



Phosphorus Inputs to Lake Champlain 1990-2008

preliminary results

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Weighted Regression on Time, Discharge and Season (WRTDS)

- Change description, not hypothesis testing
- Decompose the record into four components
 - Time (long-term trend)
 - Discharge
 - Seasonal
 - Random
- Estimate concentration and flux, for every day using a highly flexible statistical smoothing model
- Also create results that are “free” of the particular flow history (flow-randomized)

What kind of **product**
do we want?

Lake

Watershed

Streamgage
& Sampling
Location



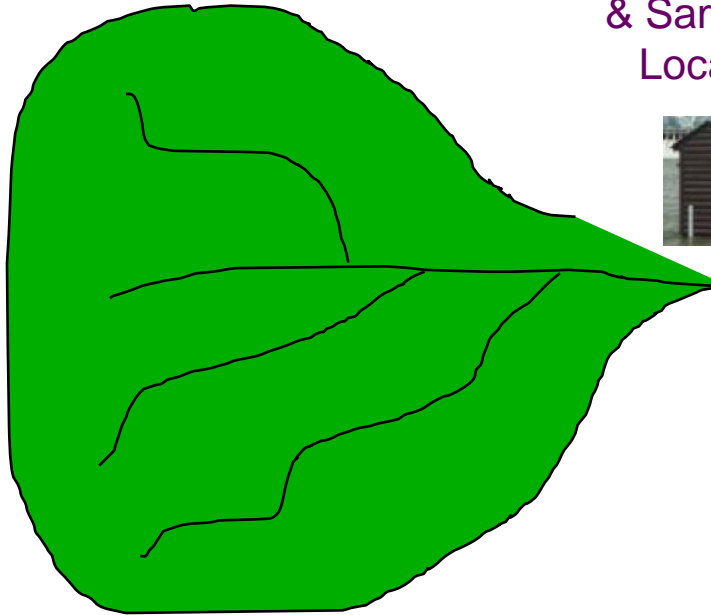
It all depends on what
we are interested in

For understanding **processes** in the Lake

Lake

Watershed

Streamgage
& Sampling
Location



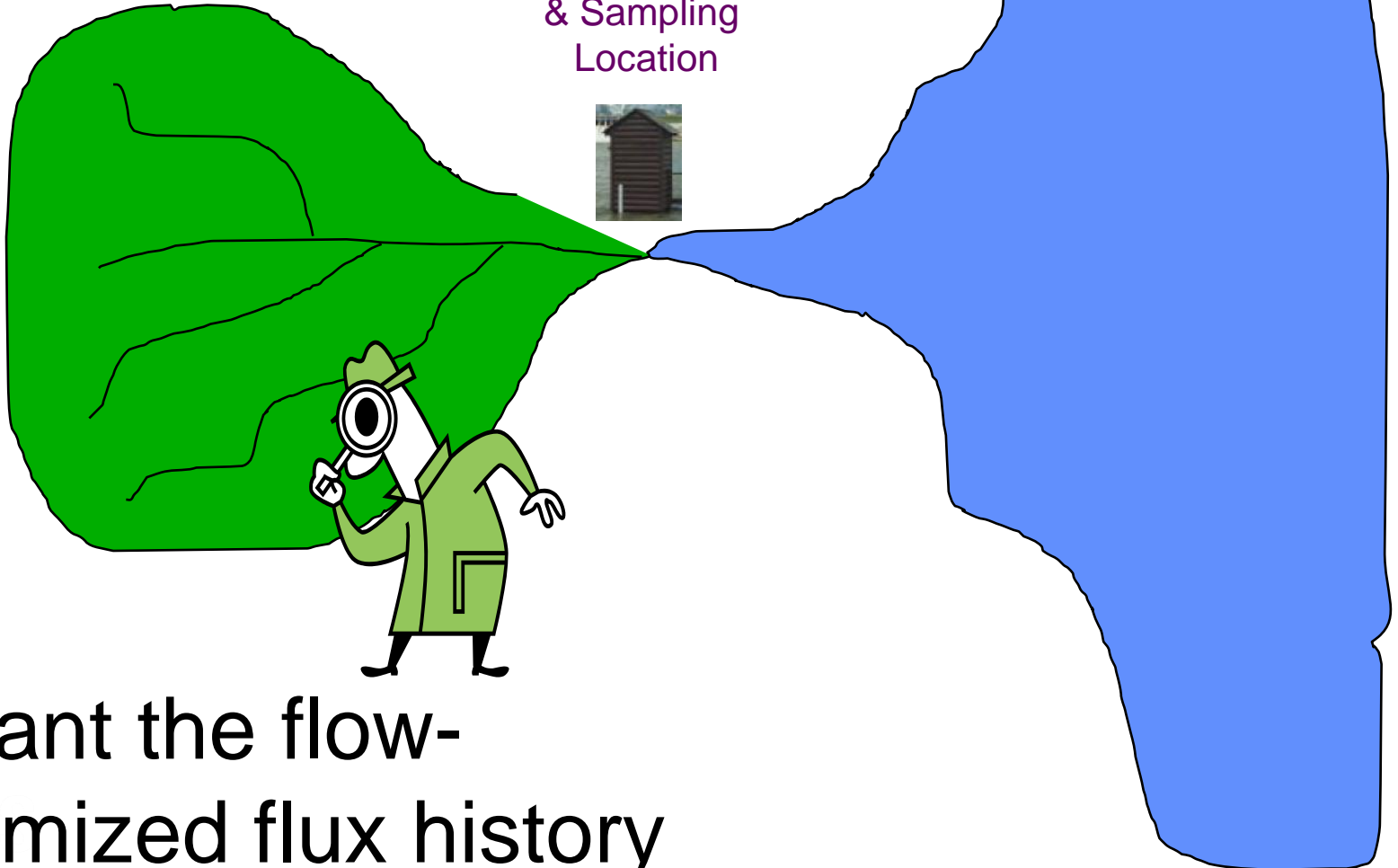
We want the estimated flux history

For understanding
progress in the watershed

Lake

Watershed

Streamgage
& Sampling
Location



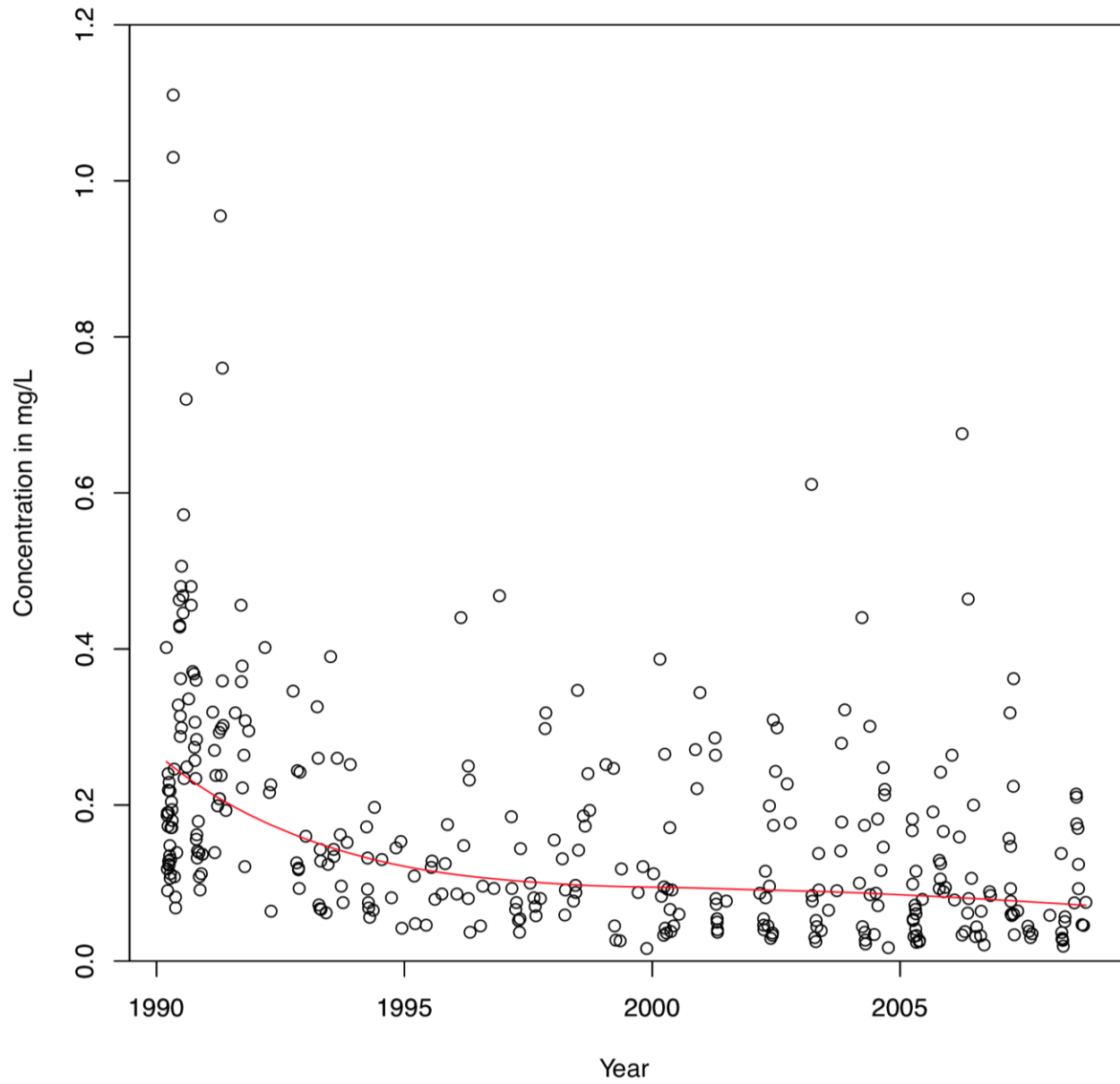
We want the flow-
randomized flux history

Let's look at some data

**LaPlatte River:
352 values over 19 years.**

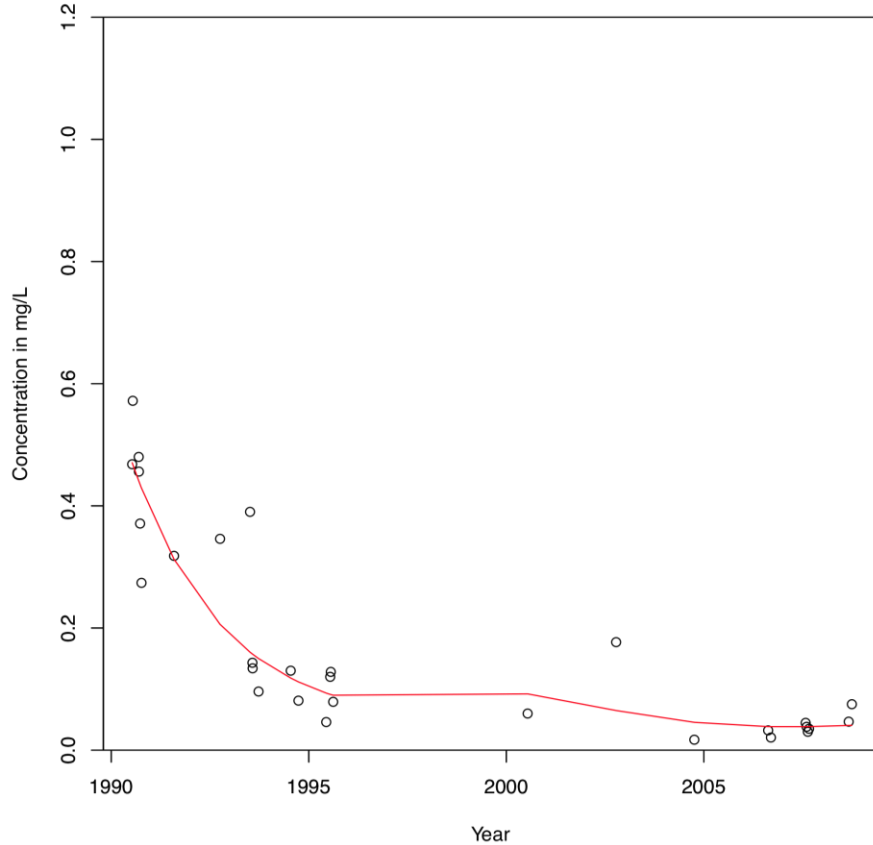
**Even a clear success
story is difficult to understand
unless we “decompose” it .**

Total Phosphorus Concentrations, LaPlatte River



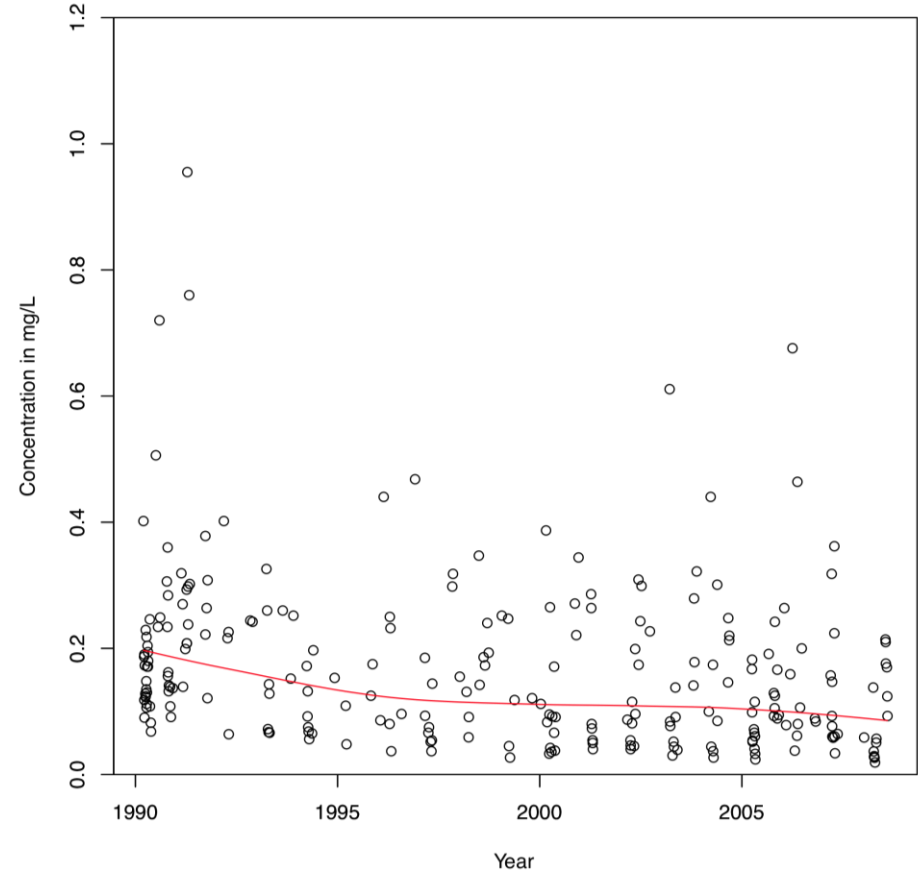
Low Flow

Total Phosphorus Concentrations, LaPlatte River
Discharge less than 8 cfs



High Flow

Total Phosphorus Concentrations, LaPlatte River
Discharge greater than 50 cfs

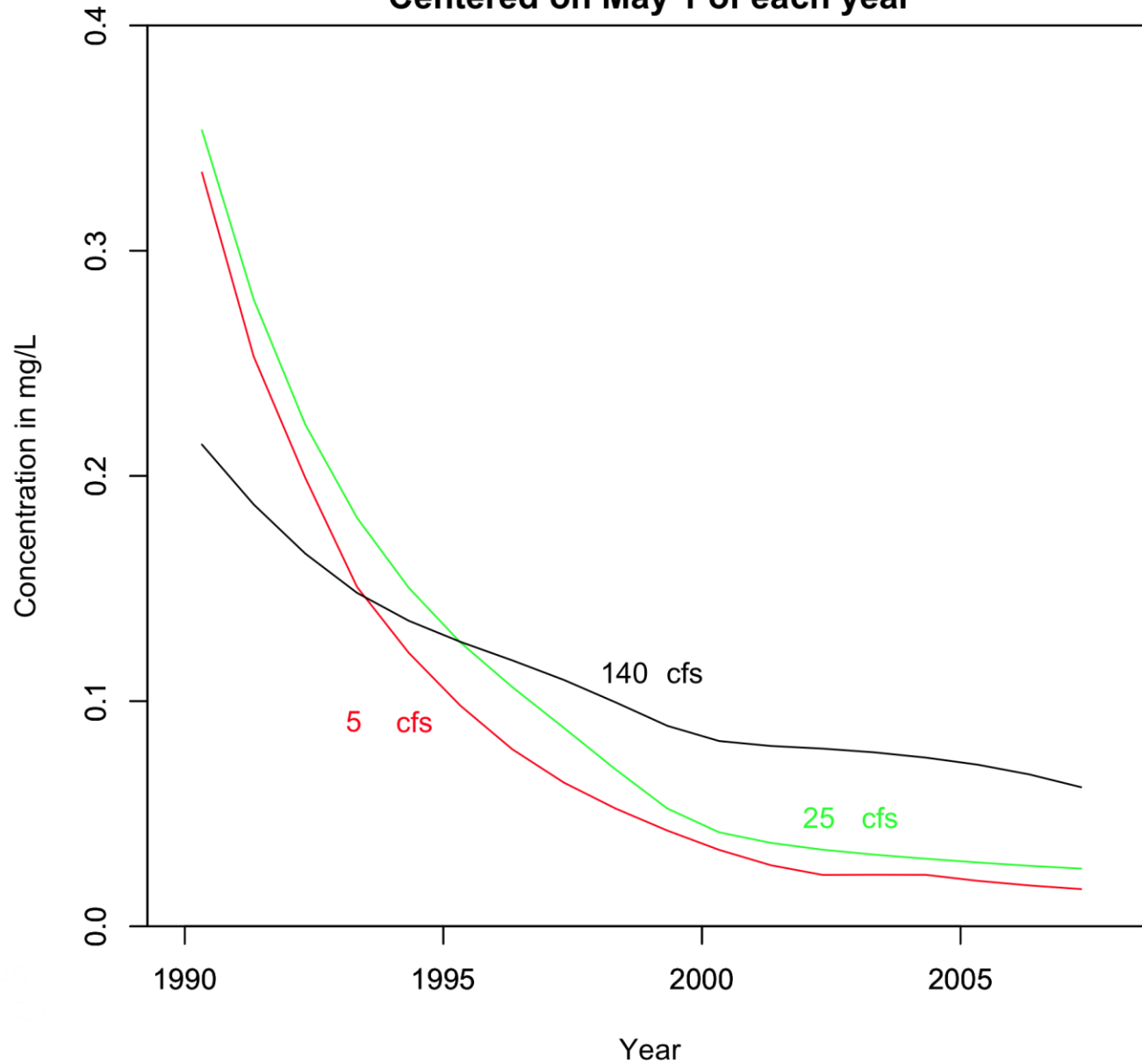


We can subdivide the data into low flow and high flow groups

WRTDS builds a statistical model for estimating concentration and flux for every day

- **Smoothly varying coefficients**
- **Estimates based on year, season, and discharge**

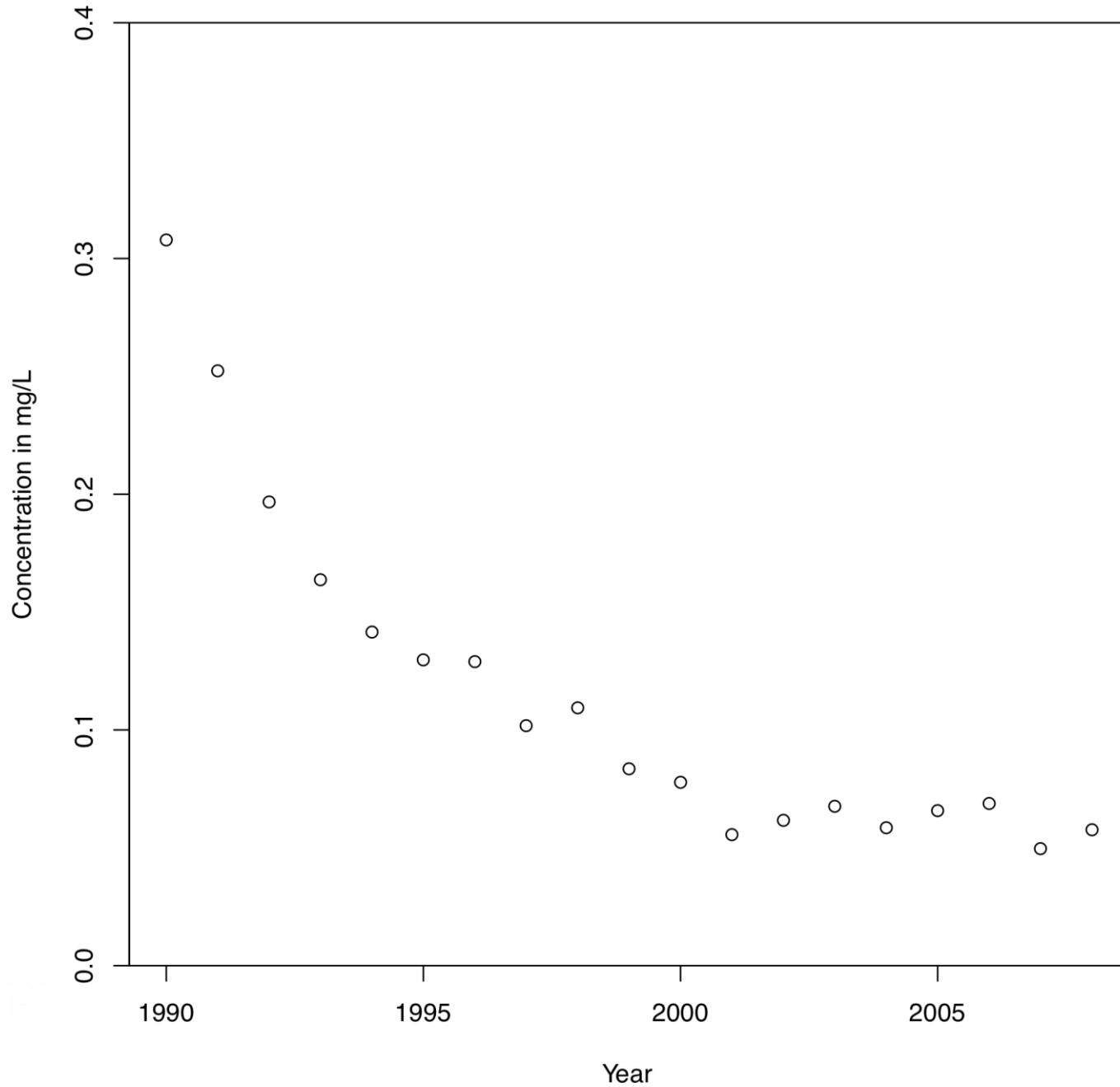
LaPlatte Total Phosphorus Spring Season Estimates Centered on May 1 of each year



WRTDS uses that statistical model to estimate concentration and flux for every day

- **Aggregates to months**
- **Aggregates to years**

LaPlatte River Total Phosphorus Concentration Annual Estimates

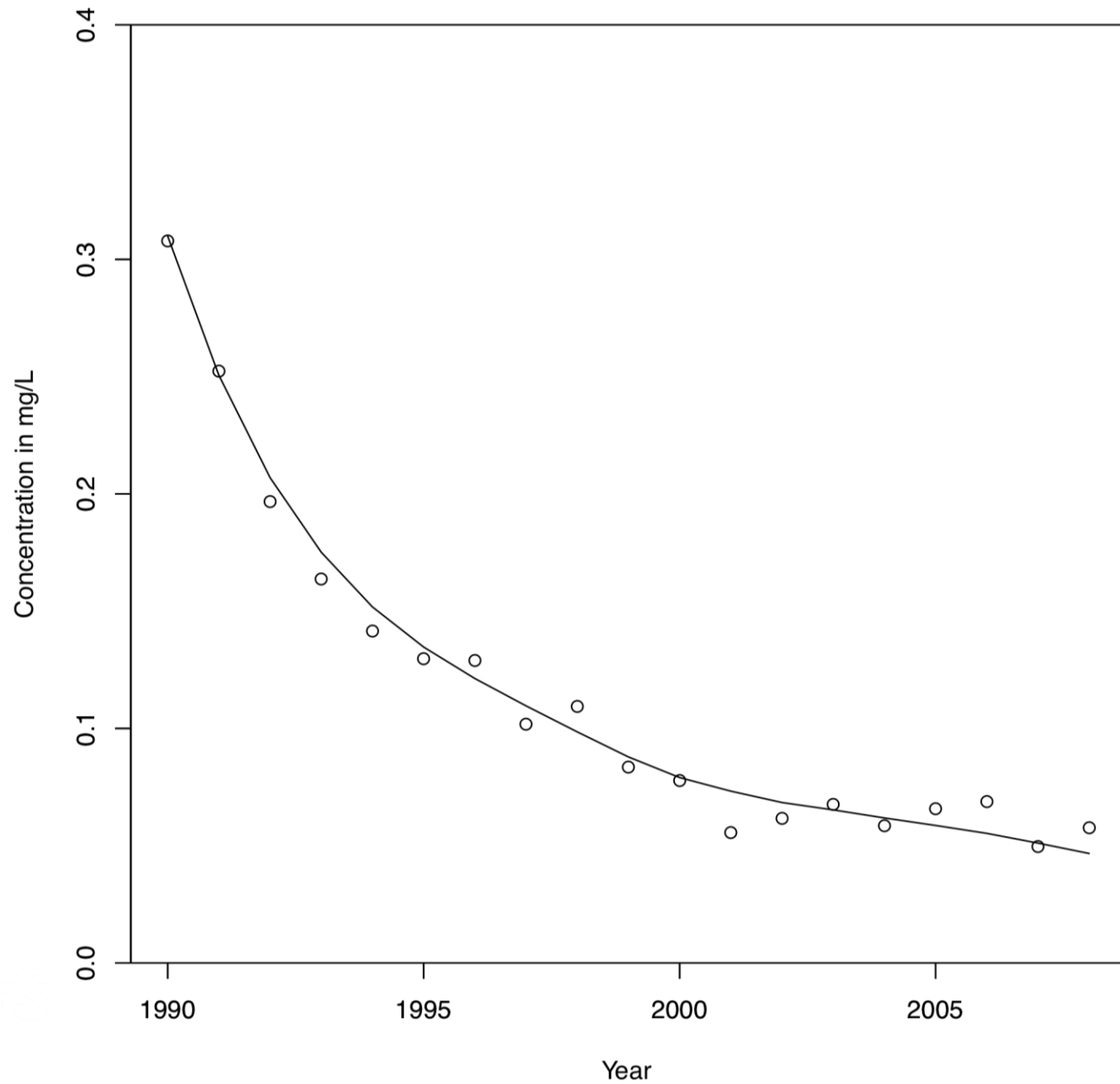


But, we also want estimates that are free of the flow-induced variations

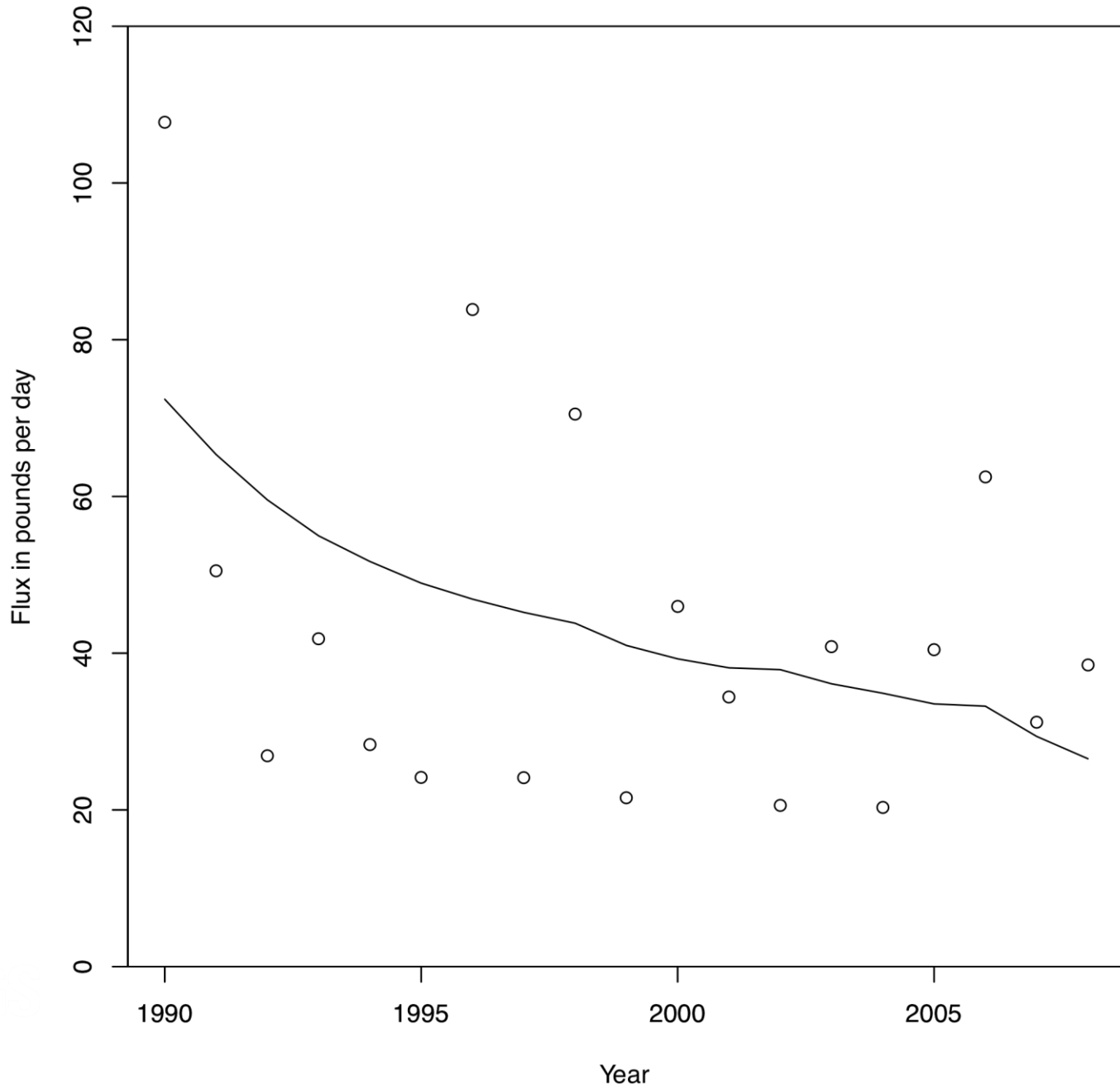
We create the flow-randomized estimates for each day using the same WRTDS model.

But with flows sampled from the entire historic population of flows for that day of the year.

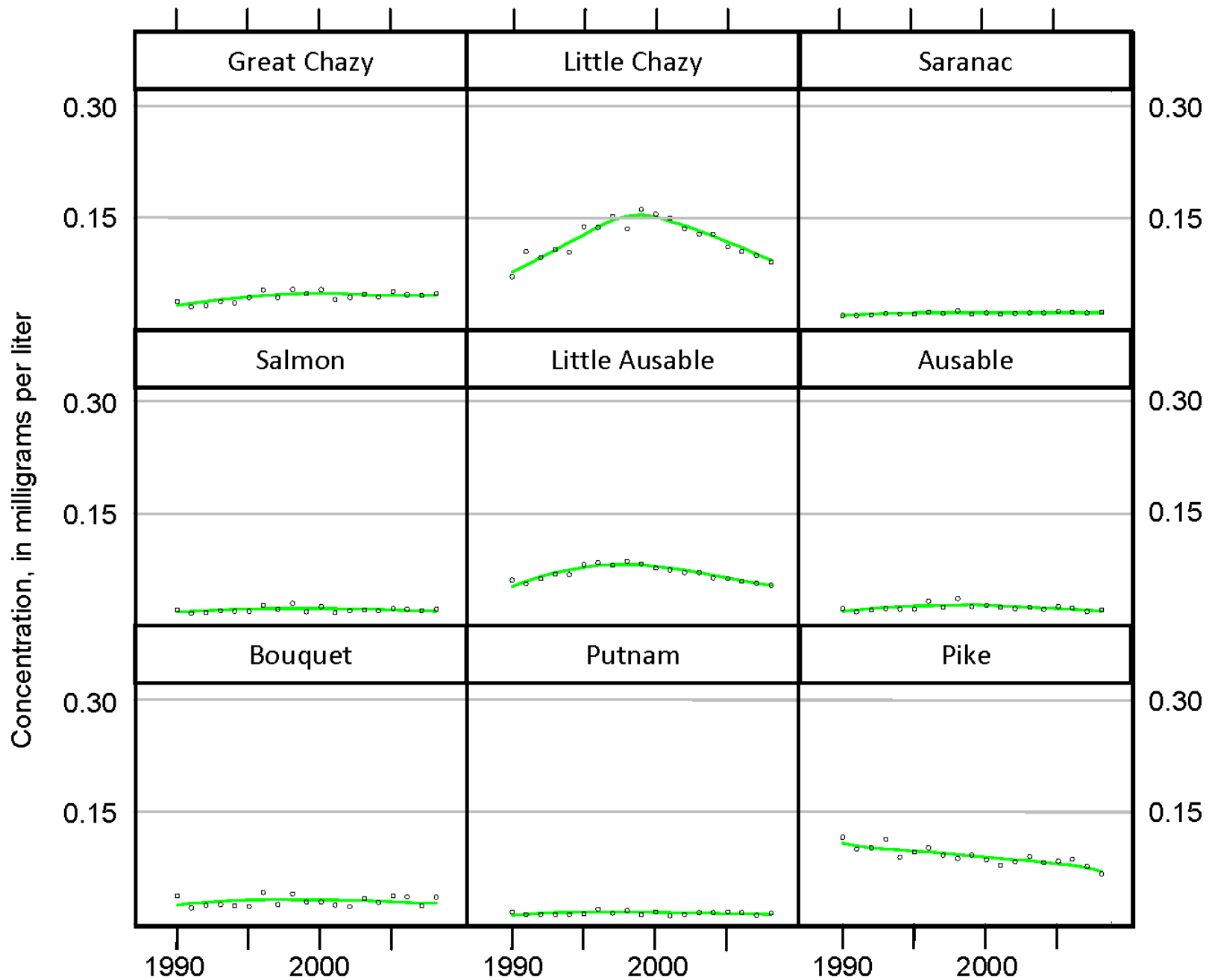
LaPlatte River Total Phosphorus Concentration Annual Estimates and Flow-Randomized Annual Estimates



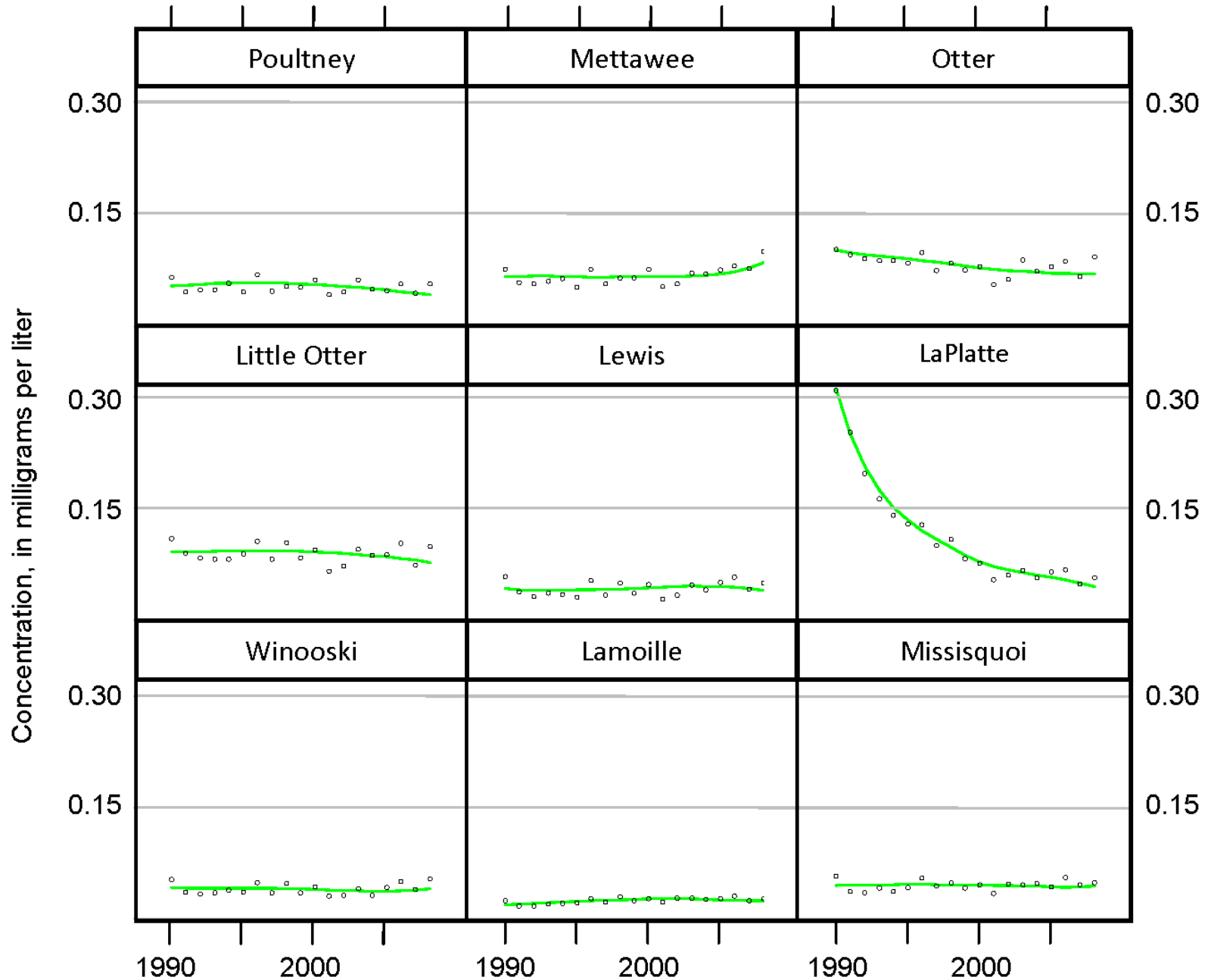
LaPlatte River Total Phosphorus Flux Annual Estimates and Flow-Randomized Annual Estimates



Phosphorus Concentration – Flow-randomized annual estimates ° Annual estimates

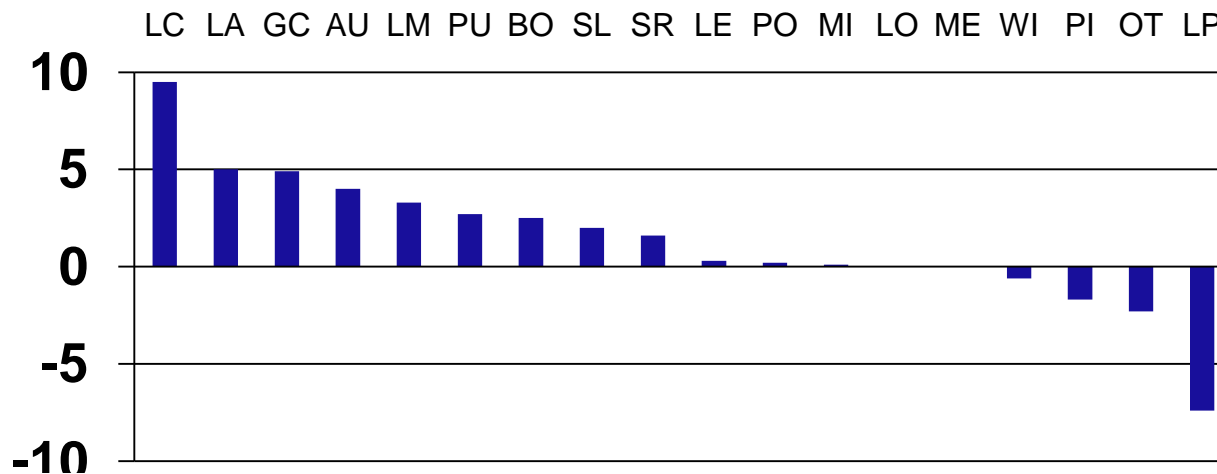


Phosphorus Concentration – Flow-randomized annual estimates ° Annual estimates

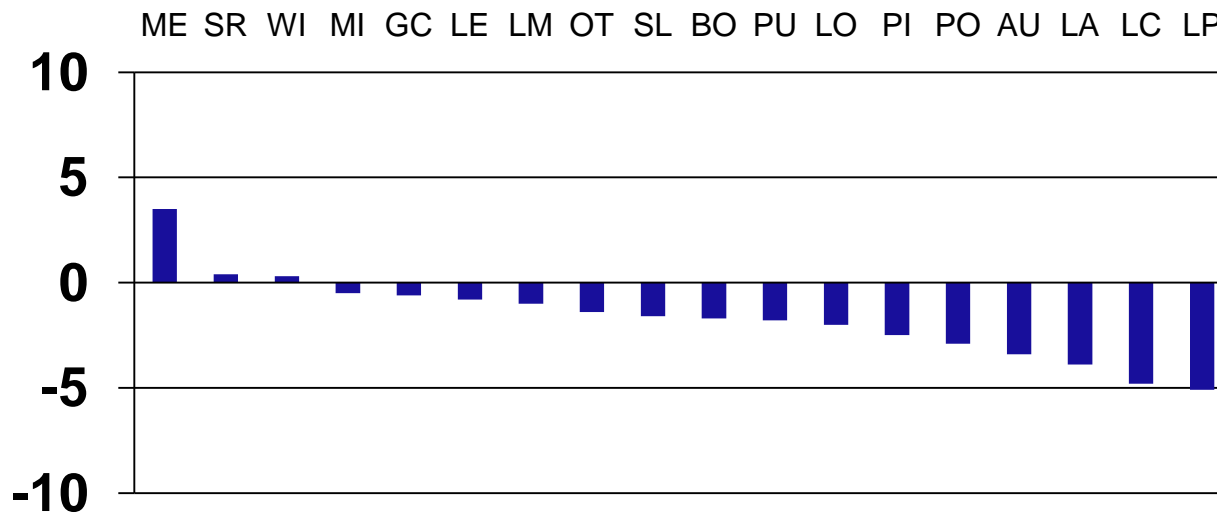


Phosphorus concentration change in % per year, flow-randomized

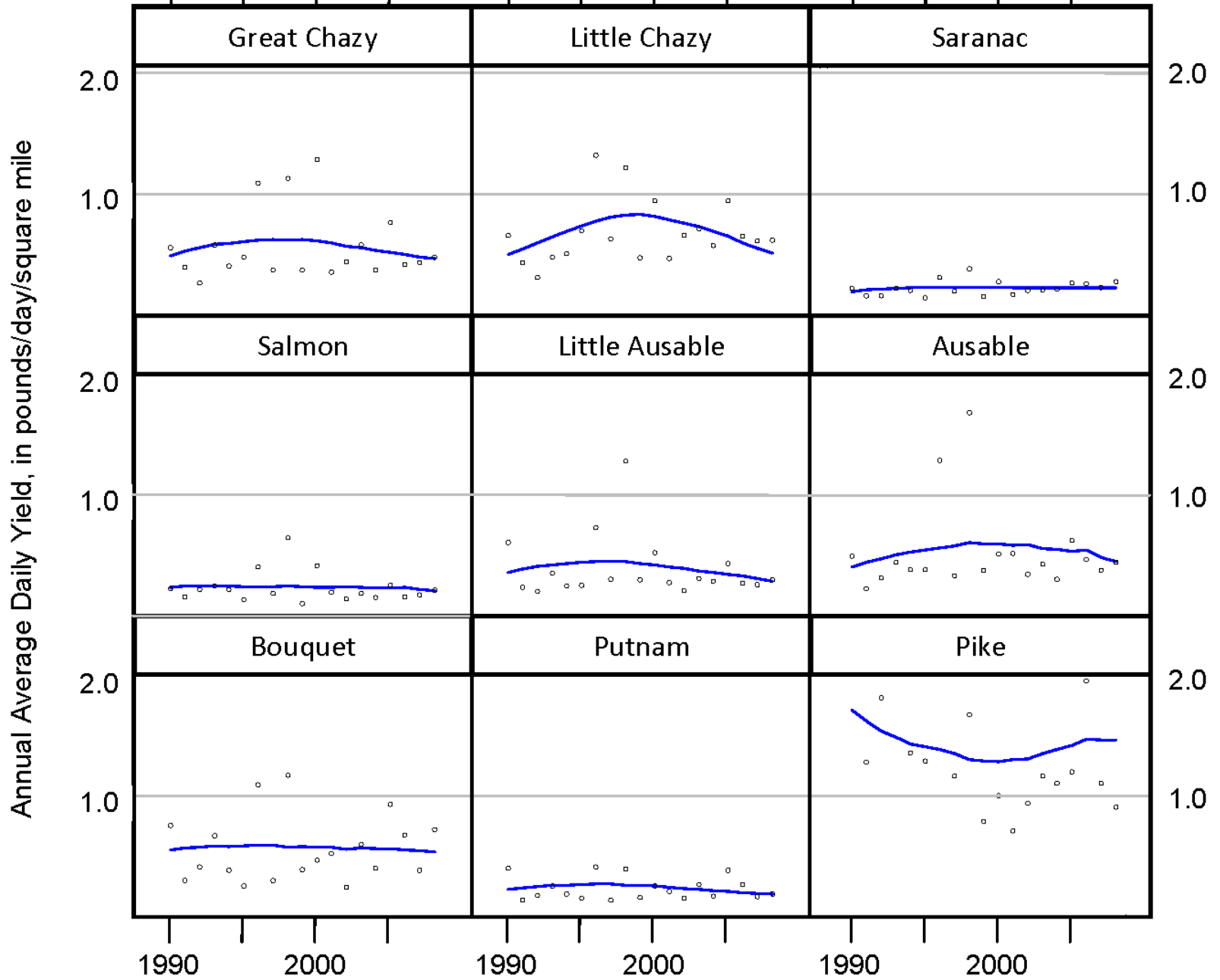
1990 to 2000



2000 to 2008



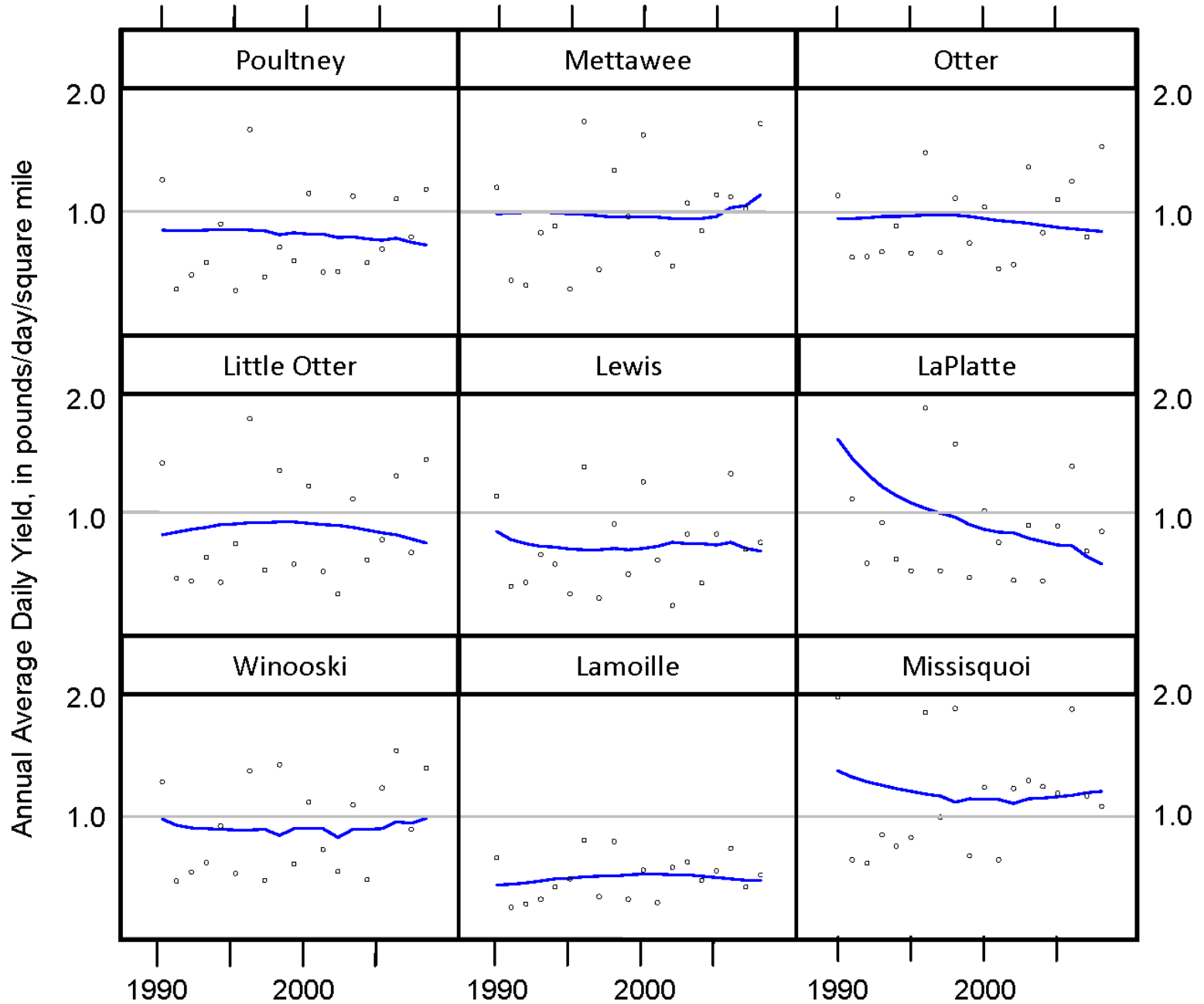
Phosphorus Yield — Flow-randomized annual estimates ° Annual estimates



Phosphorus Yield

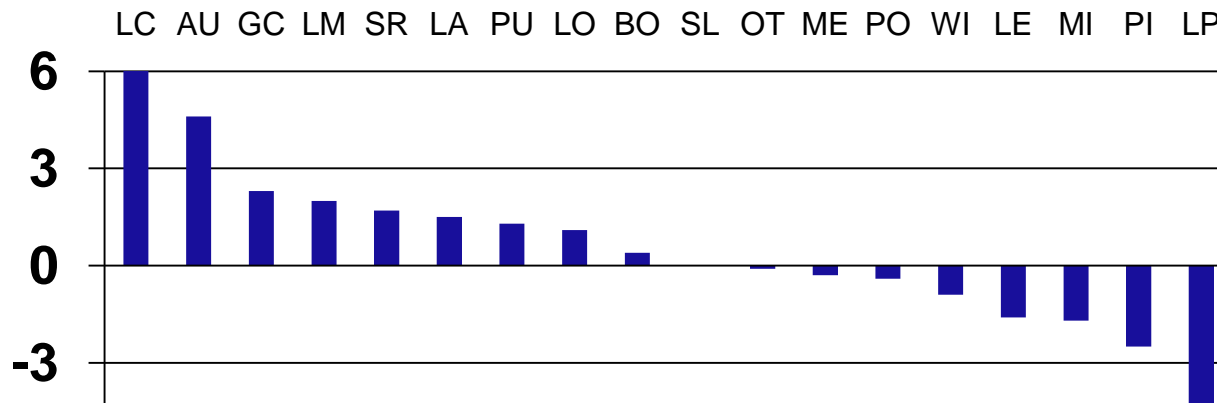
— Flow-randomized annual estimates

° Annual estimates

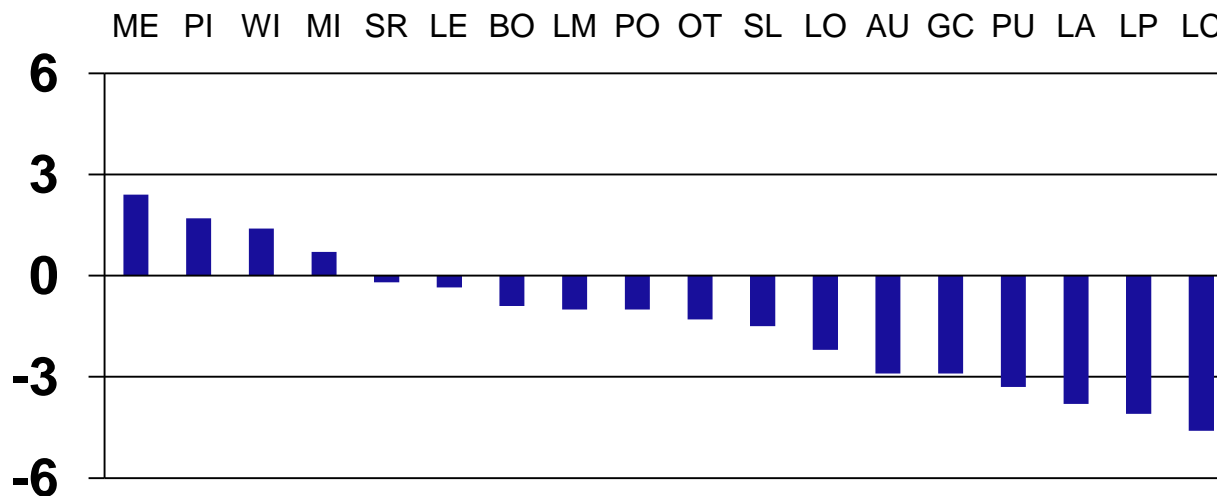


Phosphorus flux change in % per year, flow-randomized

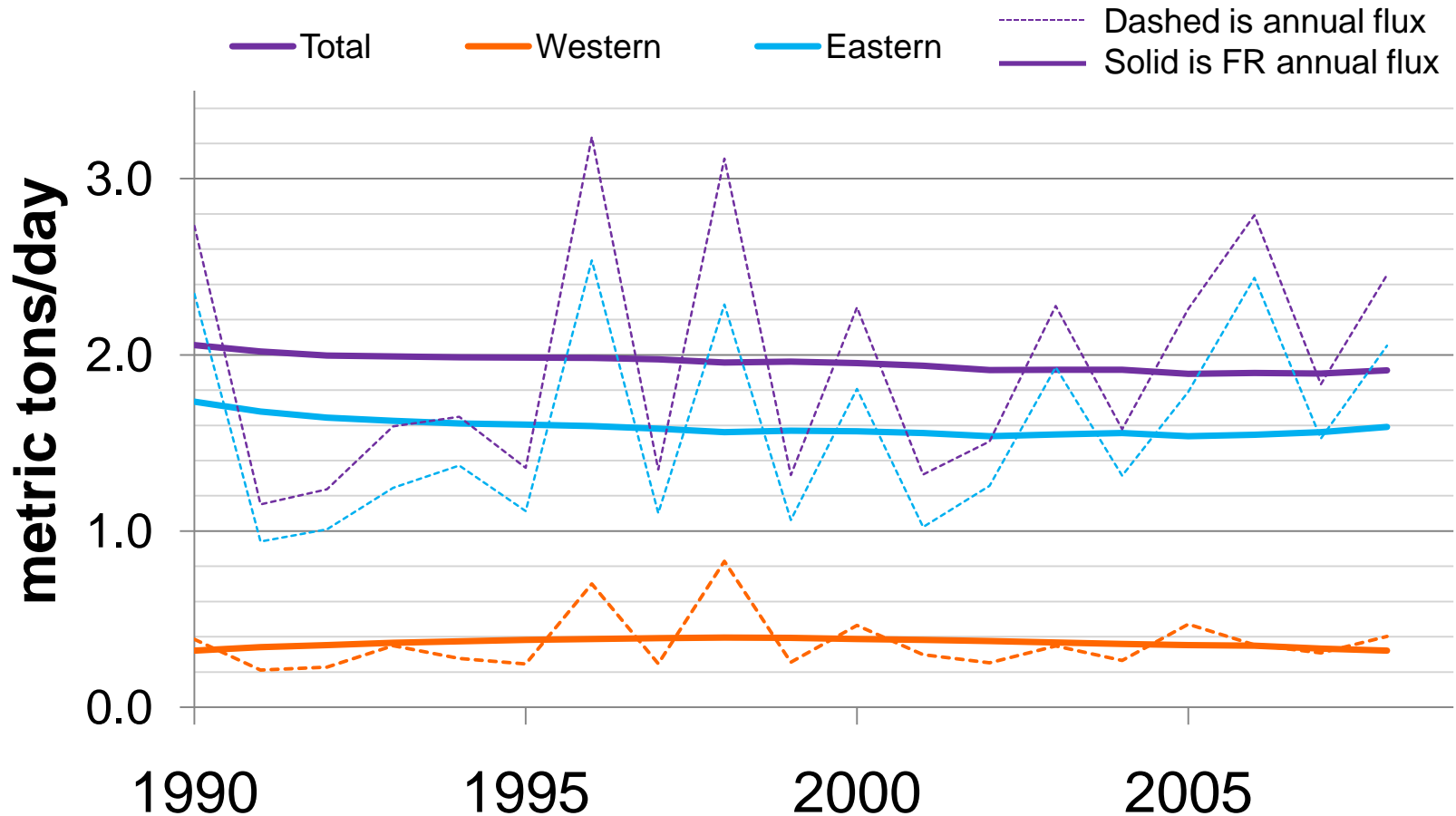
1990 to 2000



2000 to 2008



Aggregate phosphorus flux



Summary

- 1) The 90's presented a mix of increasing and decreasing river inputs to the Lake
- 2) From 2000-08 we see a broad pattern of decreases
- 3) Year-to-year fluctuations in yields are large compared to the trends — driven by climate variability

Summary – cont'd

- 4) Analysis can reveal different degrees of progress between point and non-point controls