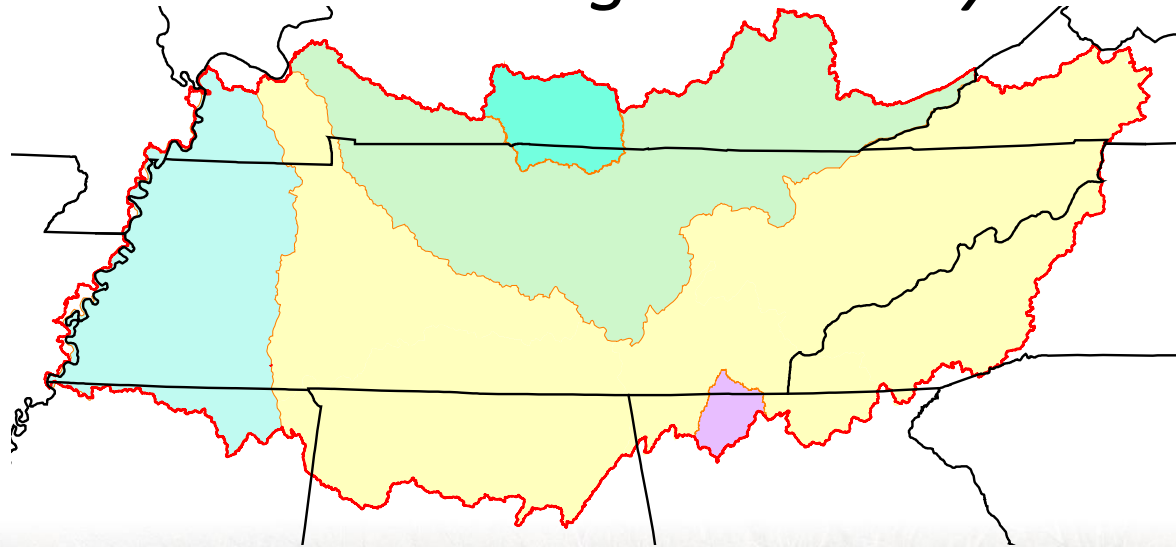
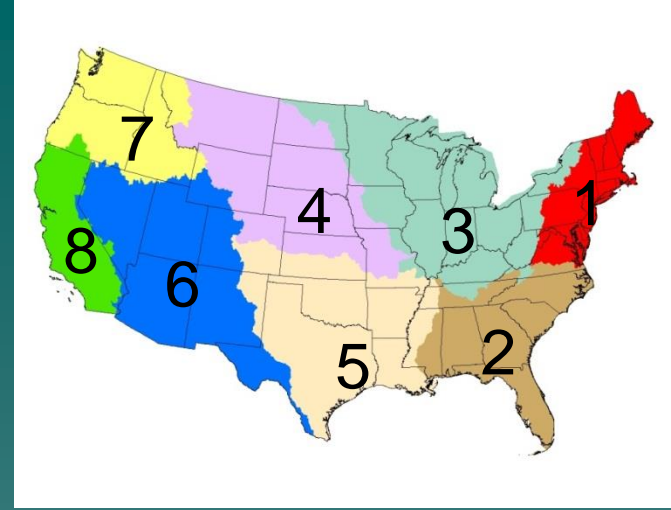


Baseline information on nitrogen and phosphorus loading in Tennessee streams

*Anne Hoos (retired) and Victor Roland,
U.S. Geological Survey*



USGS Regional assessments of nutrient sources and stream loads mass transported each year



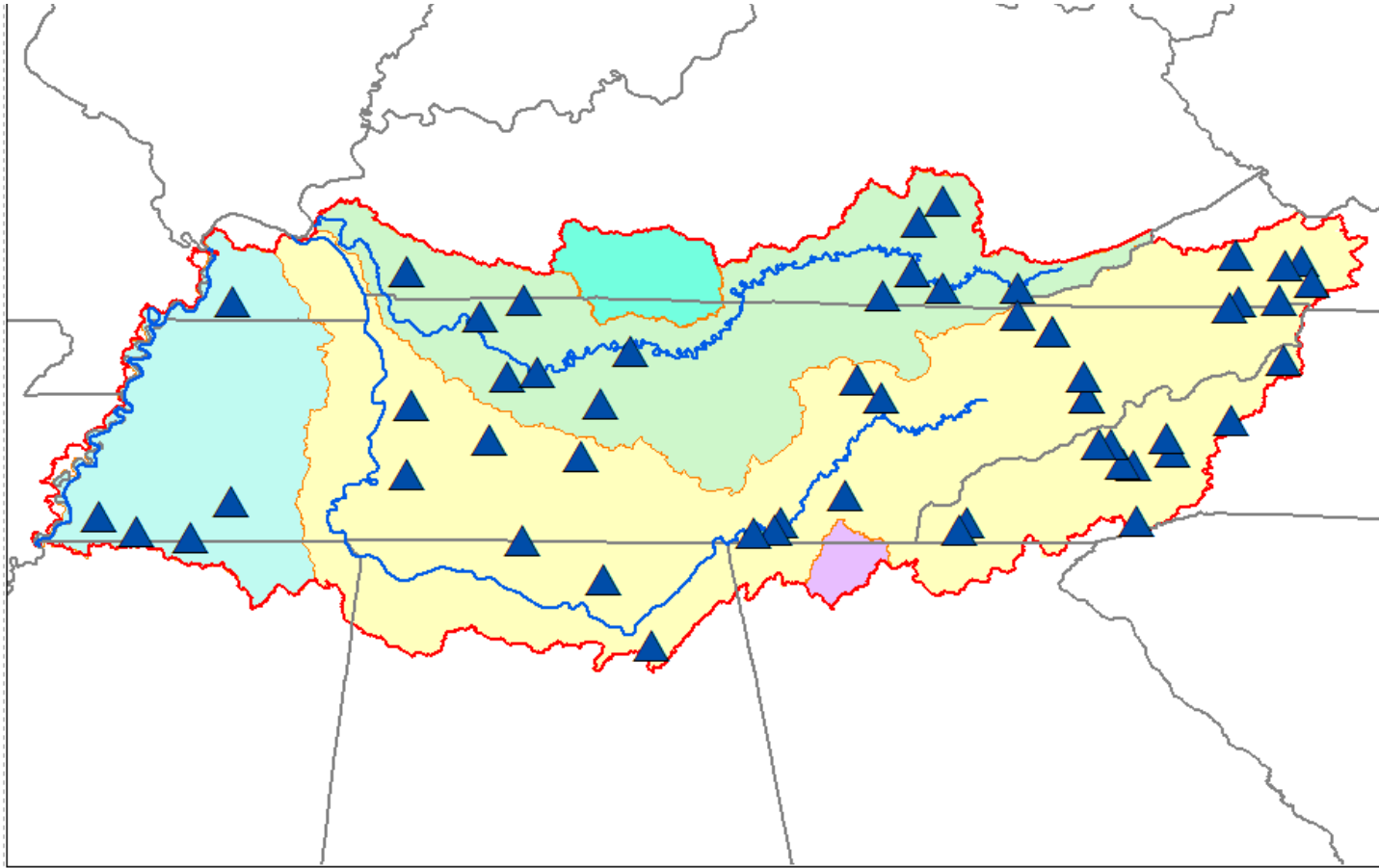
Objective: Build understanding of how human activities and natural features influence nutrient loads in streams Construct model

Practical applications:

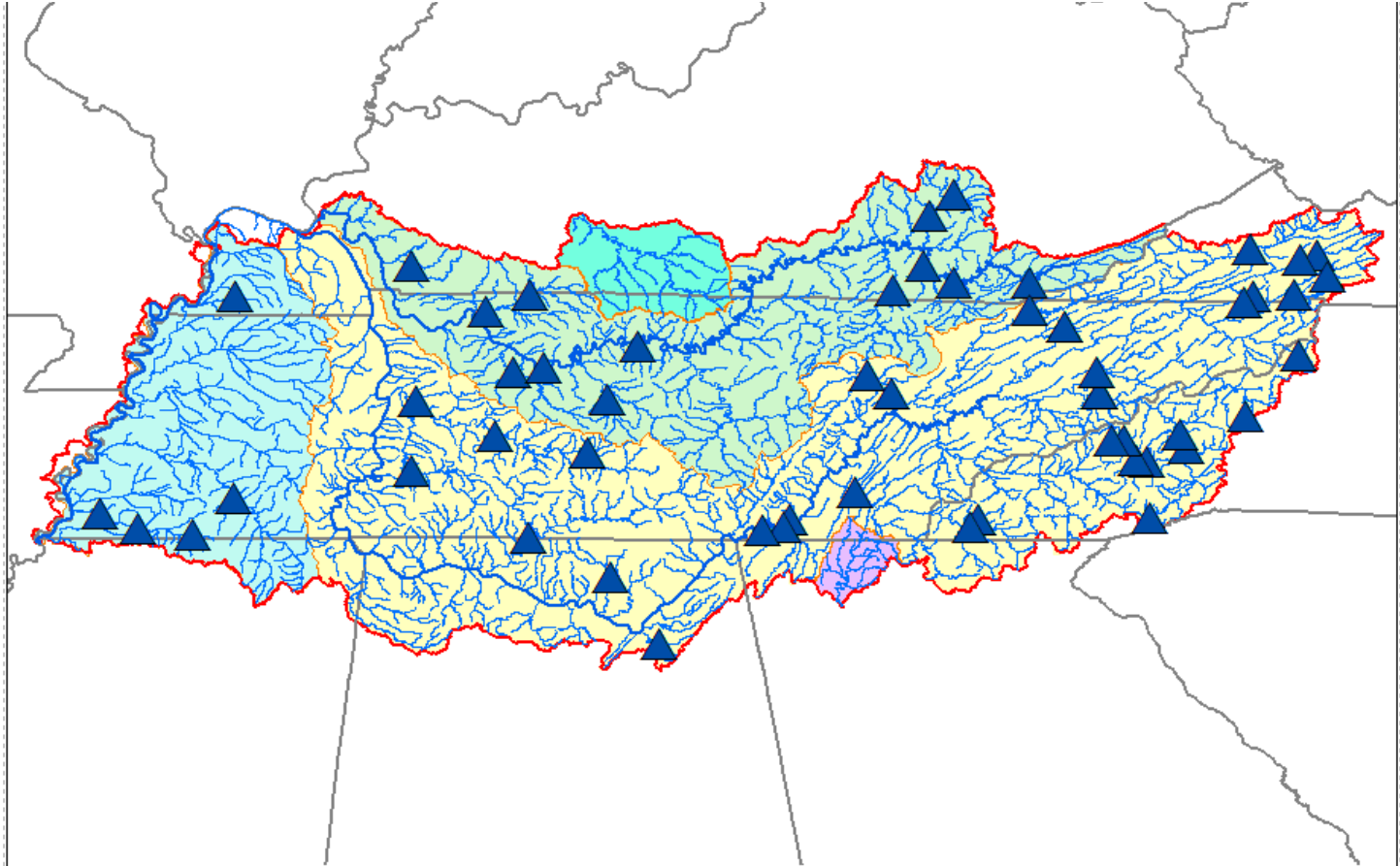
Estimates of nutrient loads in all stream reaches
Rankings by river basin or state

Estimates of source shares of stream loads

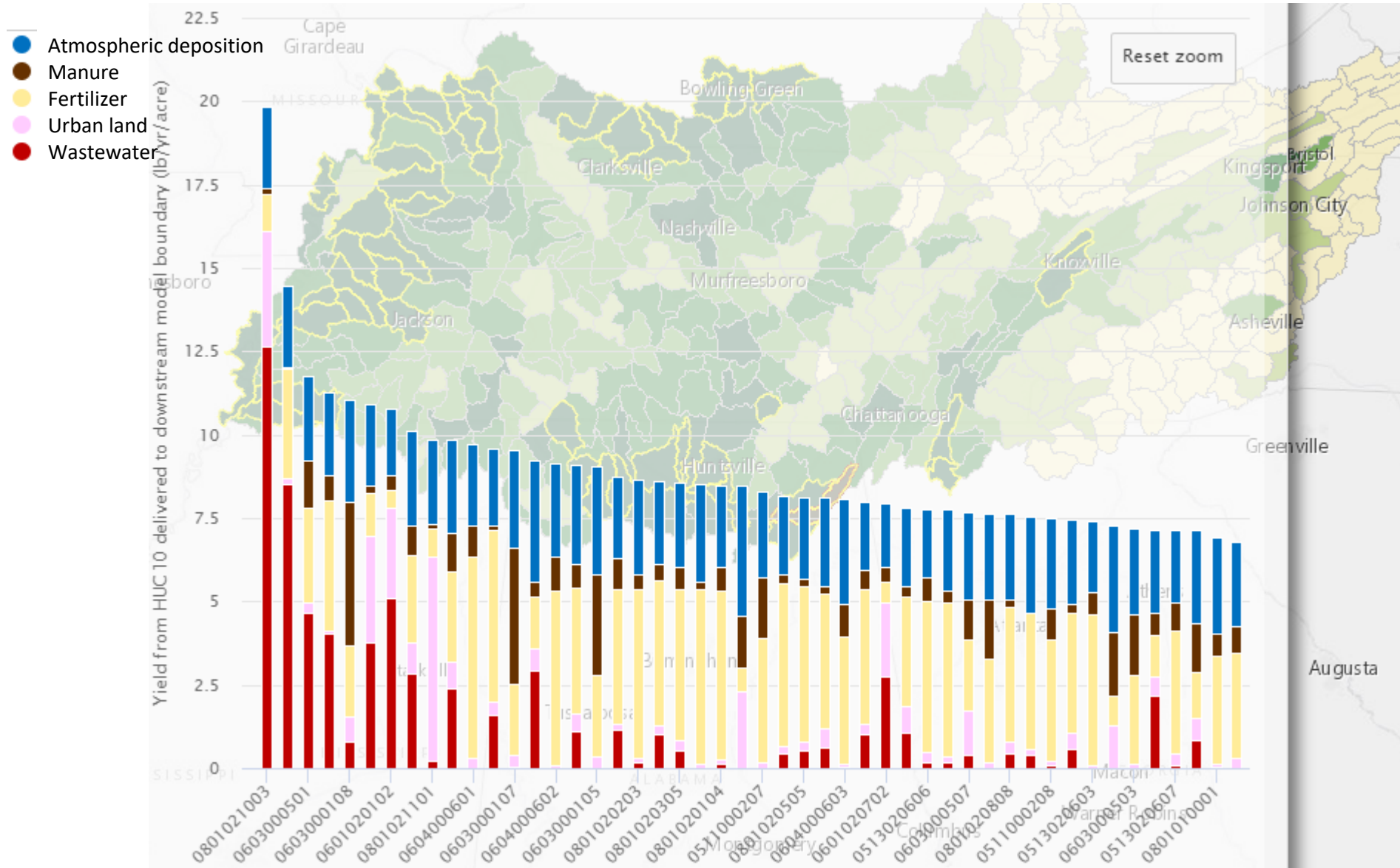
Estimates of stream nutrient loads not just for the 59 load monitoring sites ...



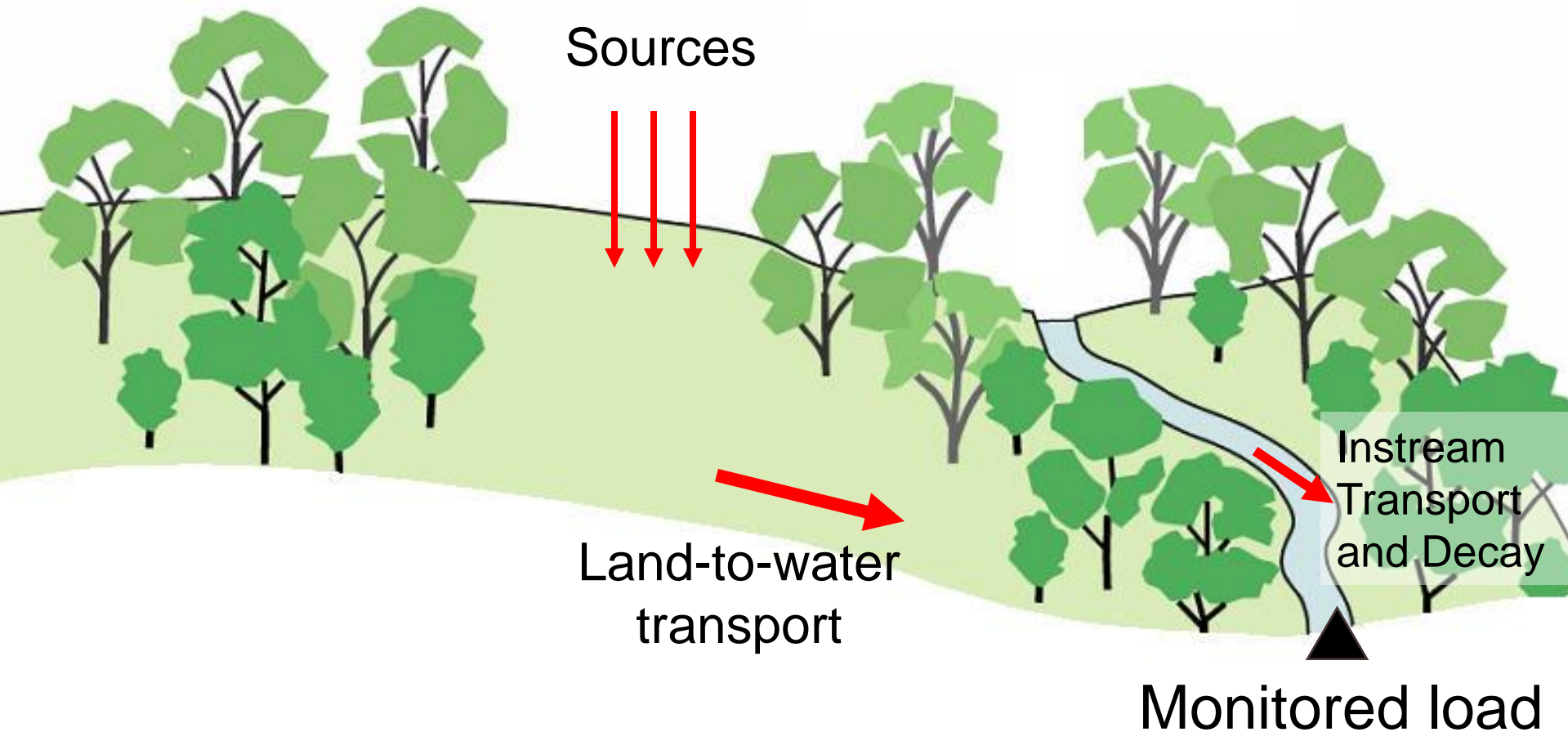
But in all 2,432 stream reaches in the
Tennessee area



Estimates of contribution from each nutrient source to the load in each reach



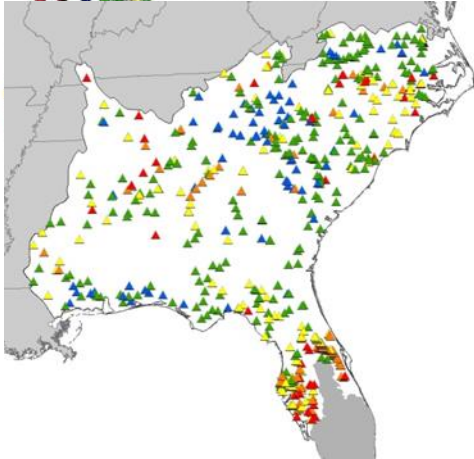
SPARROW* Model Concept



*SPATIALLY REferenced Regression On Watershed Attributes

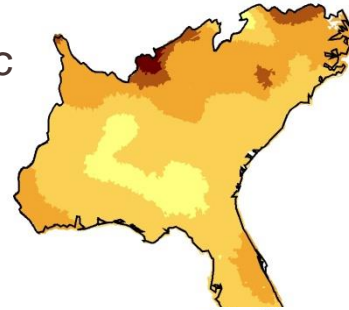
SPARROW Model Framework

Monitoring Data 804 Sites

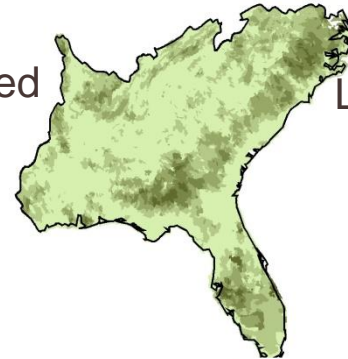


Spatial Data Layers representing sources

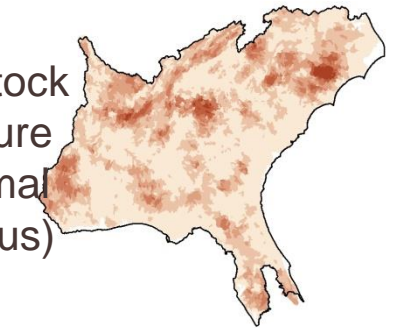
Atmospheric
deposition.
NADP,
wet



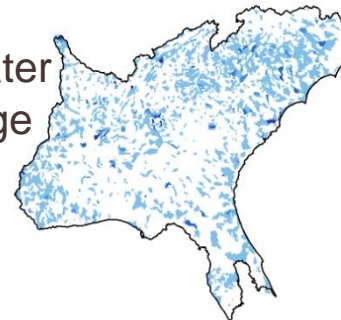
Fertilizer applied
to farmland
(sales data)



Livestock
Manure
(animal
census)



Wastewater
discharge

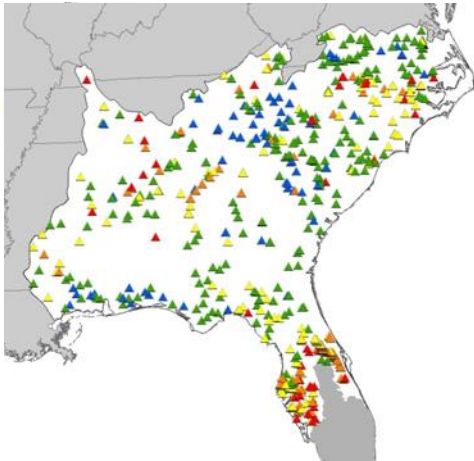


Urban
land

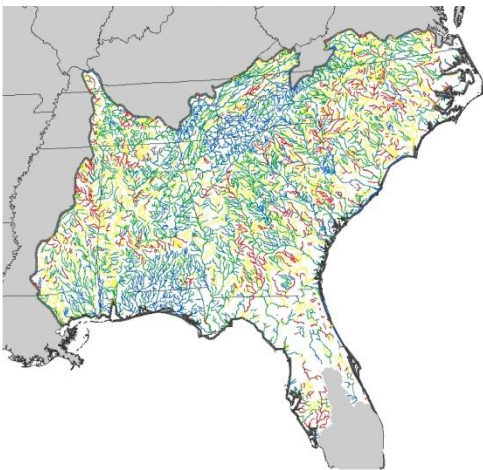


SPARROW Model Framework

Monitoring Data
804 Sites

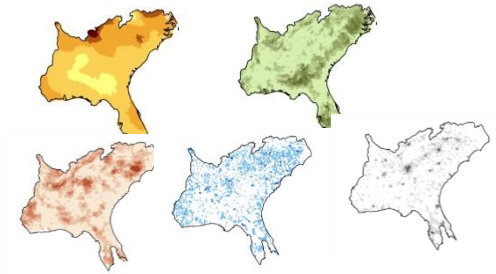


Model Predictions
8,092 Stream Reaches



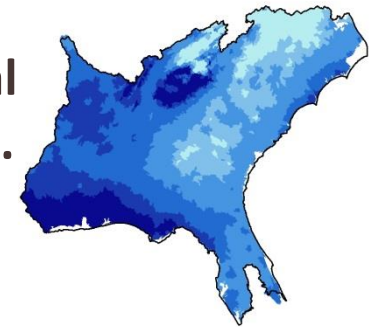
Spatial Data Layers

Sources



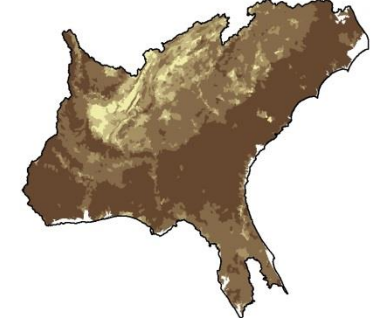
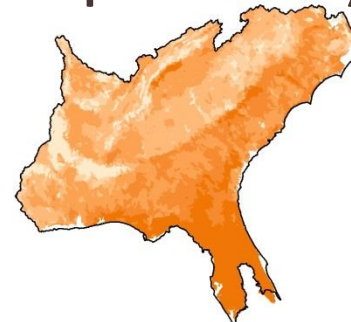
Transport factors

Annual precip.

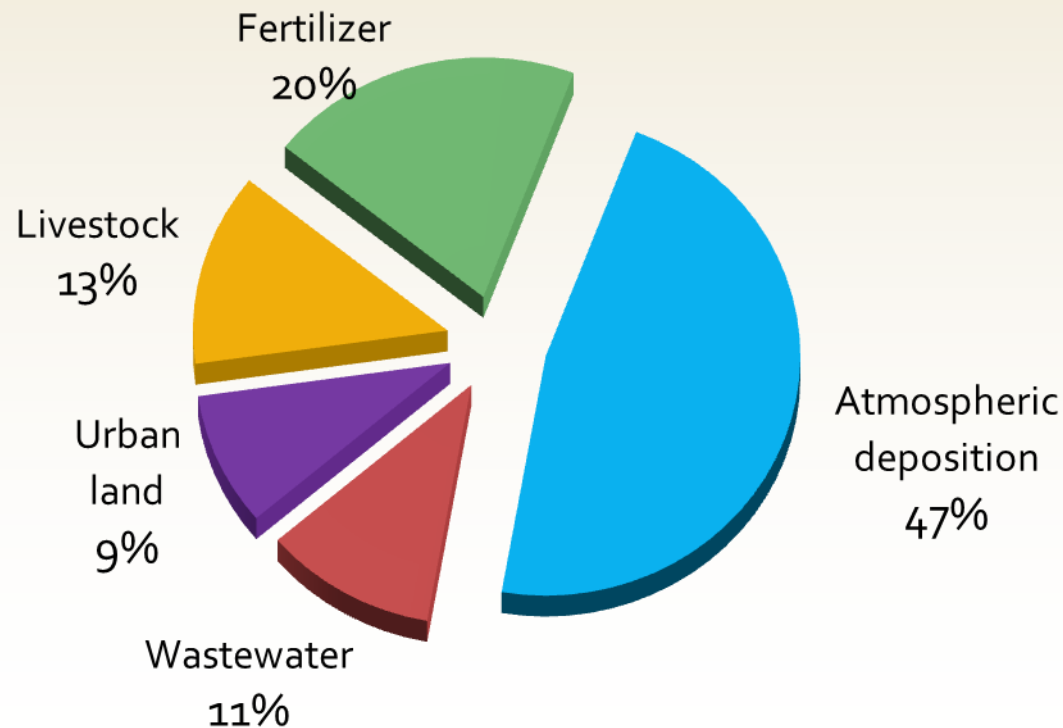
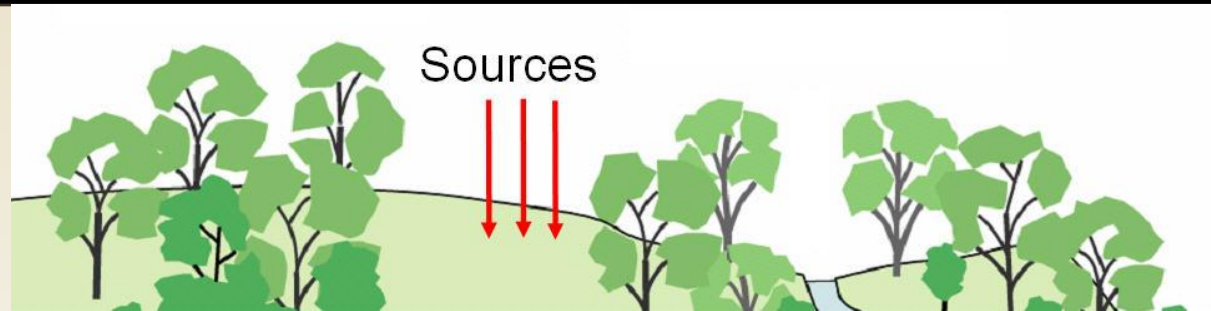


Soil permeability

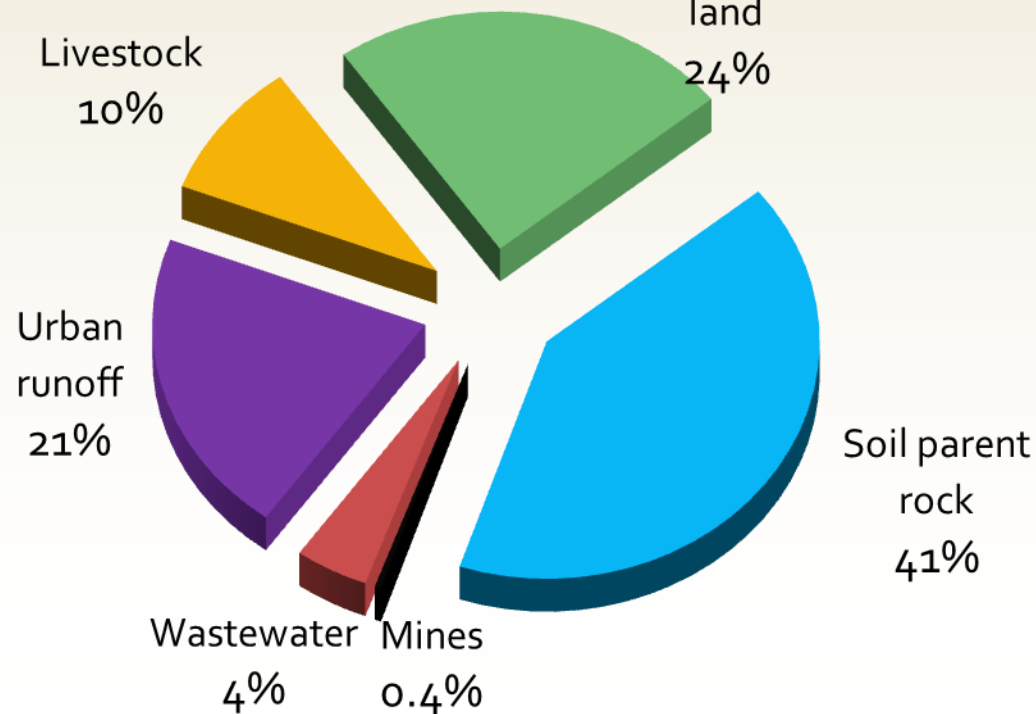
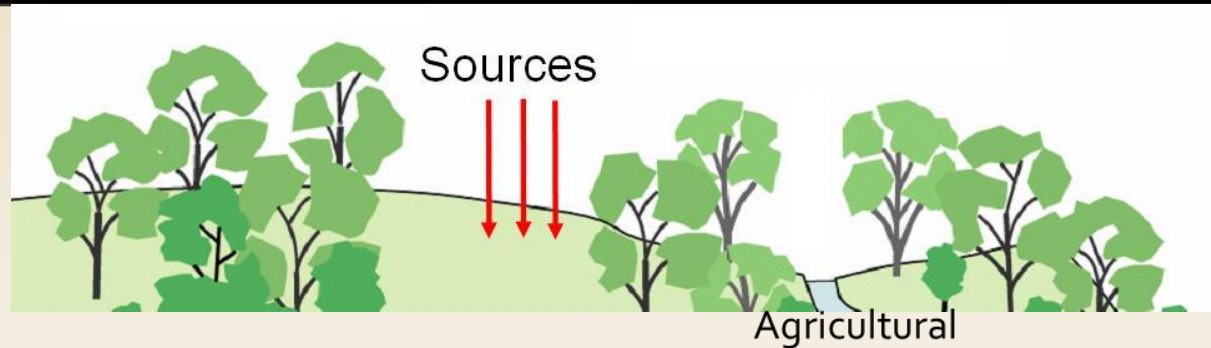
Soil thickness



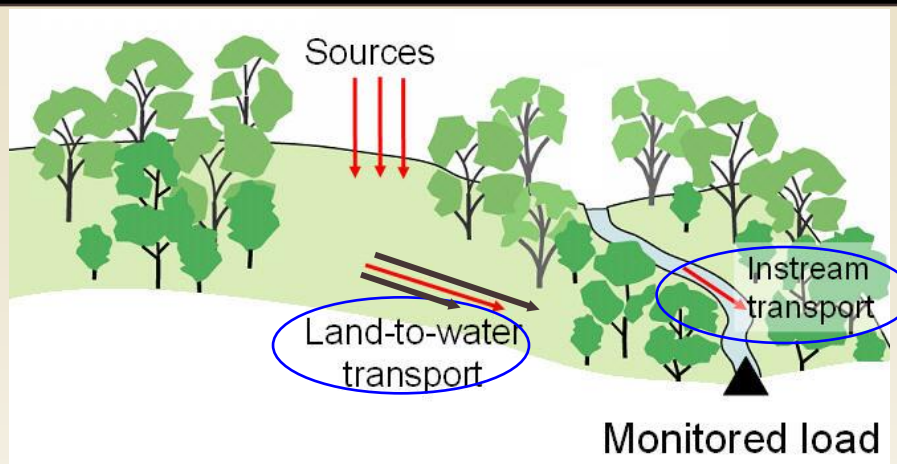
Sources accounting for instream nitrogen load in the Southeast



Sources accounting for instream phosphorus load in the Southeast



Transport variables in nutrient models



TOTAL NITROGEN

Land to water

- Soil permeability
- Soil thickness
- Annual precipitation
- Primary hydrologic path

In-stream

- Travel time, stream size
- Reservoir residence time

TOTAL PHOSPHORUS

Land to water

- Soil erodibility
- Soil pH
- Soil organic matter
- Water table depth
- Annual precipitation

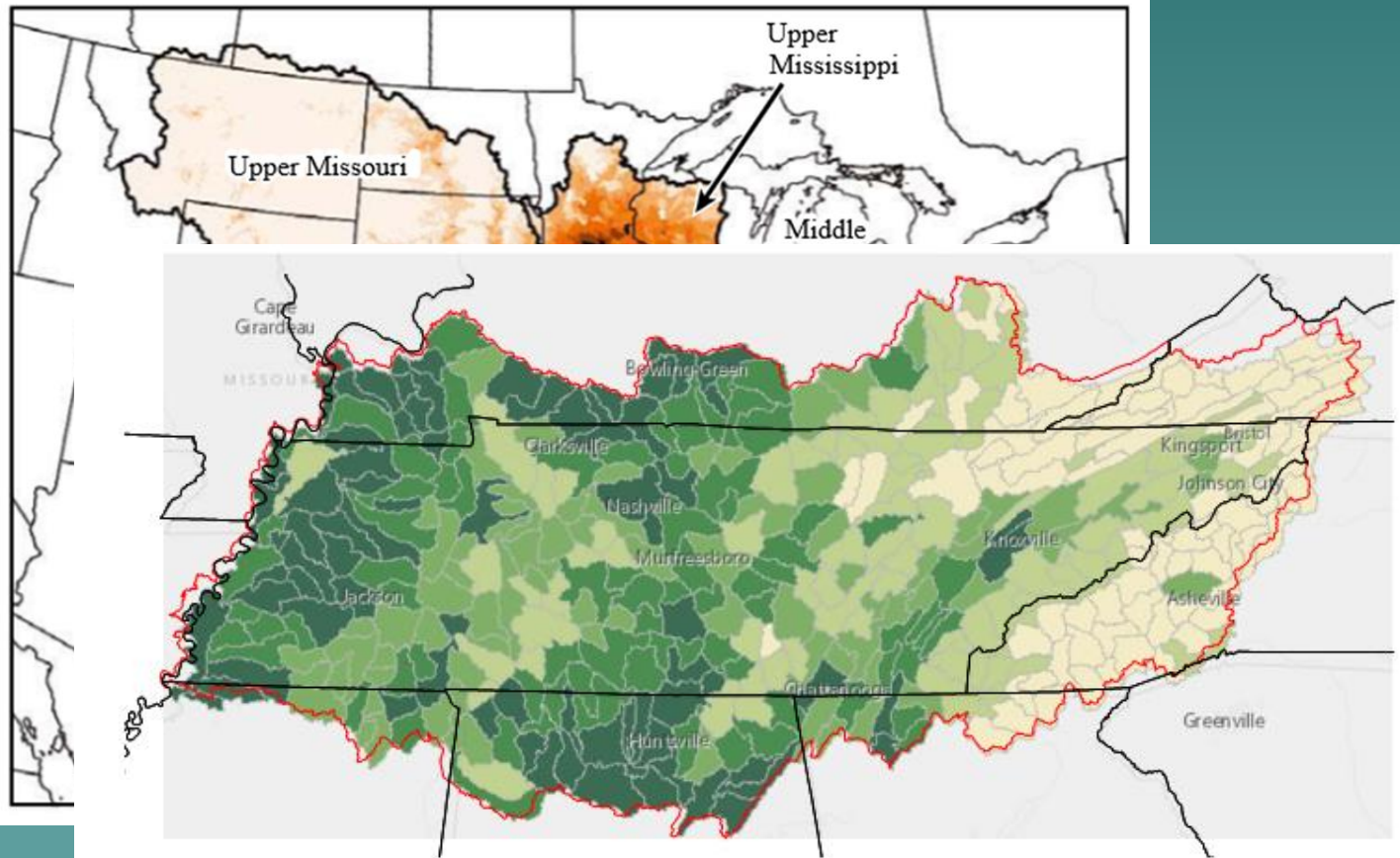
In-stream

- Travel time, stream size
- Reservoir residence time

SPARROW results are useful ...

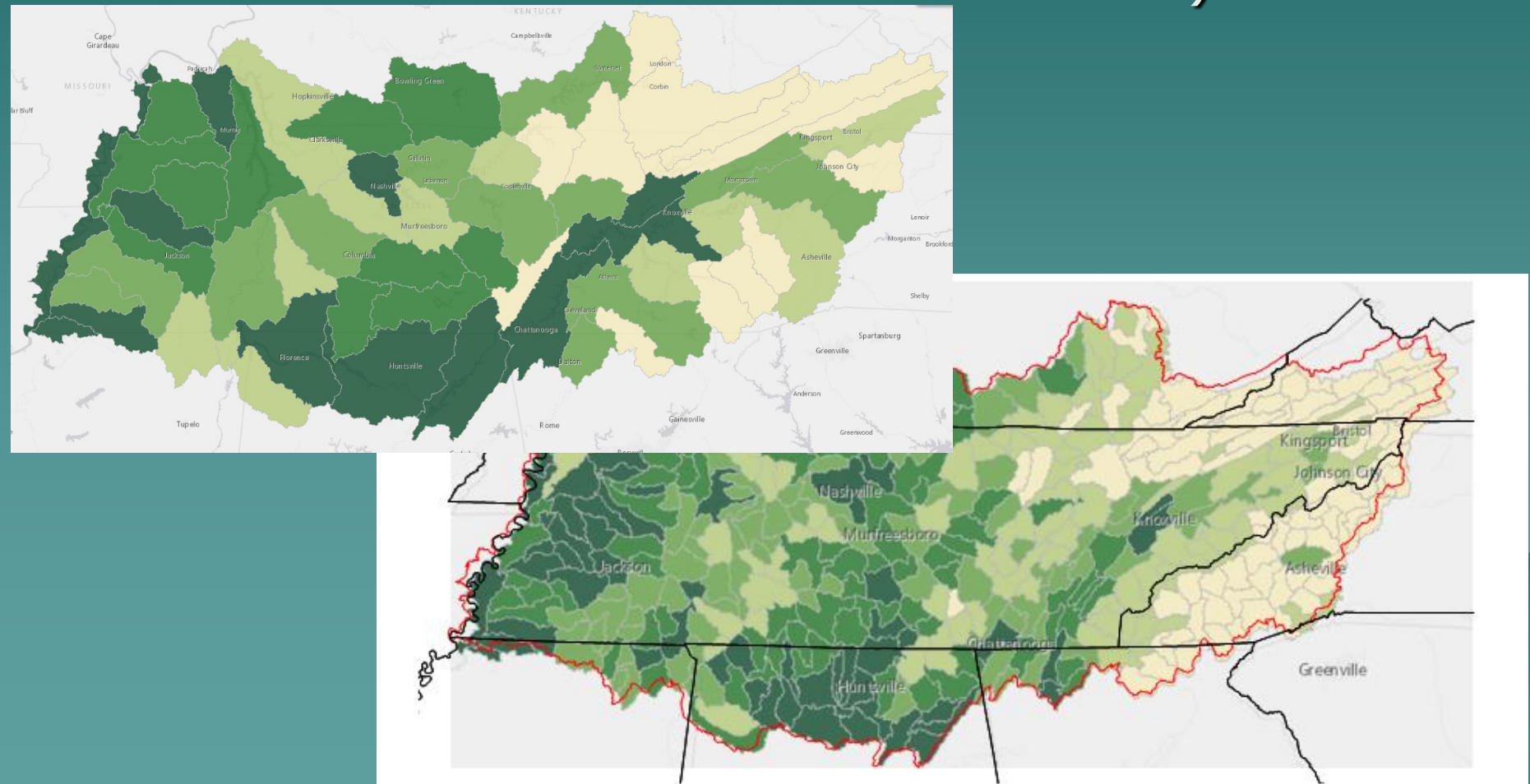
- ◆ where assessments need to be extrapolated across a large region (need consistent data and methods over wide areal extent)

C. Delivered Incremental N Yield



SPARROW results are useful ...

- ◆ where assessments need to be extrapolated across a large region (need consistent data and methods over wide areal extent)



SPARROW results are useful ...

- ◆ where assessments need to be extrapolated/applied across a large region (need consistent data and methods over wide areal extent)
- ◆ where decision-making is based on relative contribution of different watershed sources

[Tennessee Nutrient Reduction Framework](#)

Tennessee mapper (USGS-TDEC)

<https://sparrow.wim.usgs.gov/sparrow-tennessee/>

Nutrient Model

- Phosphorus
 Nitrogen

Area of Interest

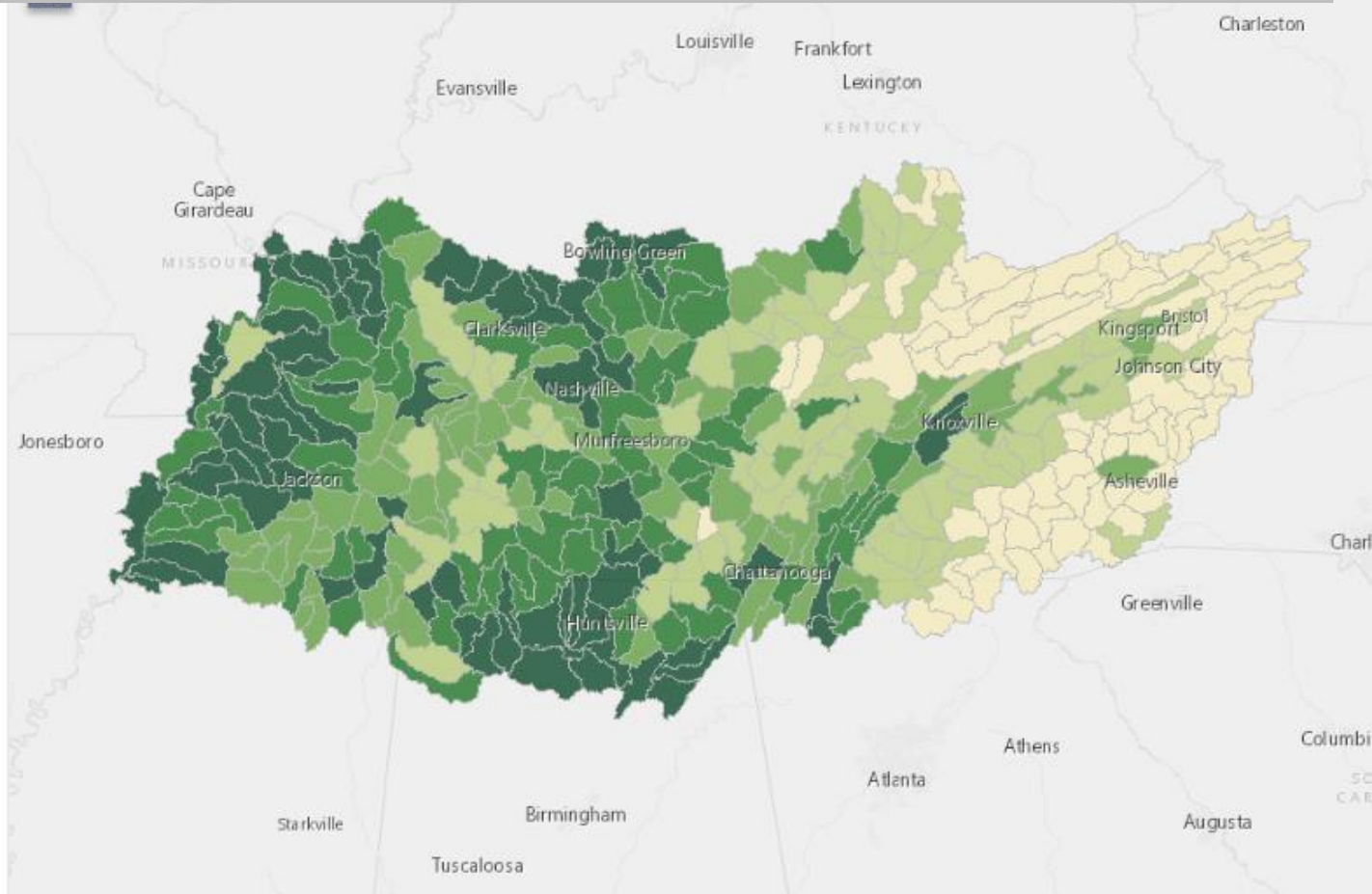
Clear Area of Interest

Displayed Metric

Group Results By

Show Chart

Show Table



Select Nutrient and Area of Interest

Nutrient Model

- Phosphorus
- Nitrogen

Area of Interest

State

Cumberland River

HUC8

Clear Area of Interest

Displayed Metric

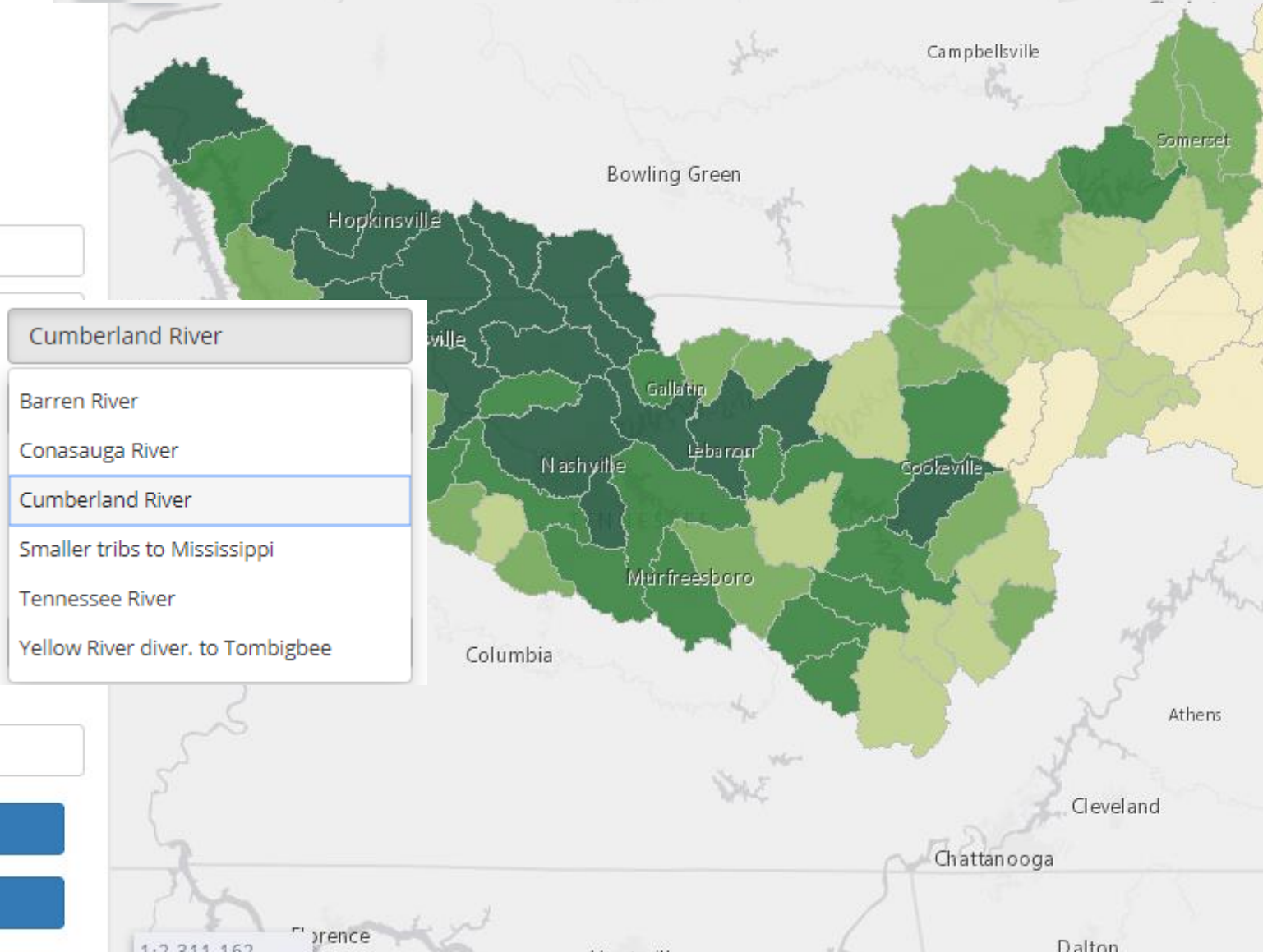
Yield from HUC10 delivered

Group Results By

HUC10

Show Chart

Show Table



Select scale for reporting results

Nutrient Model

- Phosphorus
- Nitrogen

Area of Interest

State

Cumberland River

HUC8

Clear Area of Interest

Displayed Metric

Yield from HUC10 delivered to c

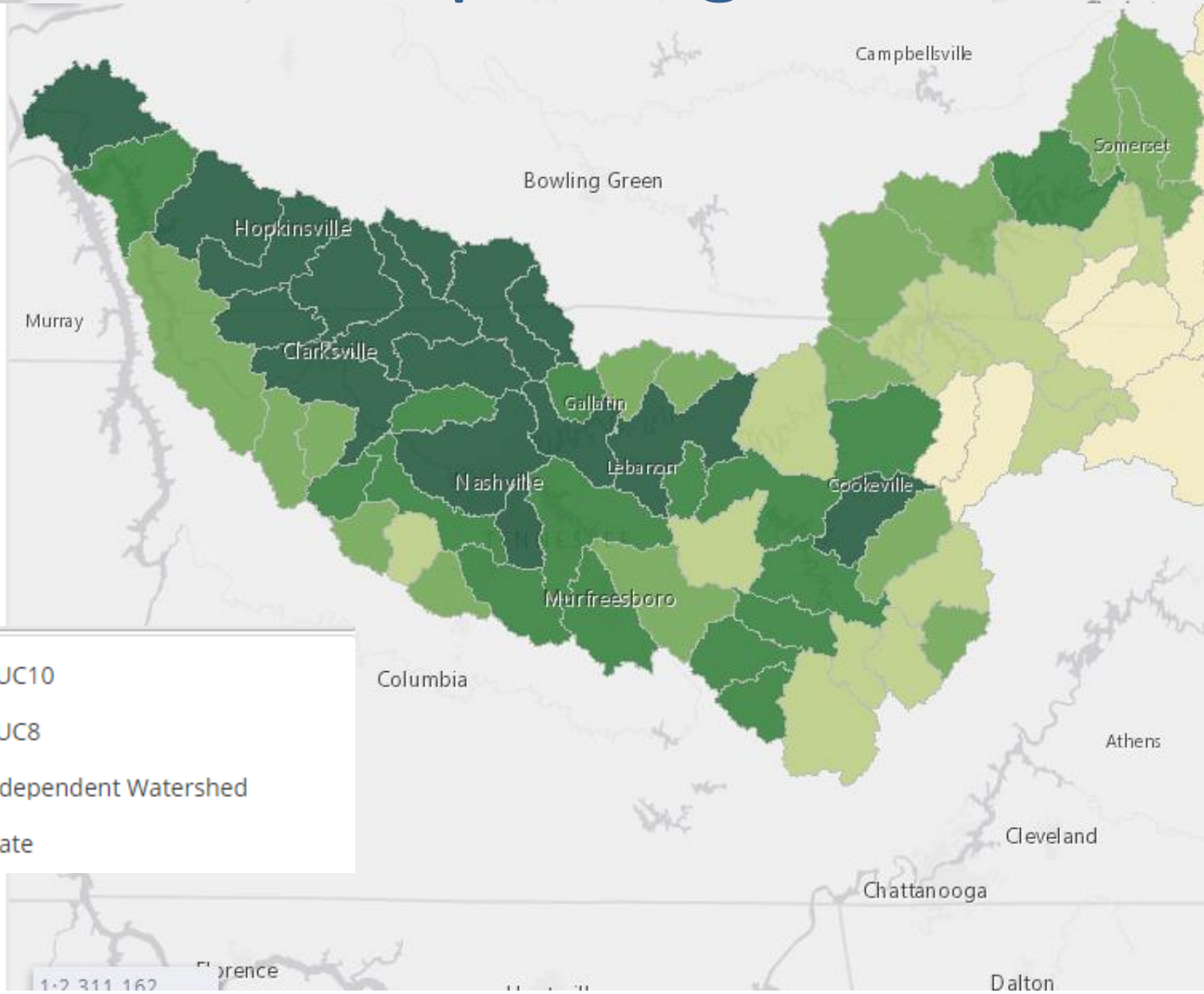
Group Results By

HUC10

Show Chart

Show Table

- HUC10
- HUC8
- Independent Watershed
- State



Select load/yield term to be displayed

Nutrient Model

- Phosphorus
- Nitrogen

Area of Interest

State

Cumberland River

HUC8

Clear Area of Interest

Displayed Metric

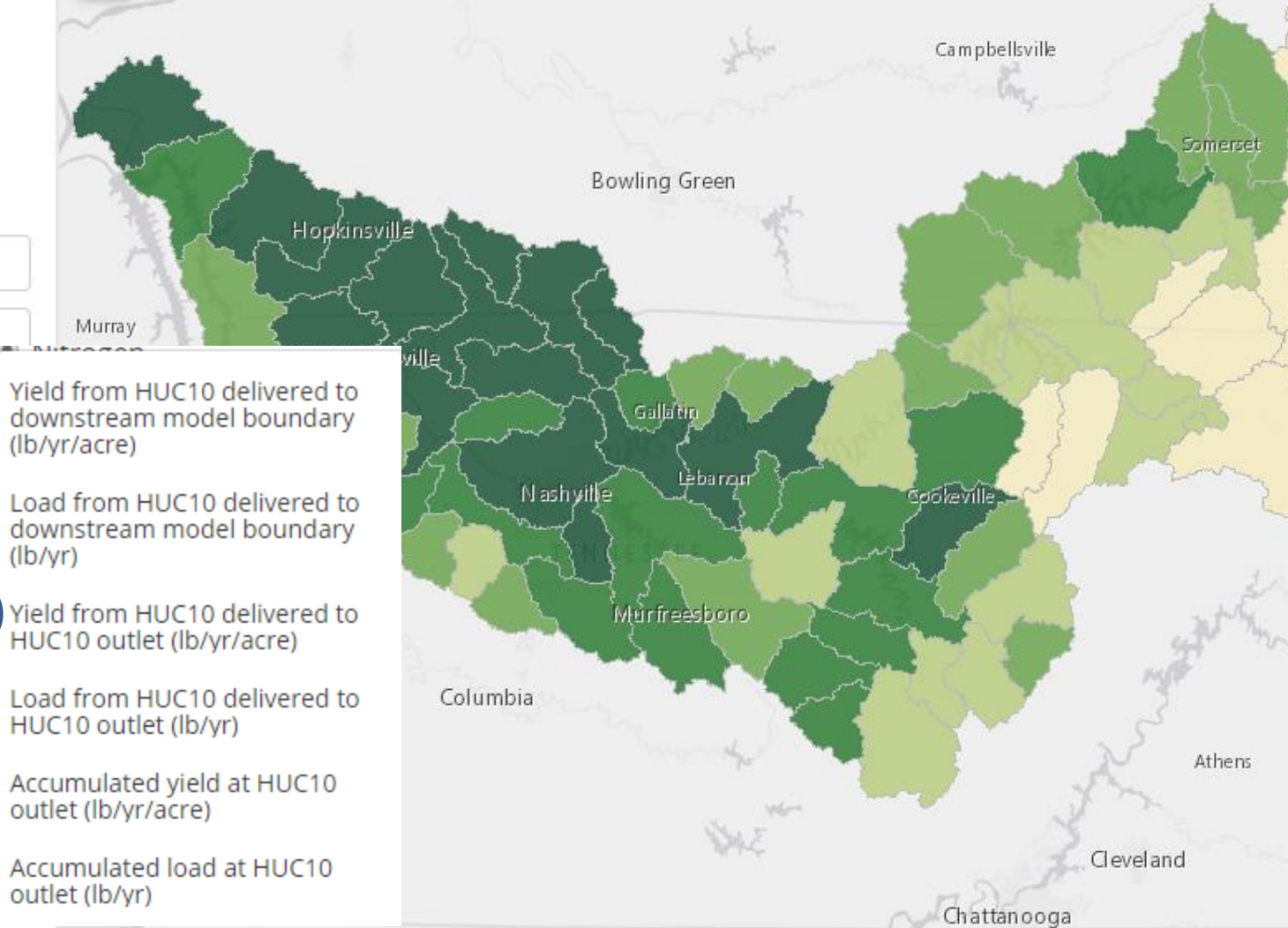
Yield from HUC10 delivered to r

Group Results By

HUC10

Show Chart

Show Table



Nitrogen yield from each HUC10 delivered to the Ohio River (lb/yr/acre)

- Phosphorus
- Nitrogen

Area of Interest

State

Cumberland River

HUC8

Clear Area of Interest

Displayed Metric

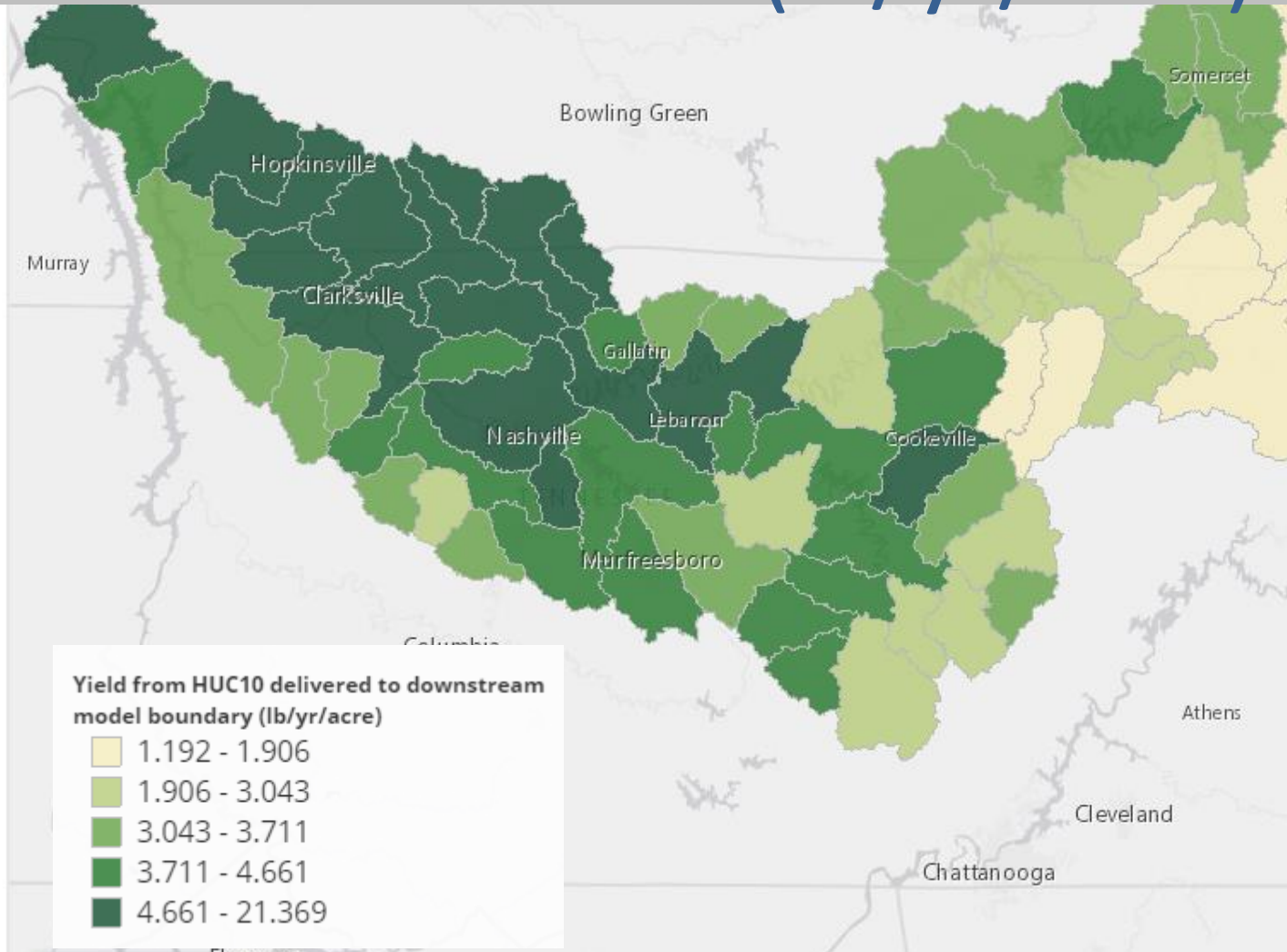
Yield from HUC10 delivered to c

Group Results By

HUC10

Show Chart

Show Table



Phosphorus yield from each HUC10 delivered to the Ohio River (lb/yr/acre)

Phosphorus

Nitrogen

Area of Interest

State

Cumberland River

HUC8

Clear Area of Interest

Displayed Metric

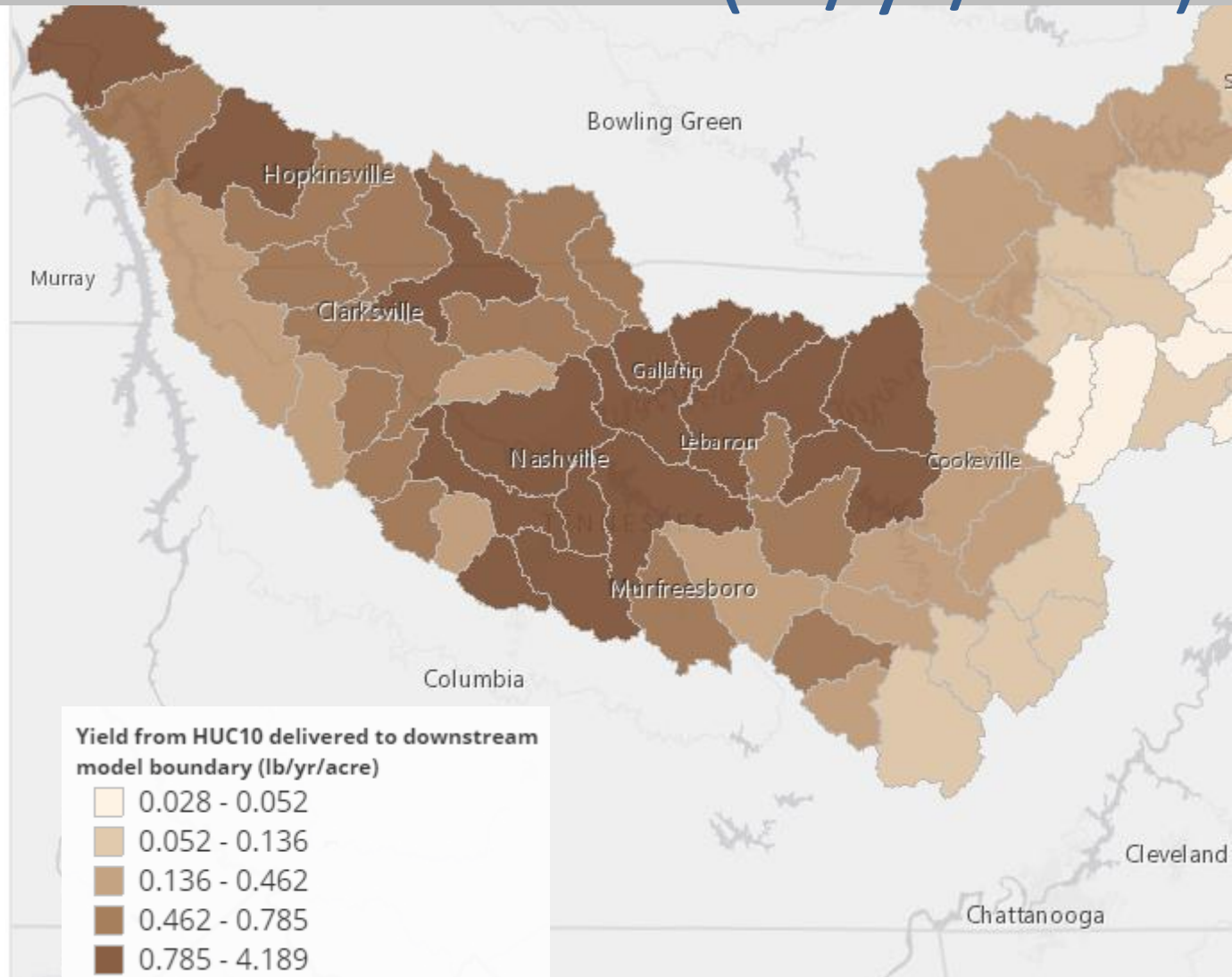
Yield from HUC10 delivered to c

Group Results By

HUC10

Show Chart

Show Table



Phosphorus yield from each HUC10 delivered to the Ohio River (lb/yr/acre)

Phosphorus

Nitrogen

Area of Interest

State

Cumberland River

HUC8

Clear Area of Interest

Displayed Metric

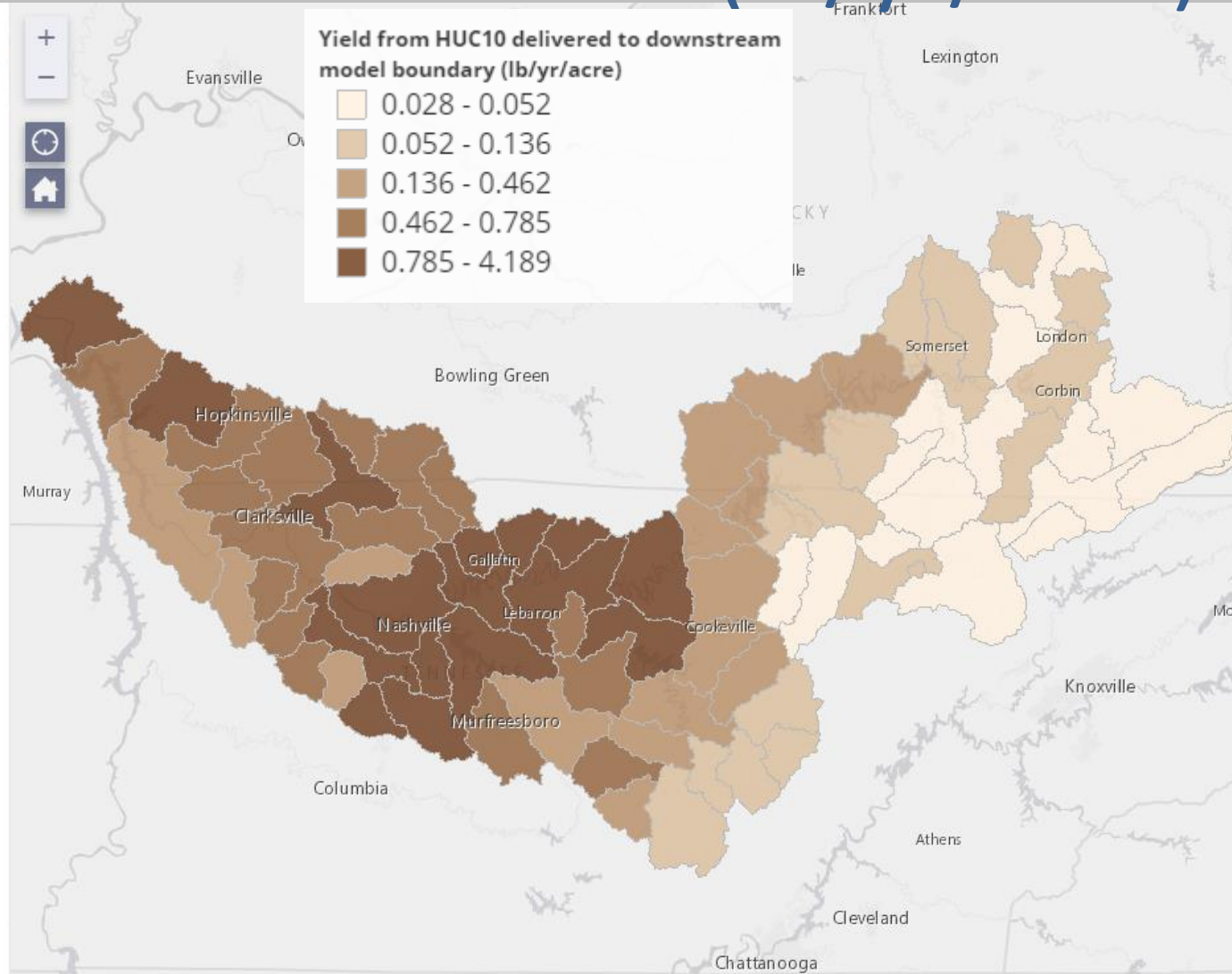
Yield from HUC10 delivered to c

Group Results By

HUC10

Show Chart

Show Table



DATA FILTERS >

+

-

Nutrient Model

Phosphorus

Nitrogen

Area of Interest

State

Cumberland River

HUC8

Clear Area of Interest

Displayed Metric

Yield from HUC10 delivered

Group Results By

HUC10

Show Chart

Show Table

Yield from HUC10 delivered to downstream model boundary (lb/yr/acre)

Load from HUC10 delivered to downstream model boundary (lb/yr)

Yield from HUC10 delivered to HUC10 outlet (lb/yr/acre)

Load from HUC10 delivered to HUC10 outlet (lb/yr)

Accumulated yield at HUC10 outlet (lb/yr/acre)

Accumulated load at HUC10 outlet (lb/yr)

Yield from HUC10 delivered to downstream model boundary (lb/yr/acre)

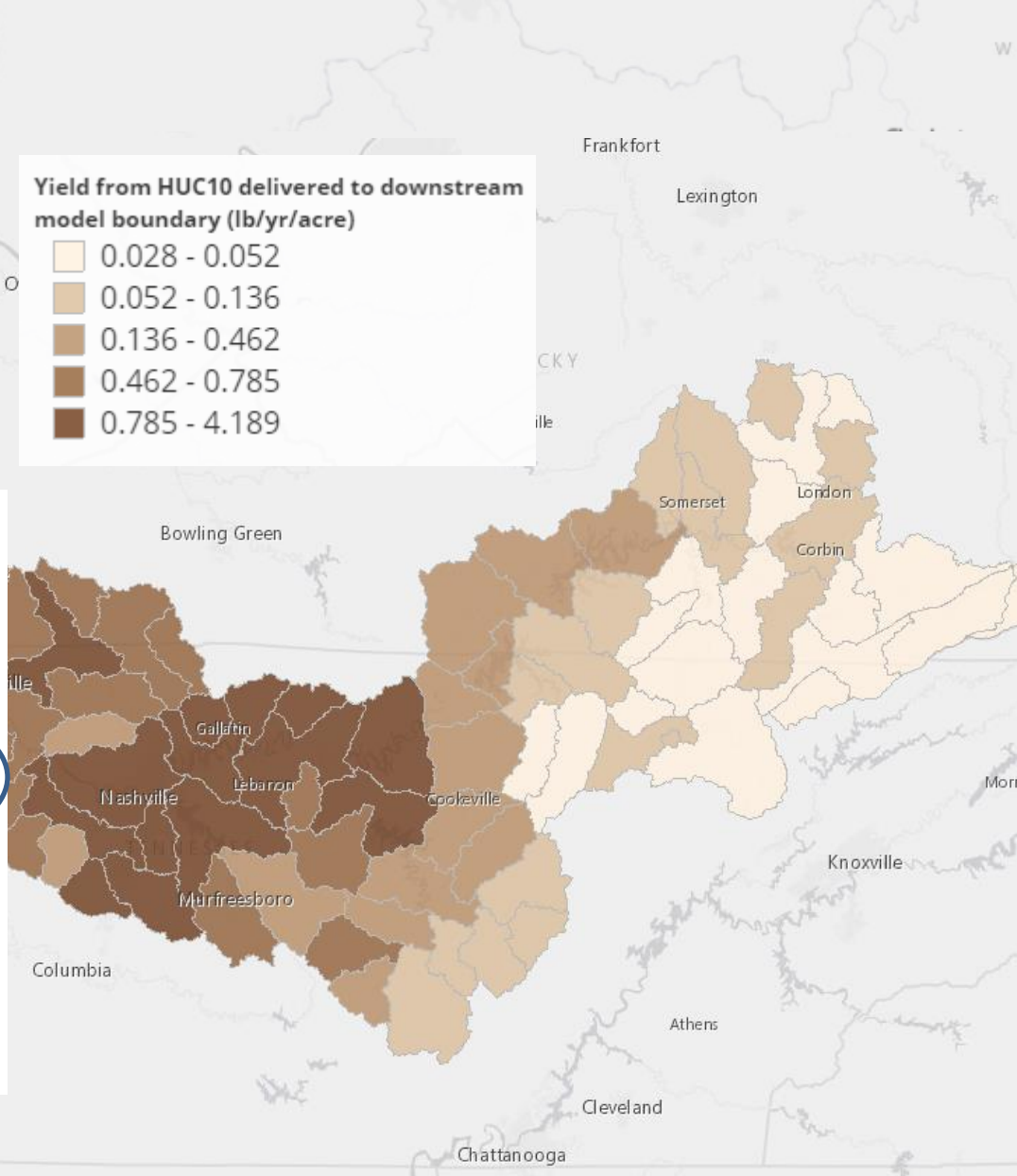
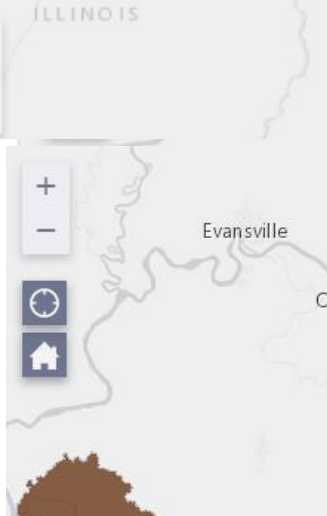
0.028 - 0.052

0.052 - 0.136

0.136 - 0.462

0.462 - 0.785

0.785 - 4.189



Phosphorus yield from each HUC10 delivered to the HUC10 outlet

Phosphorus

Nitrogen

Area of Interest

State

Cumberland River

HUC8

Clear Area of Interest

Displayed Metric

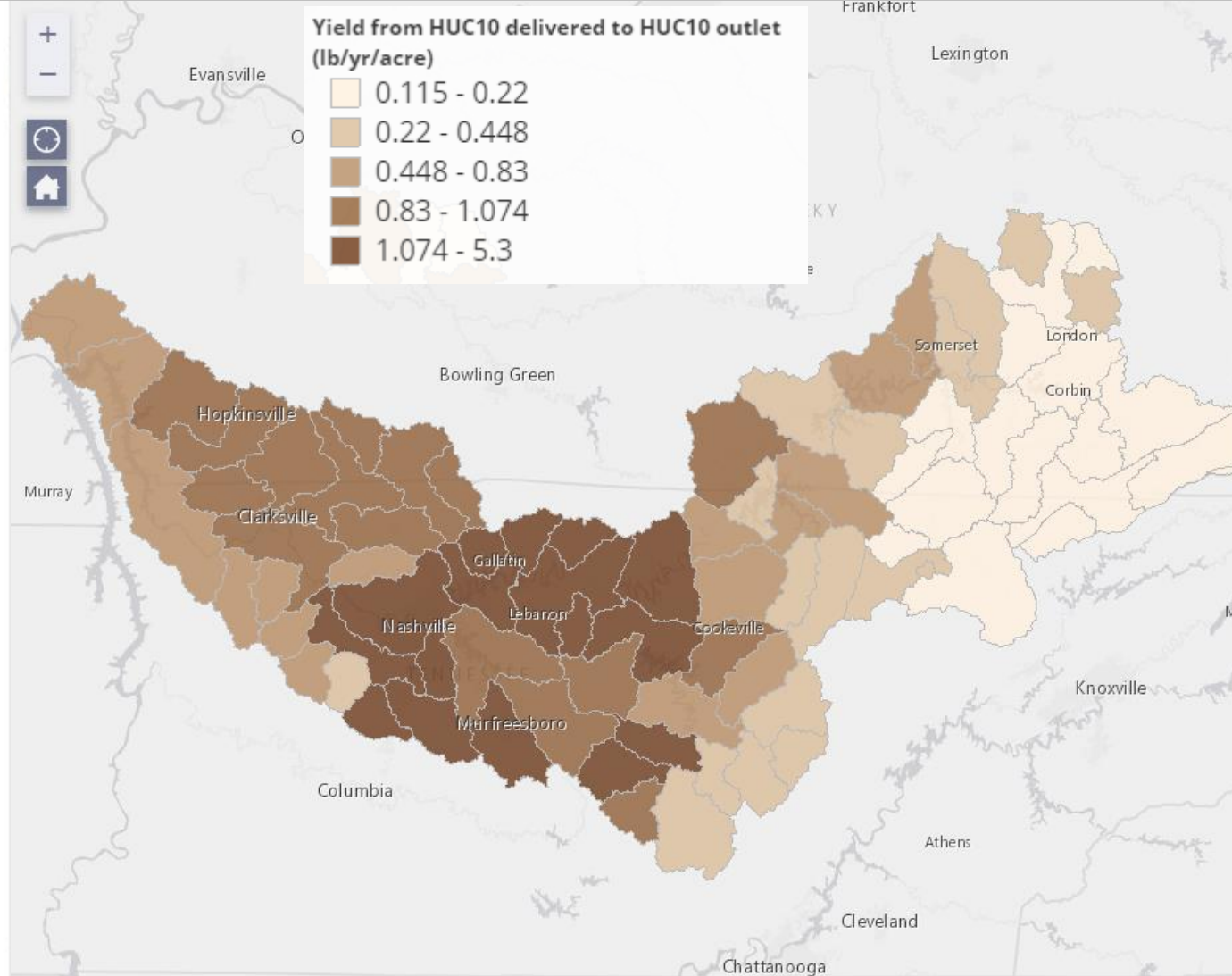
Yield from HUC10 delivered to HUC10 outlet

Group Results By

HUC10

Show Chart

Show Table



Phosphorus yield from each HUC10 delivered to the HUC10 outlet

Phosphorus
 Nitrogen

Area of Interest

State

Cumberland River

HUC8

Clear Area of Interest

Displayed Metric

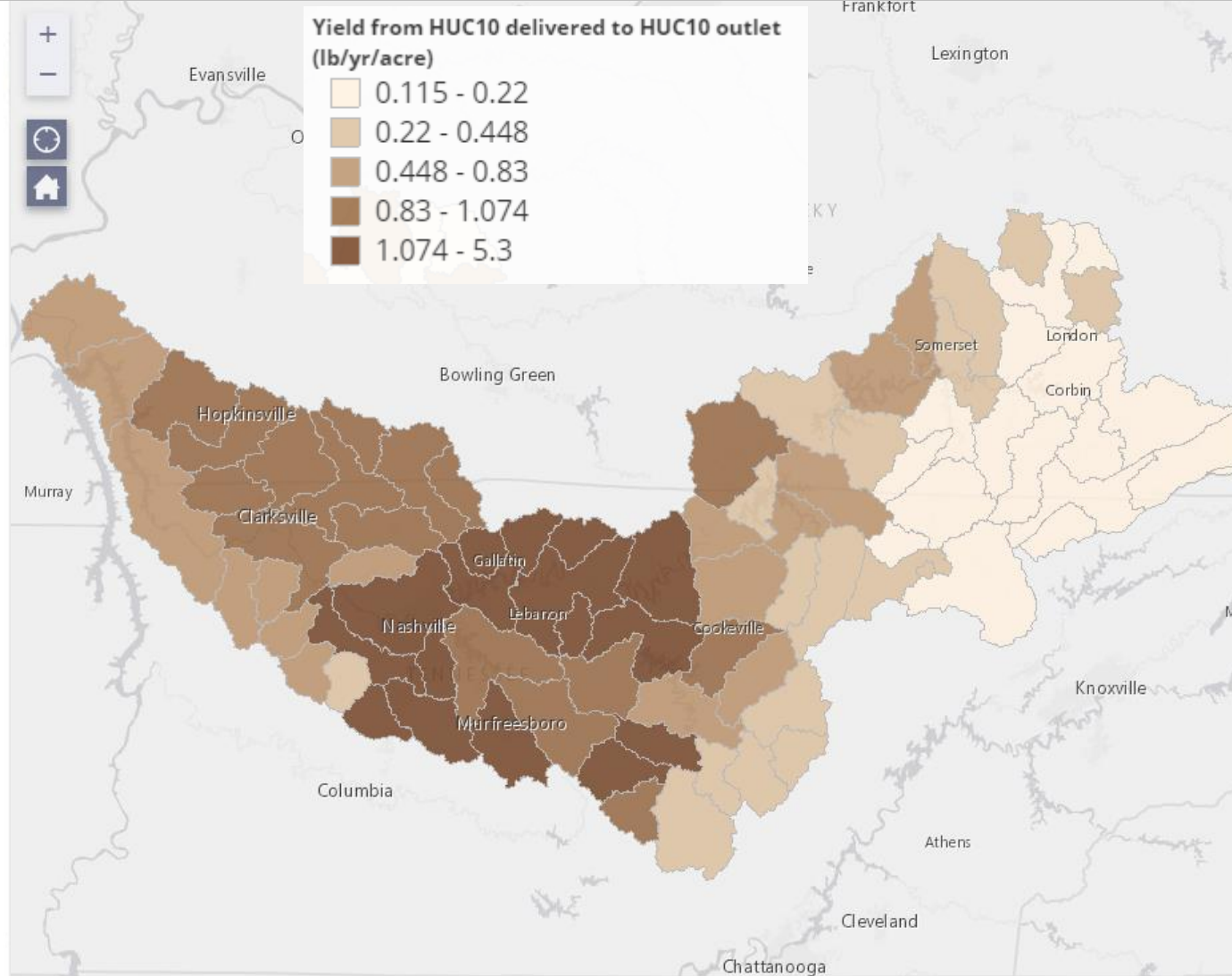
Yield from HUC10 delivered to F

Group Results By

HUC10

Show Chart

Show Table



- Soil-parent-rock yield from HUC10 delivered to HUC10 outlet (lb/yr/acre)
- Mined-land yield from HUC10 delivered to HUC10 outlet (lb/yr/acre)
- Manure yield from HUC10 delivered to HUC10 outlet (lb/yr/acre)
- Agricultural-land yield from HUC10 delivered to HUC10 outlet (lb/yr/acre)
- Urban-land yield from HUC10 delivered to HUC10 outlet (lb/yr/acre)
- Wastewater yield from HUC10 delivered to HUC10 outlet (lb/yr/acre)

MAP LAYERS >

DATA FILTERS >

Nutrient Model

- Phosphorus
- Nitrogen

Area of Interest

State

Cumberland River

HUC8

Clear Area of Interest

Displayed Metric

Yield from HUC10

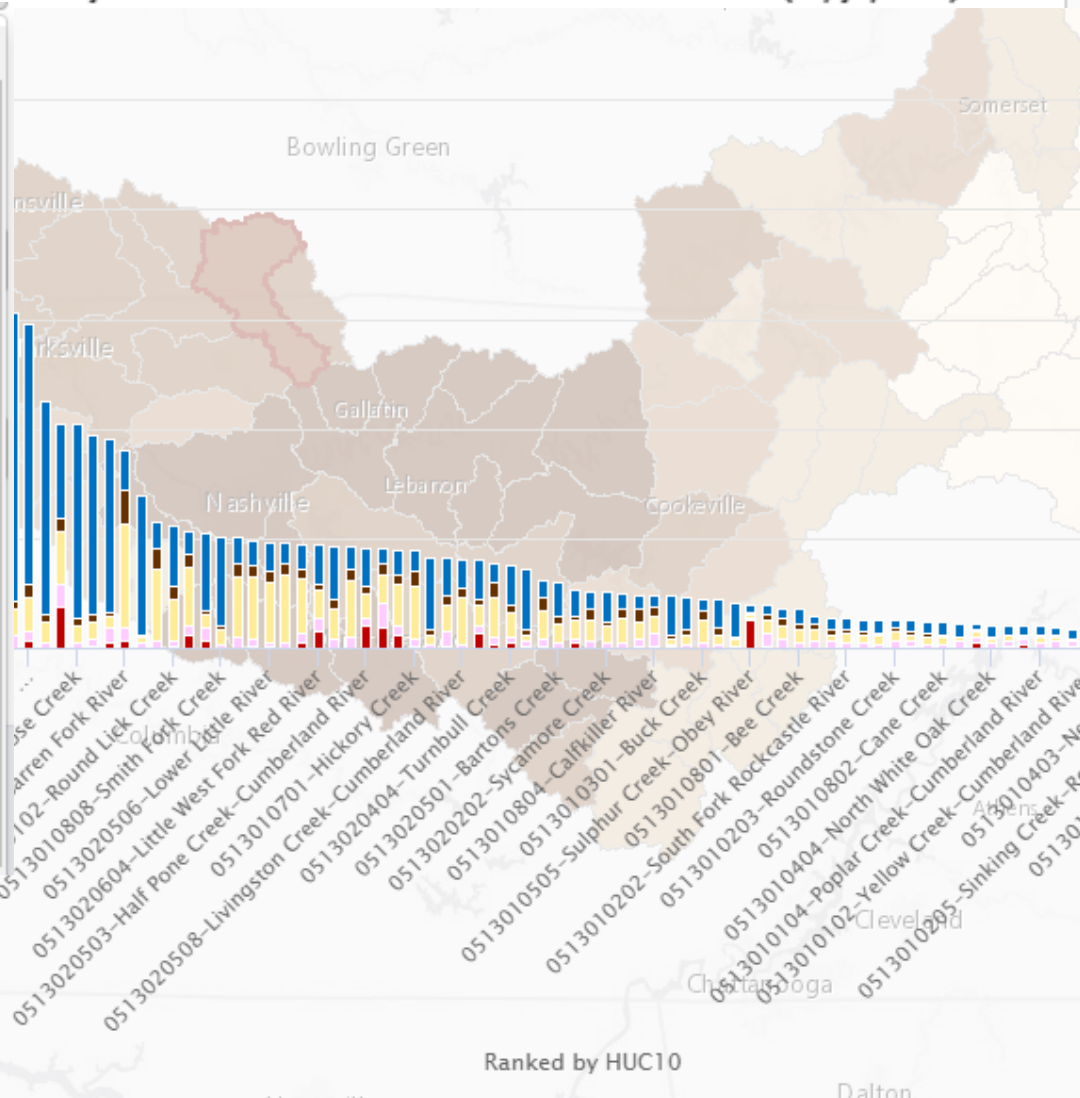
Group Results By

HUC10

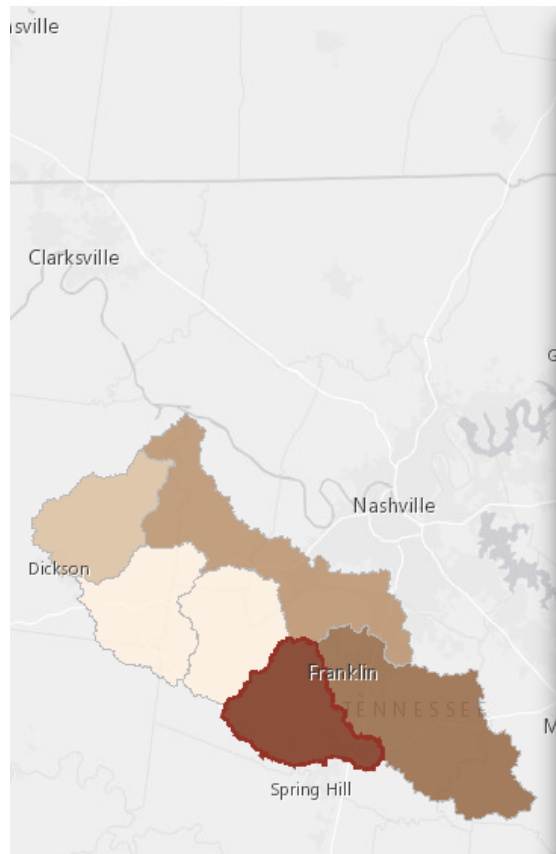
Show Chart

Show Table

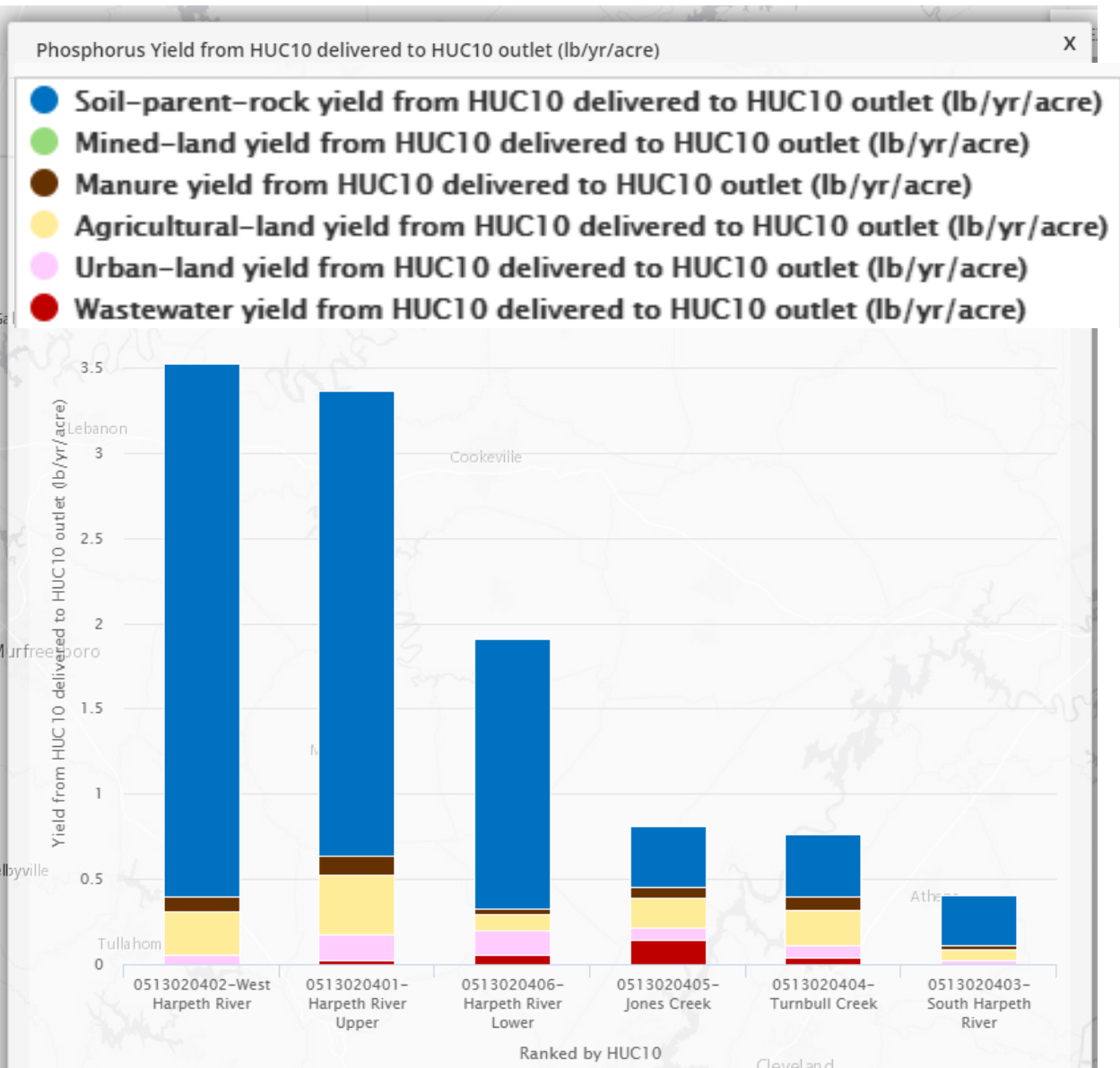
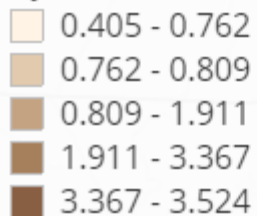
- 05130101-Upper Cumberland
- 05130102-Rockcastle
- 05130103-Upper Cumberland-Lake Cumberland
- 05130104-South Fork Cumberland
- 05130105-Obey
- 05130106-Upper Cumberland-Cordell Hull
- 05130107-Collins
- 05130108-Caney
- 05130201-Lower Cumberland-Old Hickory Lake
- 05130202-Lower Cumberland-Sycamore
- 05130203-Stones
- 05130204-Harpeth
- 05130205-Lower Cumberland



Select a single HUC8 area to map/chart: 05130204 – Harpeth River - Phosphorus

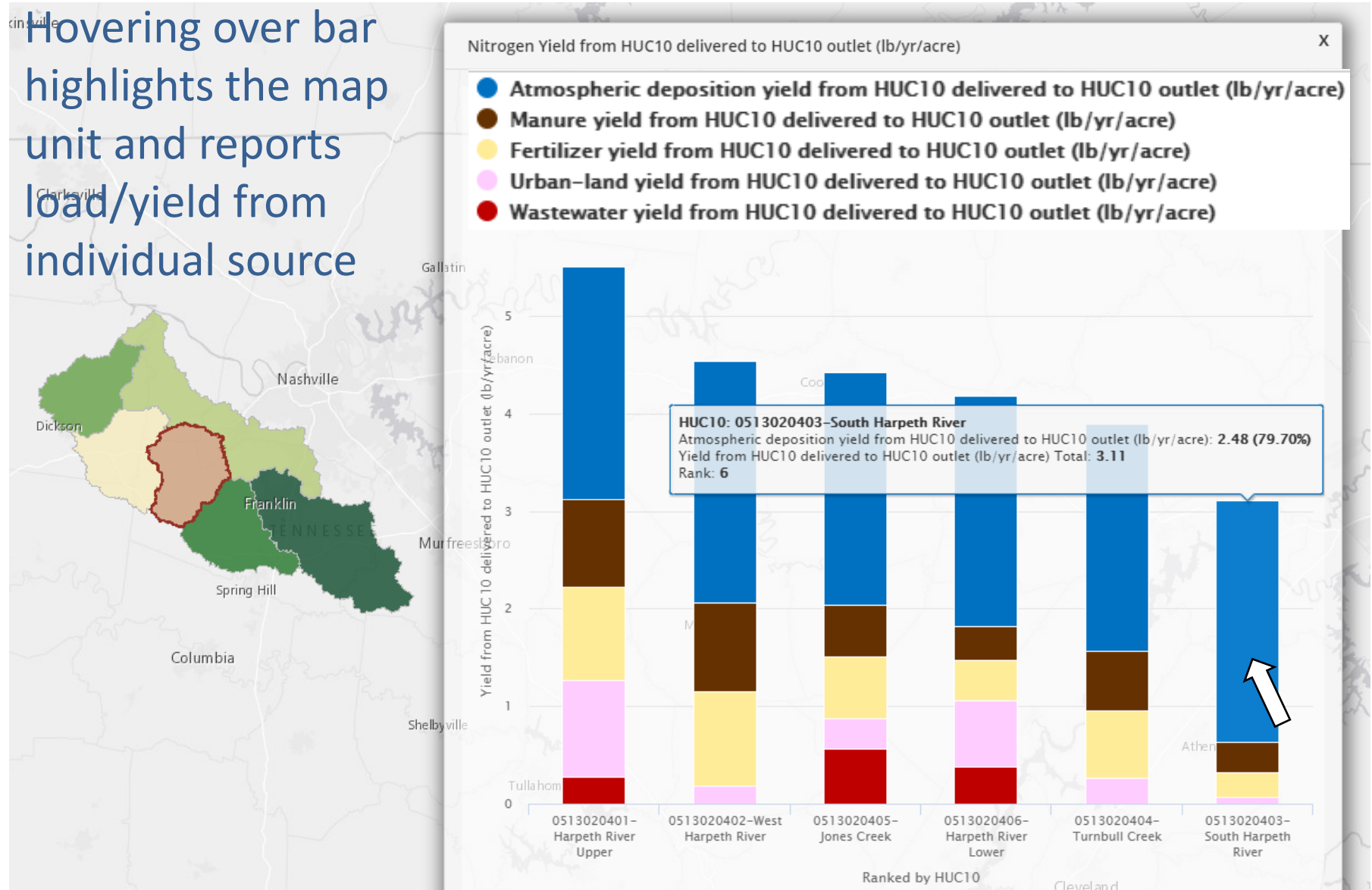


Yield from HUC10 delivered to HUC10 outlet (lb/yr/acre)

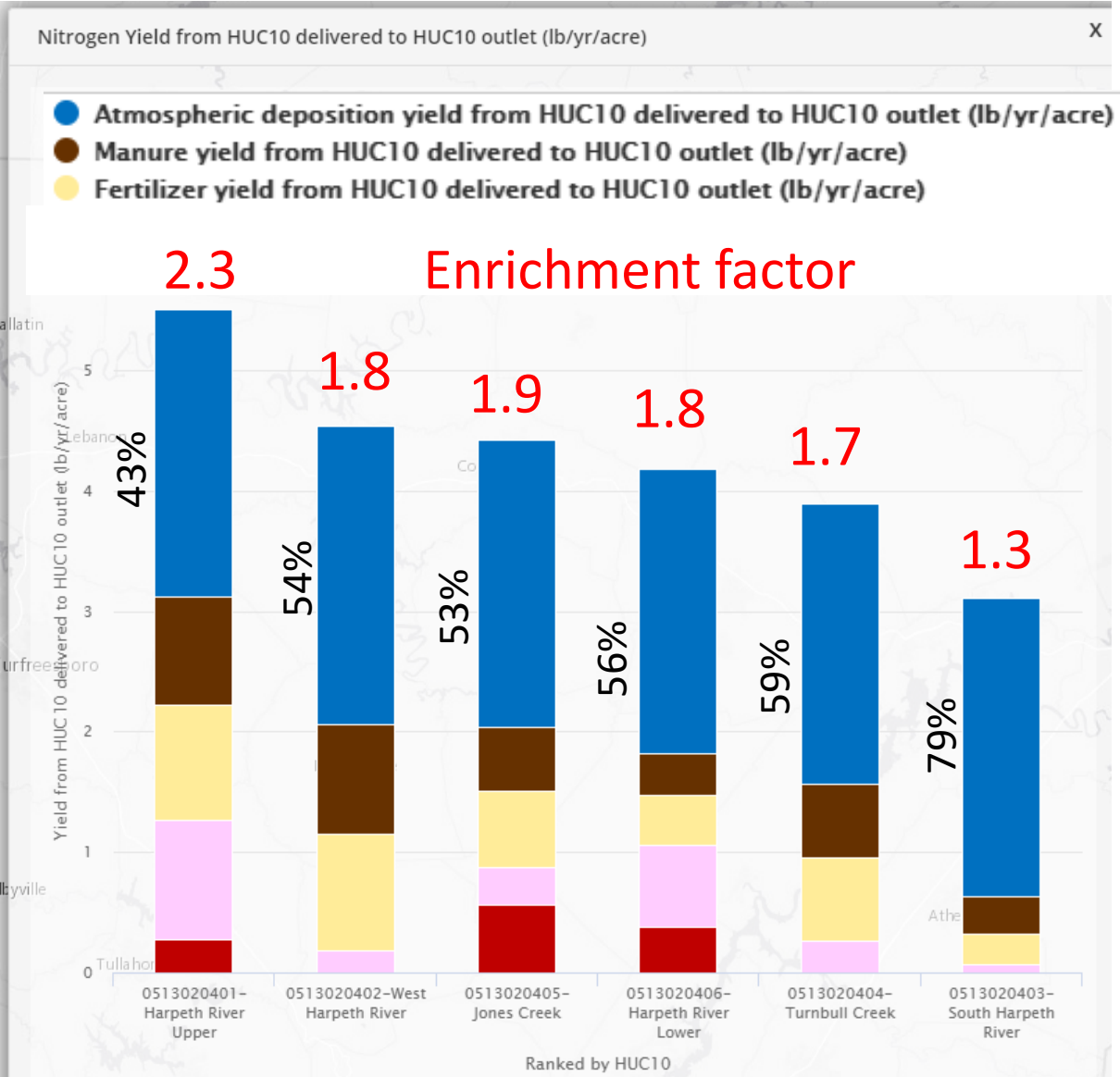
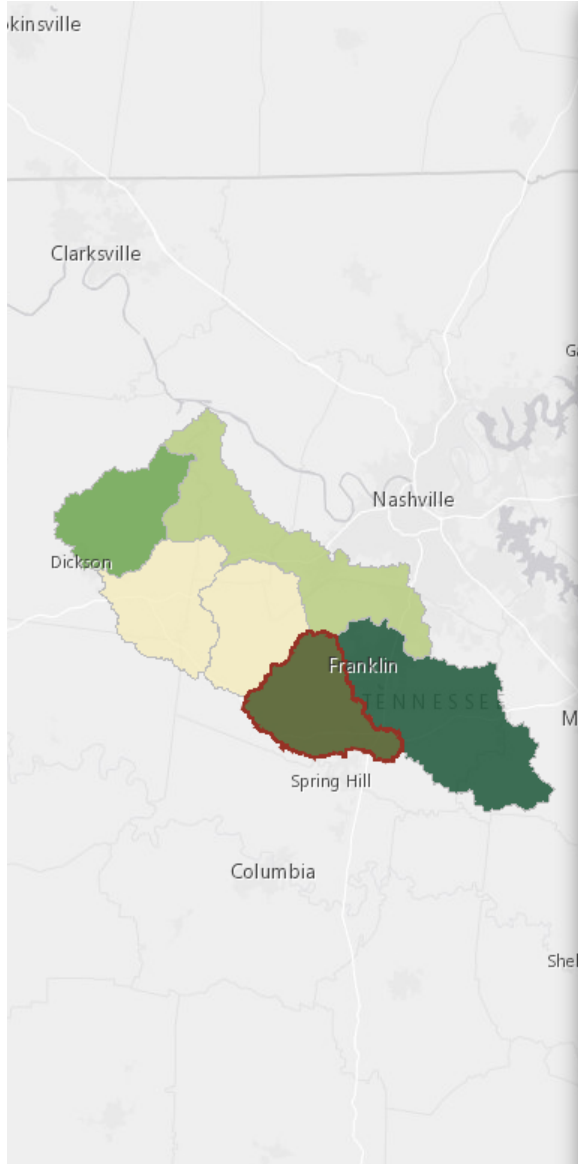


05130204 – Harpeth River - Nitrogen

Hovering over bar highlights the map unit and reports load/yield from individual source



Enrichment factor: inverse of percent contribution from 'background'



SPARROW results are useful ...

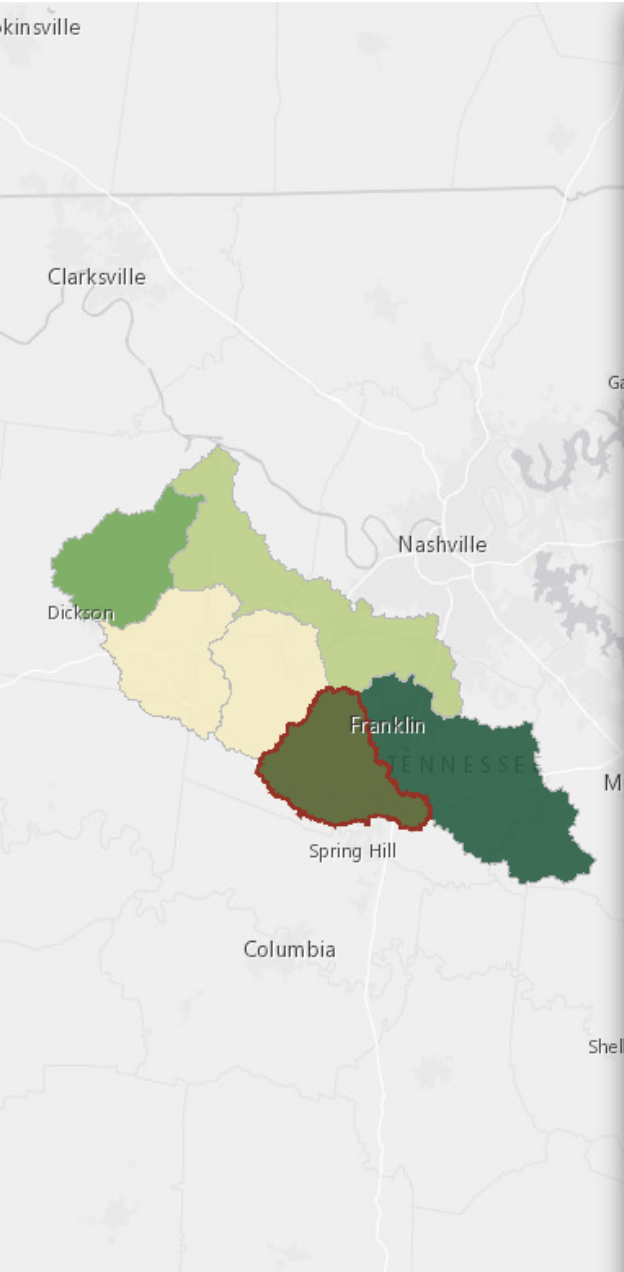
- ◆ where assessments need to be extrapolated/applied across a large region (need consistent data and methods over wide areal extent)
- ◆ where decision-making is based on relative contribution of different watershed sources
- ◆ where a future scenario is evaluated for its effect on nutrient delivery downstream

Second Tool: The Tennessee “SPARROW nutrient calculator” (Excel spreadsheet)

HUC10_comb	PNAME	Wastewater_LBperyear	Urban_SQMI	AtmosphericDep_LBperyear	Manure_Lbperyear	Fertilizer_LBperyear
0513010103	GREASY CR	0	0.160428	41998.67	3179.569	4705.431
0513010103	CUMBERLAND R	19504.031	0.317382	42974.21	2822.178	3612.556
0513010103	STRAIGHT CR	0	0.045252	6415.835	384.6401	617.2716
0513010103	STRAIGHT CR	69.511669	0.382016	138198.7	10387.27	1413.713
0513010103	STRAIGHT CR, LEFT FK	0	0.299041	89317.19	8145.079	556.5563

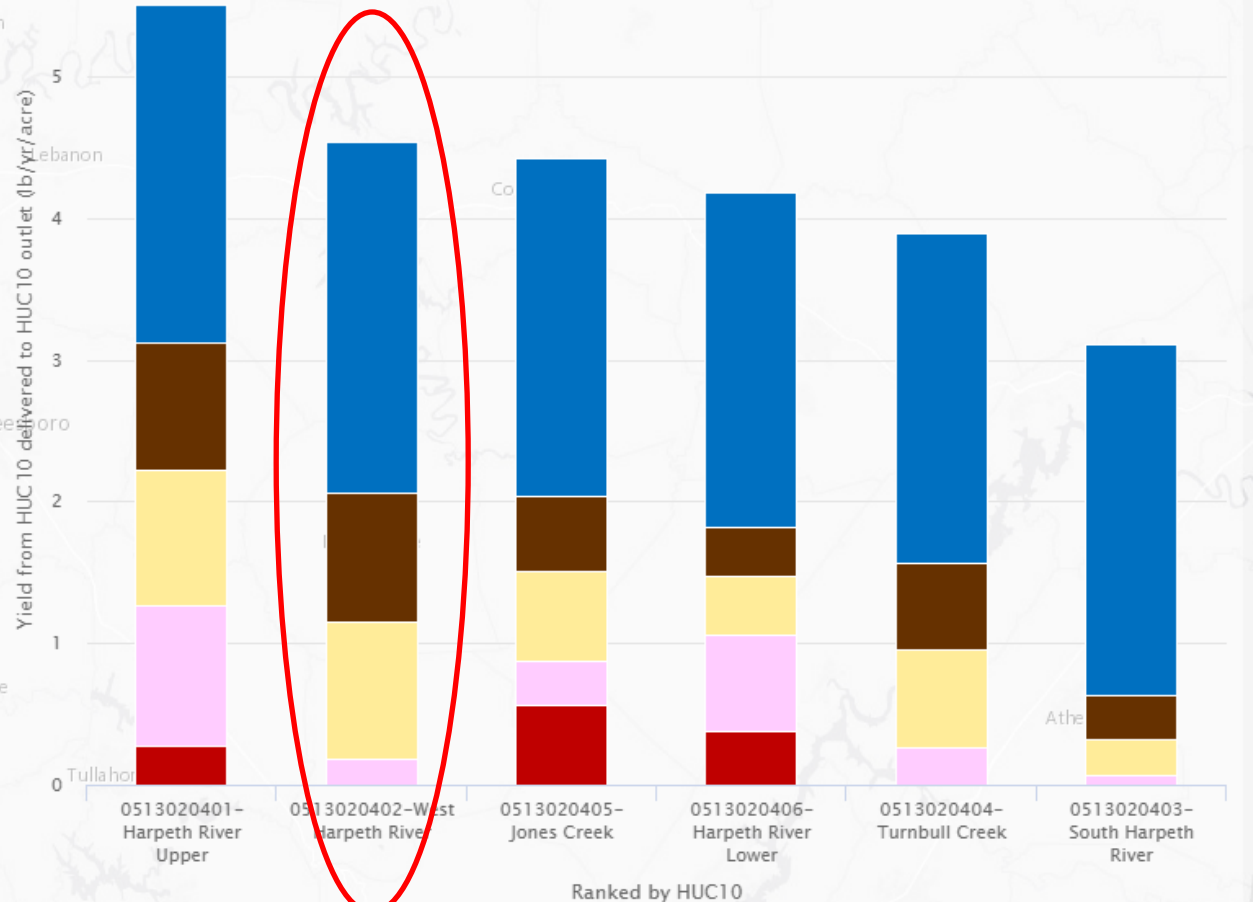
- User modifies source amounts; the spreadsheet then calculates and charts change in stream load delivered to HUC10 and HUC8 pour points and downstream targets

West Harpeth River, 0513020402, Nitrogen



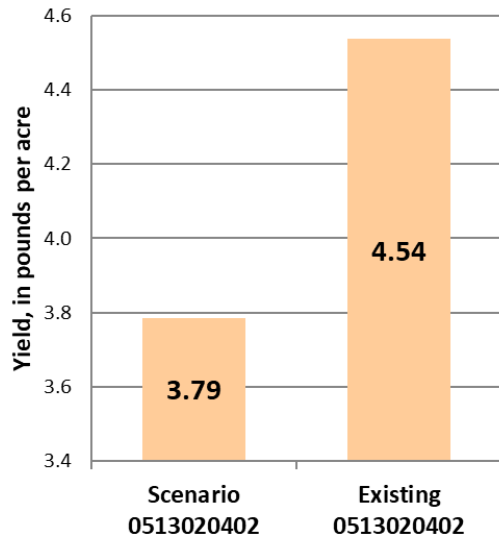
Nitrogen Yield from HUC10 delivered to HUC10 outlet (lb/yr/acre)

- Atmospheric deposition yield from HUC10 delivered to HUC10 outlet (lb/yr/acre)
- Manure yield from HUC10 delivered to HUC10 outlet (lb/yr/acre)
- Fertilizer yield from HUC10 delivered to HUC10 outlet (lb/yr/acre)
- Urban-land yield from HUC10 delivered to HUC10 outlet (lb/yr/acre)
- Wastewater yield from HUC10 delivered to HUC10 outlet (lb/yr/acre)

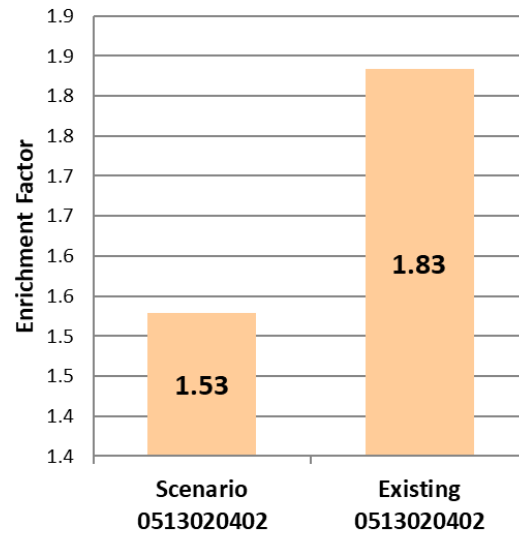


Reduce agricultural input to West Harpeth River HUC10 by 40%

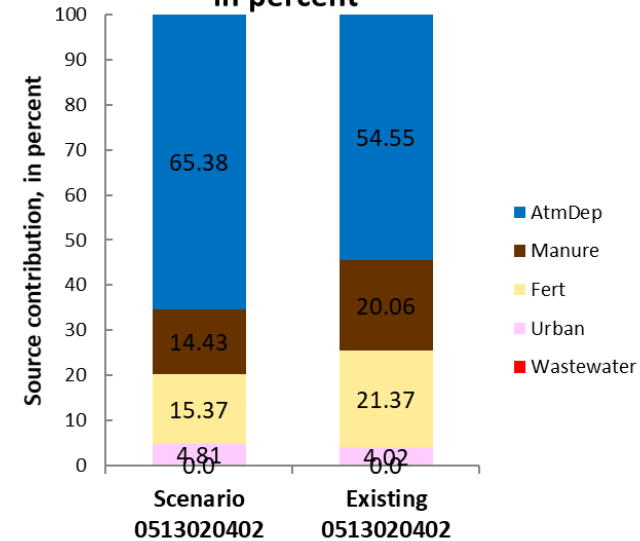
Yield, in pounds per acre



Enrichment Factor



Contribution from each source, in percent



SPARROW products for Tennessee

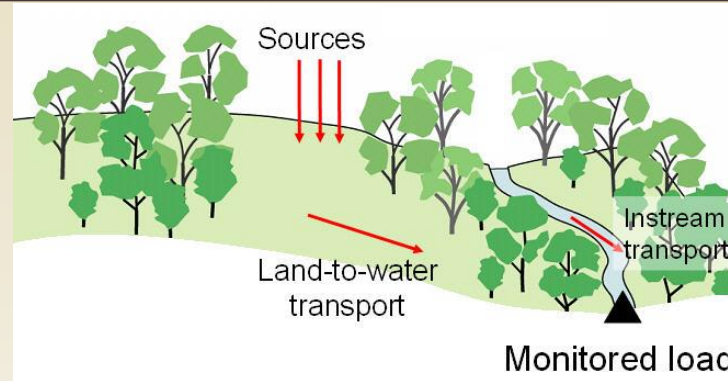
developed by USGS, in collaboration with TDEC

- Online mapper:
<https://sparrow.wim.usgs.gov/sparrow-tennessee/>
(Google chrome compatible)
- SPARROW nitrogen and phosphorus calculators:
<https://doi.org/10.5066/P96RWGU0>
- Paper describing development of the Tennessee SPARROW models from the Southeast region model:
<https://doi.org/10.1016/j.envsoft.2019.01.001>

vroland@usgs.gov abhoos@usgs.gov

Questions ??

Model limitations



TOTAL NITROGEN

TOTAL PHOSPHORUS

Average
error

35 %

55 %

Sources of error:

- Not accounting for all nutrient source categories
- Input estimates incorrect (for some reaches)

Prediction error is smaller for larger areal units (HUC10, HUC8) than for individual reaches