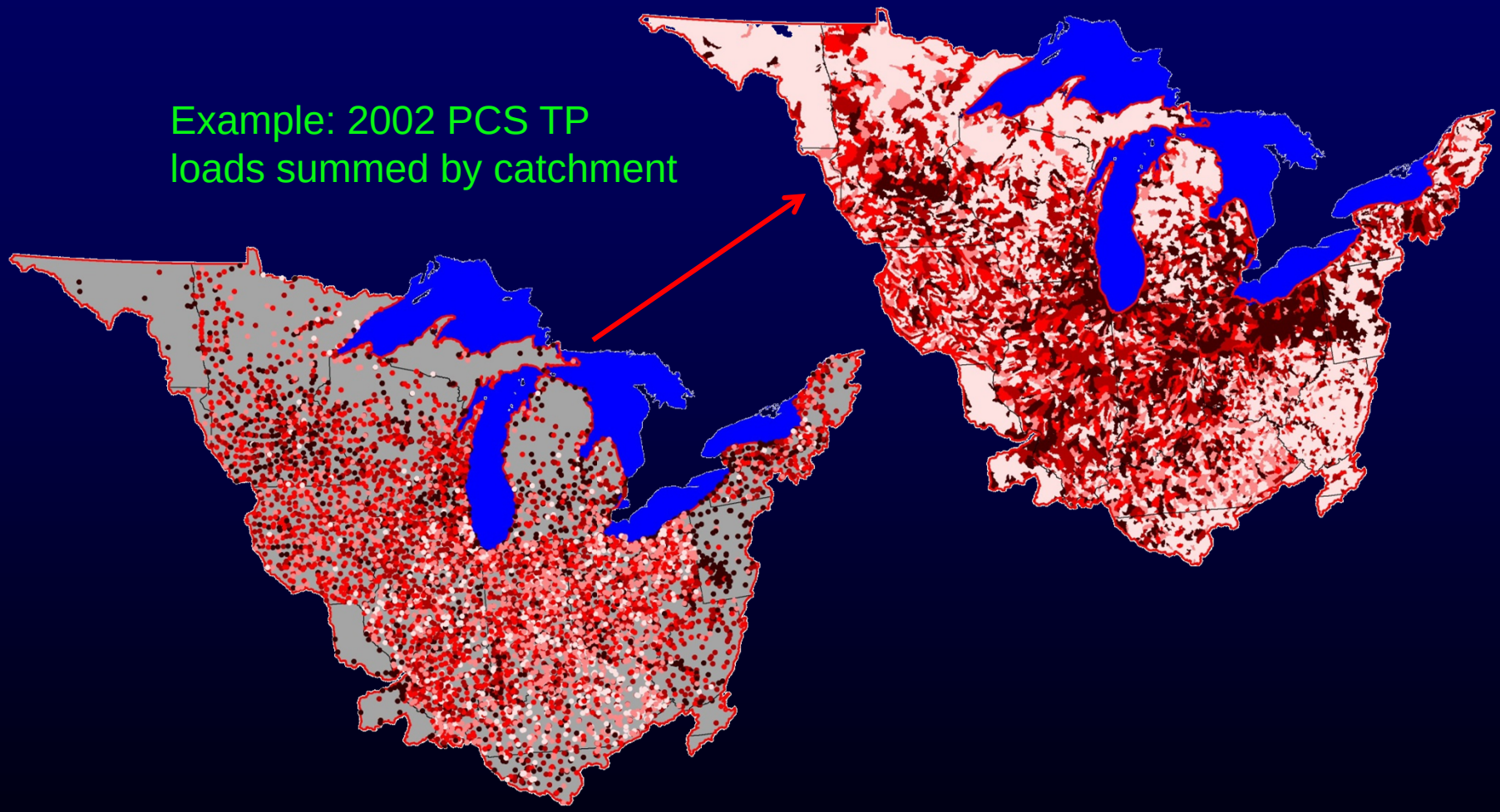


Have a much better idea of how models estimate conditions in smaller streams, but still not the smallest basins

MRB3 SPARROW model input

Nutrient Sources: Point Sources

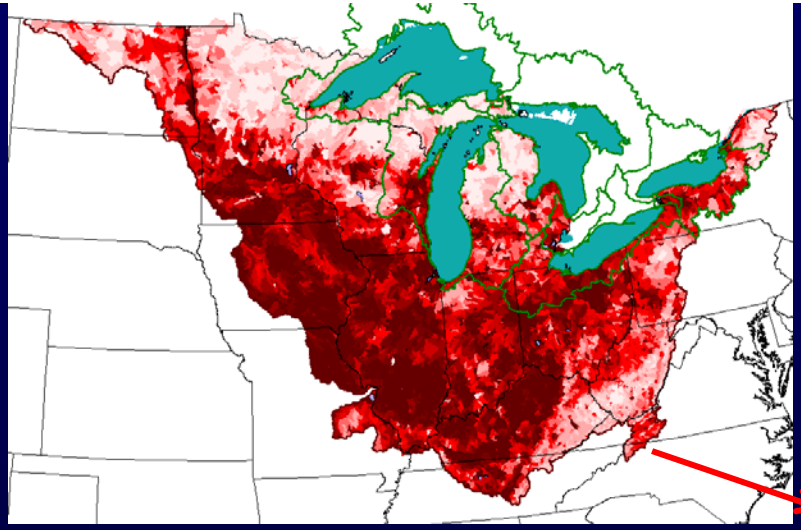
Example: 2002 PCS TP
loads summed by catchment



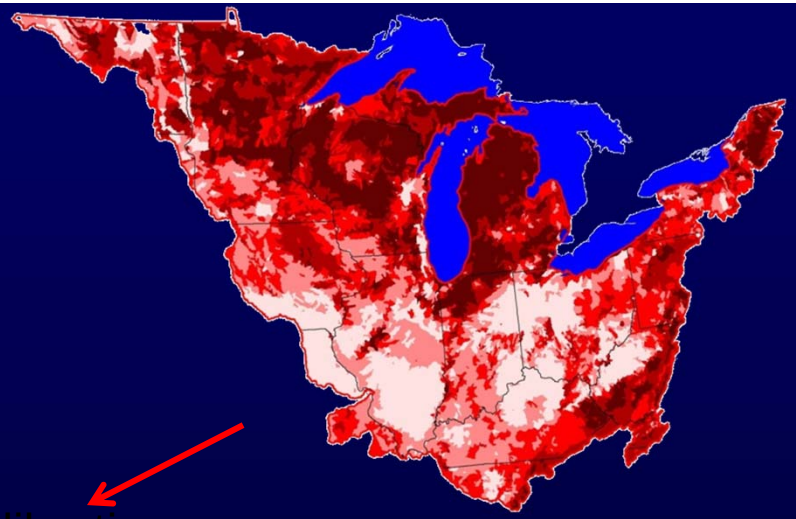
Source: USEPA Permit Compliance System (PCS) database + States

Upper Midwest SPARROW Model Calibration

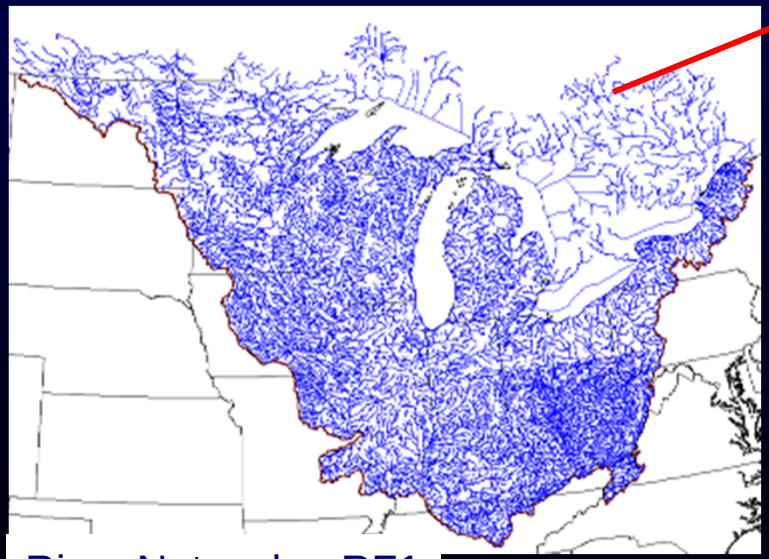
One Source: 2002 Farm Fertilizer TP inputs, kg



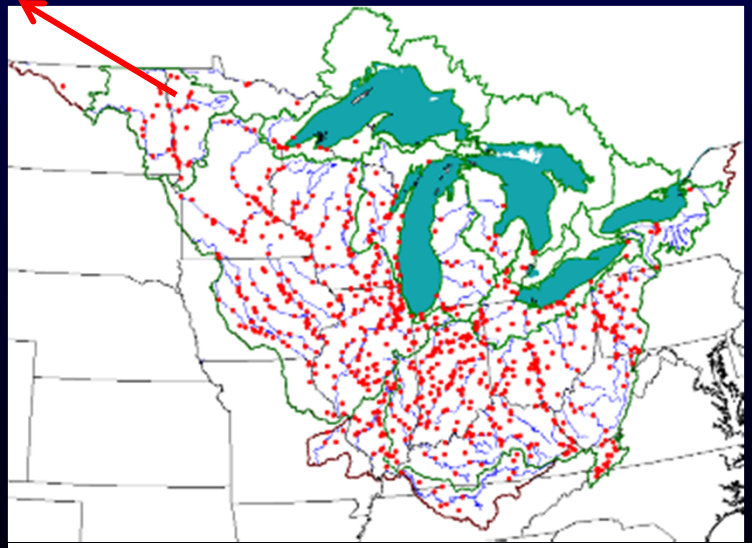
One Land-to-Water Delivery: Soil Permeability



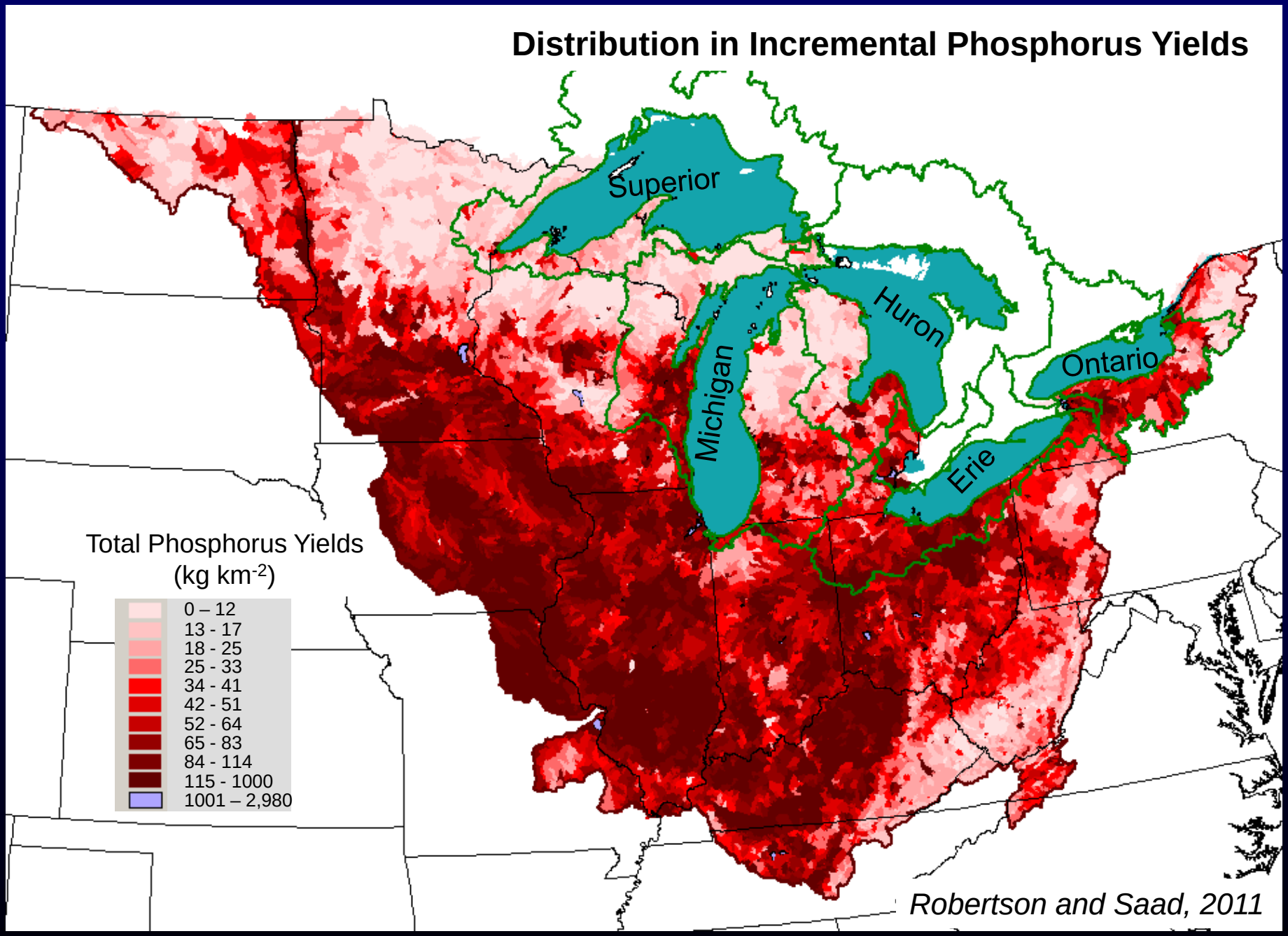
Calibration

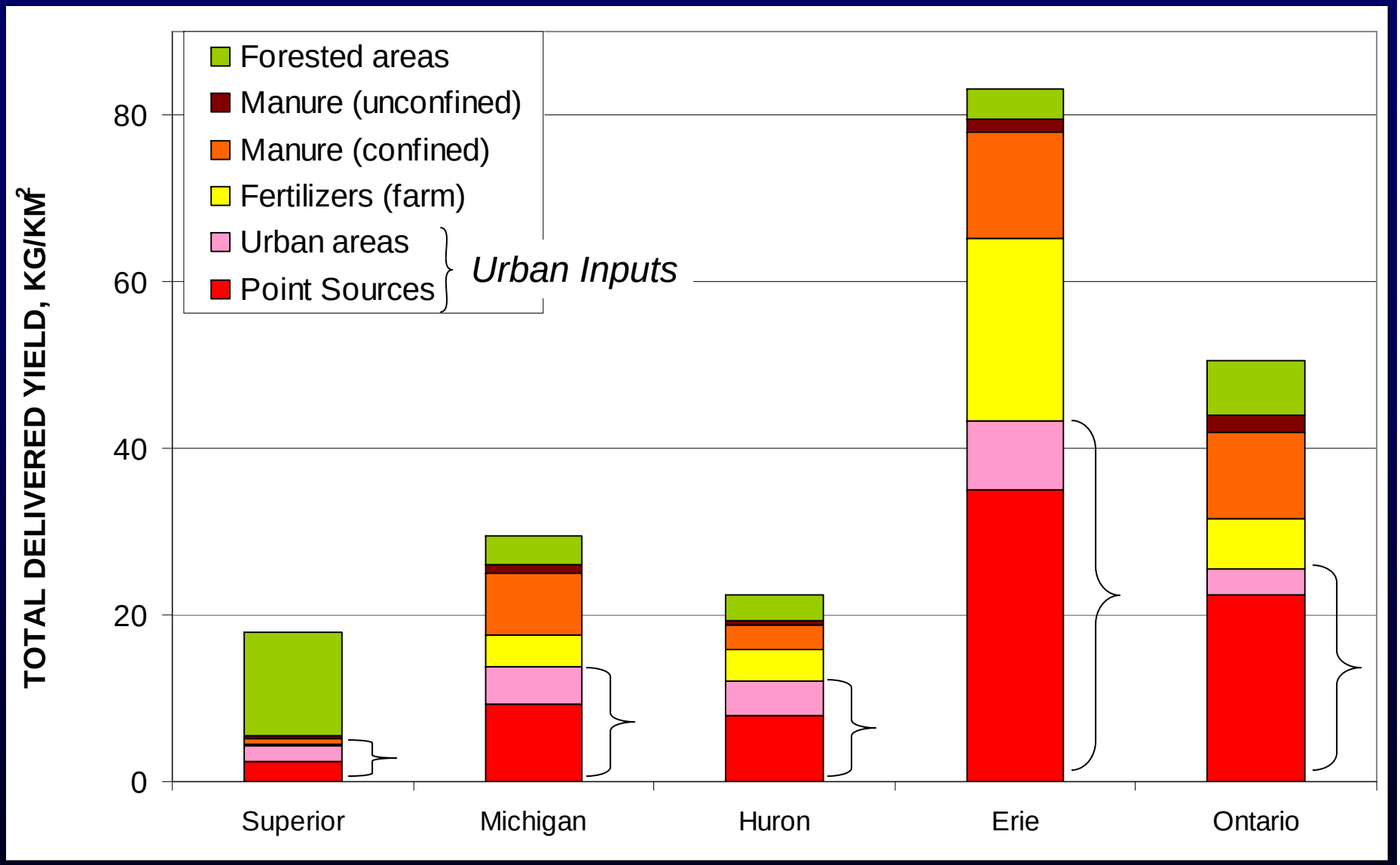


River Network – RF1



Long-term detrended Loads for 810 sites


Distribution in Incremental Phosphorus Yields
Superior
Michigan
Huron
Erie
Ontario
Total Phosphorus Yields
(kg km-2)
0 – 12
13 - 17
18 - 25
25 - 33
34 - 41
42 - 51
52 - 64
65 - 83
84 - 114
115 - 1000
1001 – 2,980
Robertson and Saad, 2011

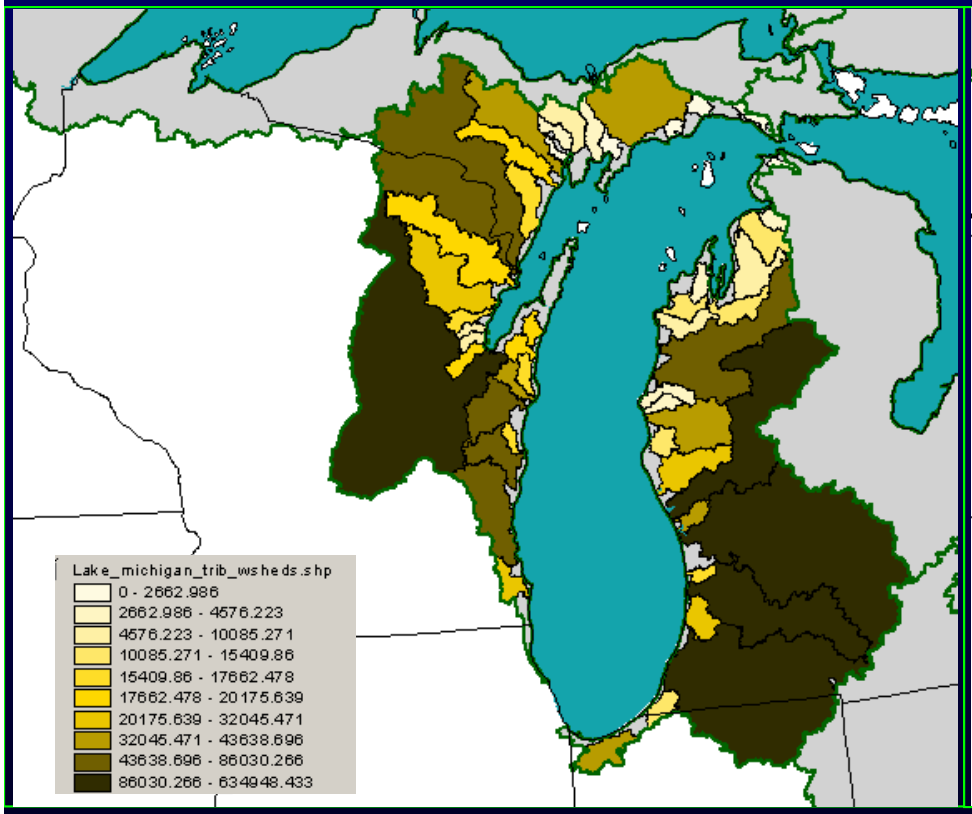


Phosphorus Yields from the U.S. Portion of the Basins by Source

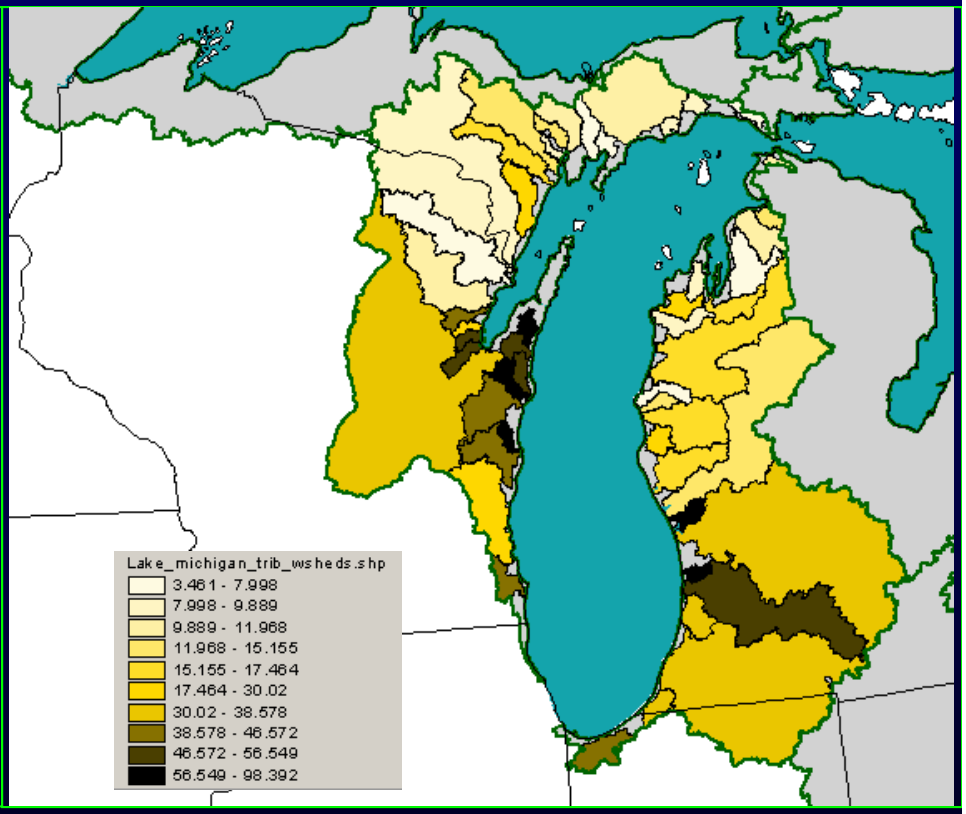
Robertson and Saad, 2011

Ranking the Lake Michigan Tributaries Based on :

Phosphorus Loads



Phosphorus Yields



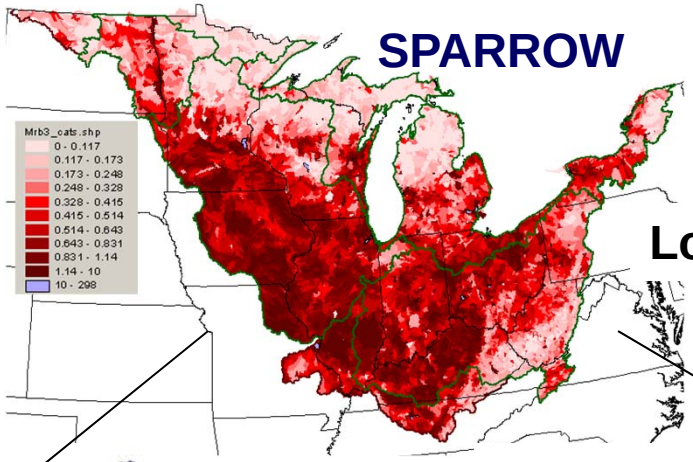
Robertson and Saad, 2011

HydroSPARROW:

A GIS Regional Modeling Approach for Estimating Nutrient Loading to the Great Lakes Under Current and Future Climate and Land-Use Conditions

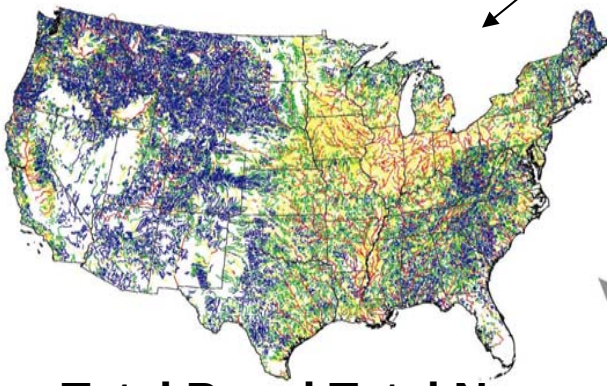
USGS

HydroSPARROW

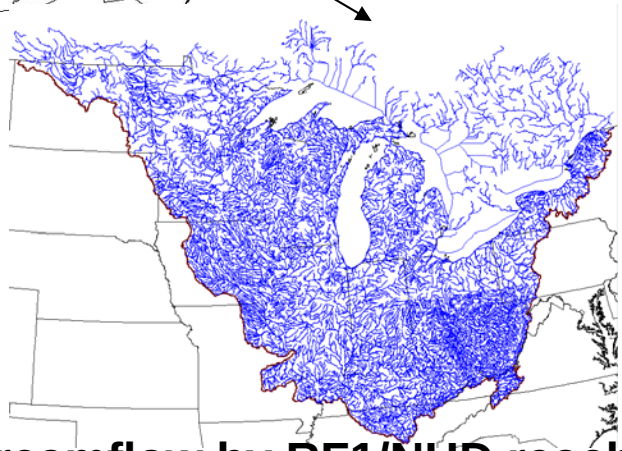


SPARROW

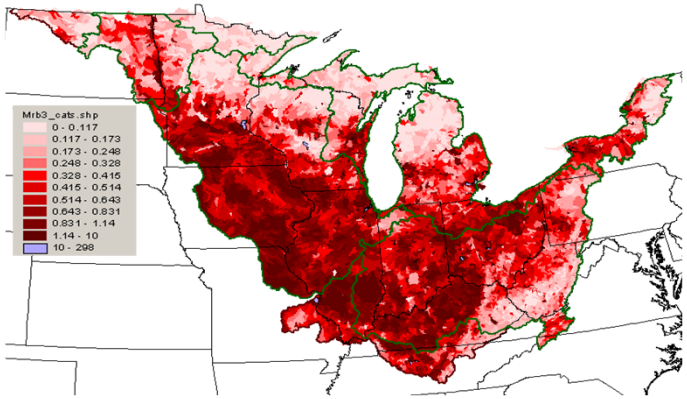
Loads/Yields



Total P and Total N Concentrations by Reach



Streamflow by RF1/NHD reach

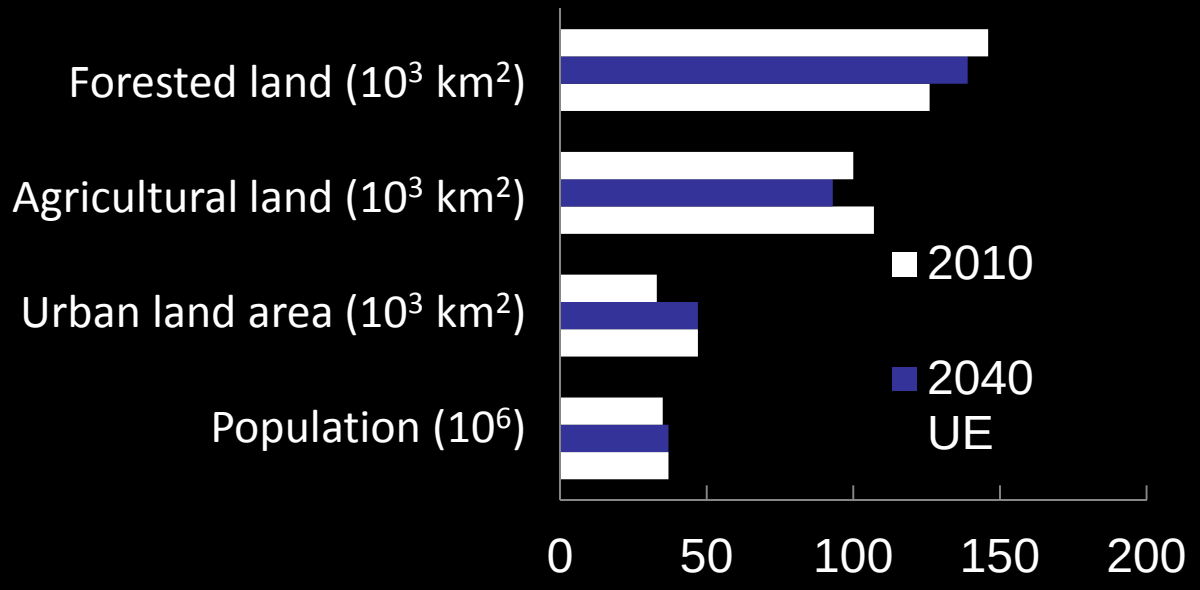


Total P and Total N Loads

Forecasting Future Nutrient Loading with Changing Land Use

Projected Changes in Population and Land Use

Predicted change in population and land use in basin

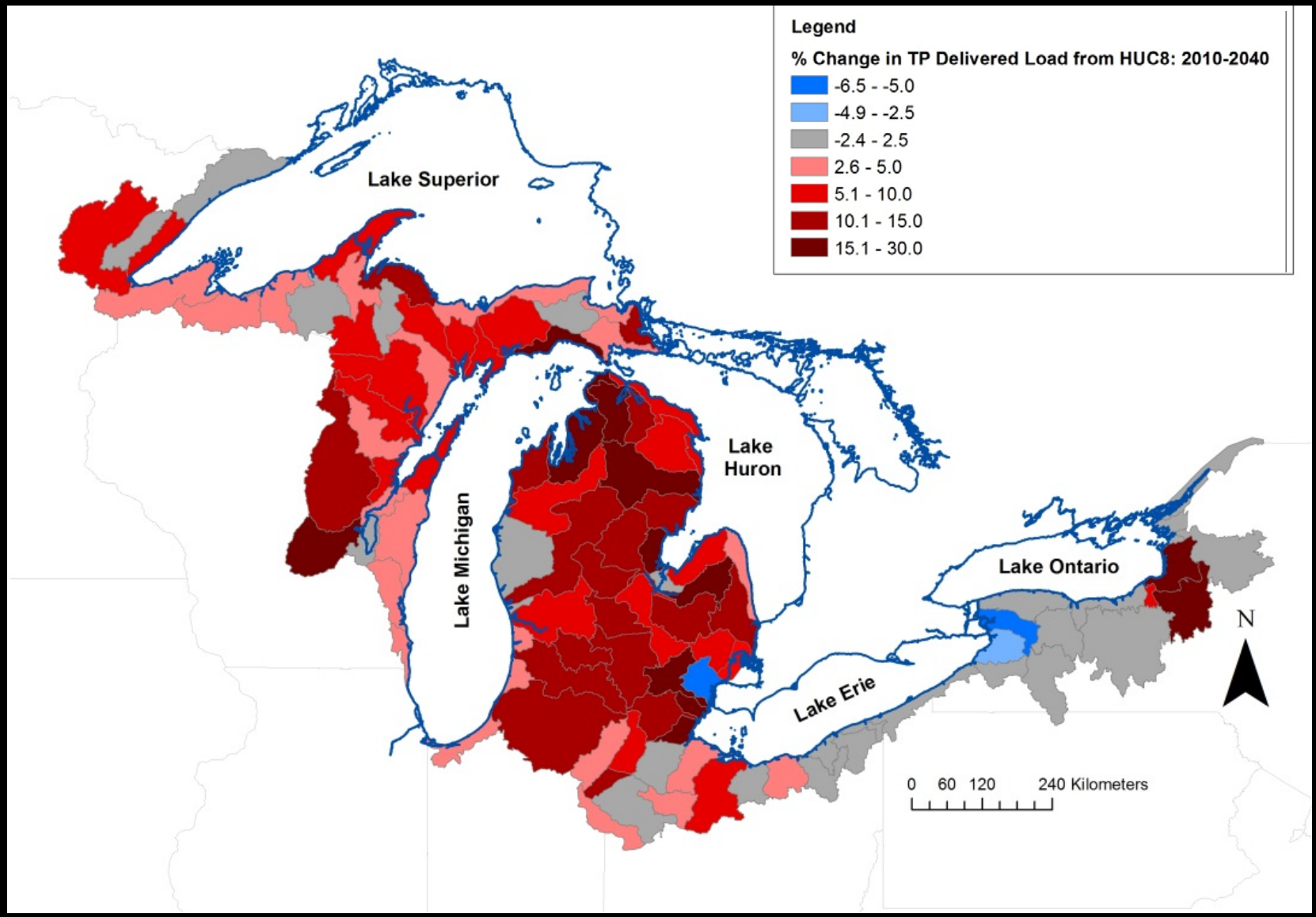


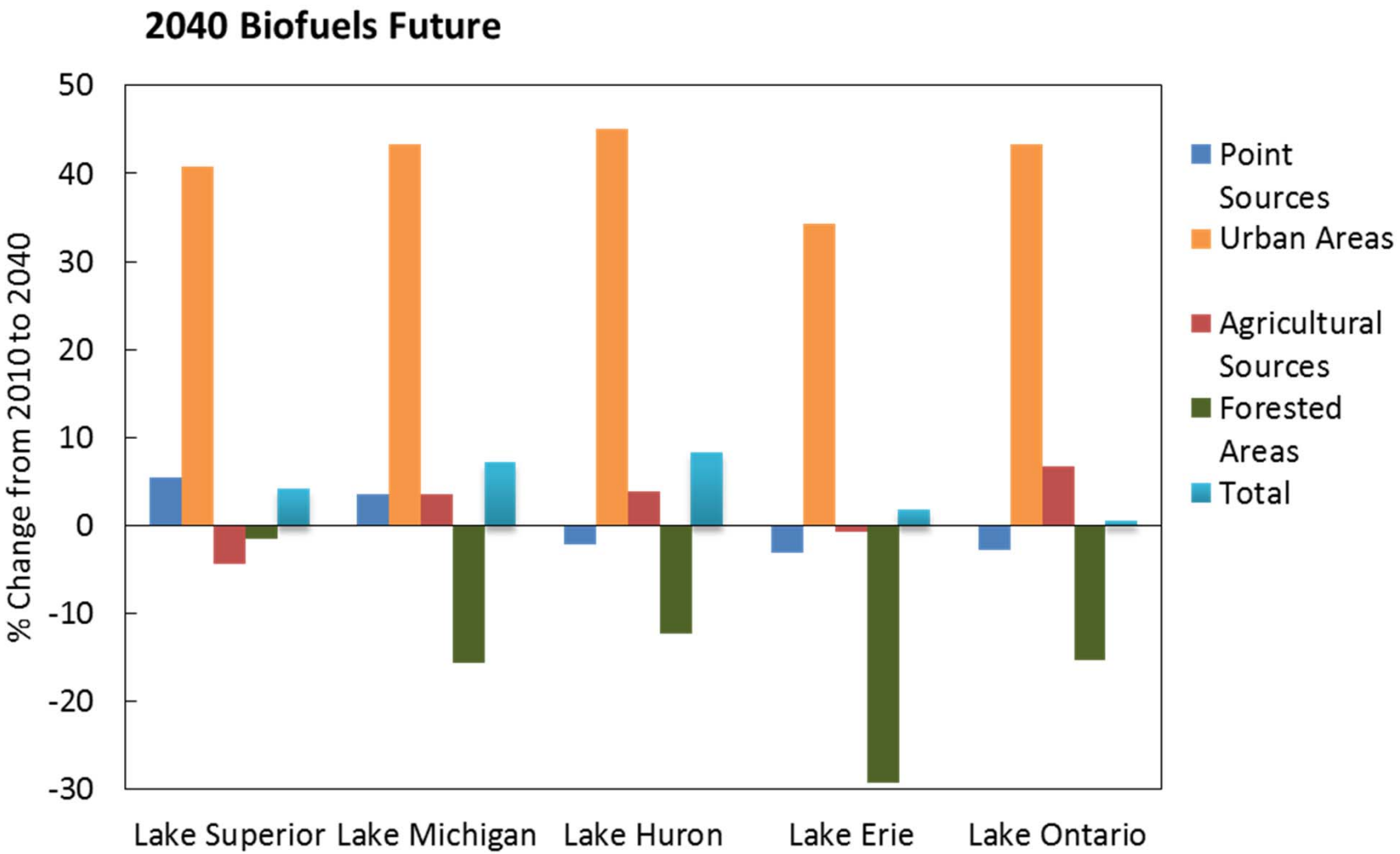
Used to estimate changes in Nutrient Inputs

Michigan Tech Create the Future | USGS science for a changing world | MICHIGAN STATE UNIVERSITY

LaBeau et al., In Review

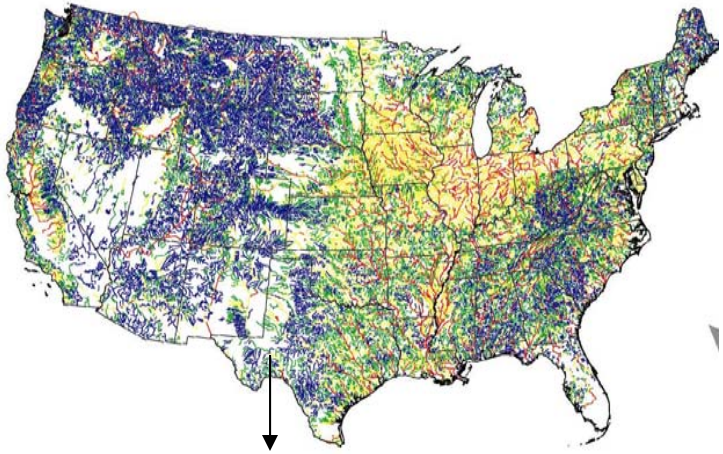
Change in P loads (% Change) by watershed in 2040 for BioFuels Future Scenario




2040 Biofuels Future
% Change from 2010 to 2040
50
40
30
20
10
0
-10
-20
-30
Lake Superior
Lake Michigan
Lake Huron
Lake Erie
Lake Ontario
Point Sources
Urban Areas
Agricultural Sources
Forested Areas
Total

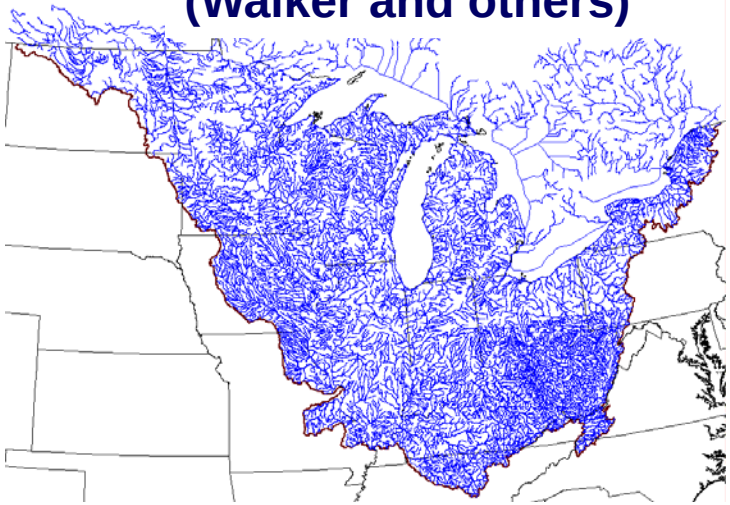
Forecasting Future Nutrient Loading with Changing Climate

SPARROW

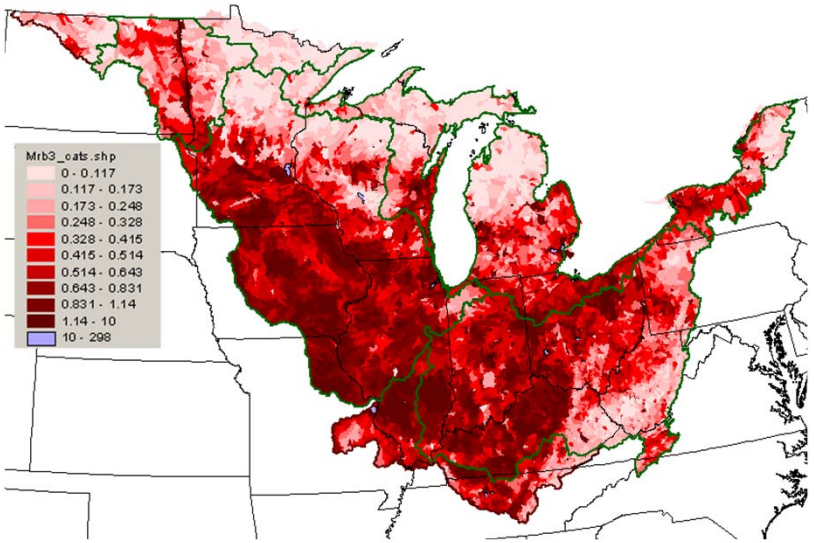


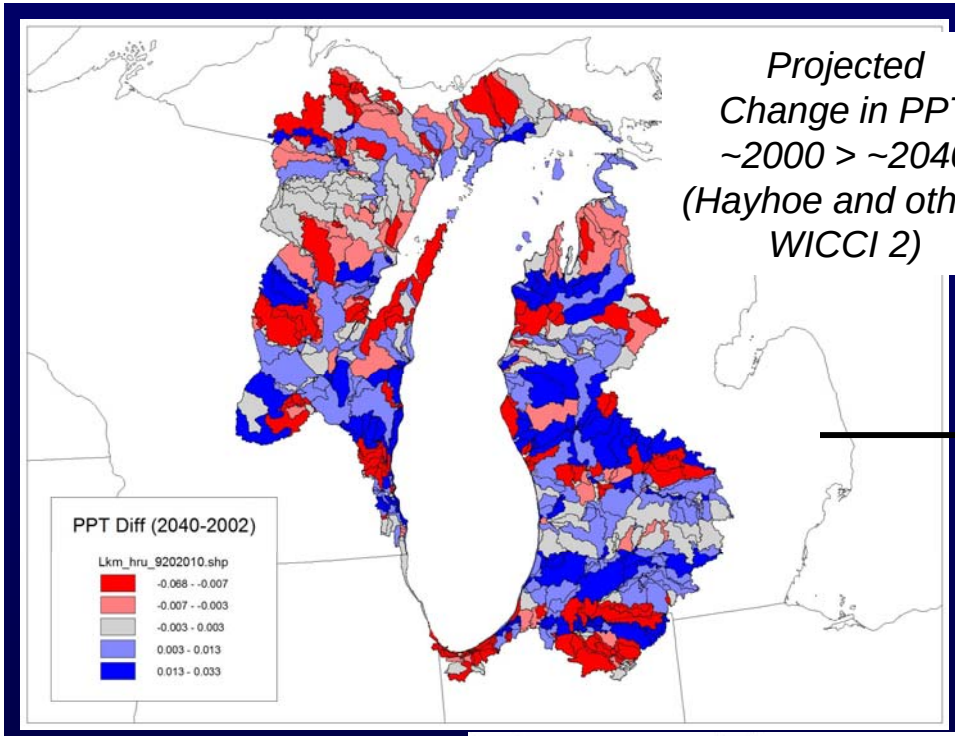
Total P and Total N Concentrations by Reach

PRMS/ TOPMODEL (Walker and others)

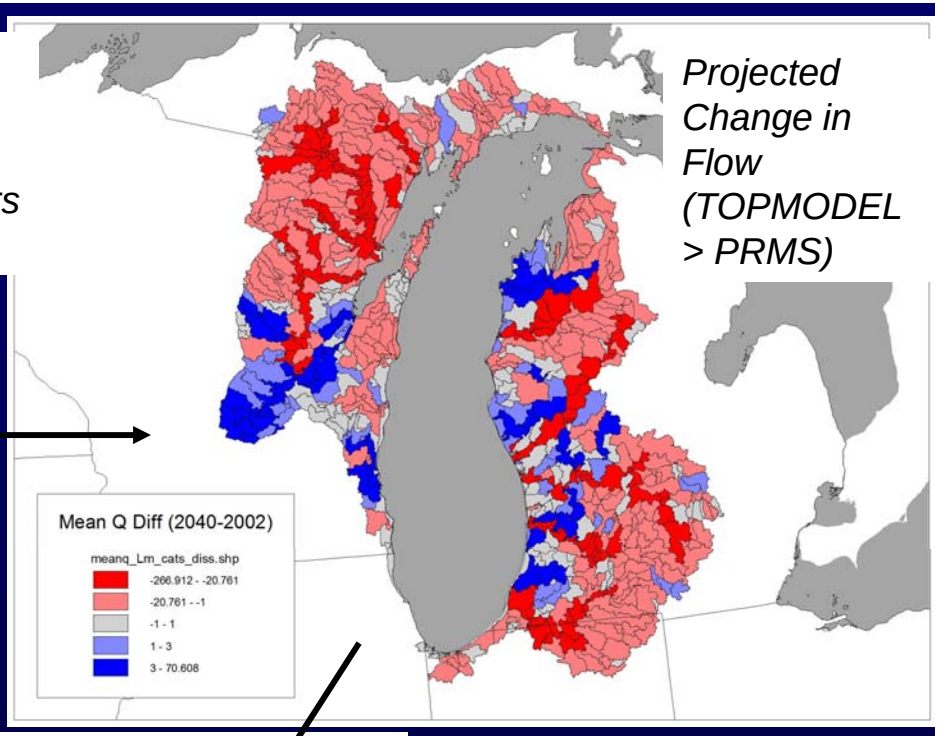


Streamflow by RF1/NHD reach

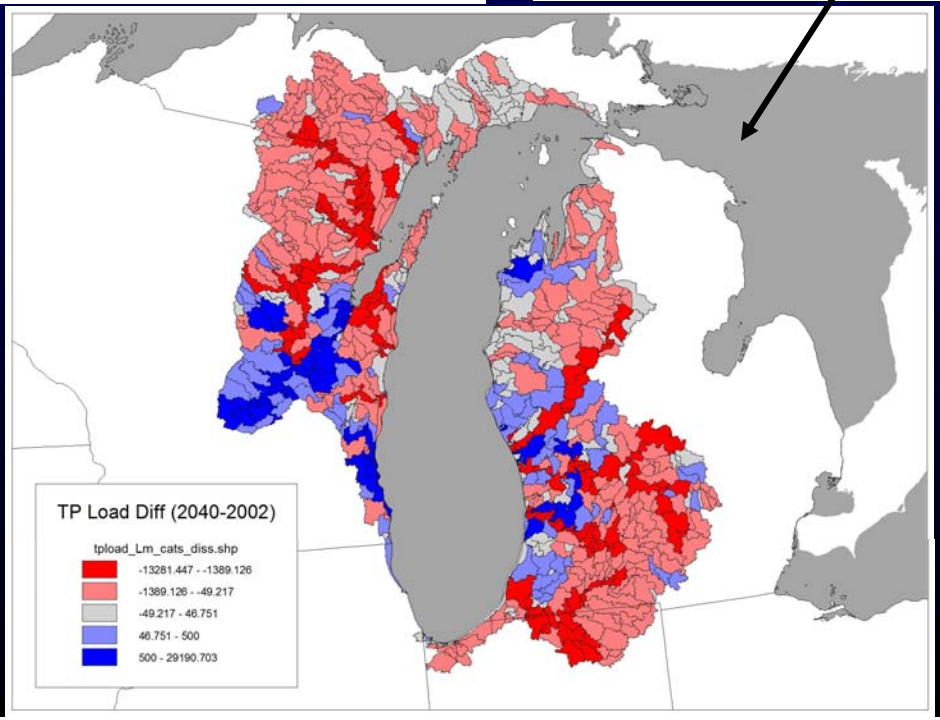




Projected Change in PPT ~2000 > ~2040 (Hayhoe and others WICCI 2)

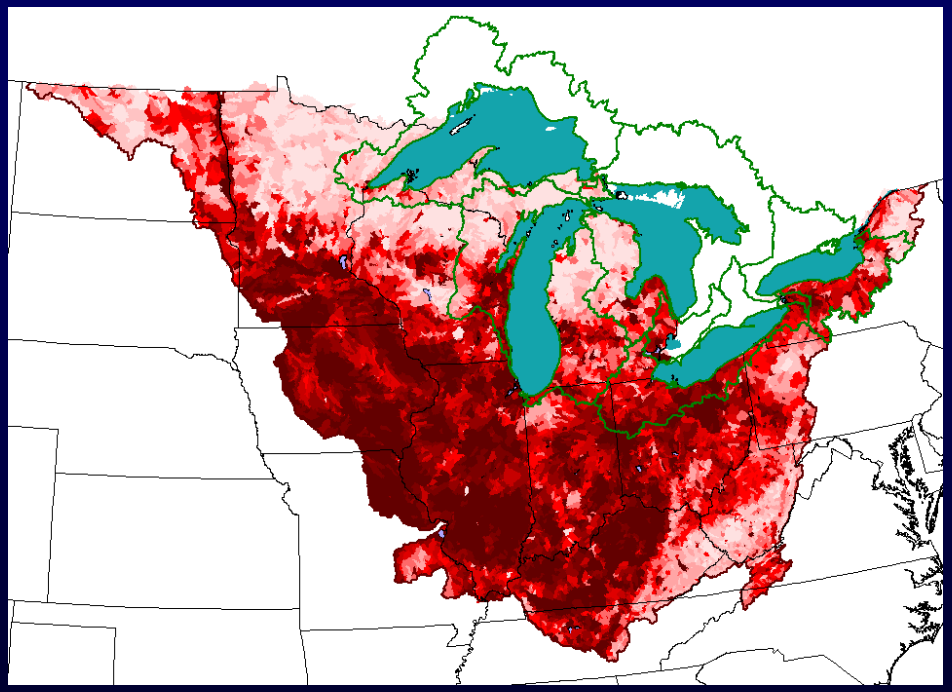


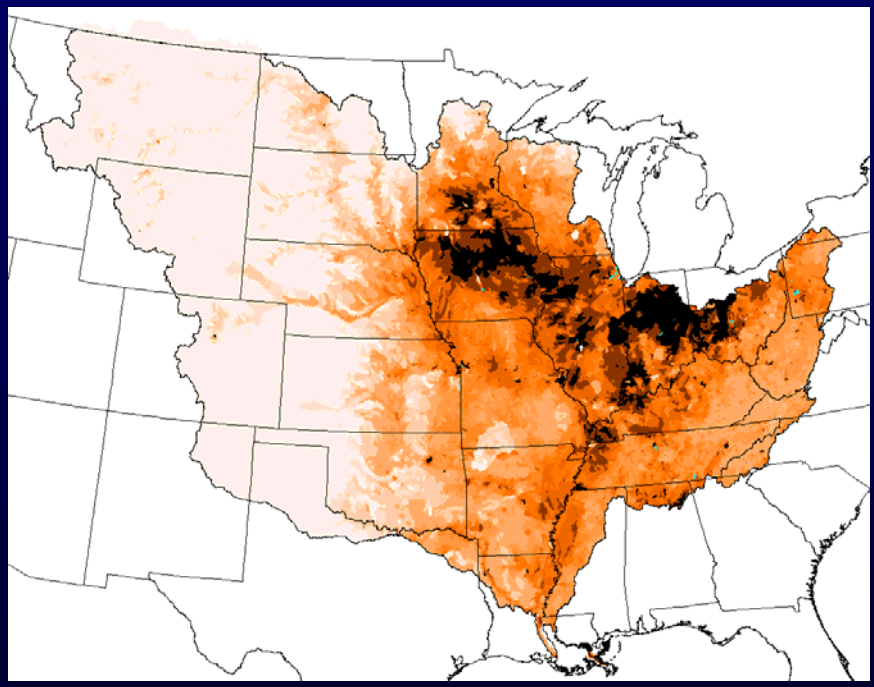
Projected Change in Flow (TOPMODEL > PRMS)



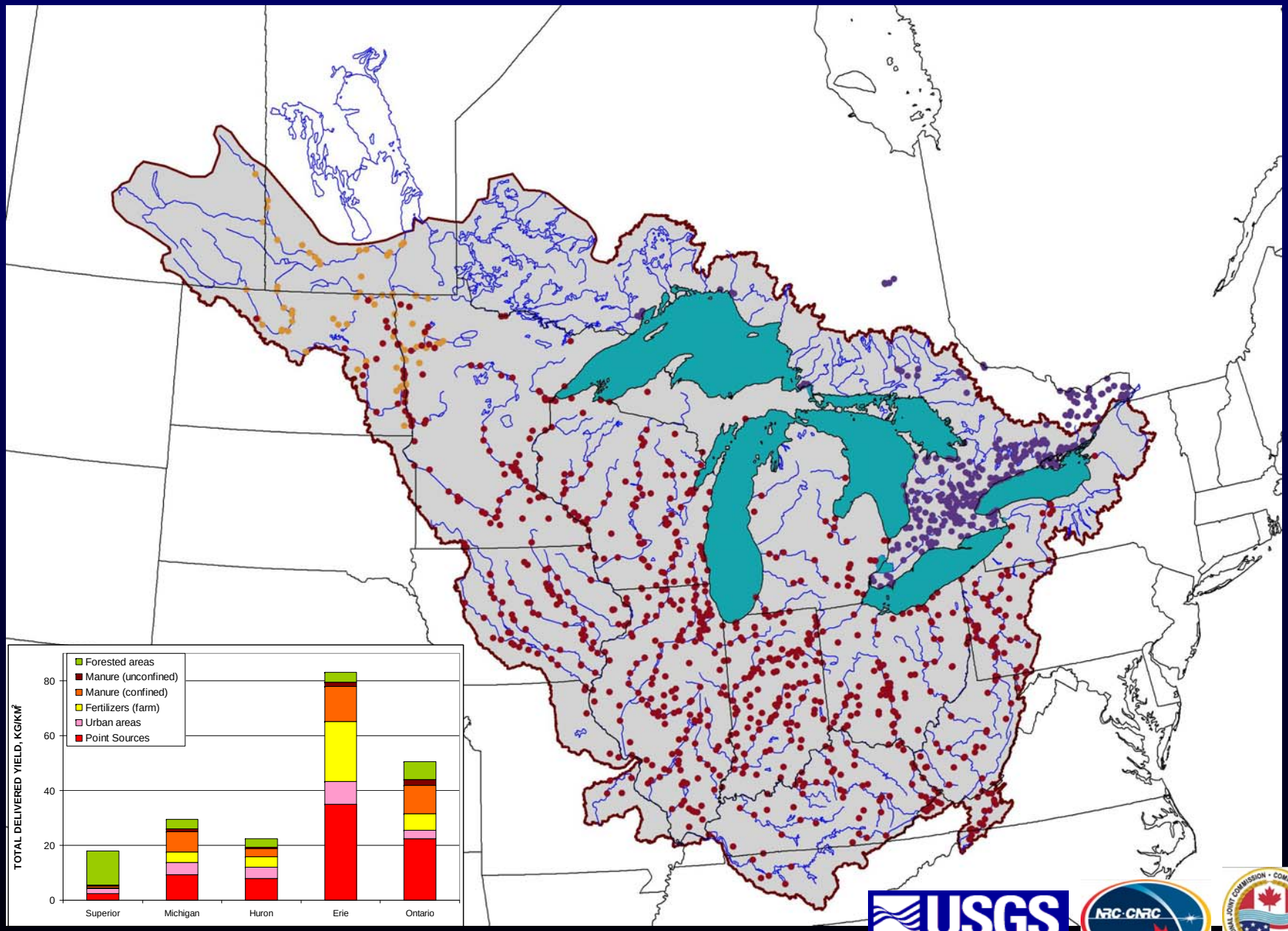
Projected Change in TP Loads based on HydroSPARROW

Future SPARROW Modeling
RF1 > ~NHD Plus Scale (1:100,000)





Binational SPARROW Model for the Upper Midwest



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NRC·CNRC

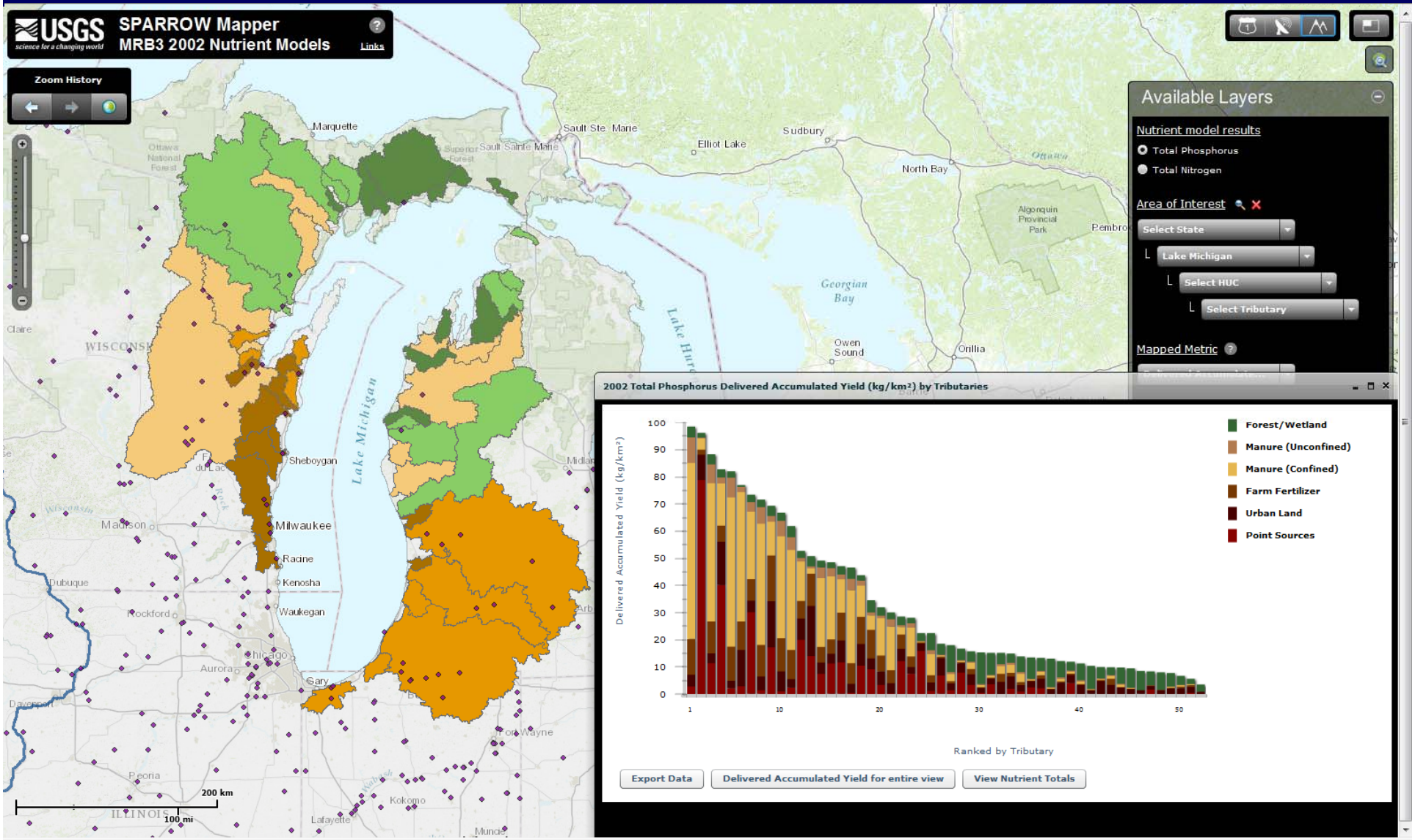
Methods to demonstrate results and help guide decisions > Nutrient Reduction Strategies

1. **SPARROW Mapper –**
   Easy and simple way to get SPARROW results, especially by hydrologic and political boundaries.

http://wim.usgs.gov/Sparrow/SparrowMapper.html#

http://wim.usgs.gov/SparrowMississippi/SparrowMissMapper.html#

SPARROW MAPPER



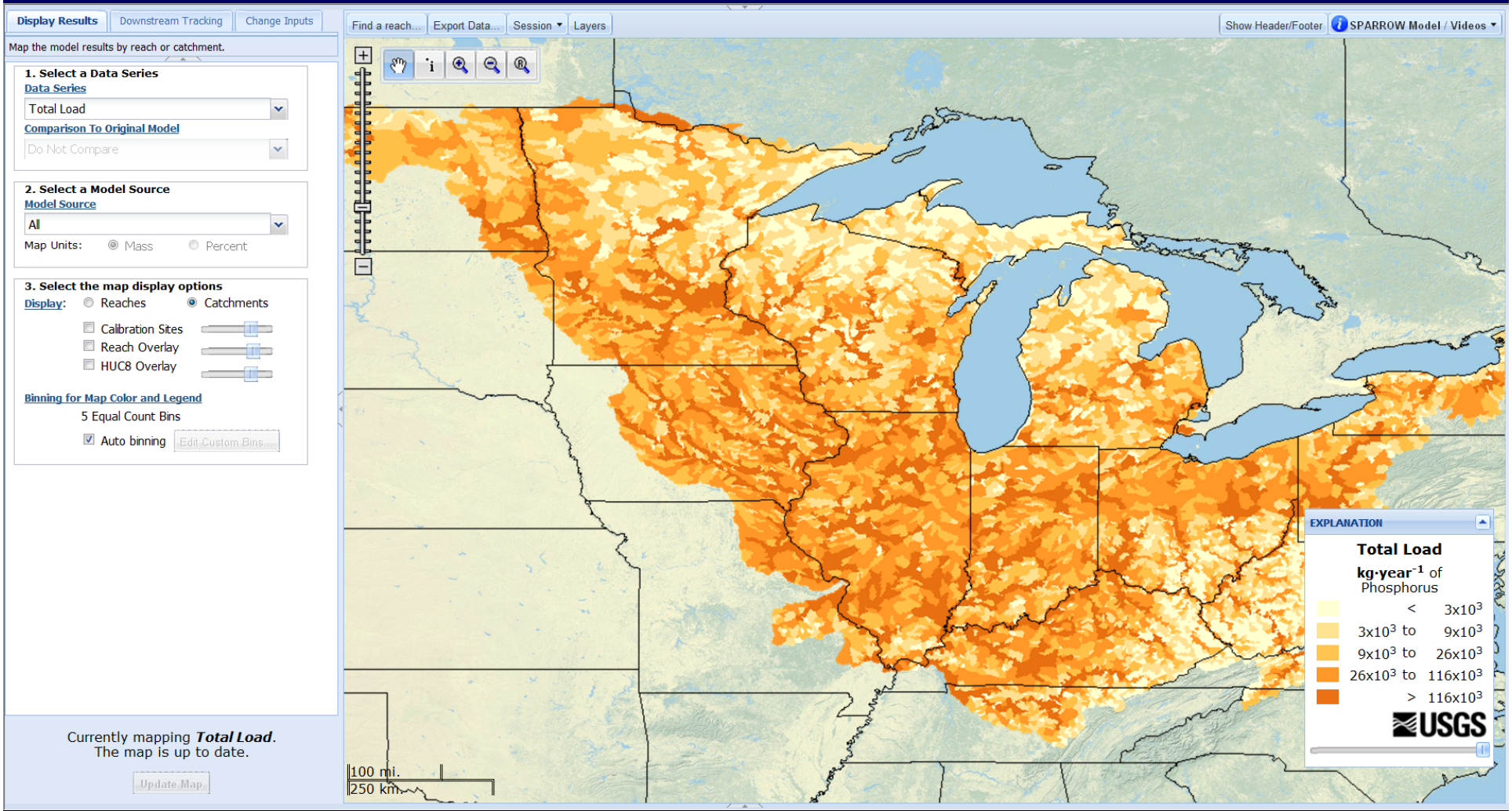
Methods to demonstrate results and help guide decisions

1. Decision Support System

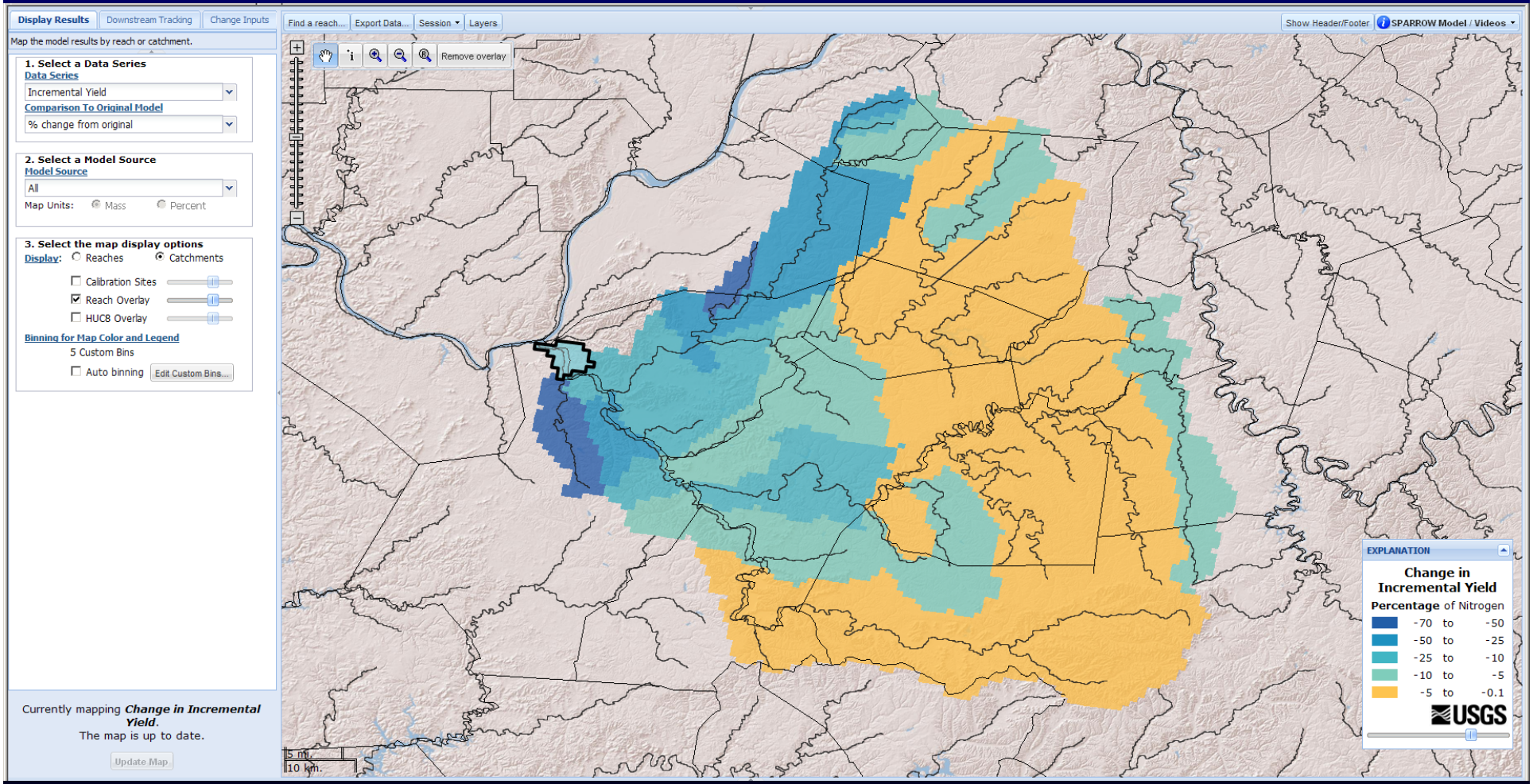
Scientists/Managers – Capable of using to visualize SPARROW output and run various scenarios.

Booth et al., 2011

SPARROW Decision Support System



SPARROW Decision Support System



Scenario Results - Percent Changes in Incremental Yields

Recent Progress in SPARROW Watershed Modeling in the Great Lakes Basin

Questions??

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