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science for a changing world

Watershed-scale changes in nitrate and total phosphorus in the Lower & Upper Fox River watersheds:

Improvements in point source contributions but mixed responses from nonpoint sources

Fox River Study Group: Lunch 'n Learn
May 1, 2025 (virtual)

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

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Scope of effort

Time periods

1997–2011, 2012–2017, 2018–2022

Loads & yields [total, point, nonpoint]

* Nitrate+Nitrite, as N (NO3)
* Total phosphorus (TP)
* % dissolved and particulate phosphorus (DP & PP)
* Water yields

Ambient sites & load estimation

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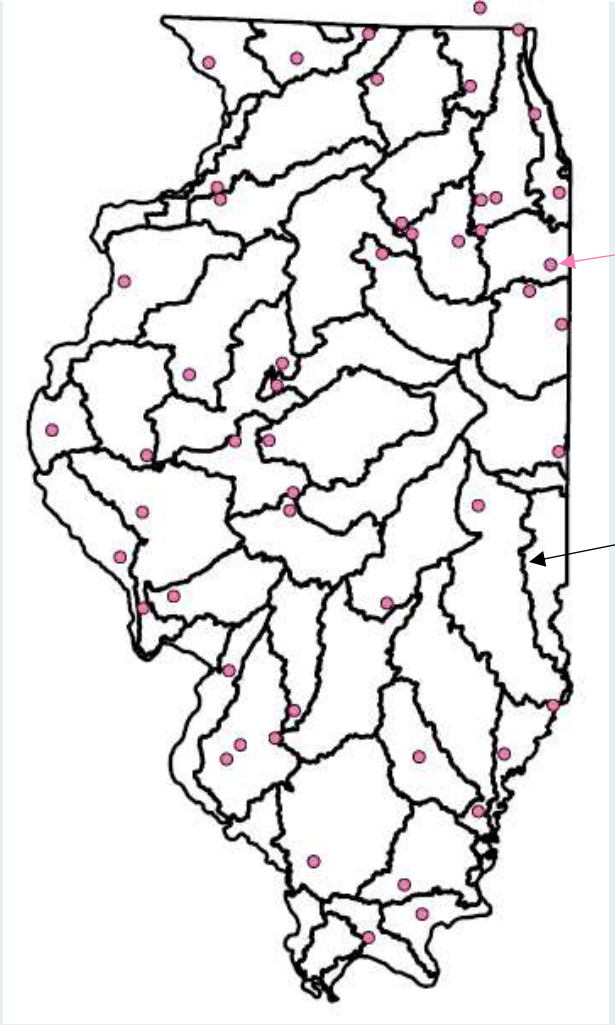
Illinois Environmental Protection Agency (IEPA) ambient sites



Water-quality data sources

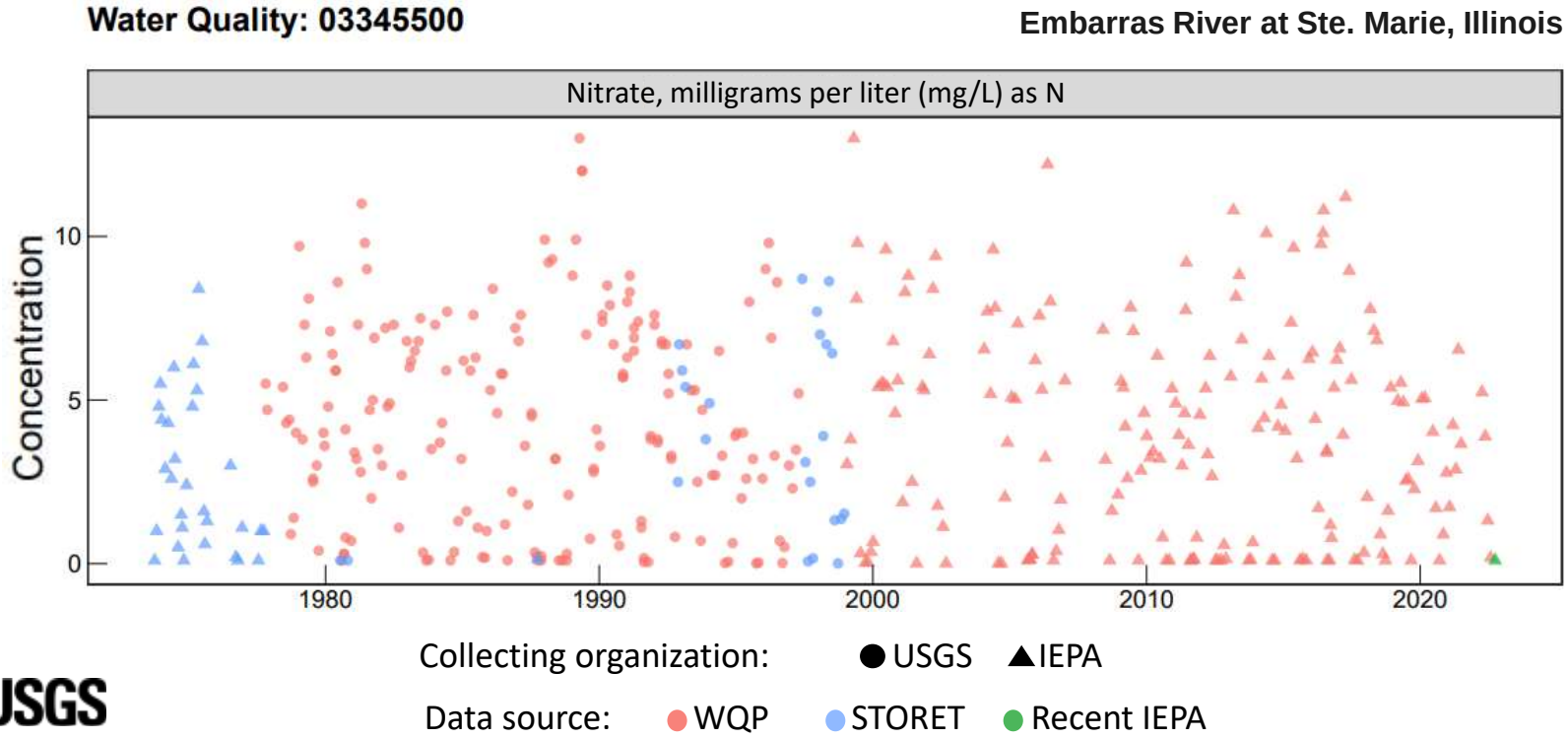
Water Quality Portal (WQP)

Recent Samples from *IEPA

Legacy IEPA Data from *STORET

*Illinois Environmental Protection Agency (IEPA)
*STOrage and RETrieval (STORET) Data Warehouse

Example of water-quality time series



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Load estimation: Weighted Regressions on Time, Discharge, and Season (WRTDS)

$$\ln(c) = \beta_0 + \beta_1 Q + \beta_2 t + \beta_3 \sin(2\pi t) + \beta_4 \cos(2\pi t) + \varepsilon$$

Concentration

Stream flow

Time trend

Seasonal cycle

Random component

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Random component

+ Kalman Filter post-processing procedure

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HUC8 load and yield computations

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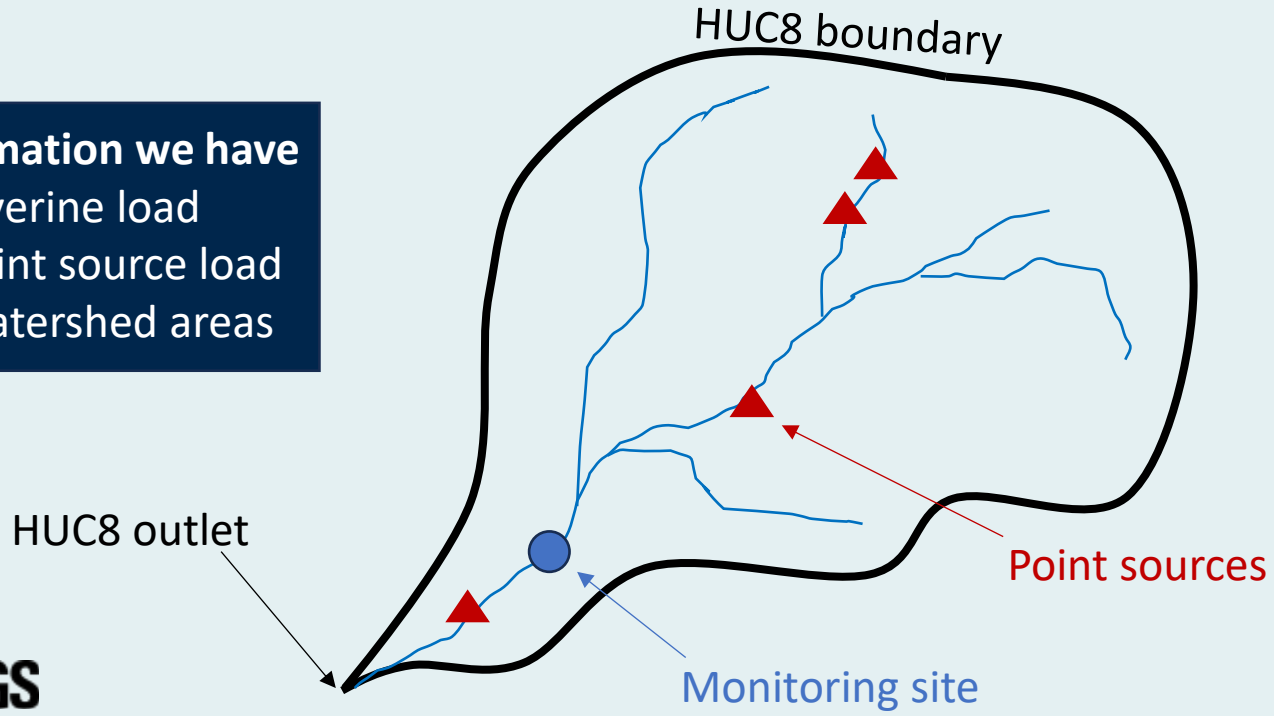
Ambient loads → Incremental HUC8 loads

Information we have

- Riverine load
- Point source load
- Watershed areas



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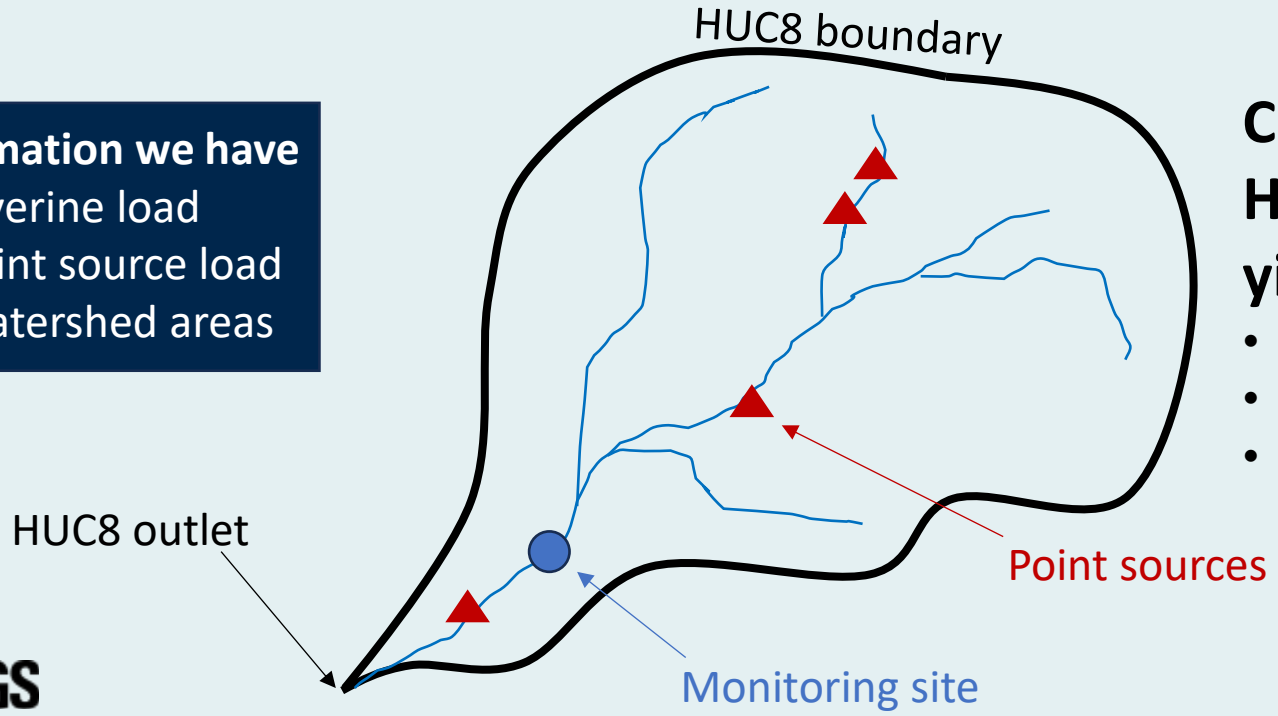

Computed HUC8 loads and yields for
- Total (riverine)
- Point source
- Nonpoint source

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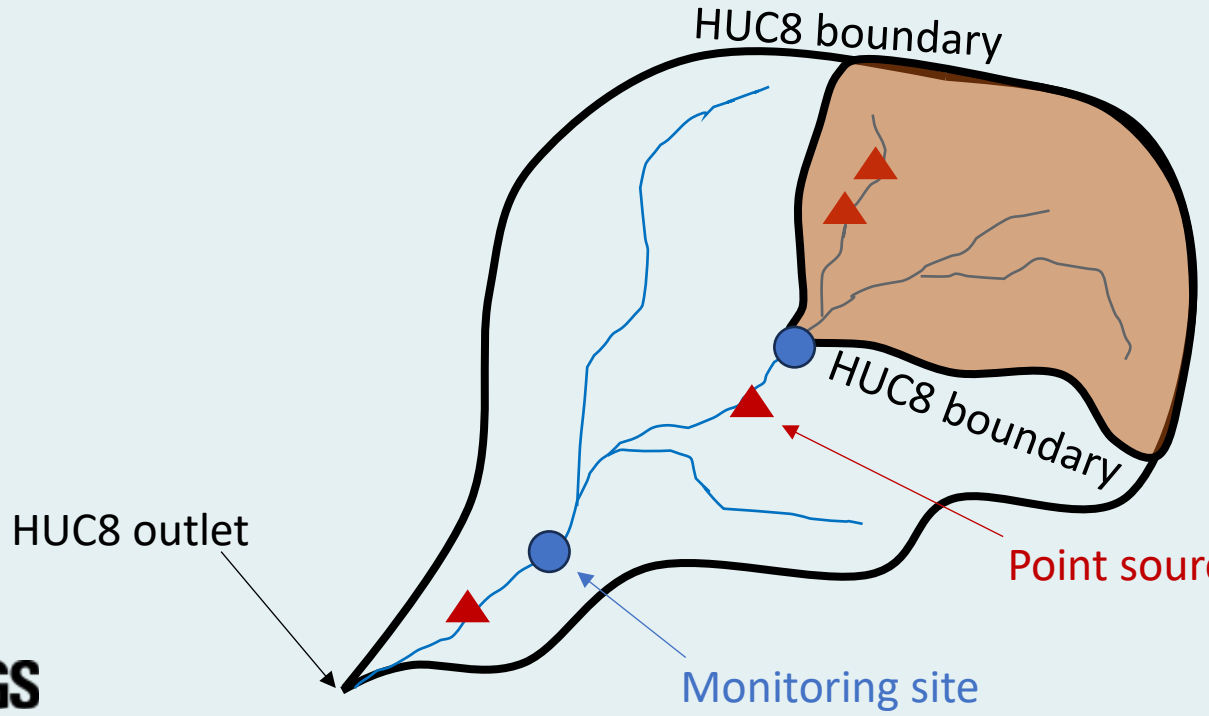
Ambient loads → Incremental HUC8 loads



Computed HUC8 loads and yields for

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Report and Datasets

Kamrath, B.J.W., Murphy, J.C., Podzorski, H.L., Schafer, L.A., and McIsaac, G.F., 2025, **Diverging trends in nitrate and phosphorus loads and yields across Illinois watersheds, 1997–2022**: EarthArXiv preprint https://doi.org/10.31223/X50H77

Podzorski, H.L., Murphy, J.C., Kamrath, B.J., and Schafer, L.A., 2025, **Estimation of annual and monthly loads of nitrate + nitrite, total phosphorous, and dissolved phosphorus in Illinois for water years 1974 to 2022**: USGS data release, https://doi.org/10.5066/P1TB3ENJ

Kamrath, B.J.W., Podzorski, H.L., Schafer, L.A., and Murphy, J.C. 2025, **Average annual loads and yields of nitrate and phosphorus from Illinois watersheds (HUC8s) for three periods between 1997 and 2022**: USGS data release, https://doi.org/10.5066/P13GTMFS

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Lower & Upper Fox River Watersheds
Illinois only

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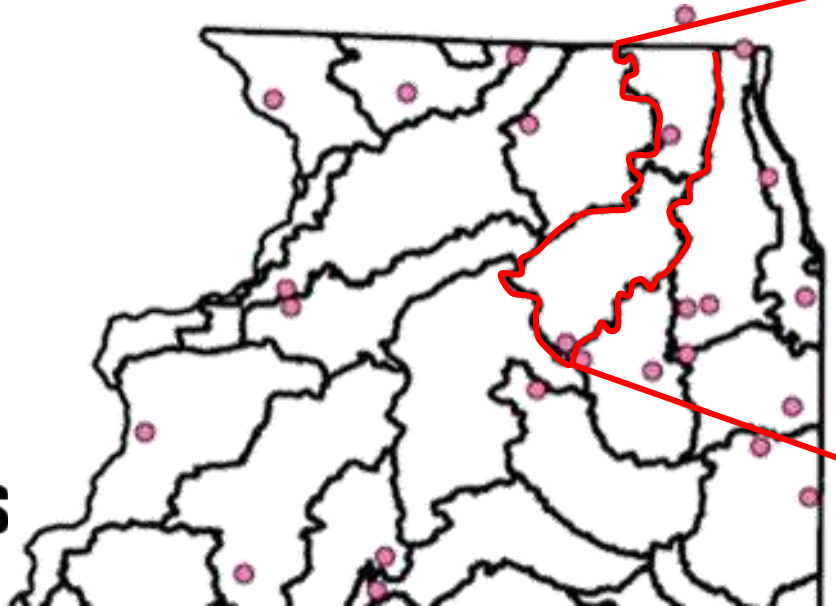
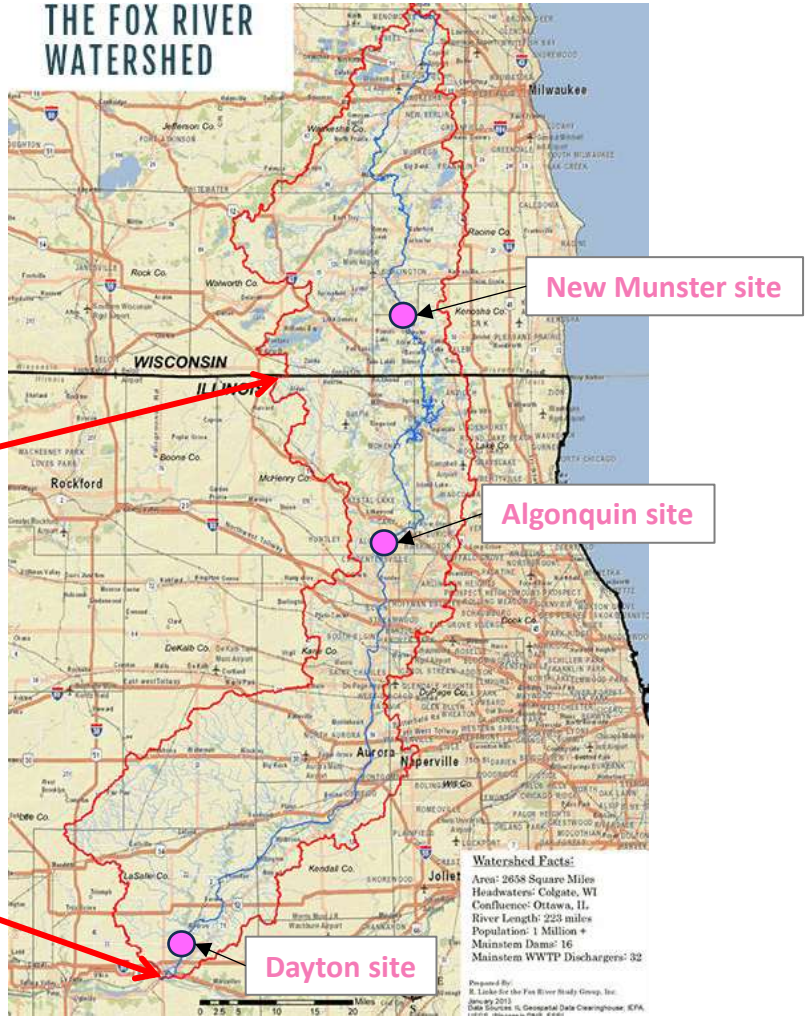
Upper Fox River HUC

New Munster (WI) site → Algonquin site

Lower Fox River HUC

Algonquin site → Dayton site





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Lower & Upper Fox River Watersheds
Nitrate

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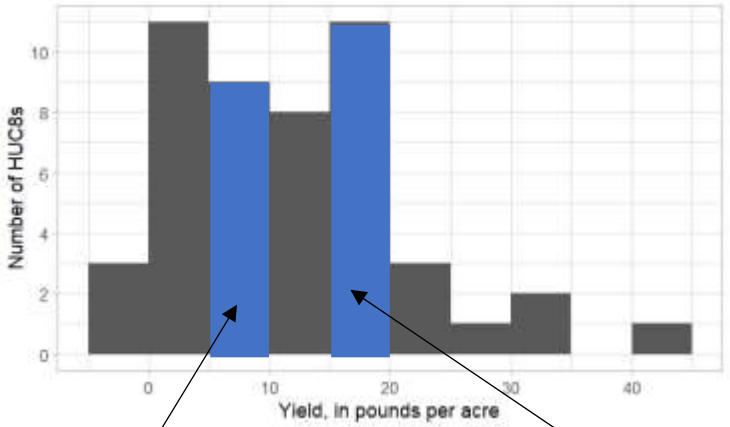
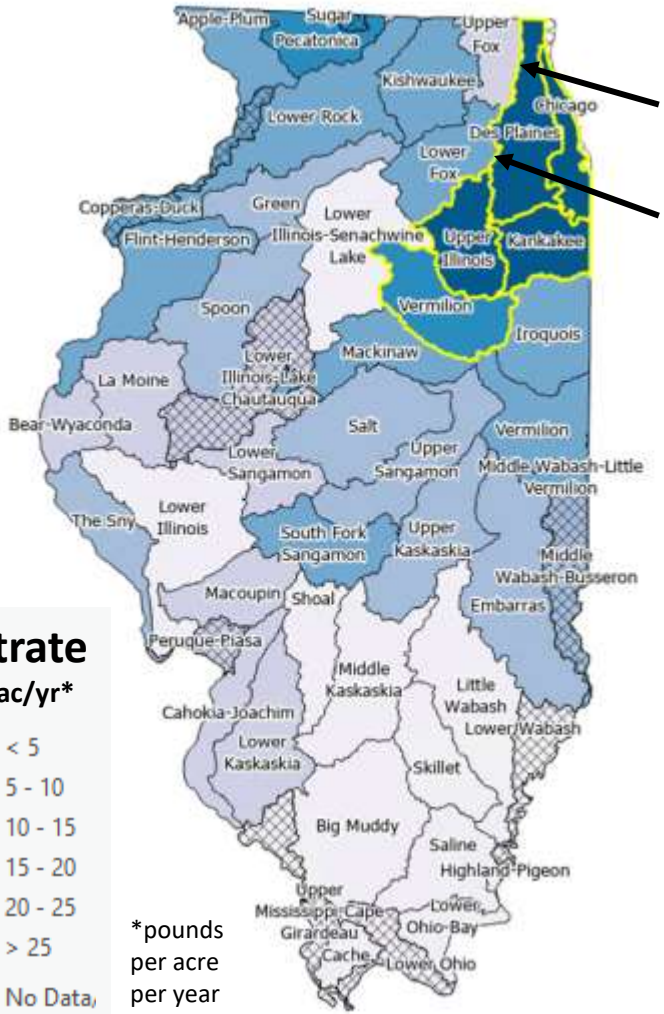
Near some of the highest nitrate yielding watersheds in Illinois



Upper Fox:
8 lbs/ac/yr

Lower Fox:
16 lbs/ac/yr



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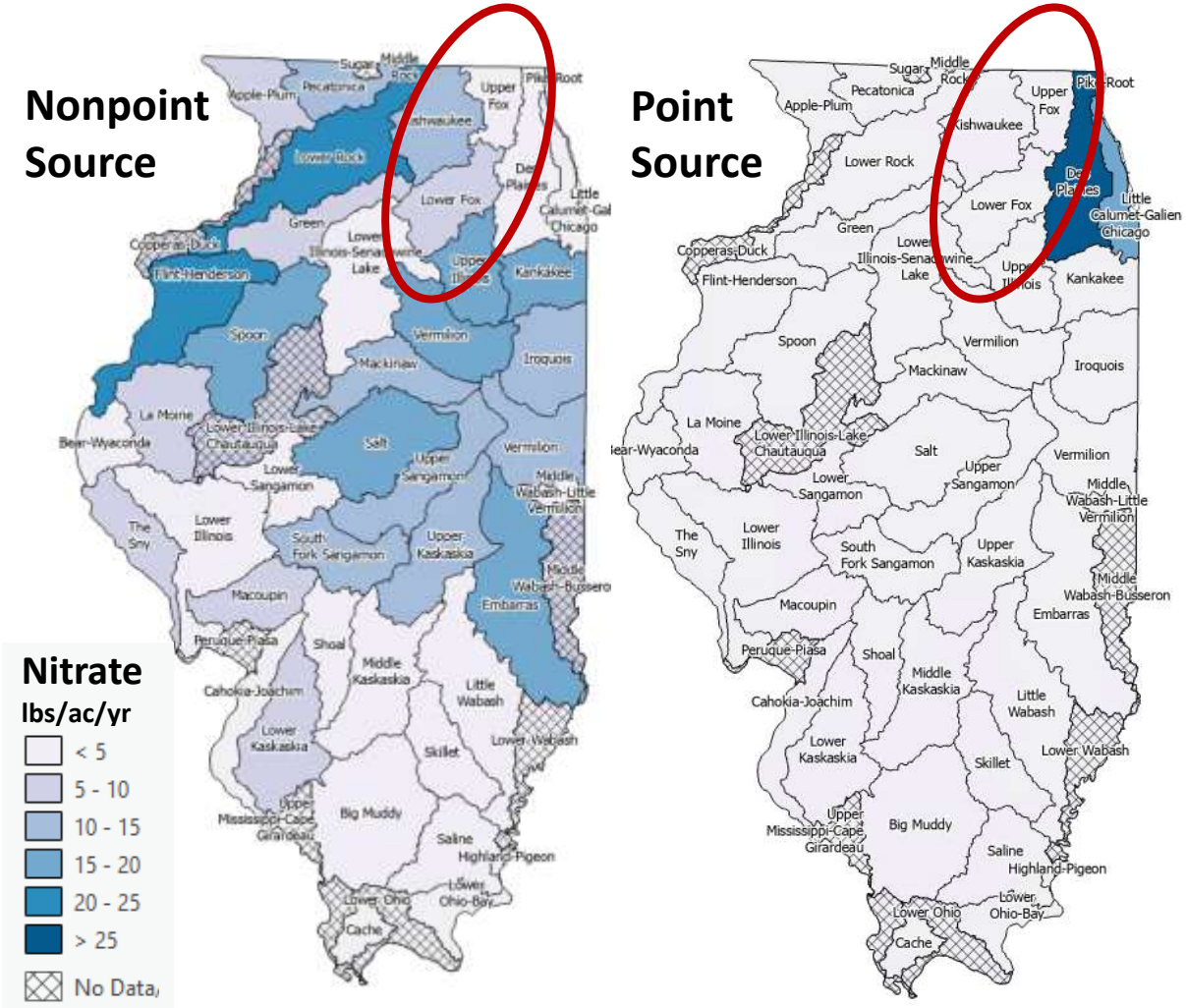
Substantial point source contributions



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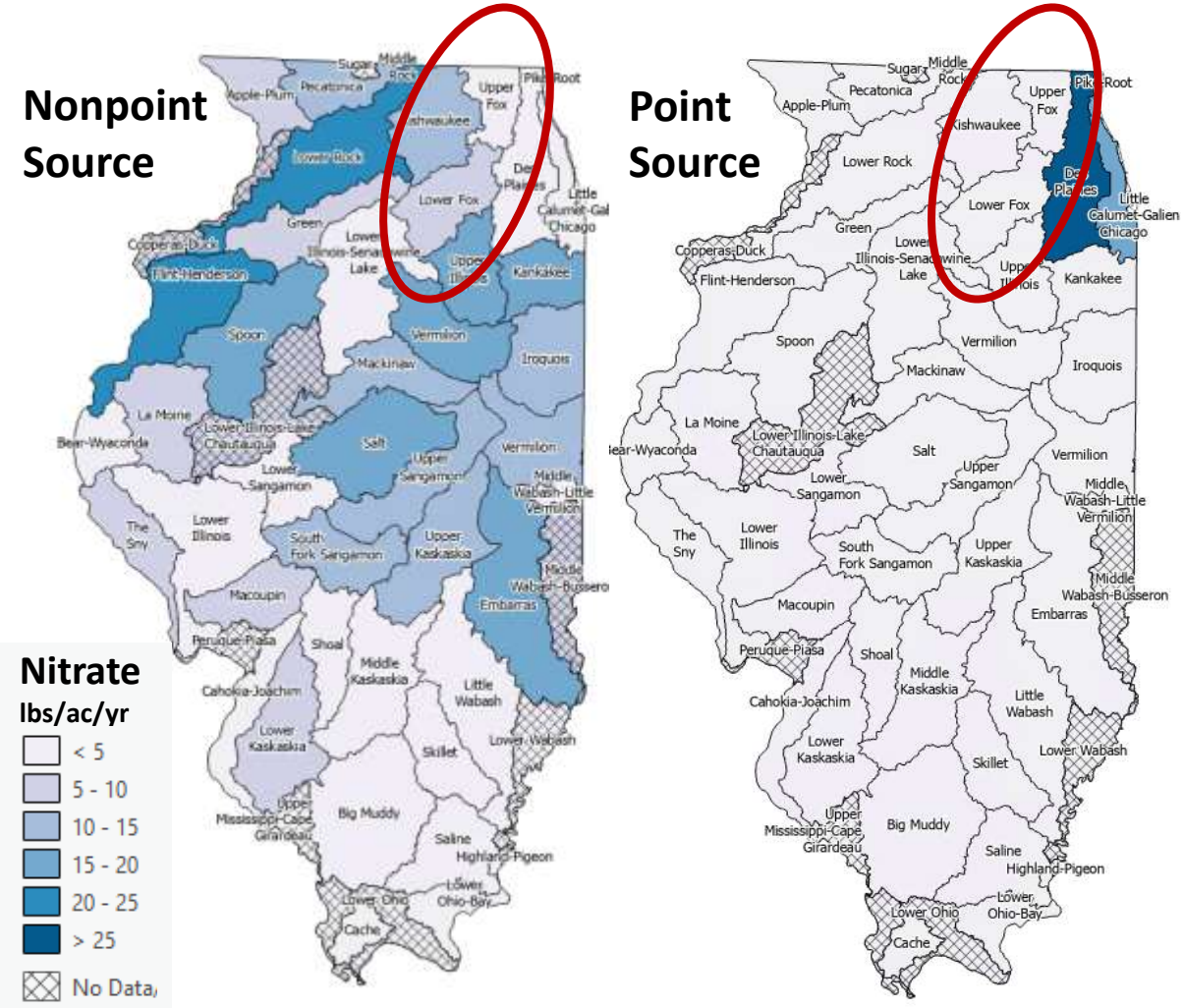
Substantial point source contributions

Percent of total load

	Non-point source	Point source
Upper Fox	~0%**	~100%**
Lower Fox	26%	74%



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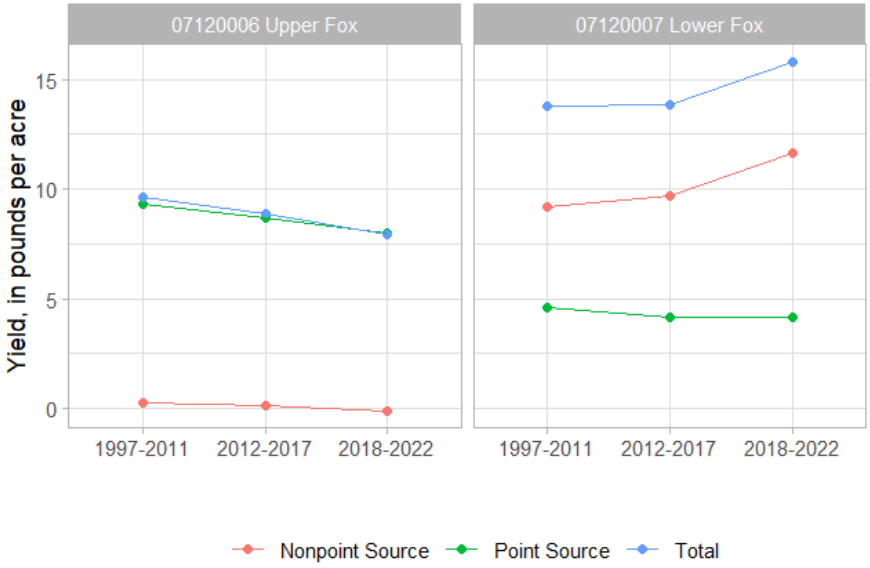
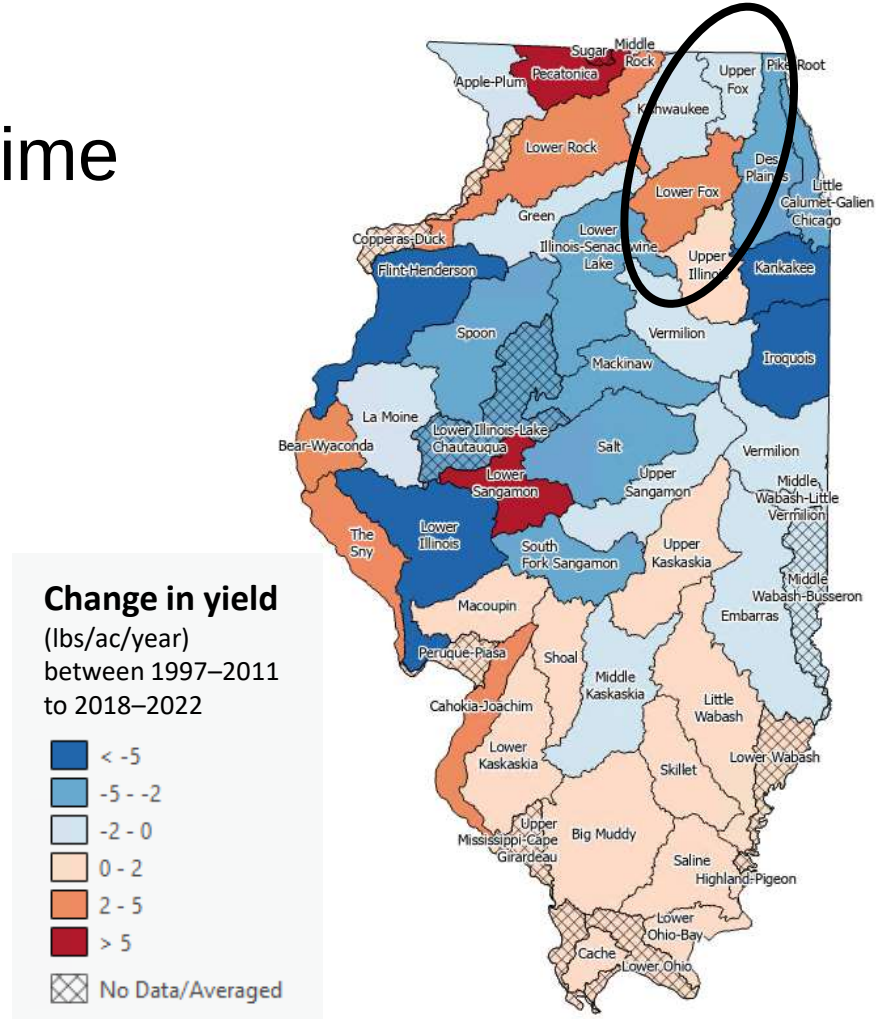
How nitrate changed over time





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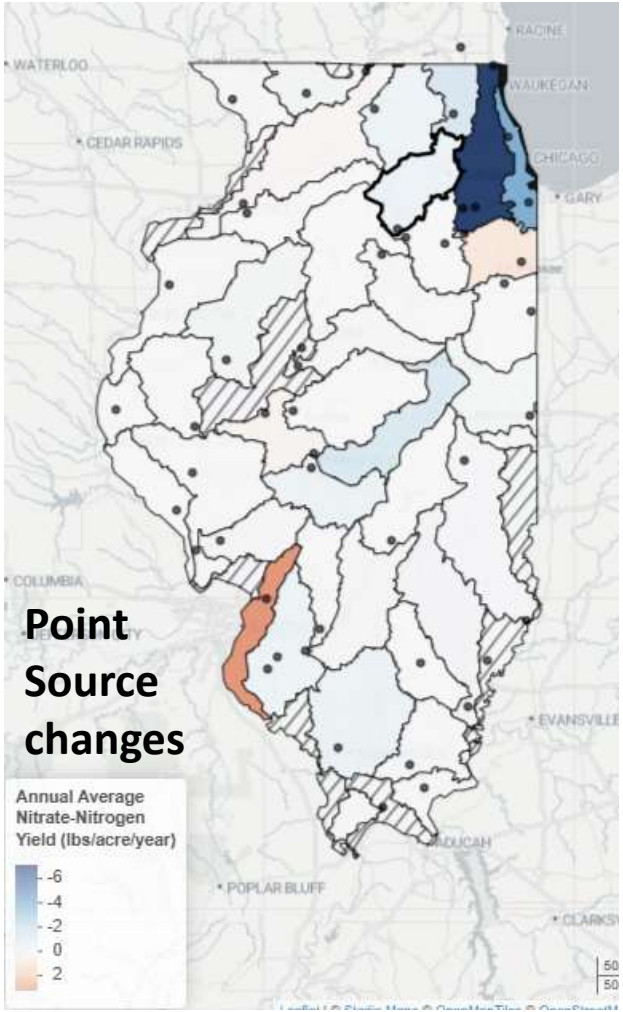
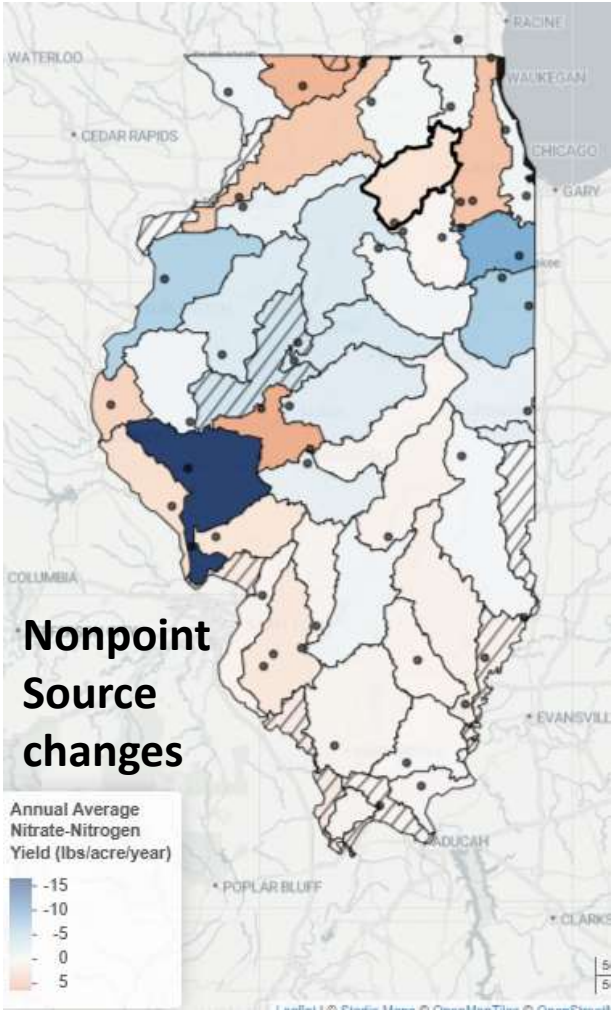
Changes from **Baseline** (1997-2011) to **Recent** (2018-2022)





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Lower & Upper Fox River Watersheds
Total Phosphorus

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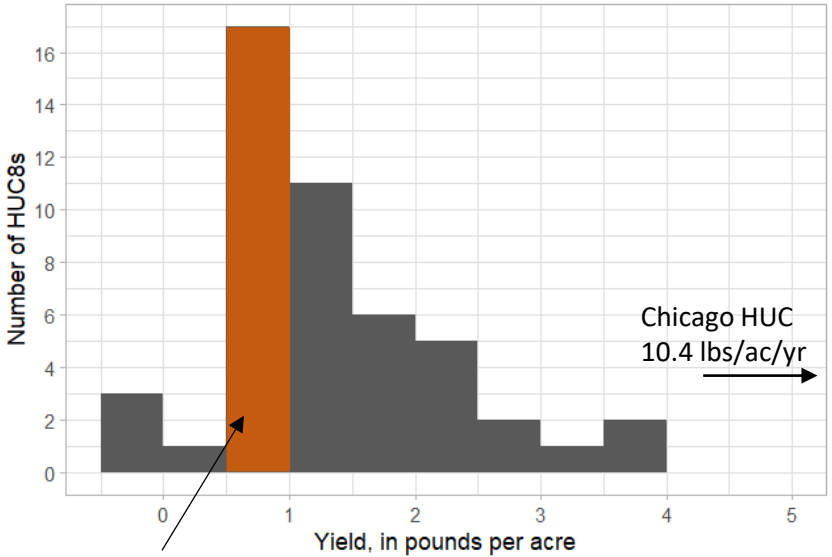
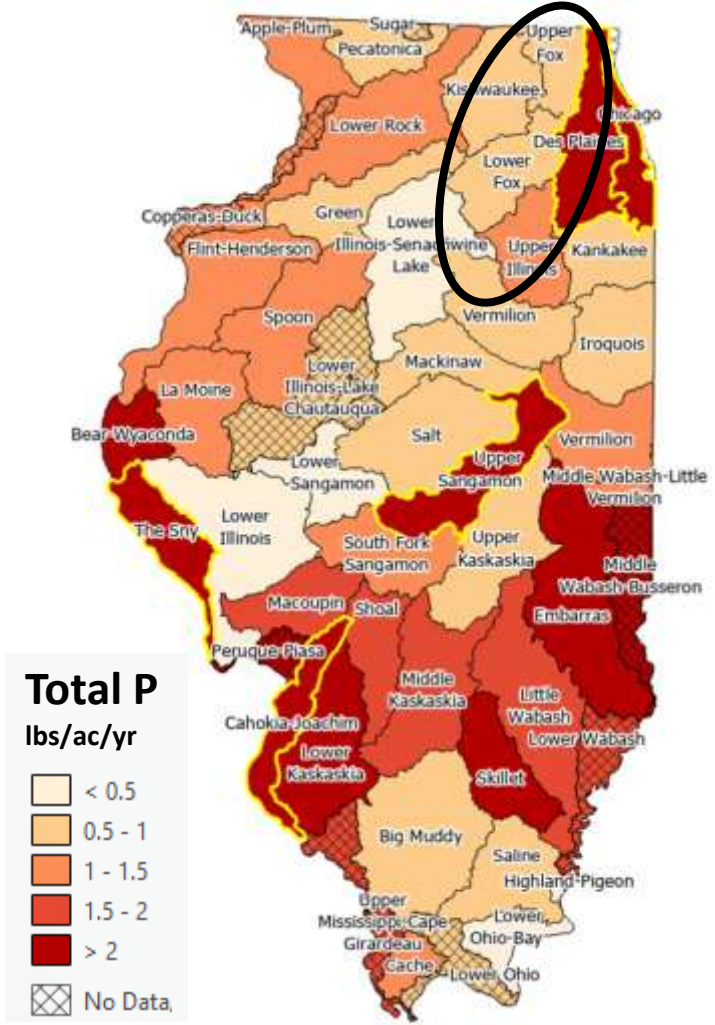
Below average TP yields



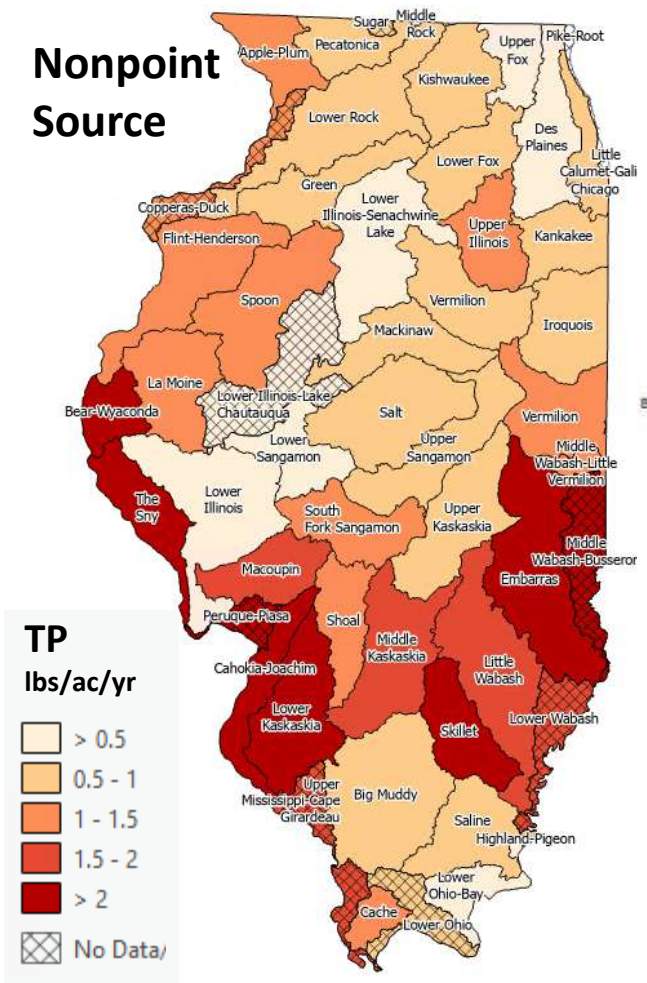
Upper Fox: 0.8 lbs/ac/yr
Lower Fox: 0.8 lbs/ac/yr



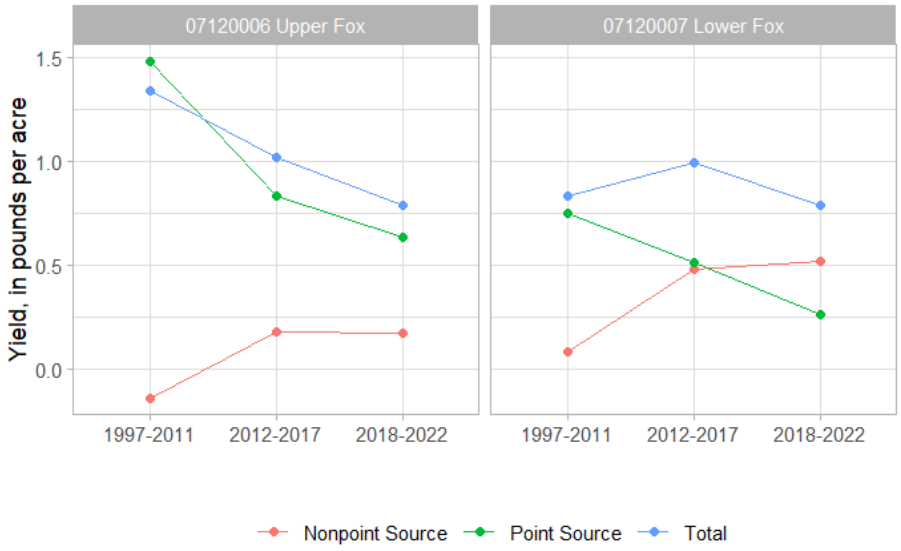
Still substantial point source contributions

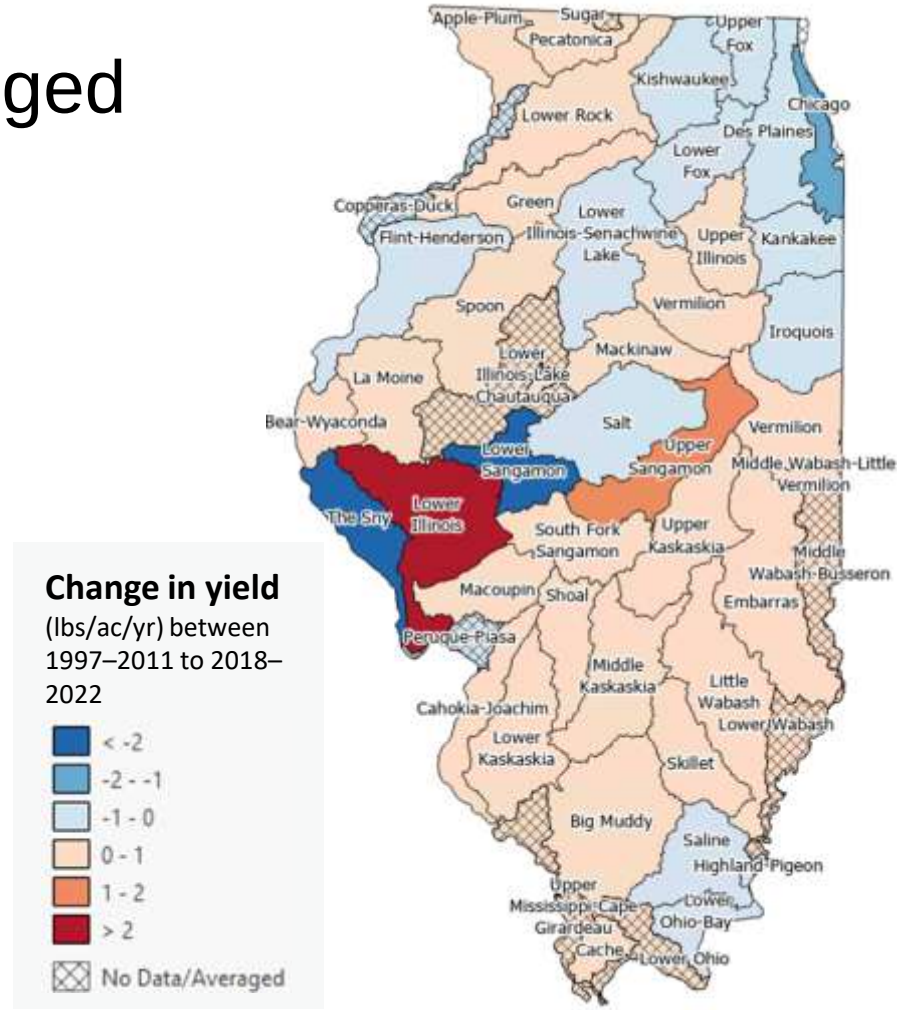
Percent of total load

	Non-point source	Point source
Upper Fox	20%	80%
Lower Fox	66%	33%



How total phosphorus changed over time





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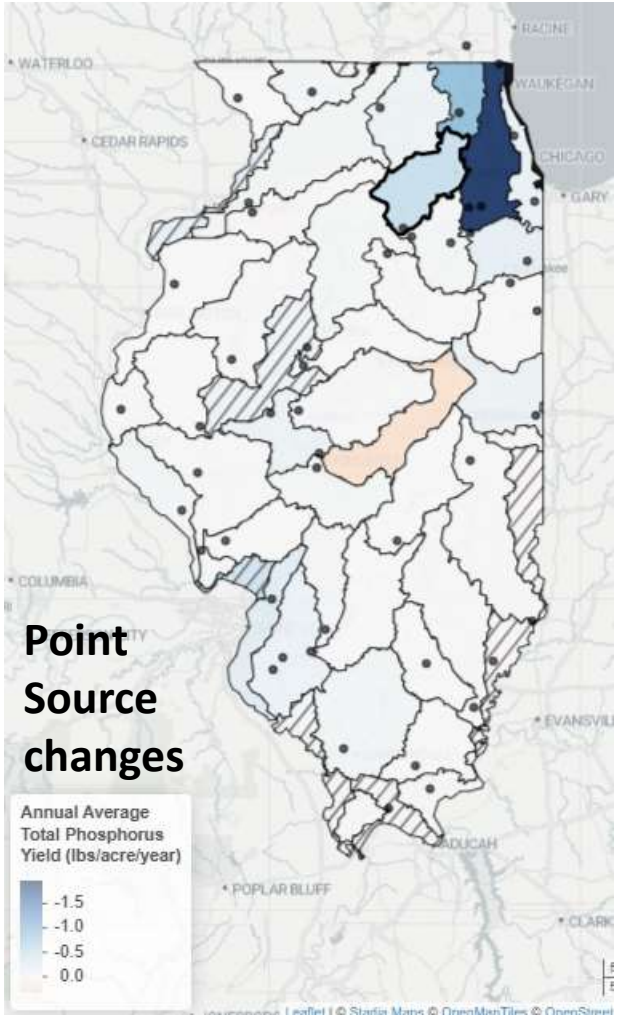

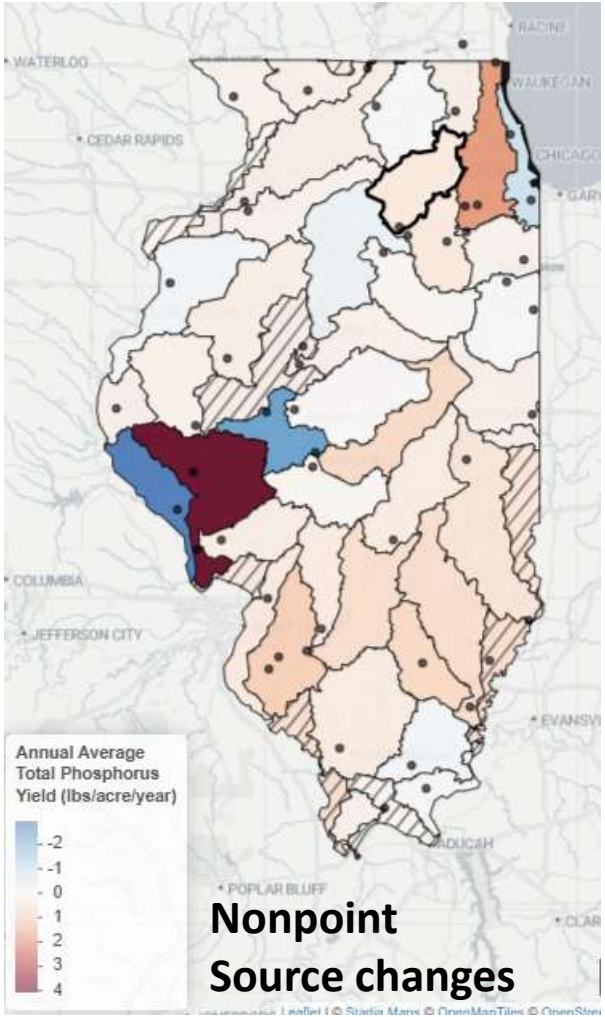

Conclusions

- Recent NO3 and TP yields near mean for the State

Fox River Bridge in South Elgin

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Conclusions

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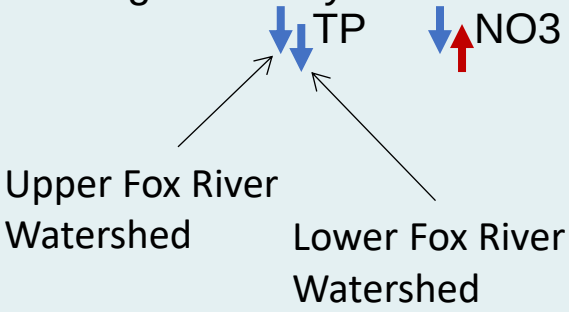
- Change in total yields:

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Conclusions

- Recent NO3 and TP yields near mean for the State
- Change in total yields:
  ↓TP ↓↑NO3
- High % of total yield from point sources (PS)
- High PS yields


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Conclusions

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- Change in total yields:
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- Change in PS yields:
  ↓TP ↓NO3


Fox River Bridge in South Elgin

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Conclusions

jmurphy@usgs.gov

- Recent NO3 and TP yields near mean for the State
- Change in total yields:
  ↓TP ↓↑NO3
- High % of total yield from point sources (PS)
- High PS yields
- Change in PS yields:
  ↓TP ↓NO3
- Change in non-PS yields:
  ↑TP ↓↑NO3

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