Watershed Modeling
Cayuga Lake Modeling Project Meeting

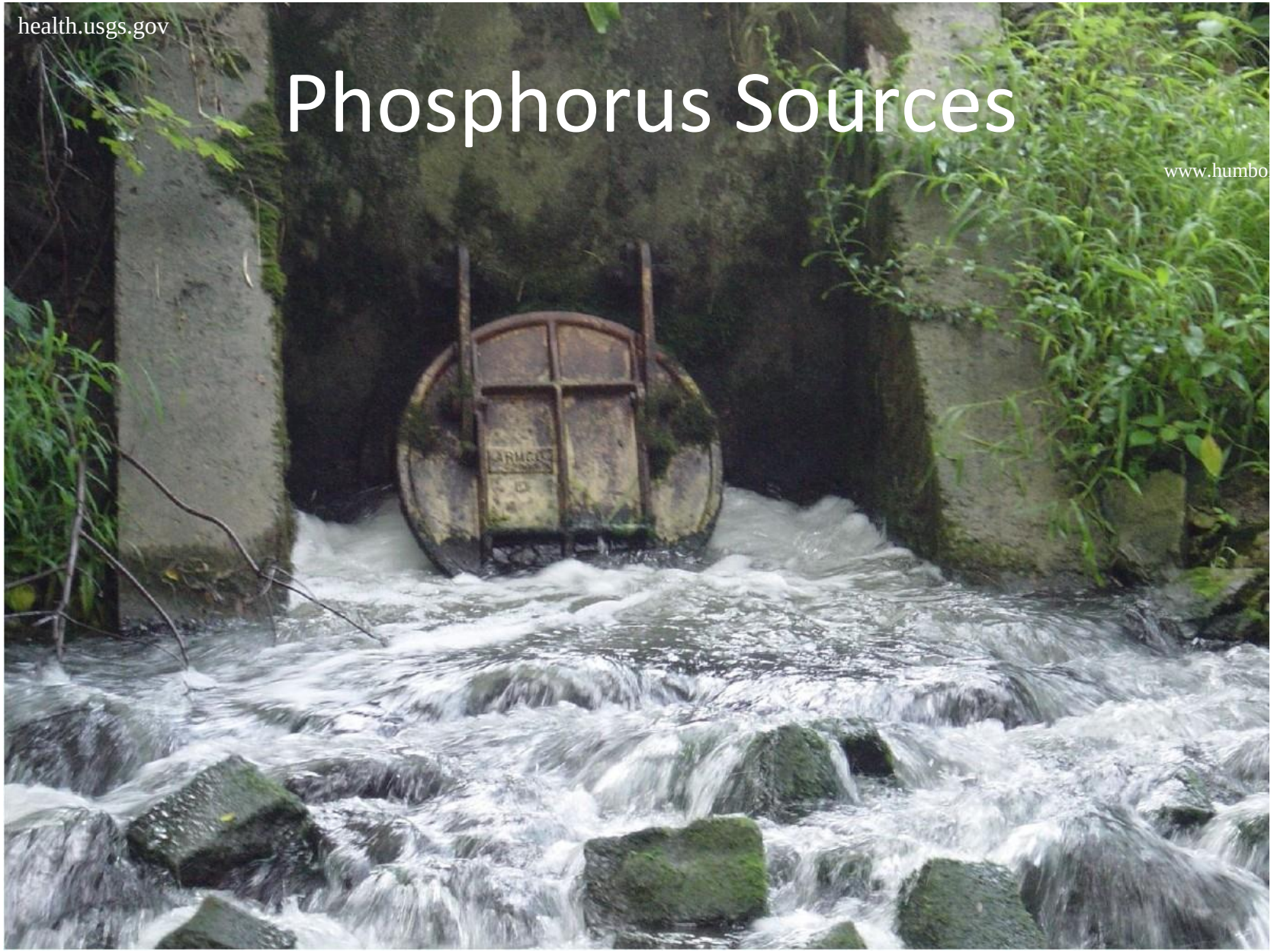
Soil and Water Lab

Biological and Environmental Engineering
Cornell University
Ithaca, NY

Why?

- In order to model the lake, we need to estimate how much phosphorus is flowing into it – the watershed model will provide this information to the lake model
- Models are a convenient tool for testing the likely consequences of different scenarios, e.g., changes in land management

Phosphorus Sources

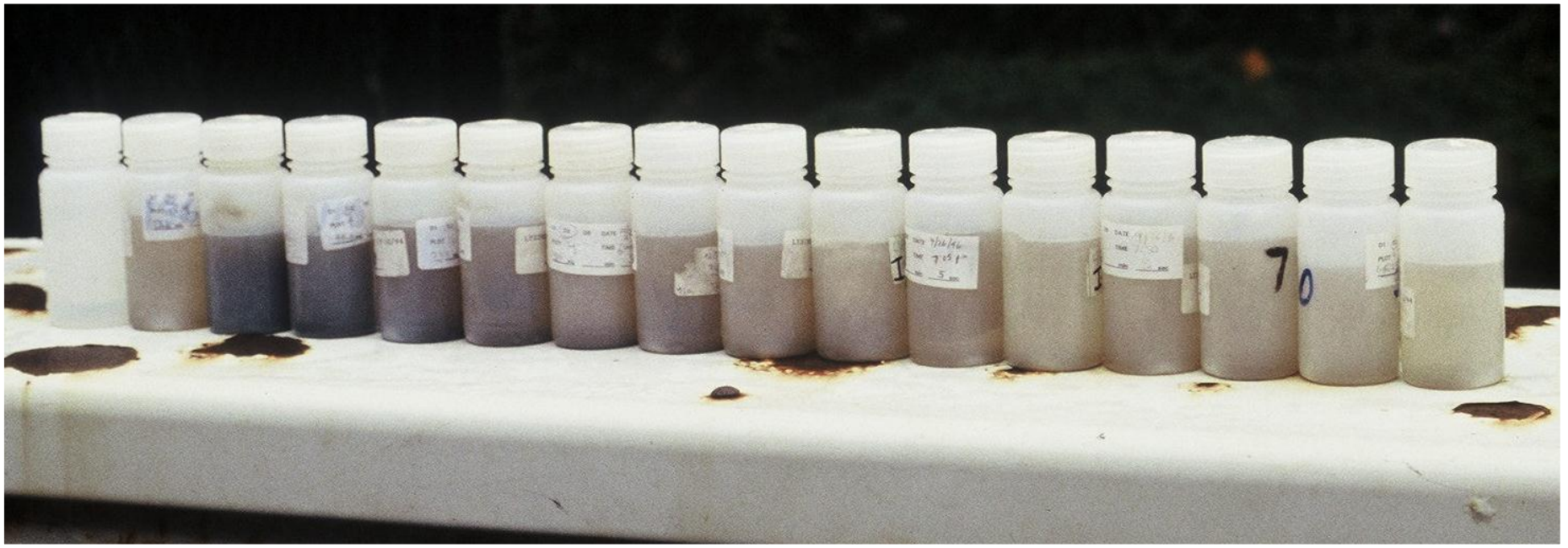


Phosphorus Sources

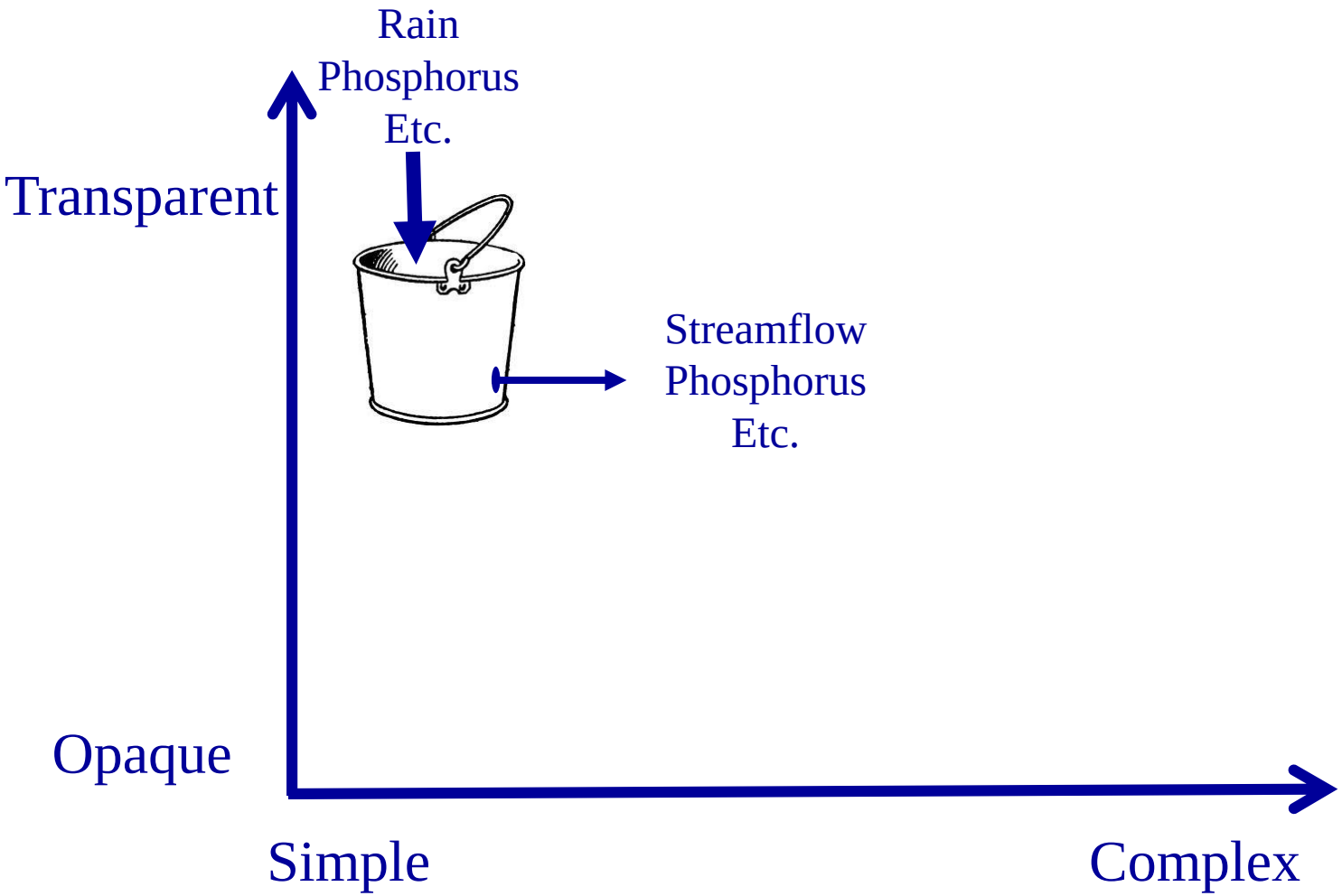
Phosphorus Sources

Phosphorus Transport

Phosphorus Transport



One Modeling Challenge



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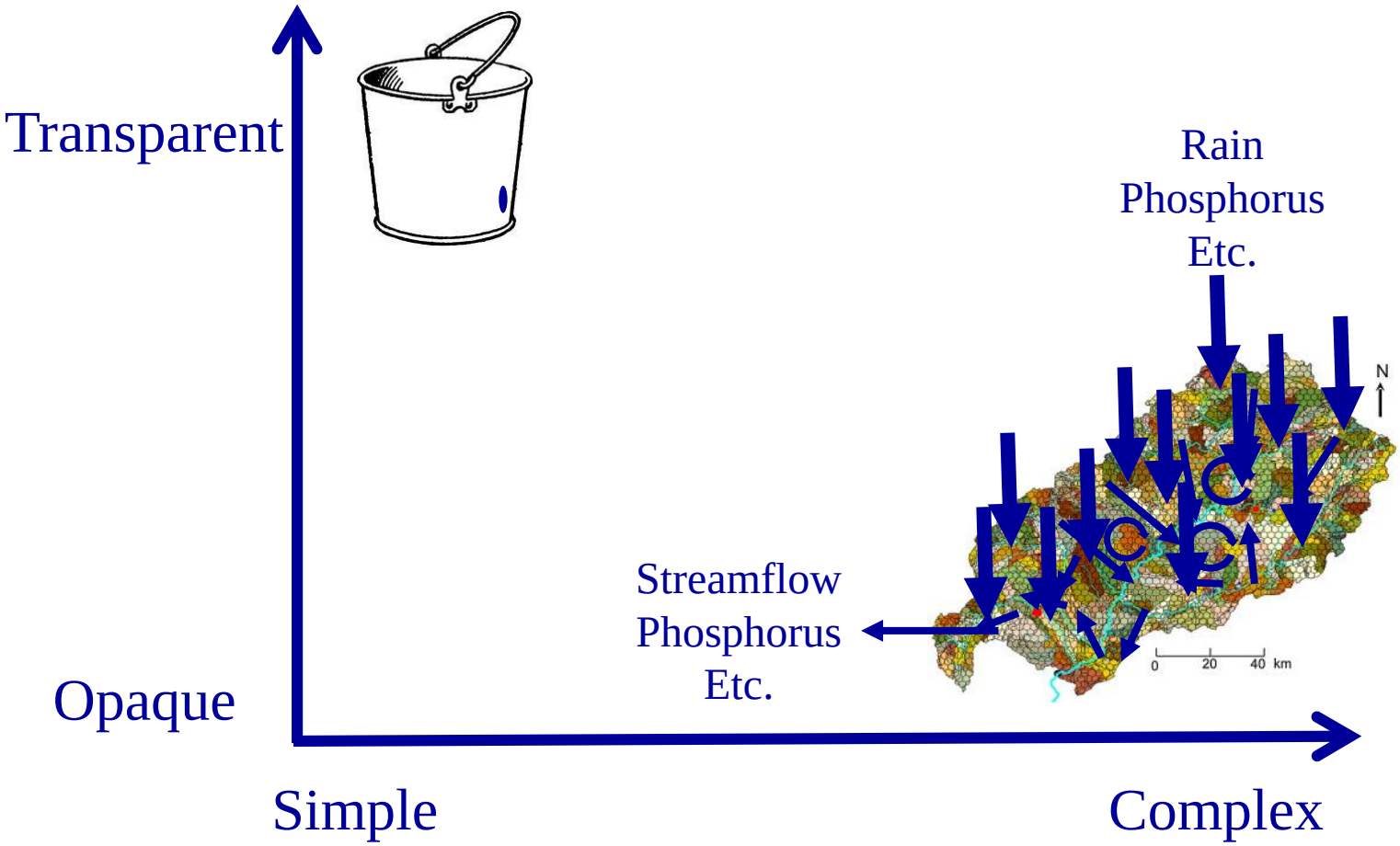
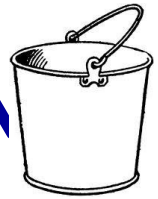


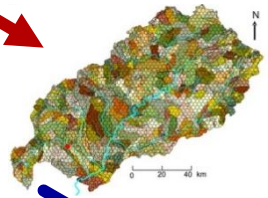
One Modeling Challenge



Transparent

Opaque

We will use both modeling approaches together to take advantages of the each approaches benefits

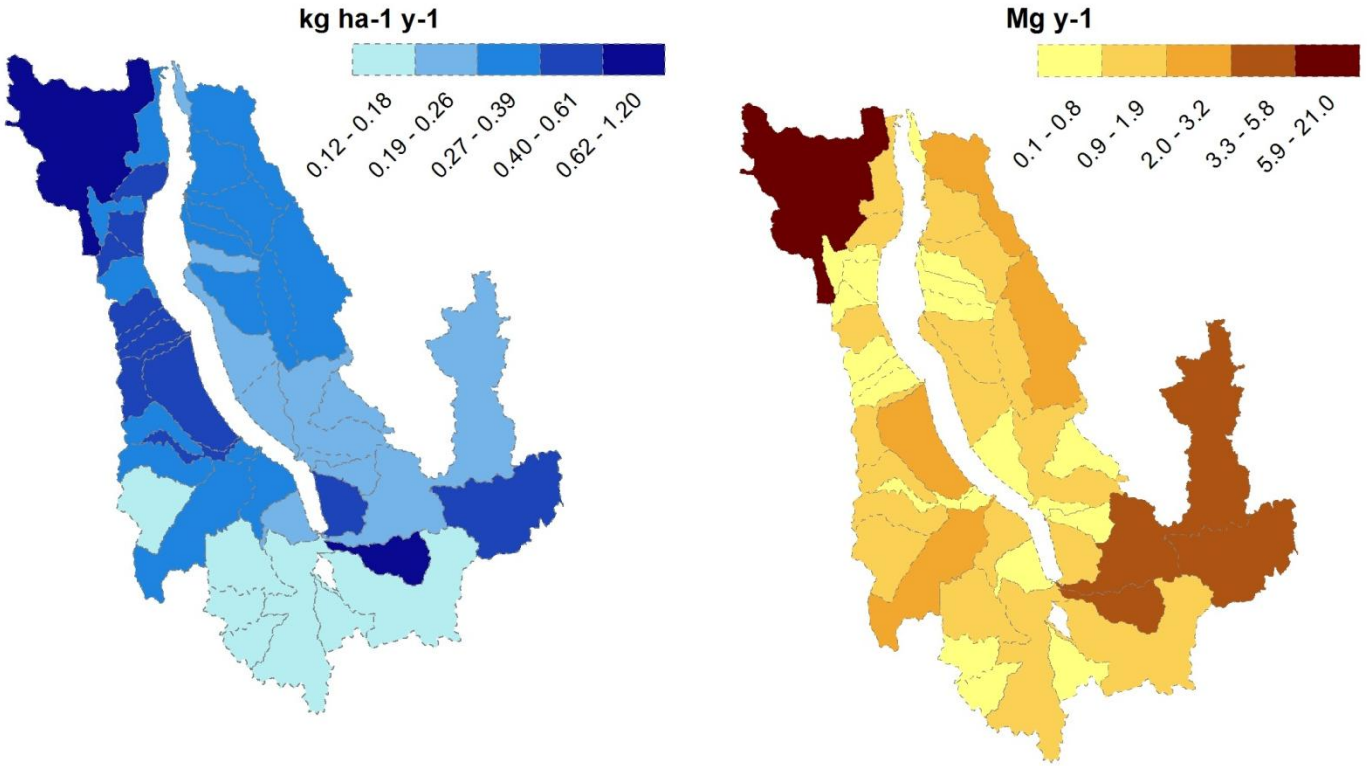


Simple

Complex

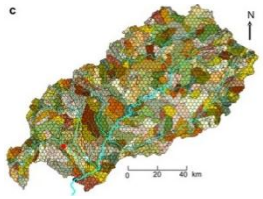
Modeling Strategy: Big Picture

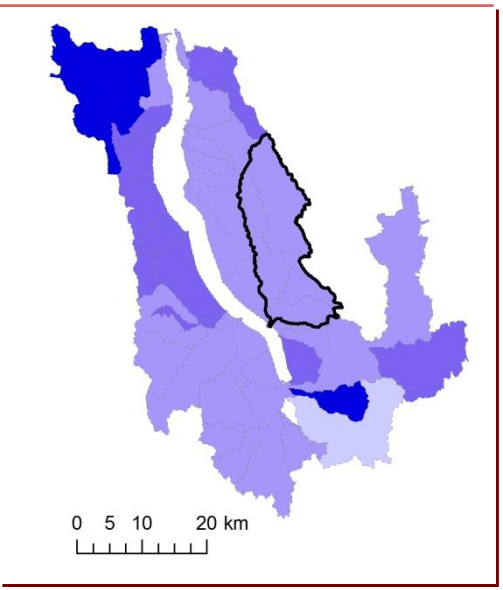
Cayuga Lake Watershed Phosphorus Export



Courtesy of Doulas Haith

Land use + soils + weather → Phosphorus Export

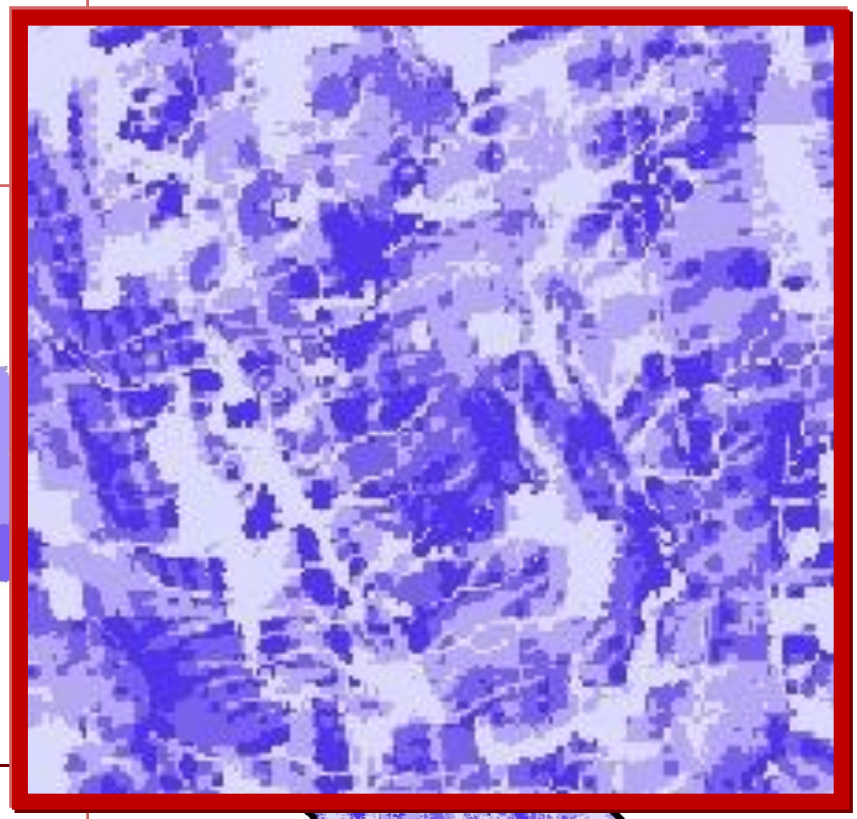


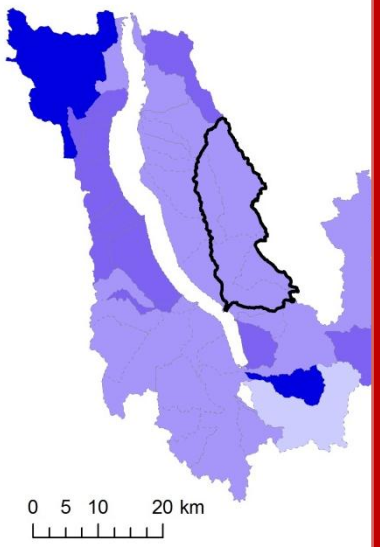


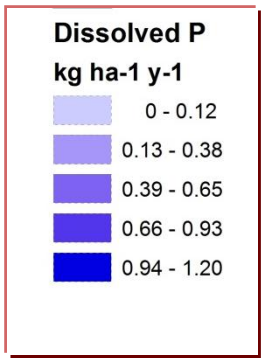
Dissolved P
kg ha-1 y-1

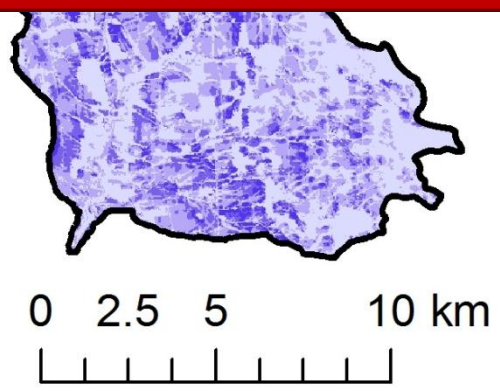
- 0 - 0.12
- 0.13 - 0.38
- 0.39 - 0.65
- 0.66 - 0.93
- 0.94 - 1.20

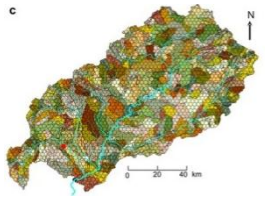
Salmon Creek Variable-



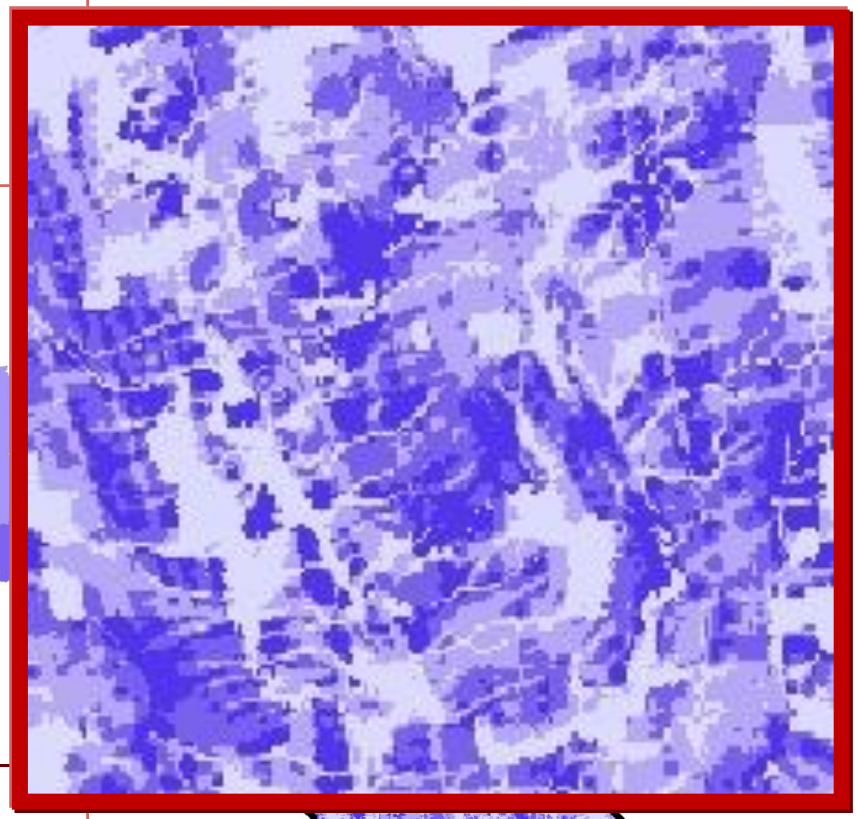


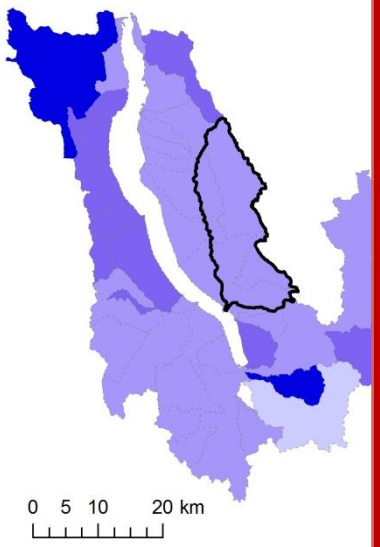


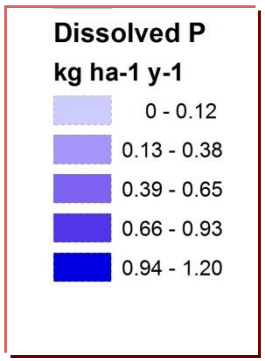


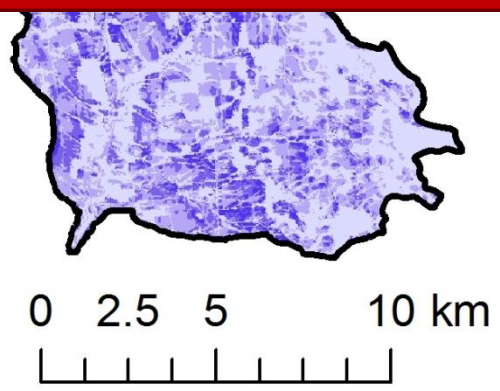


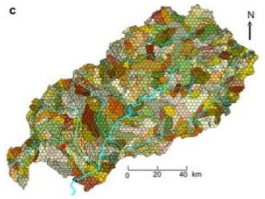
Salmon Creek Variable-

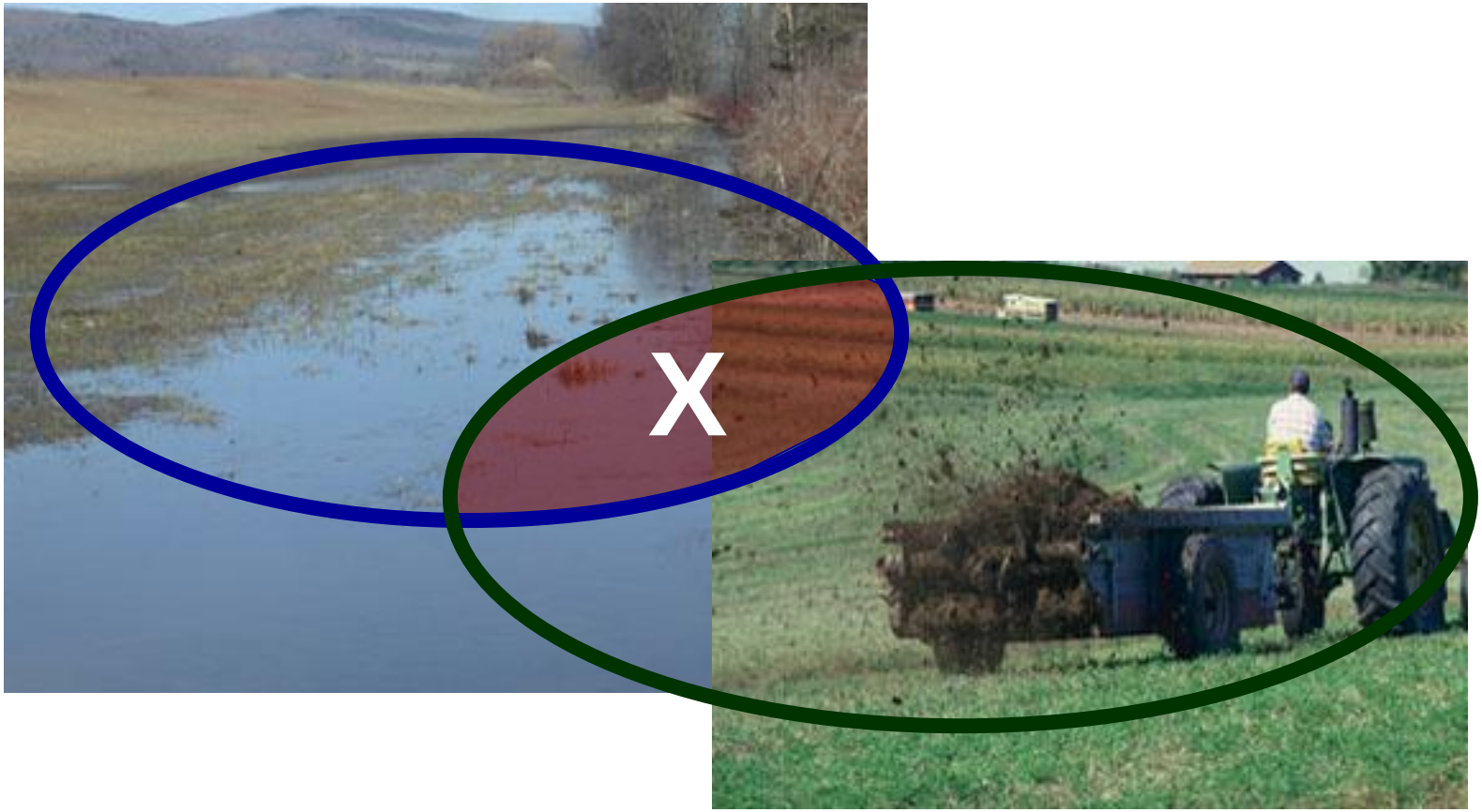


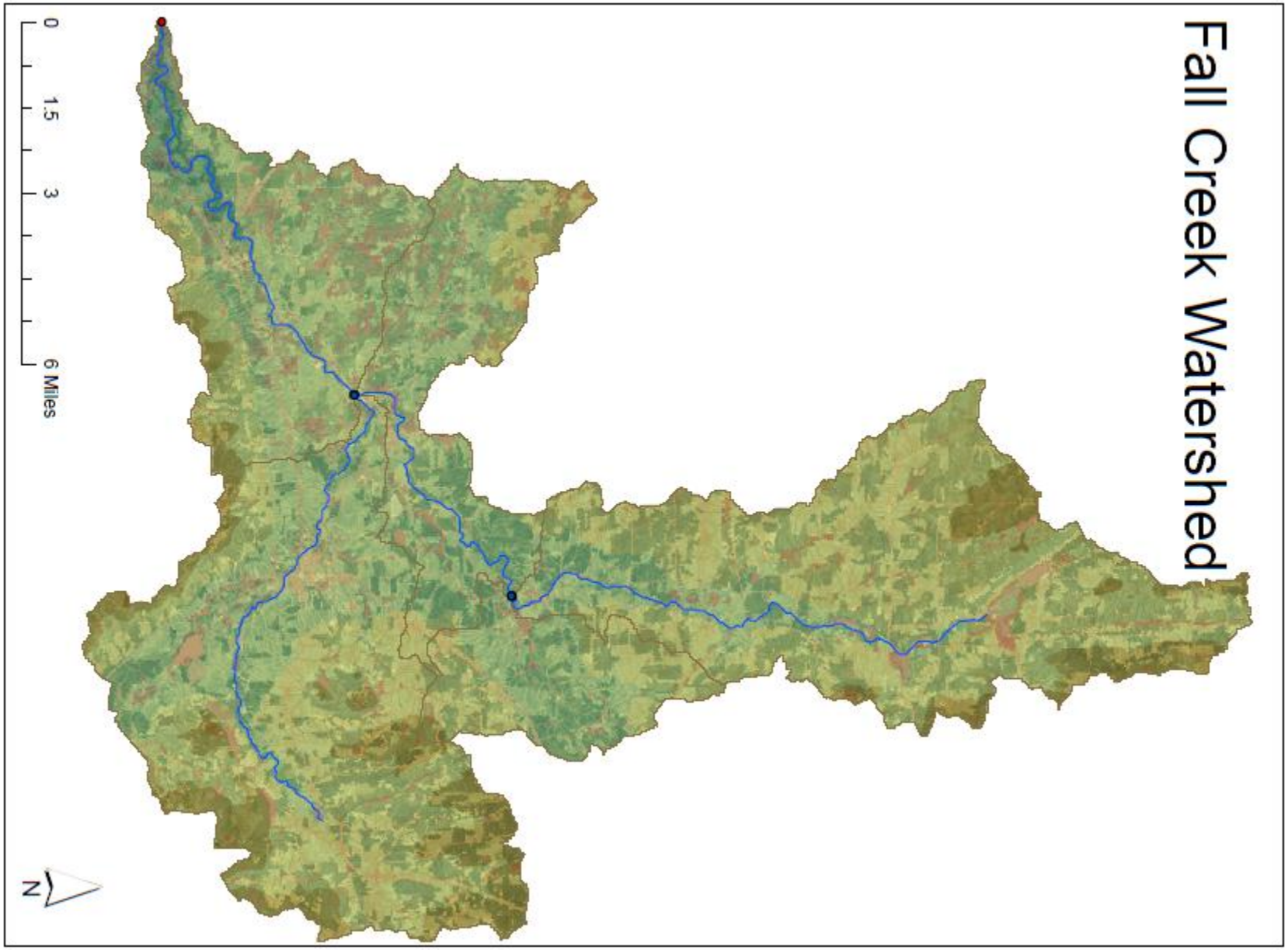




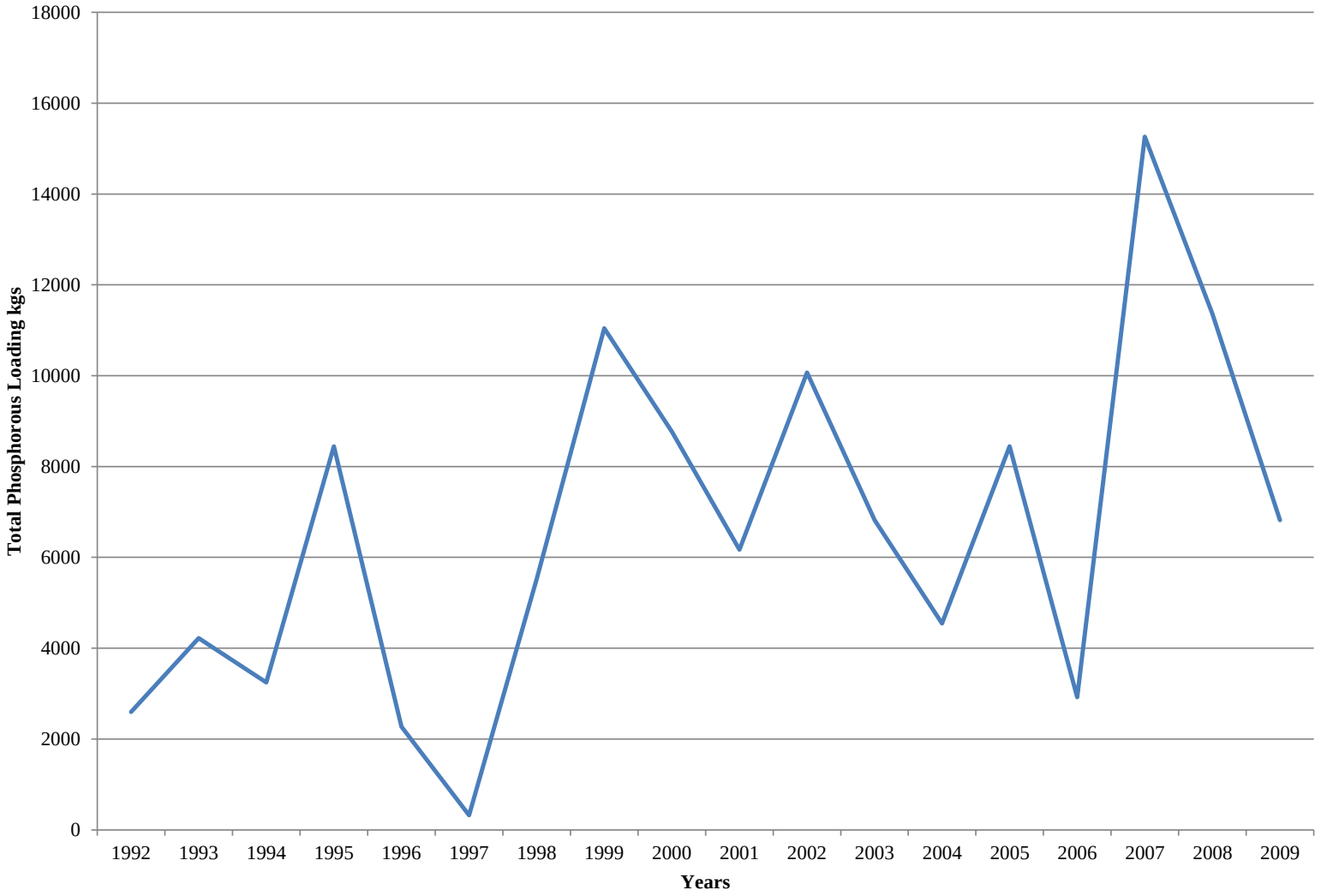




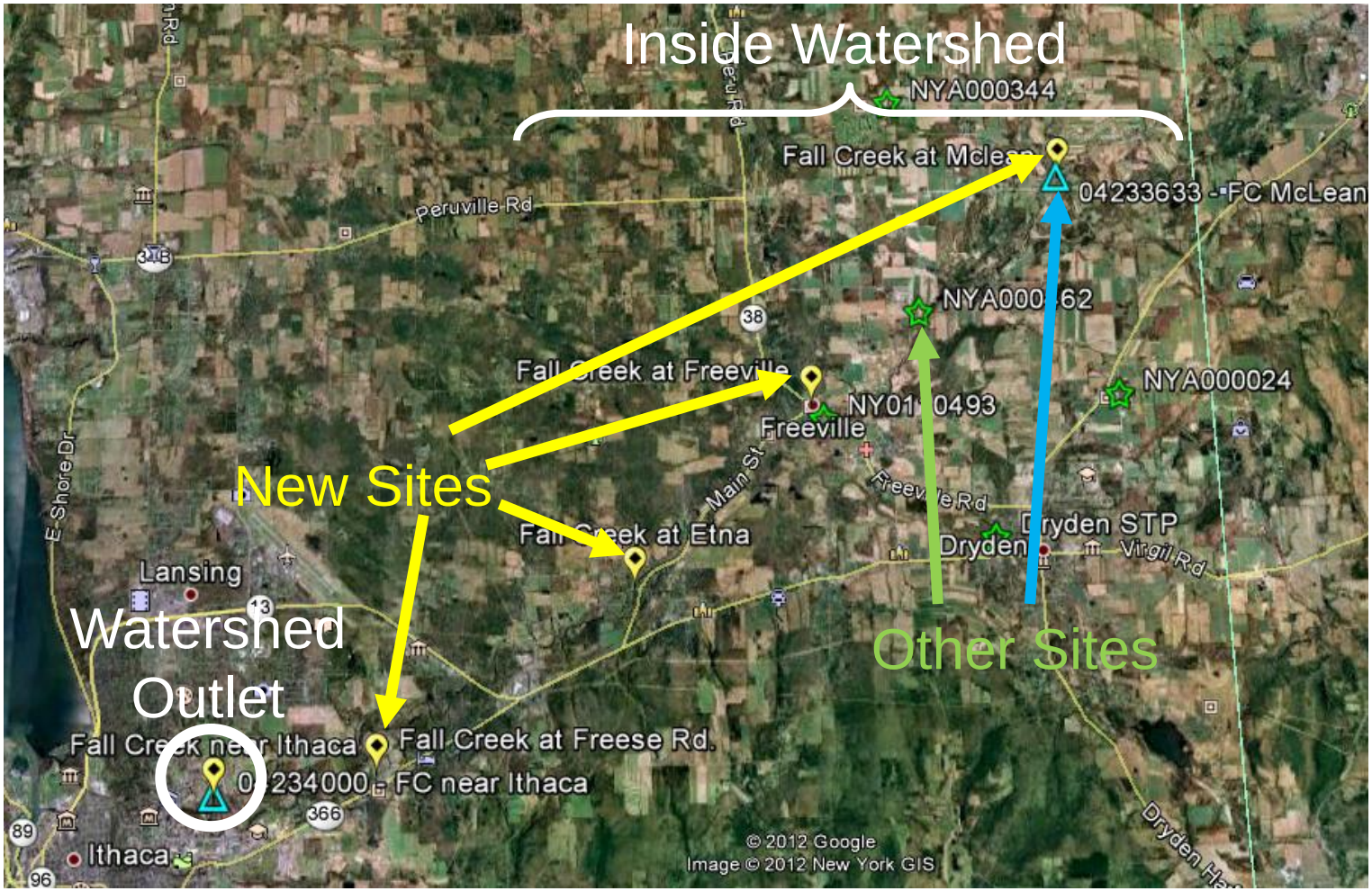

X


Fall Creek Watershed
0
1.5
3
6 Miles
N

Preliminary Output (TDP)



Monitoring/Data Strategy

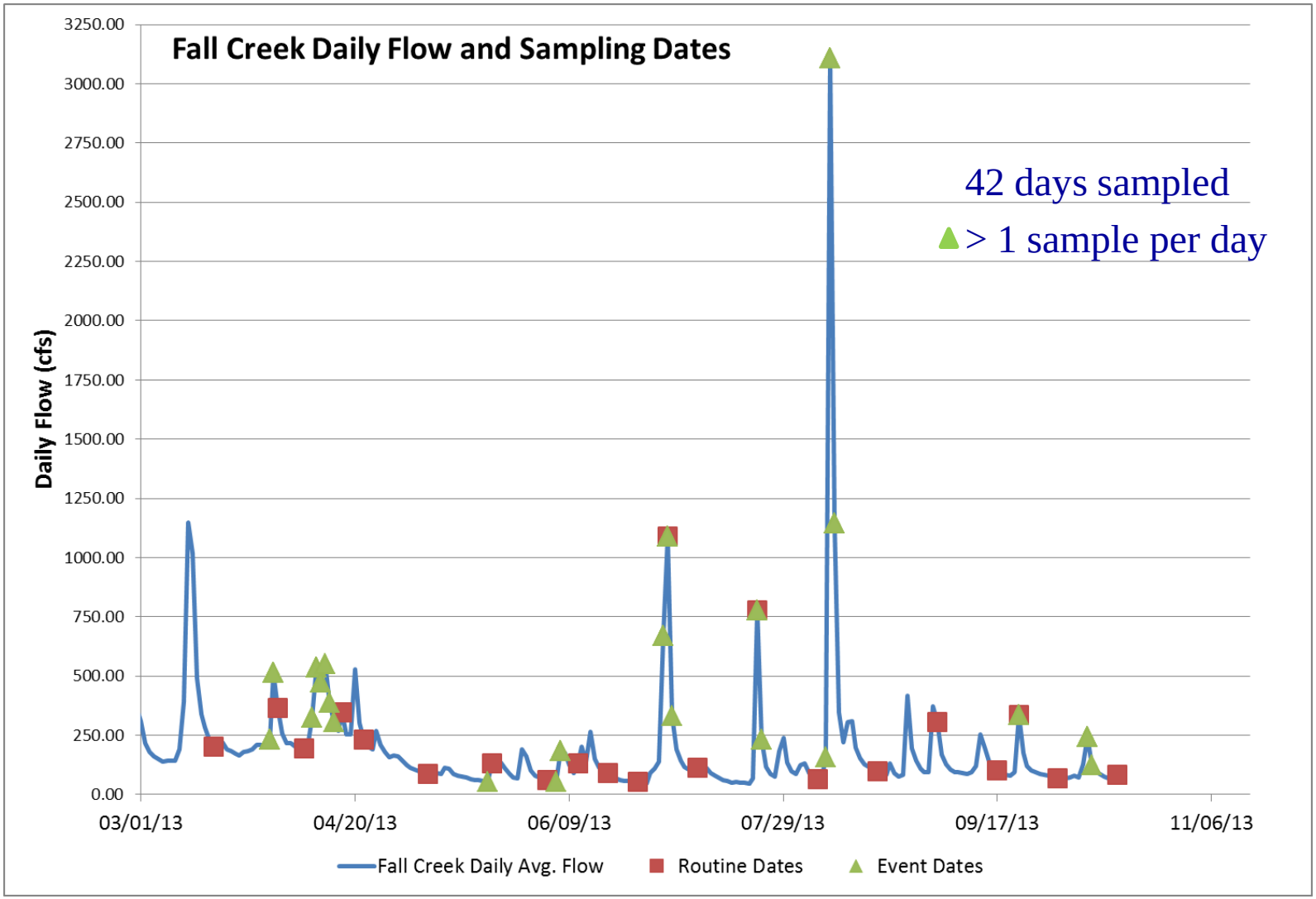


UFI Tributary Monitoring

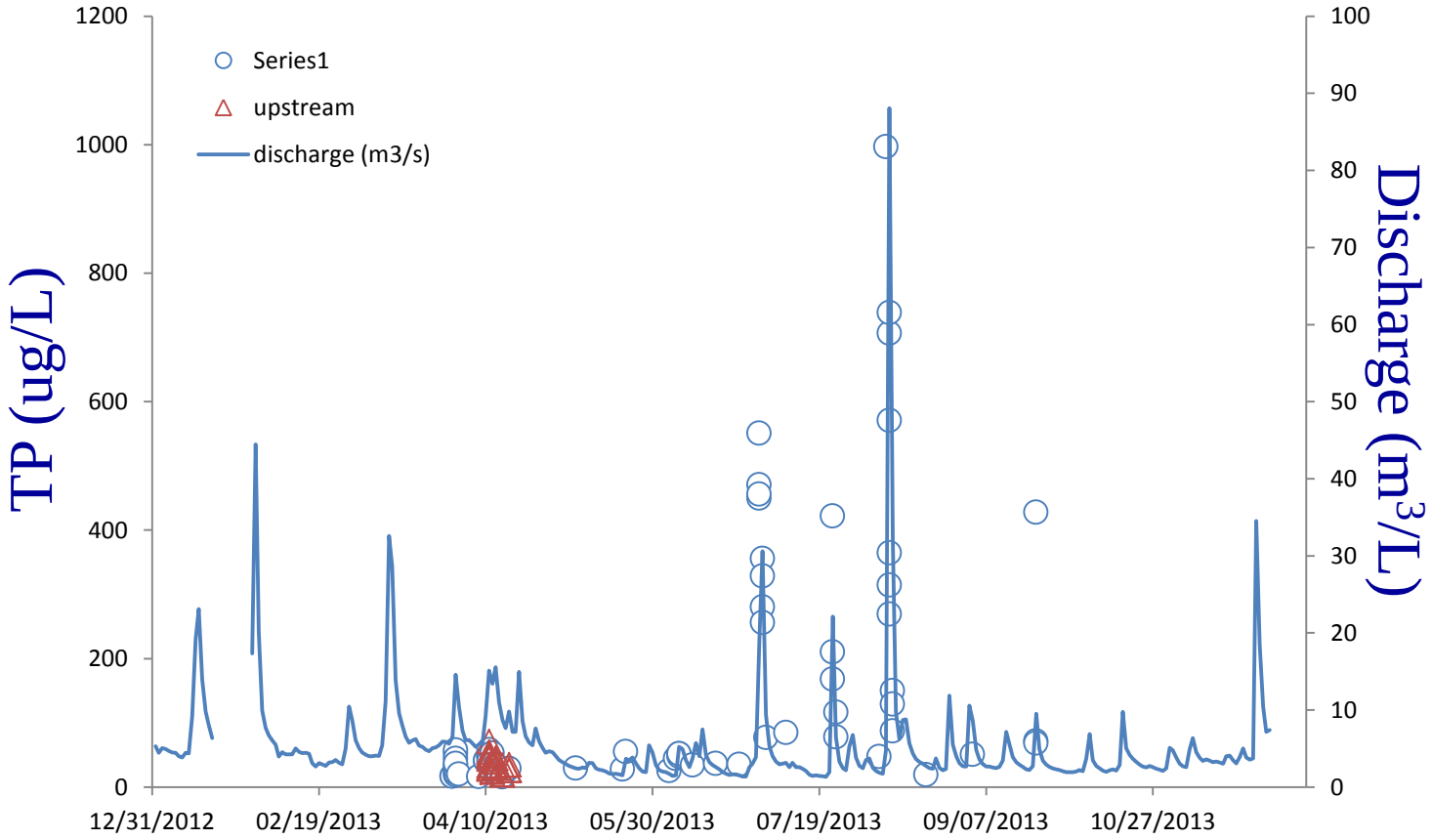
- Routine Monitoring
  - Program began in March and has continued biweekly (3/18-10/30)
  - **>17 routine monitoring days collected in 2013**
  - Field measurements and chemistry analytes have been collected

- Event Monitoring (**4 events were proposed for the project)**
  - Events were monitored in April, June, July, August, September, and October
  - 6 runoff events (~ 55 total samples) monitored for **Fall Creek**, including Aug. 8-10 which was the highest flow peak of the year.
  - Similar results for other 3 streams (**Salmon Creek, Six-Mile Creek, and Cayuga Inlet**)

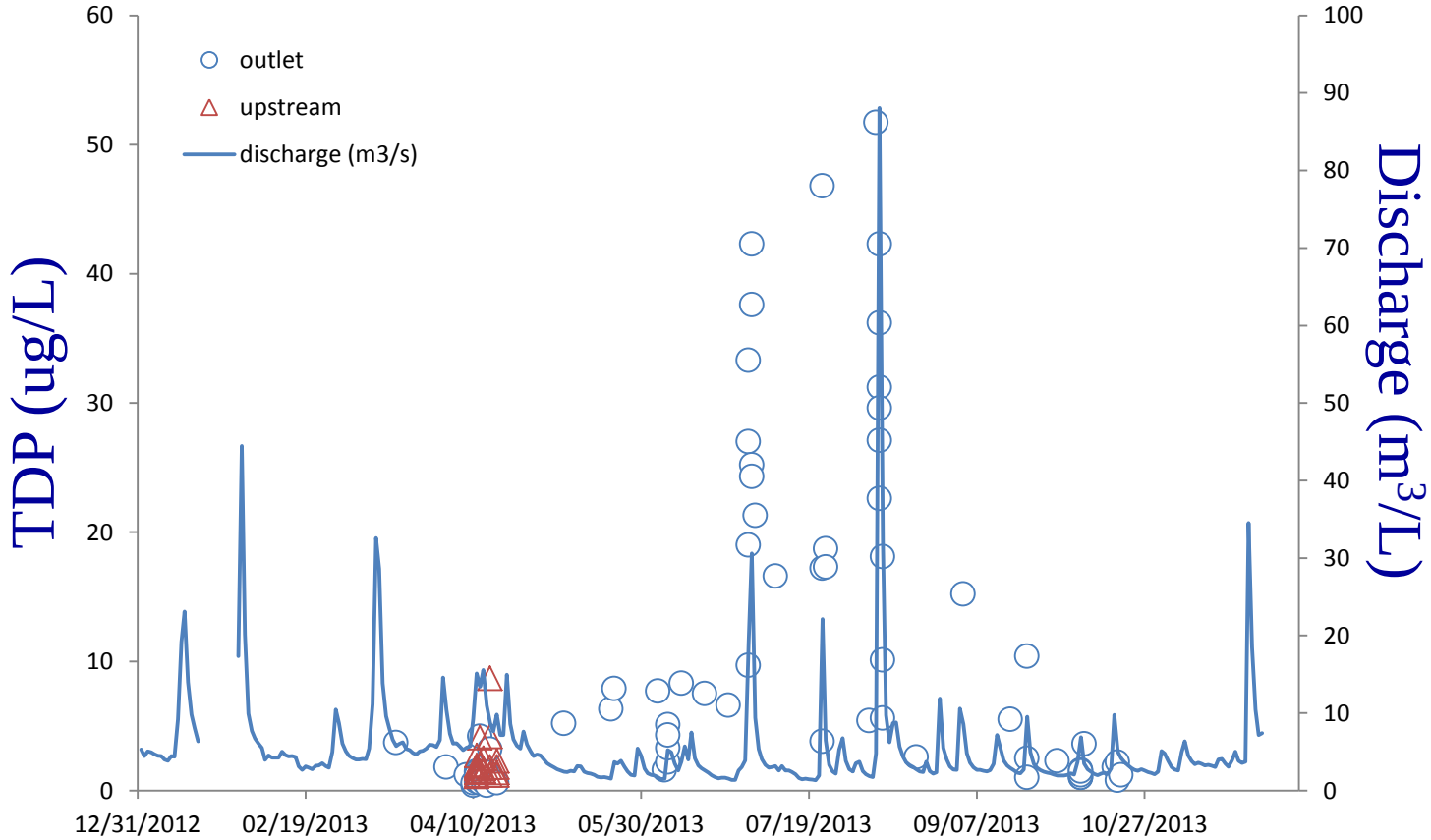
UFI Tributary Monitoring Coverage: Fall Creek



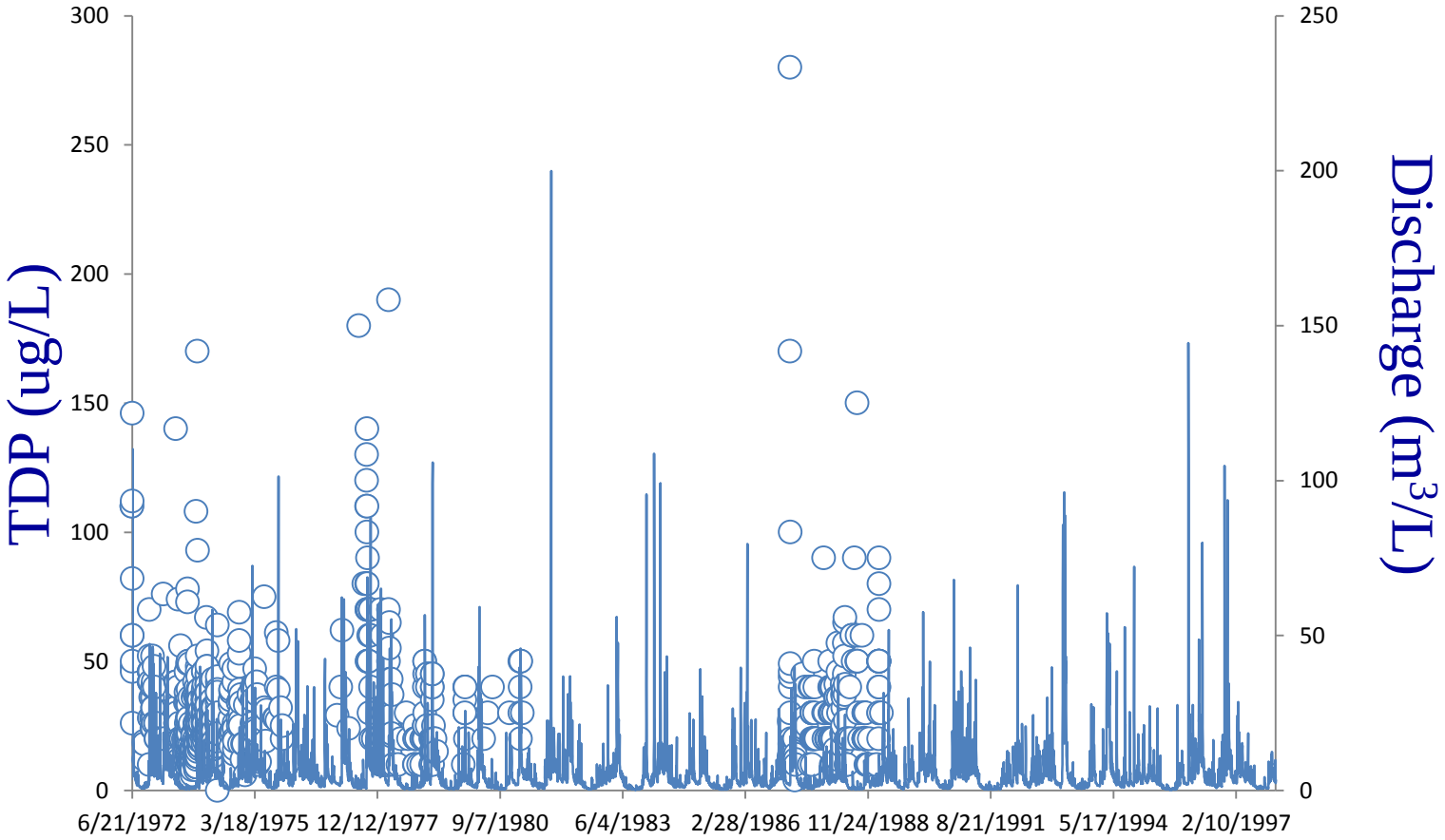
Fall Creek


Series1
upstream
discharge (m3/s)
TP (ug/L)
Discharge (m3/L)
1200
1000
800
600
400
200
0
100
90
80
70
60
50
40
30
20
10
0
12/31/2012
02/19/2013
04/10/2013
05/30/2013
07/19/2013
09/07/2013
10/27/2013

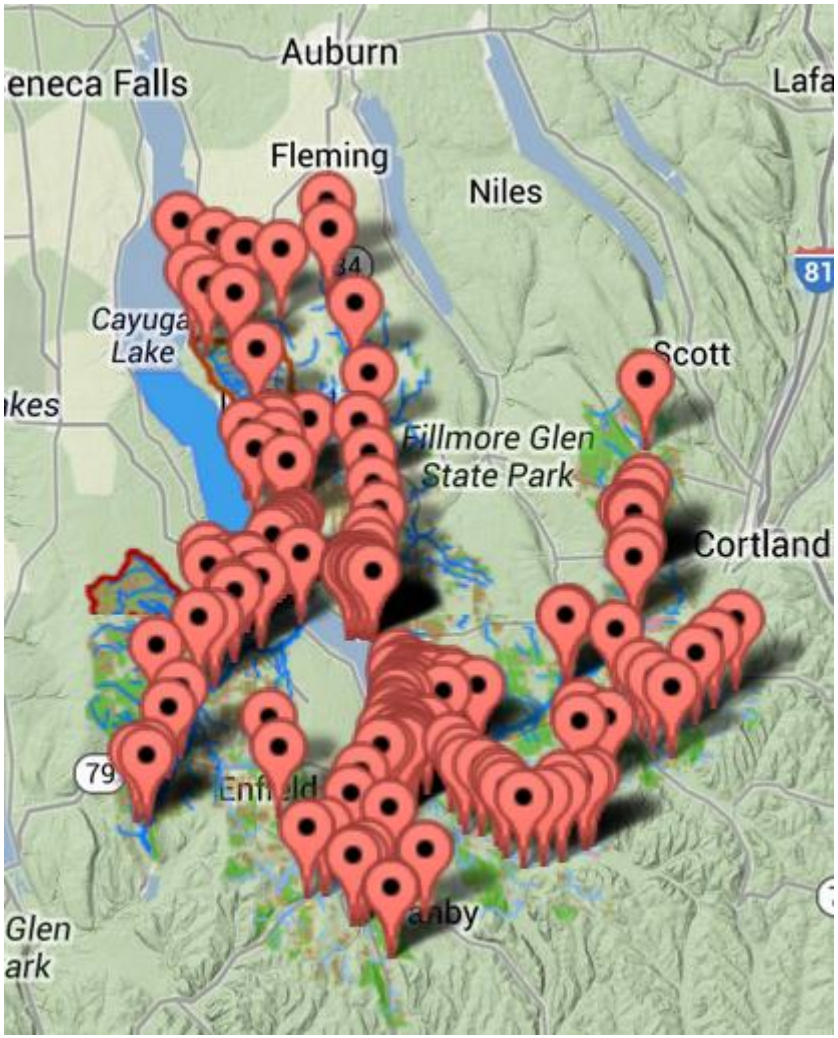
Fall Creek Tributary Data

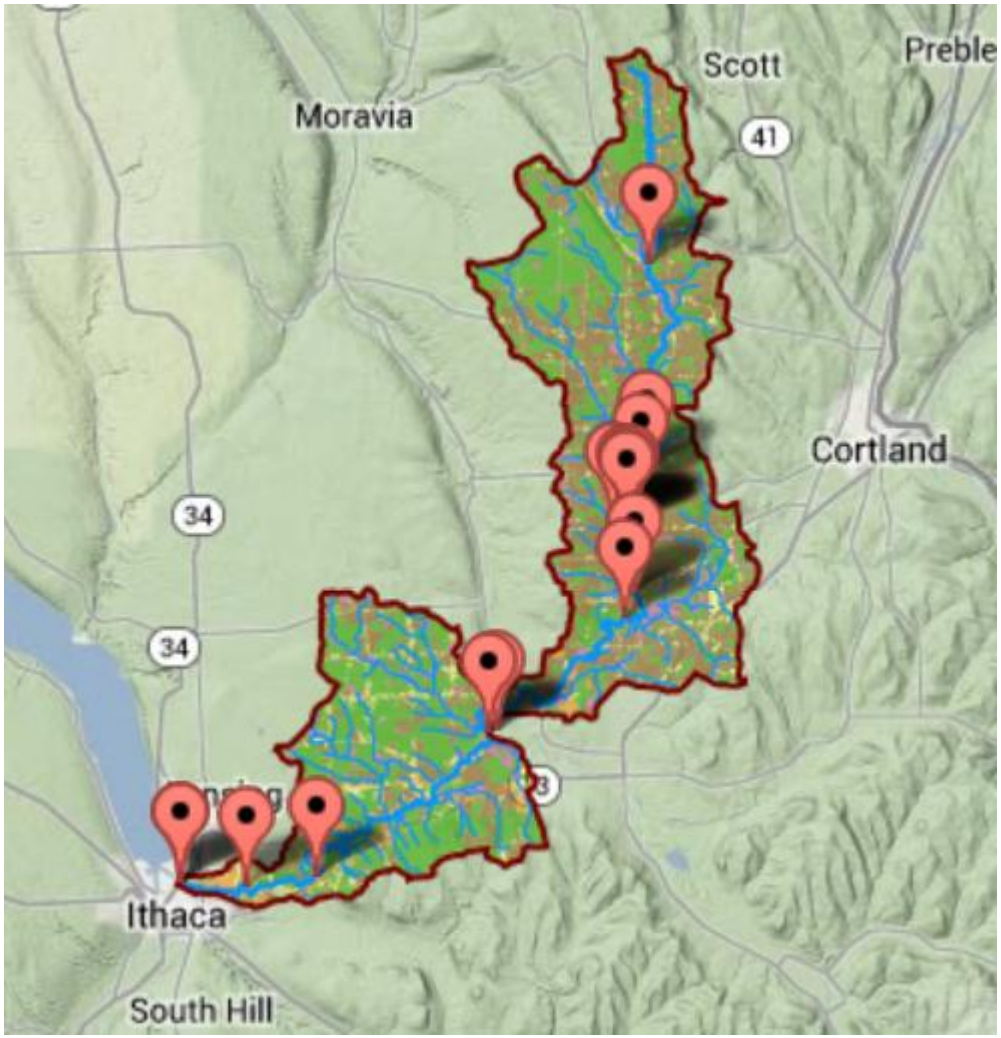


Fall Creek (Bouldin data)

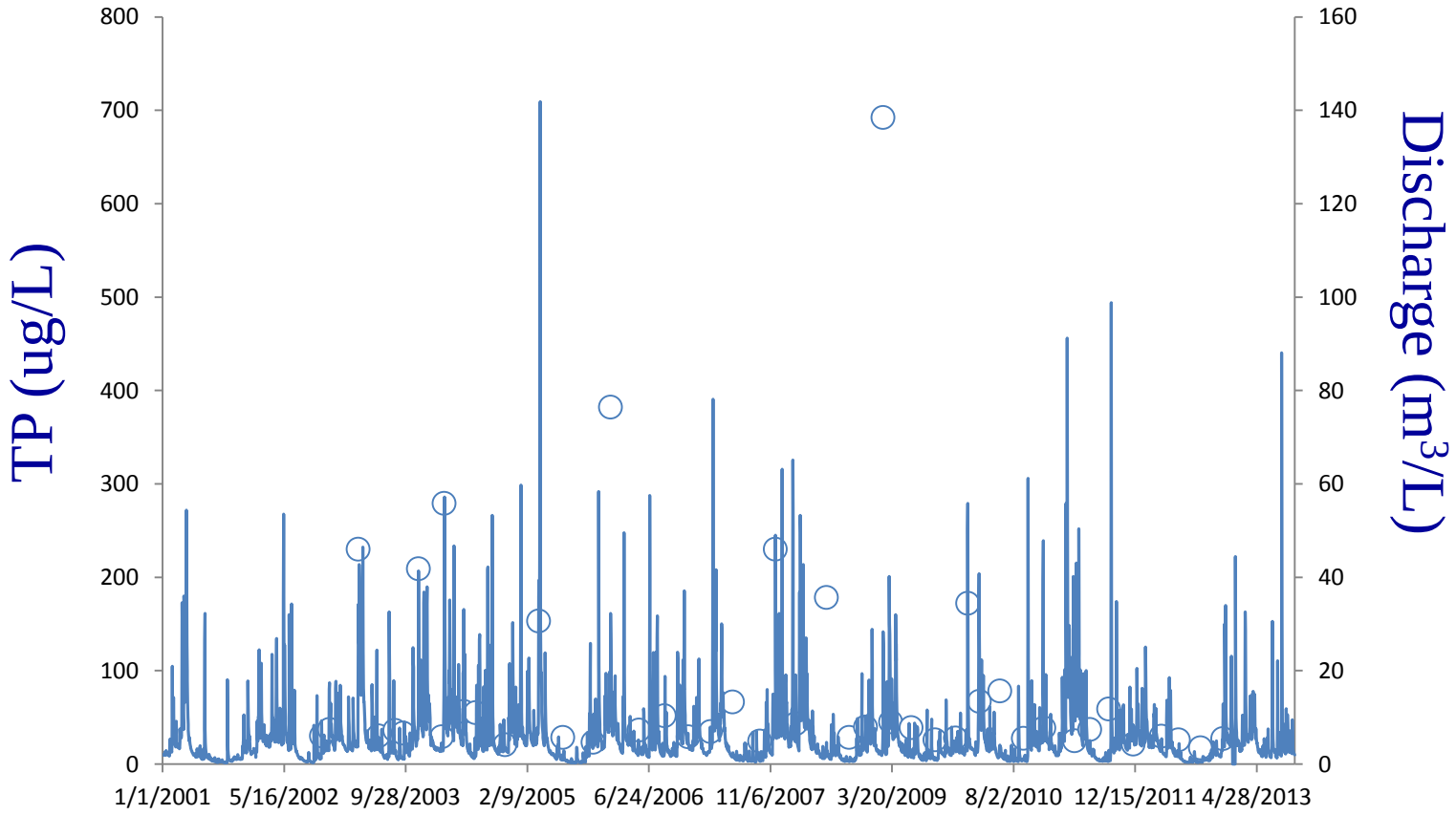


Fall Creek (CSI data)





Fall Creek (CSI data)



Some Known Data Sources

- USGS – Stream discharge, Fall Cr., Sixmile Cr., Inlet, some Salmon Cr.
- Dave Bouldin – Fall Creek, Cayuga Lake
- CSI – Various points along several creeks
- Various independent research projects
  - Easton et al. 2007. *Water Resources Research*
  - Likens. 1974. Water and Nutrient Budgets for Cayuga Lake, New York

Looking for more as part of this project

Acknowledgements

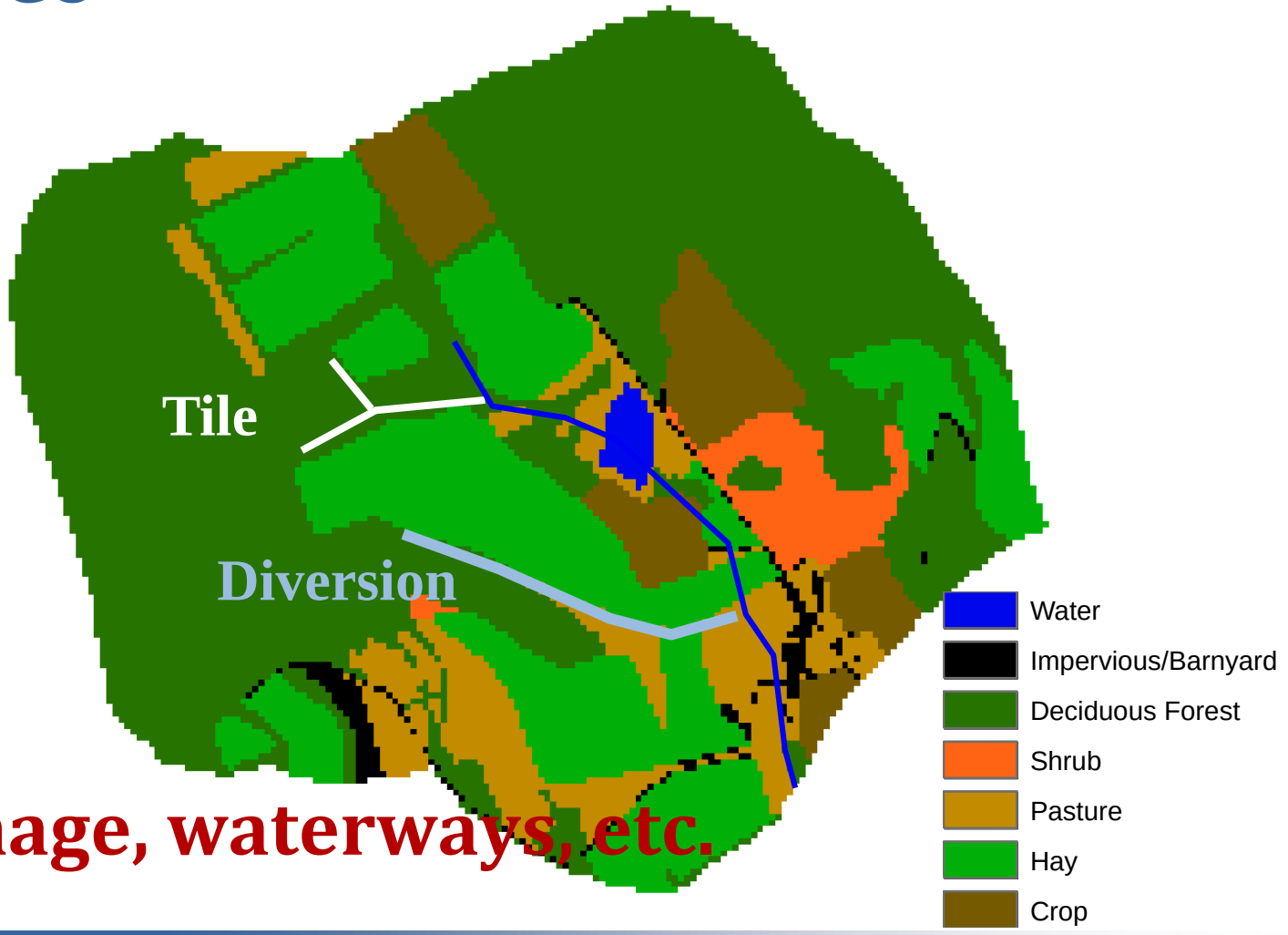
Erin Menzies, Brian Buchanan, Becky Marjerison

Also thanks to:

Zach Easton, Tammo Steenhuis, Larry Geohring, Dan Fuka,
NYC-DEP (Schneiderman/Zion), USDA-ARS (Gburek/Sharpley), NYS-DEC (Bishop)

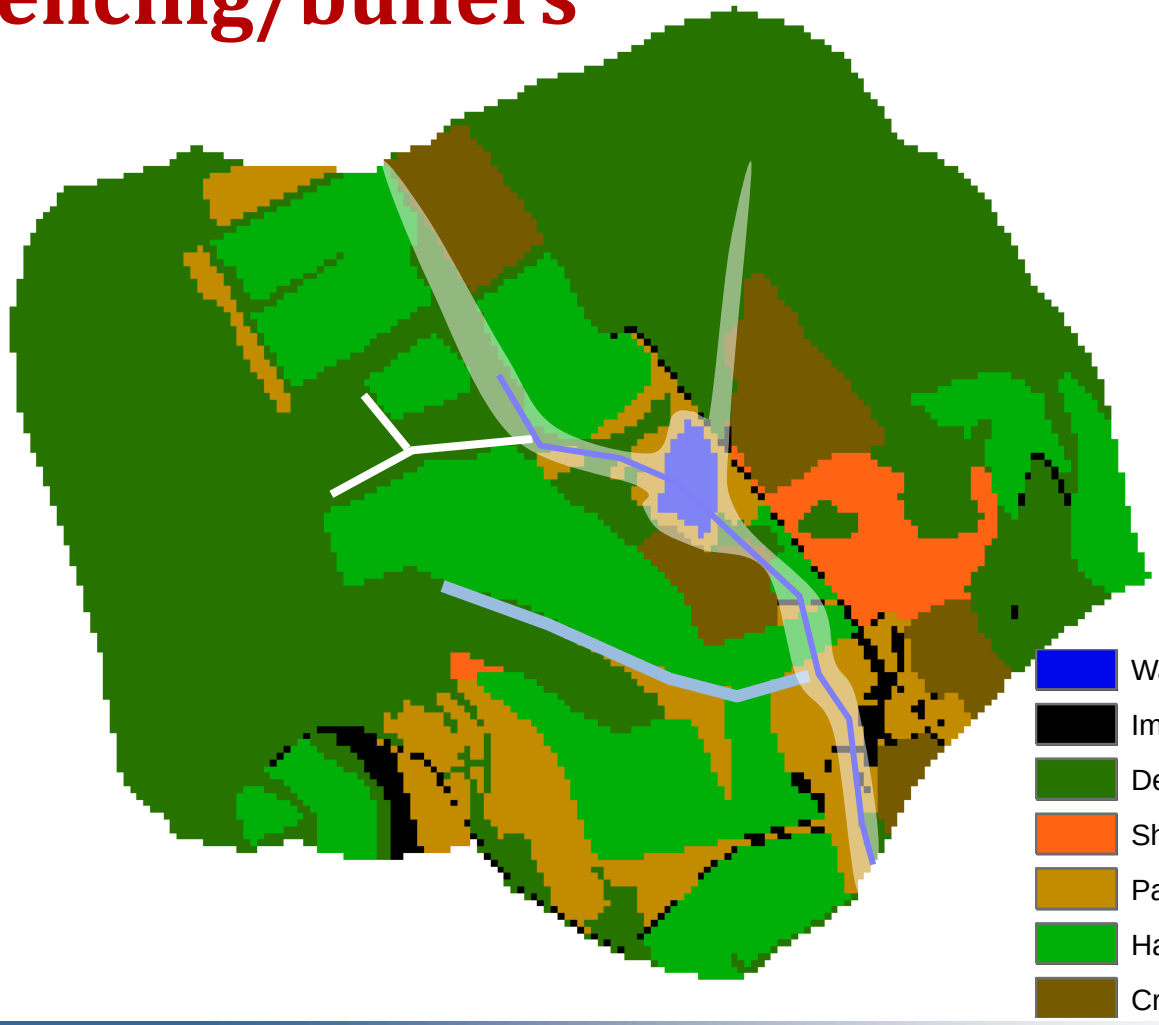
Could run through an example modeling analysis from the NYC watersheds

Evaluate "Best Management Practices"



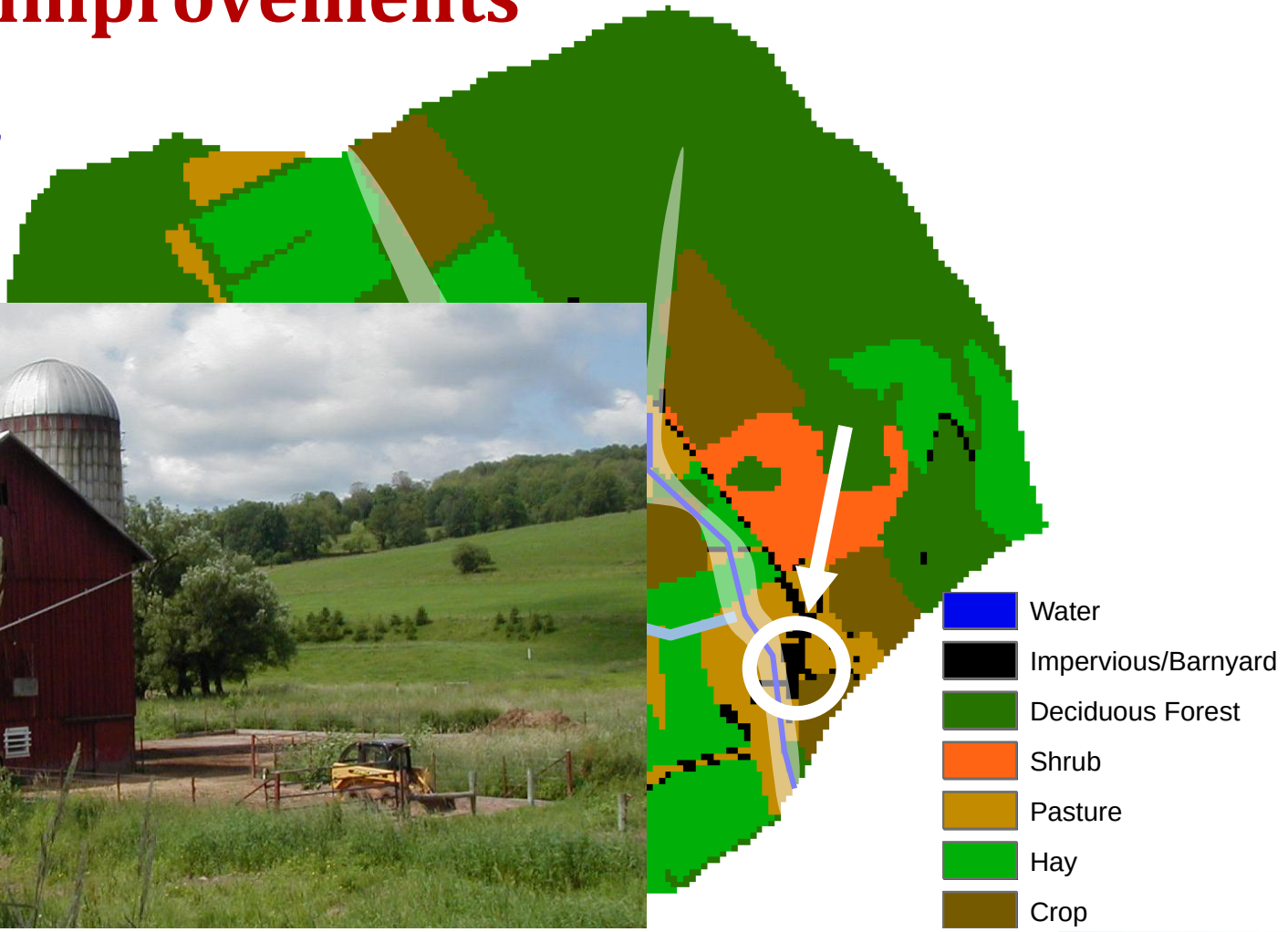
- **New drainage, waterways, etc.**

- **Riparian fencing/buffers**

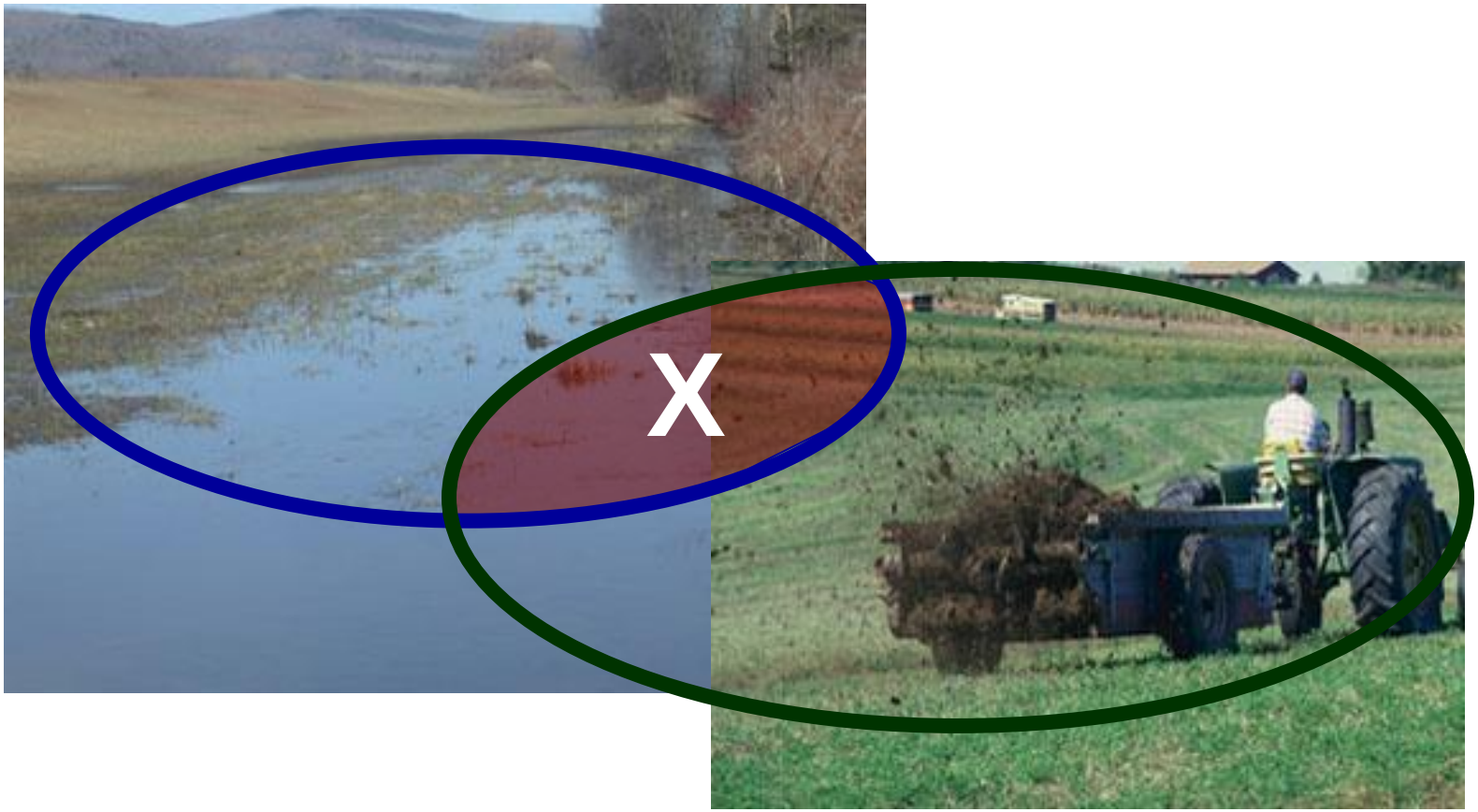


- **Barnyard improvements**

e.g., **re-grade, divert water, concrete pad**

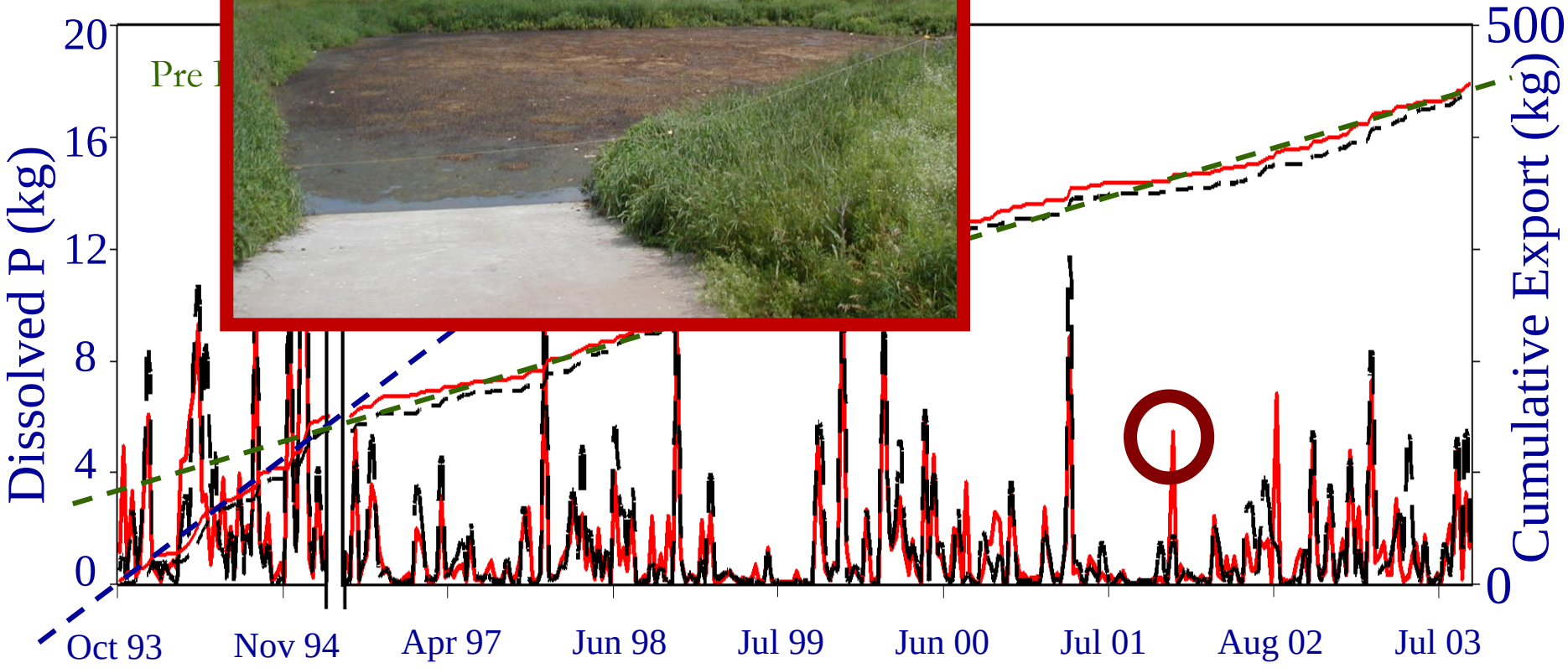


- **Use the NYS P-Index to develop spreading schedule**



Easton, Walter, Steenhuis. 2008. *J. Environ. Qual.* (in press)

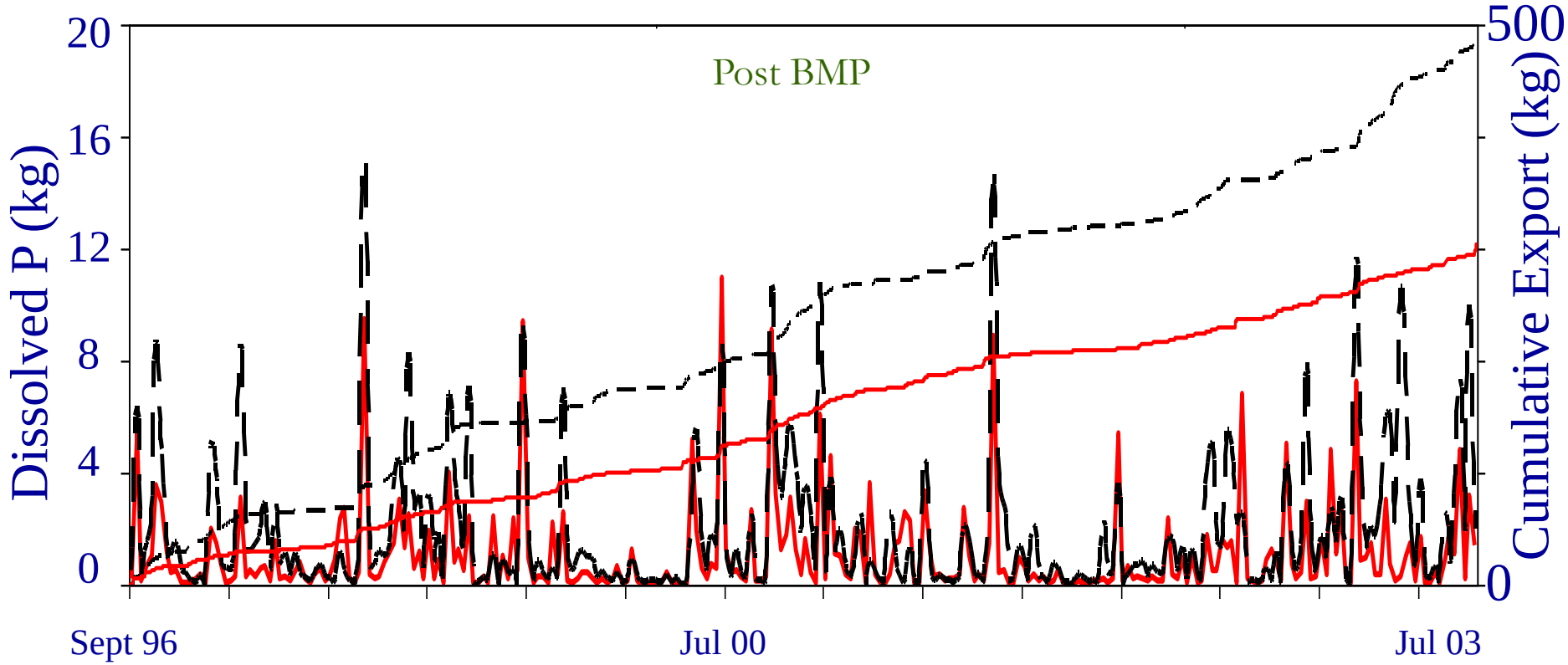
phorus



	Pre BMP	Post BMP	
Observed ———	0.49	0.27	kg/ha-yr
Predicted - - - - - - - -	0.48	0.27	

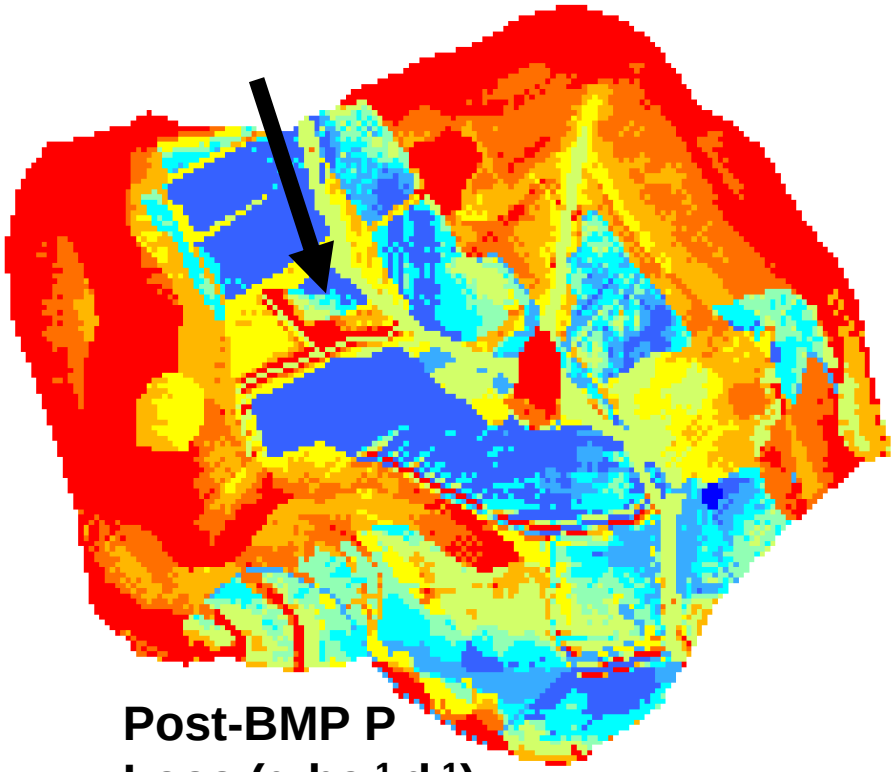
Easton, Walter, Steenhuis. 2008. *J. Environ. Qual.* (in press)

What If: We made no changes?



	Pre BMP	Post BMP	
Observed	0.49	0.27	kg/ha-yr
Modeled	0.48	**0.42**	

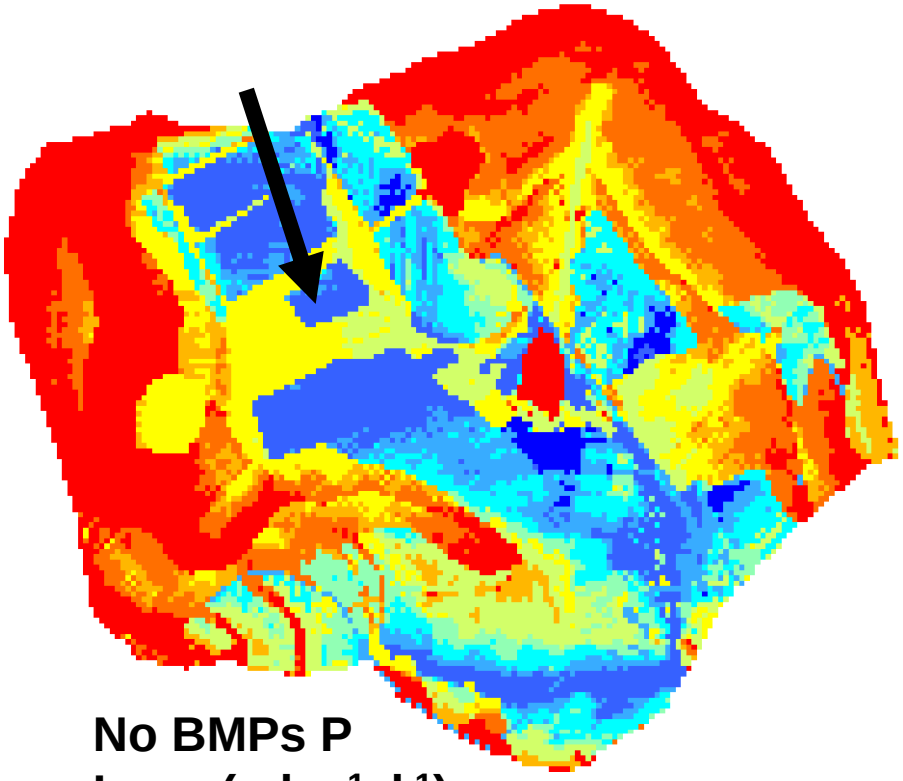
Complex Patterns of P Loss



Post-BMP P Loss (g ha^{-1} d^{-1})

0

20



No BMPs P Loss (g ha^{-1} d^{-1})

0

20

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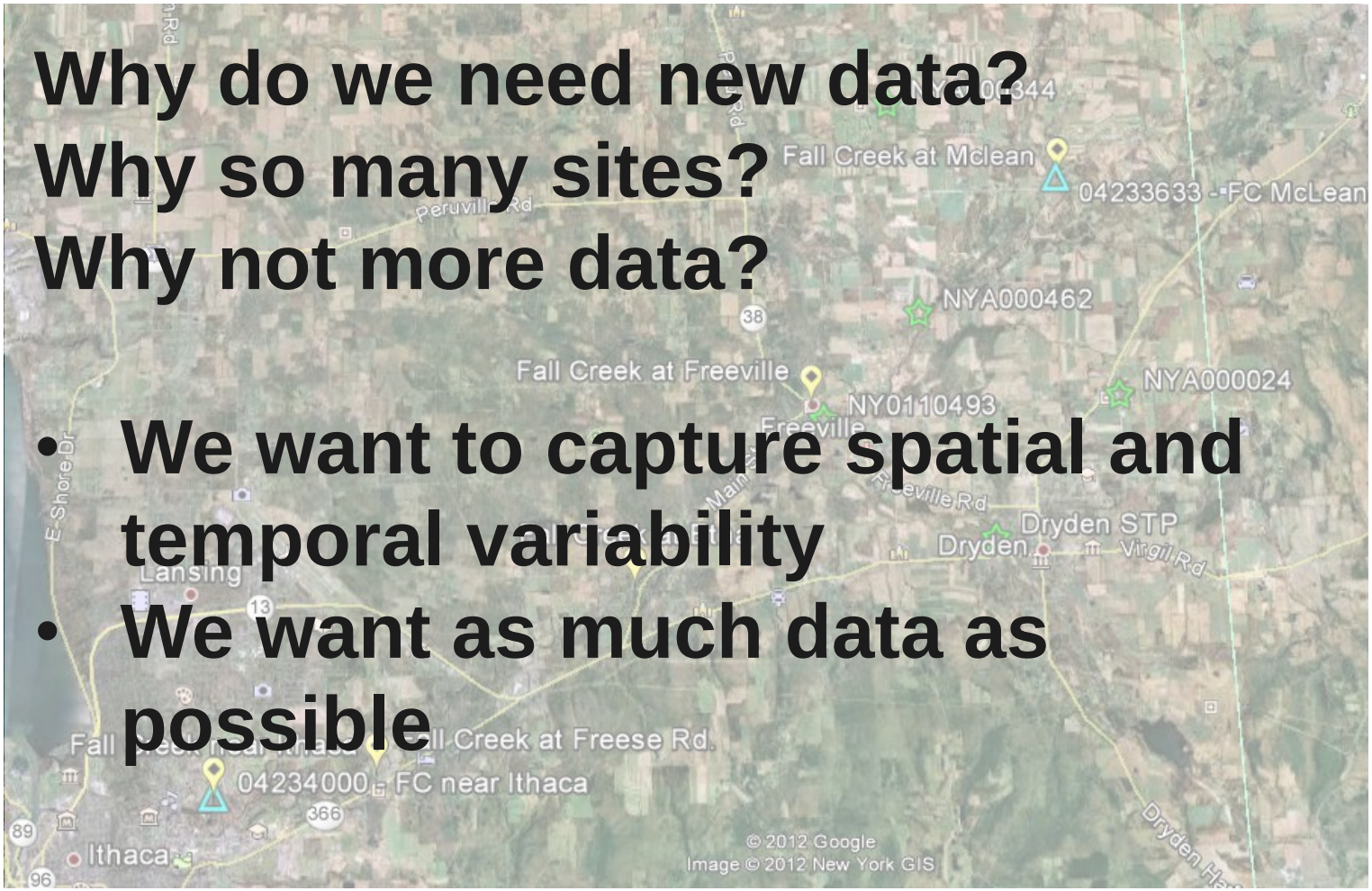
We want to avoid this

Monitoring/Data Strategy



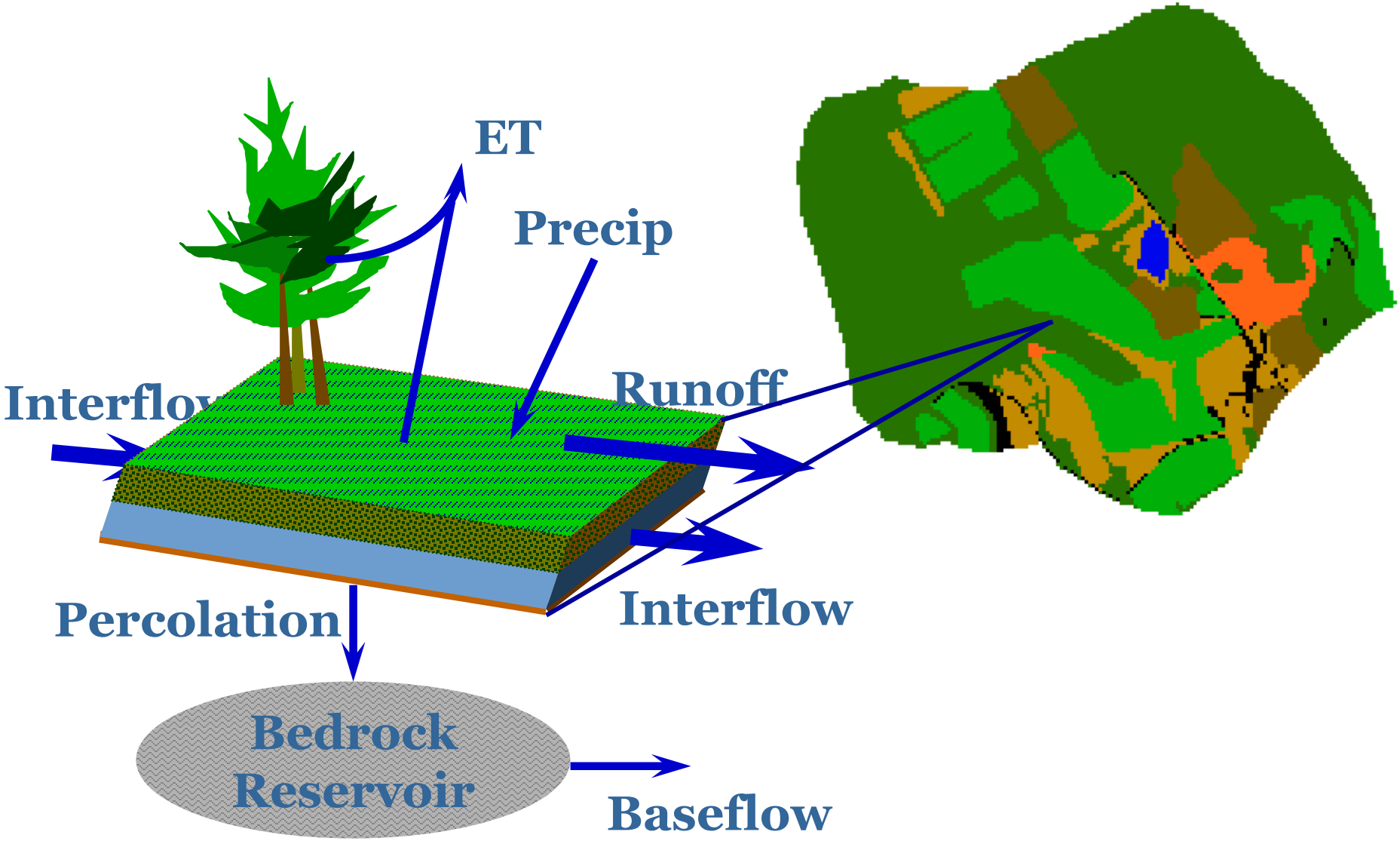
- We want to capture spatial and temporal variability
- We want as much data as possible

Some Known Data Sources

- USGS – Stream discharge, Fall Cr., Sixmile Cr., Inlet, some Salmon Cr.
- Dave Bouldin – Fall Creek, Cayuga Lake
- CSI – Various points along several creeks

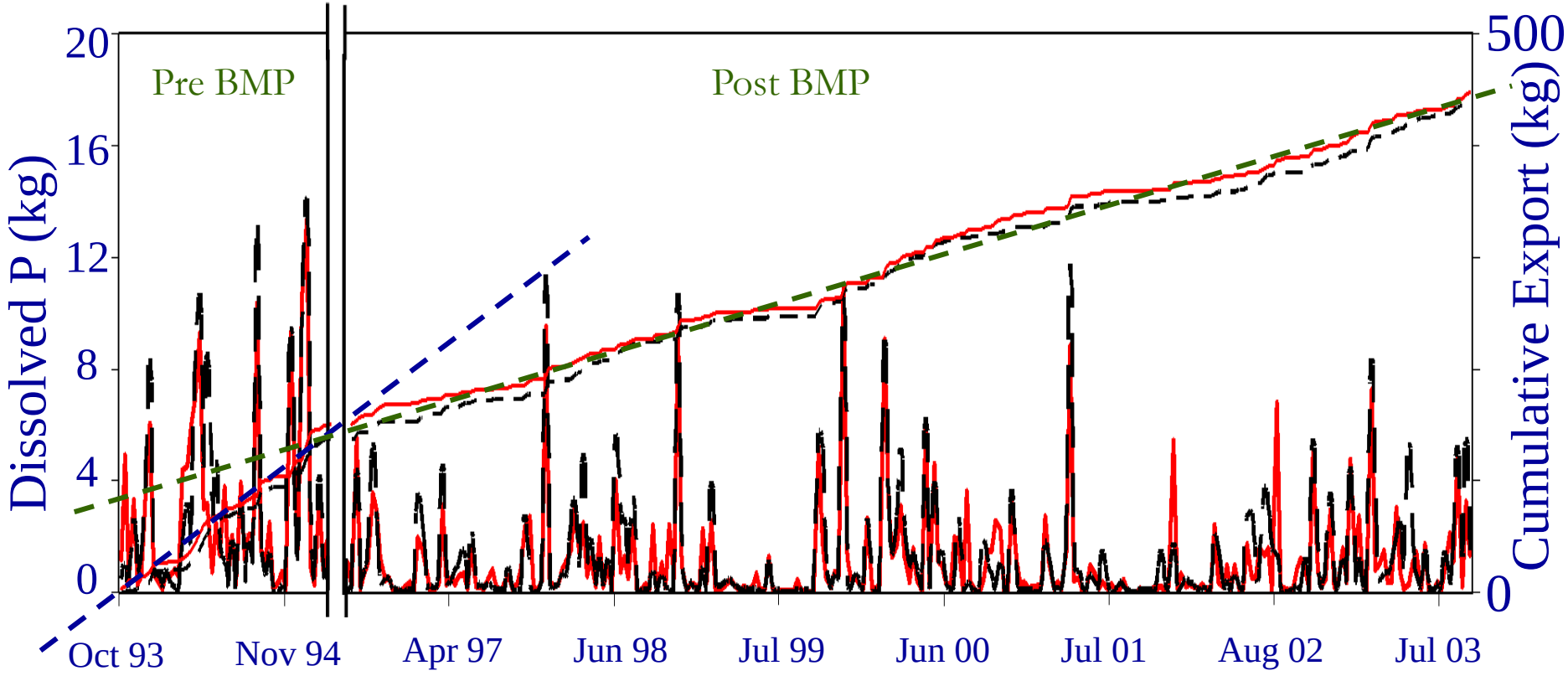
We will look for more as part of this project

Distributed Modeling



Easton, Walter, Steenhuis. 2008. *J. Environ. Qual.* (in press)

Example: Management questions



	Pre BMP	Post BMP	
Observed	0.49	0.27	kg/ha-yr
Predicted	0.48	0.27	

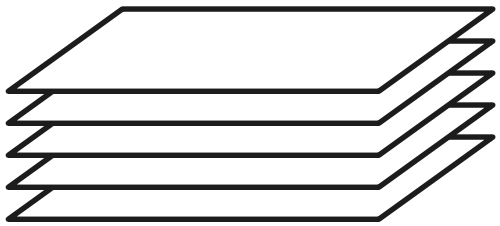
Take-home messages

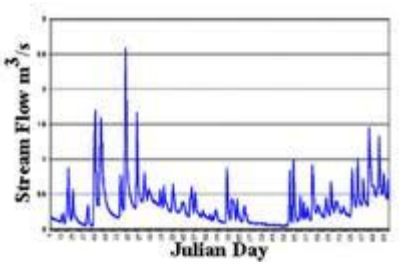
- **Nobody believes the model**
  (except the guy who made it)
- **Everybody believes the data**
  (except the guy who collected them)
- **So do both**

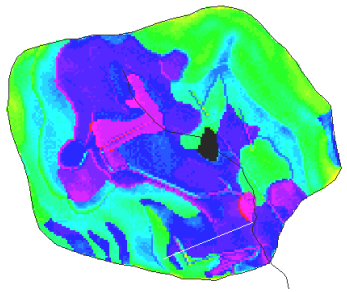
What is a Watershed Model?

- A collection of equations that calculate the flow of water and pollutants.

Weather
Topography
Land use
Soils



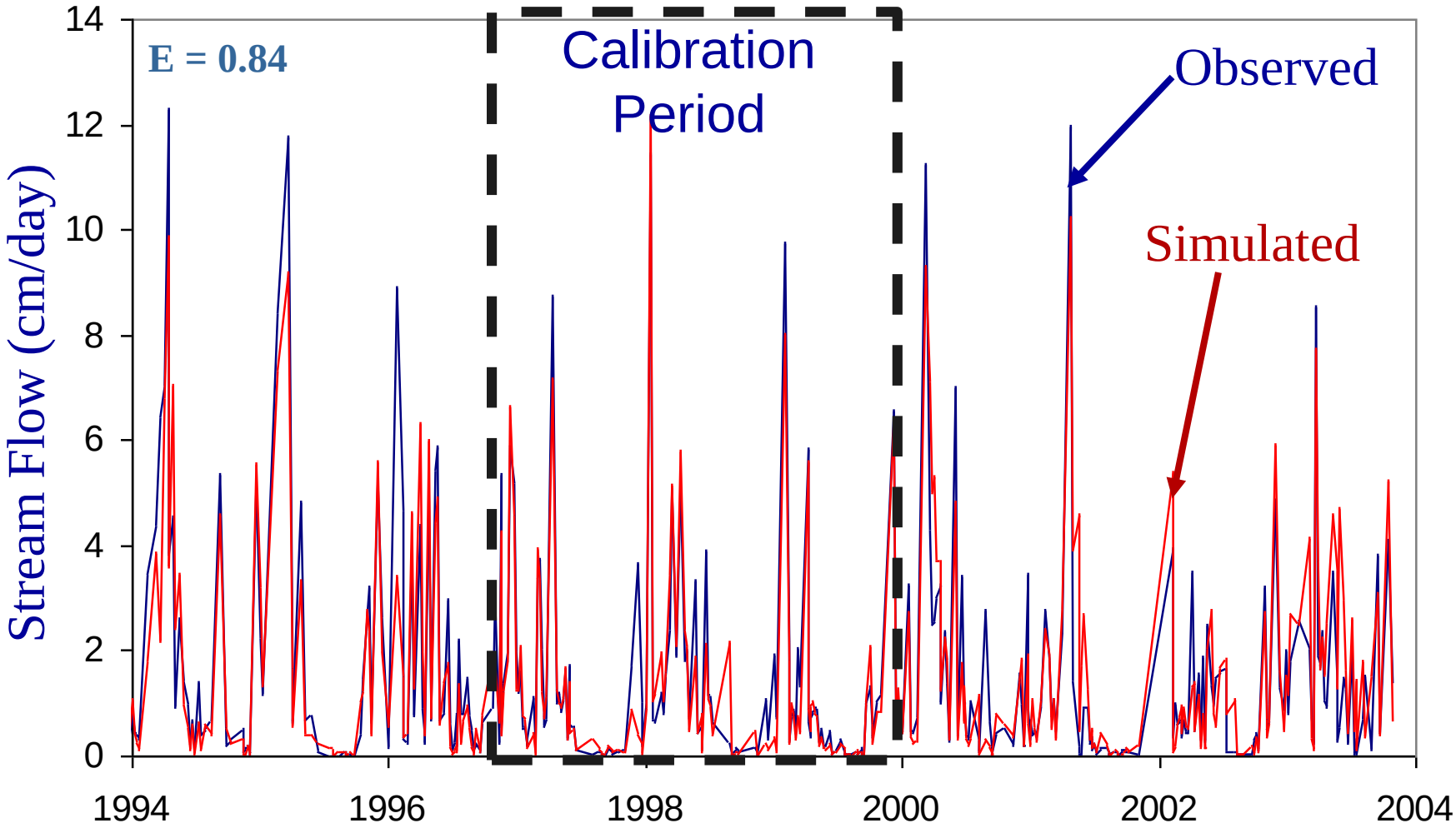




Stream flow and Water Quality Data?

- **Calibration:** Because we do not have a perfect understanding of how the environment works, some equations need to be calibrated.
- **"Validation" (or testing):** We need to check that our calibrated model works be testing it against different data.

Example from the Catskills



Progress to Date

- Assembled most base data (e.g., topography, land use, etc.)
- Proof-of-concept simple and complex modeling for Salmon Creek watershed
- Developing a systematic way to calibrate sub-watersheds
- Working on algorithm to predict stream sediment loads