

Phosphorus Forms at Different Spatial Scales in The Lower Fox River Basin

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Lower Fox River Watershed Monitoring Project

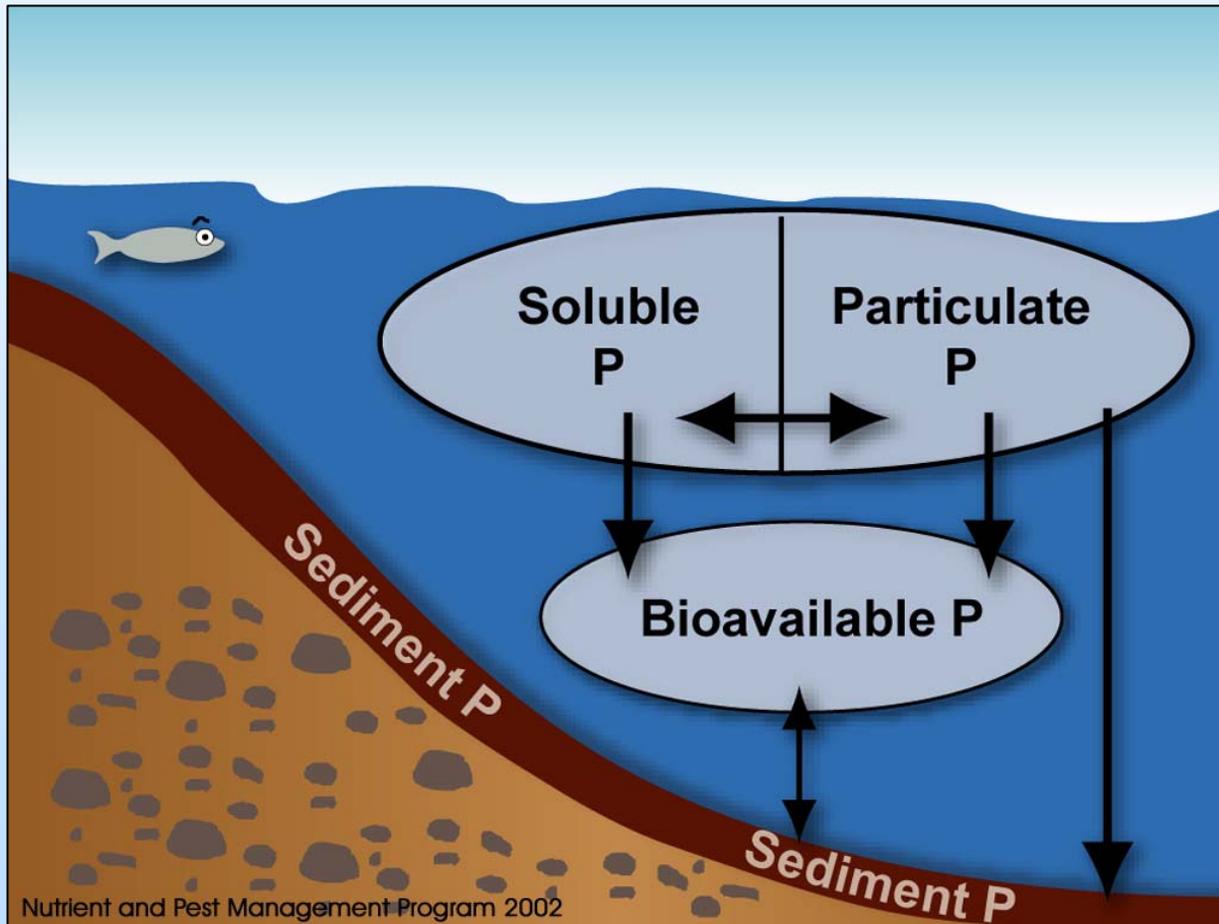
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Annual Meeting for the Wisconsin
Section of the American Water
Resource Association

Wisconsin Dells, WI – March 1-2,
2007

Phosphorus Forms



Primary Goal

To better understand and predict the forms of phosphorus in agricultural watersheds to enhance management decisions and improve the usability and biological integrity of our water resources.

Presentation Outline

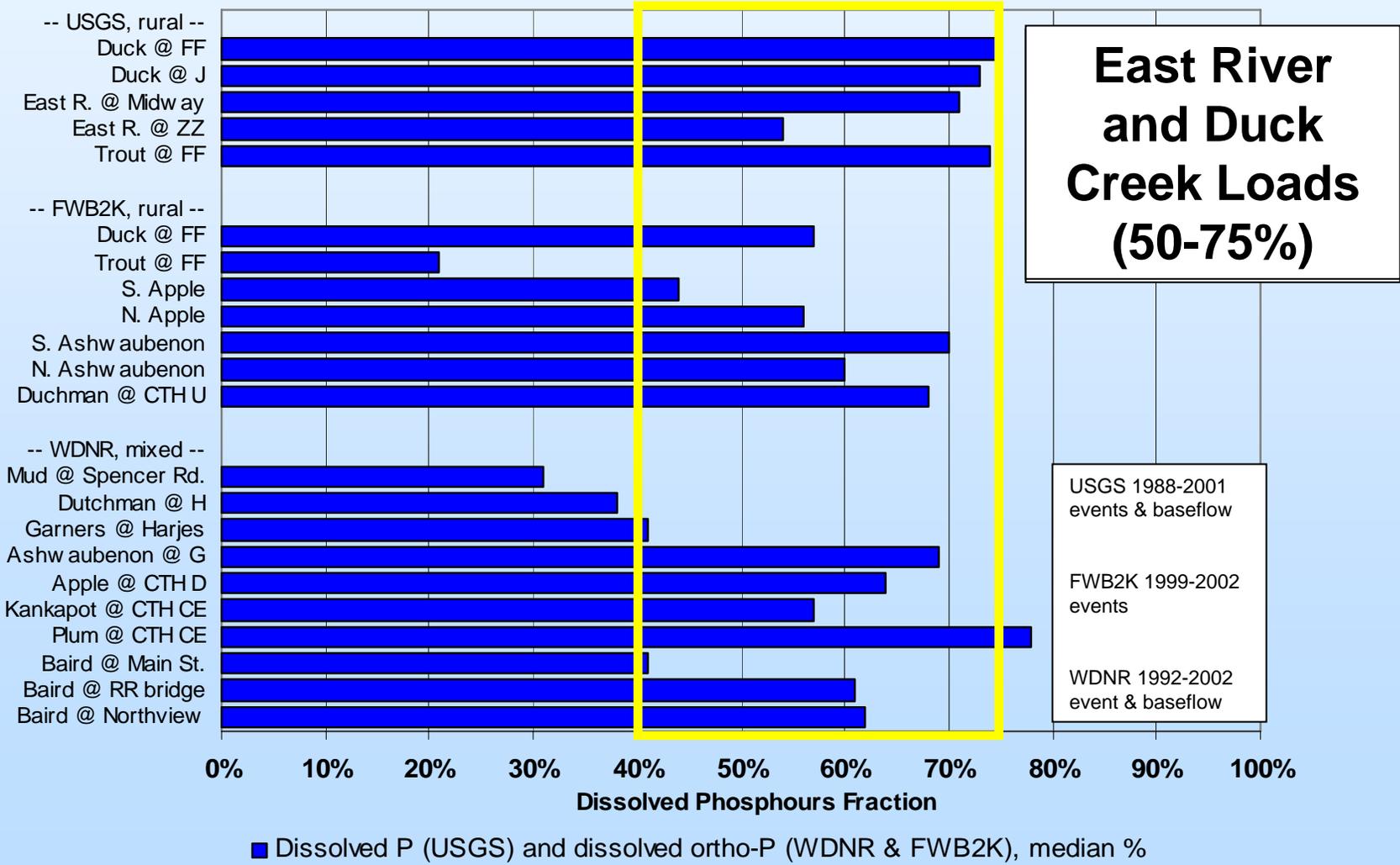
1. Description of Study Area
2. Lower Fox River Sub-Basin Tributary Monitoring
 - Watershed Scale
 - Background-Results-Conclusions
3. Apple Creek Phosphorus Forms Study
 - Background-Methods-Results-Conclusions
 - Multi-field Analysis with the Wisconsin P-Index
4. Summary & Conclusions

Lower Fox River Tributaries: Monitoring Background

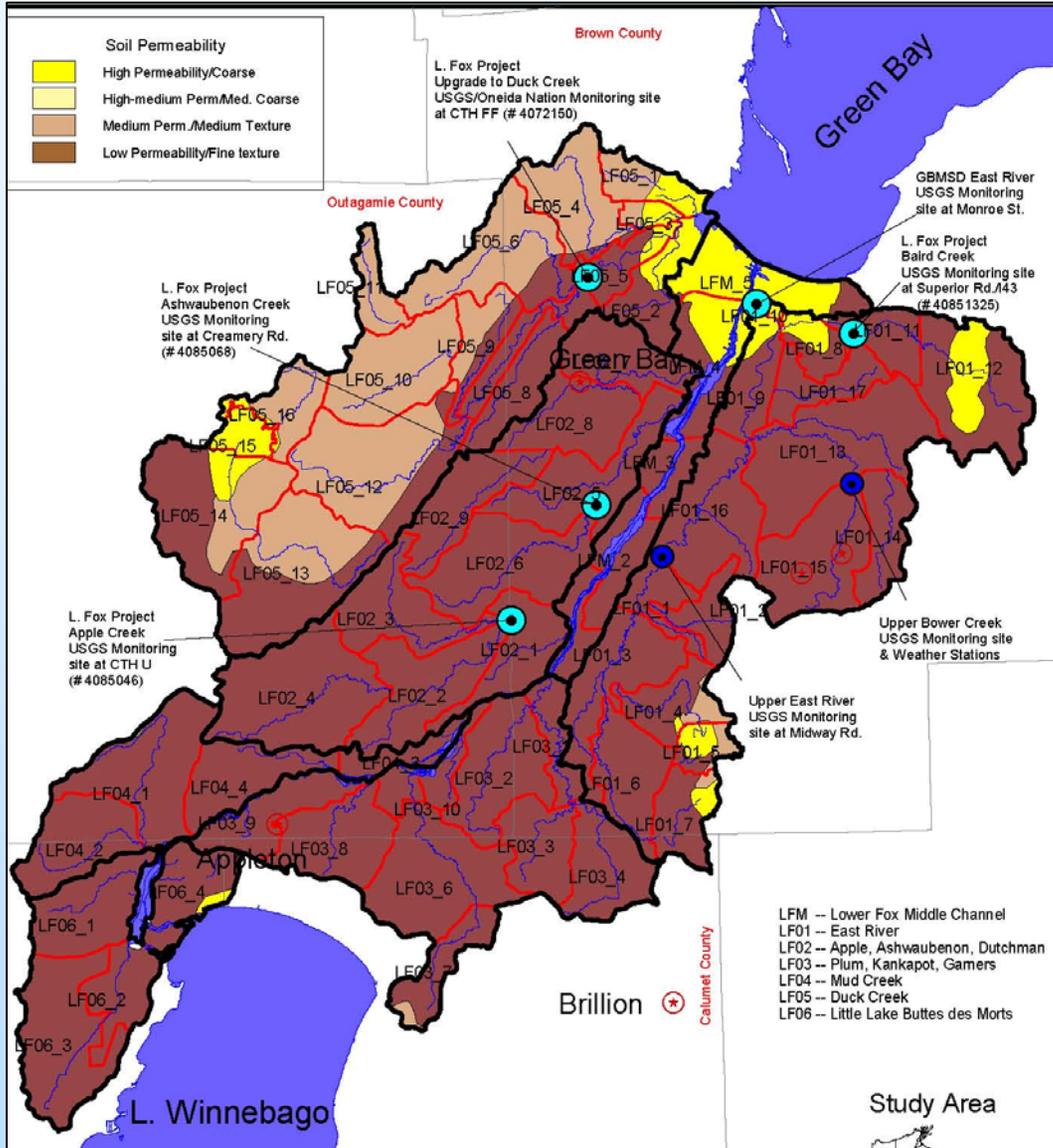


Lower Fox River Tributary Monitoring (1988-2002)

Dissolved Phosphorus in L. Fox Tributaries

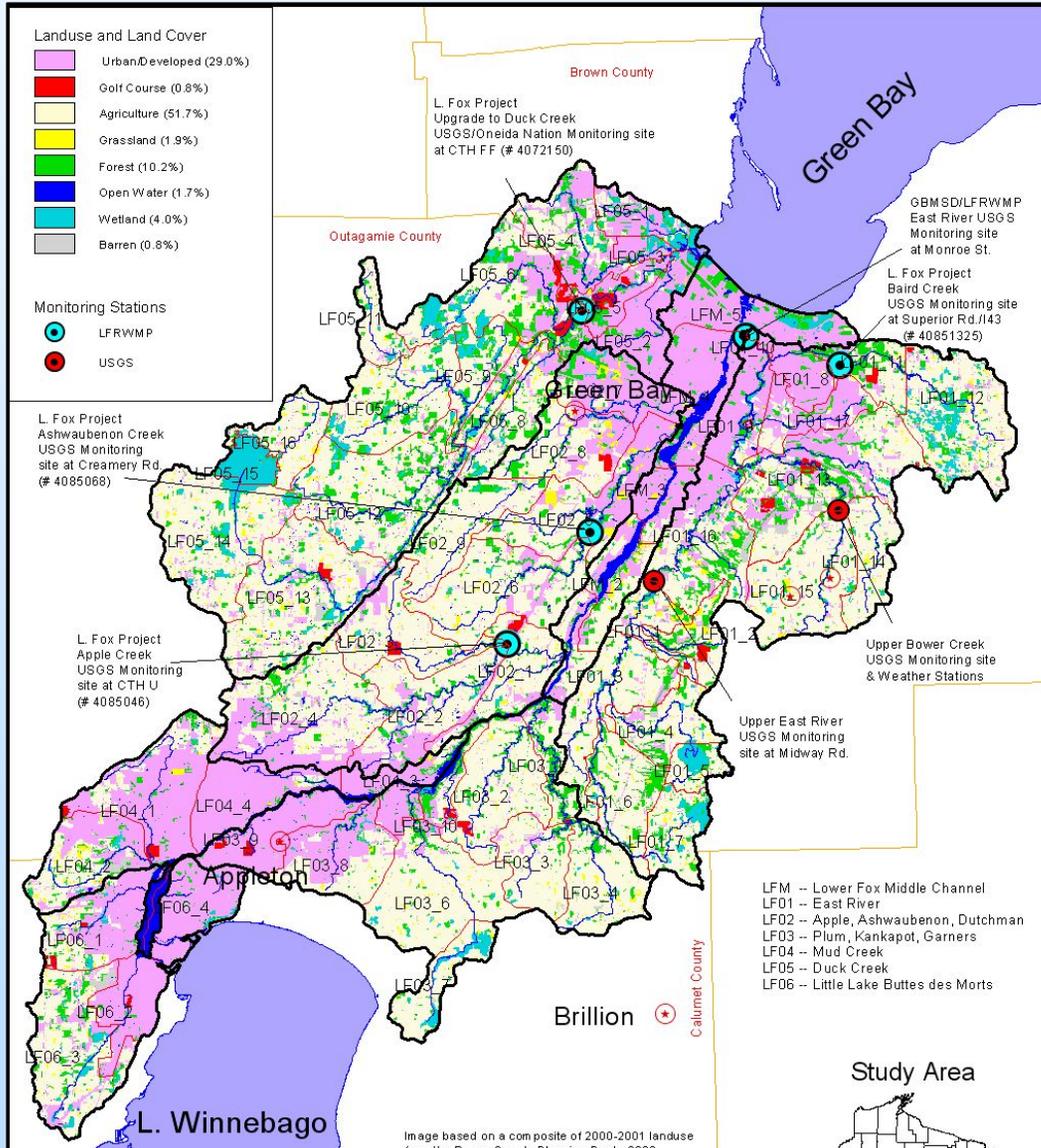


Soil Permeability of Lower Fox River Sub-Basin



- 💧 LFR Basin – Low Permeable Soils
- 💧 High % runoff

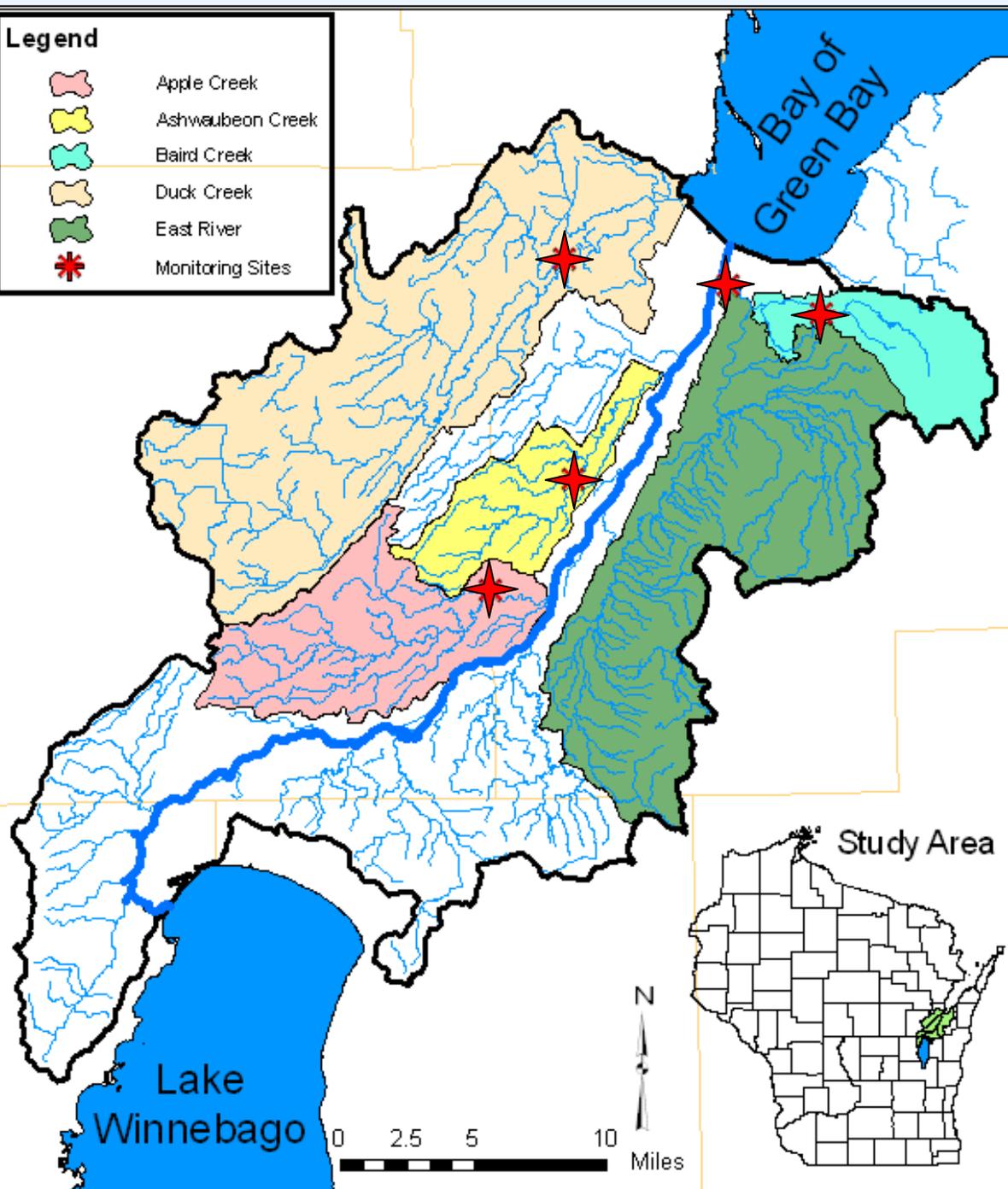
Lower Fox River Watershed Monitoring Program



- 3 water years
- Event and low-flow sampling
- Continuous flows
- TP, DP, TSS



Legend	
	Apple Creek
	Ashwaubenon Creek
	Baird Creek
	Duck Creek
	East River
	Monitoring Sites



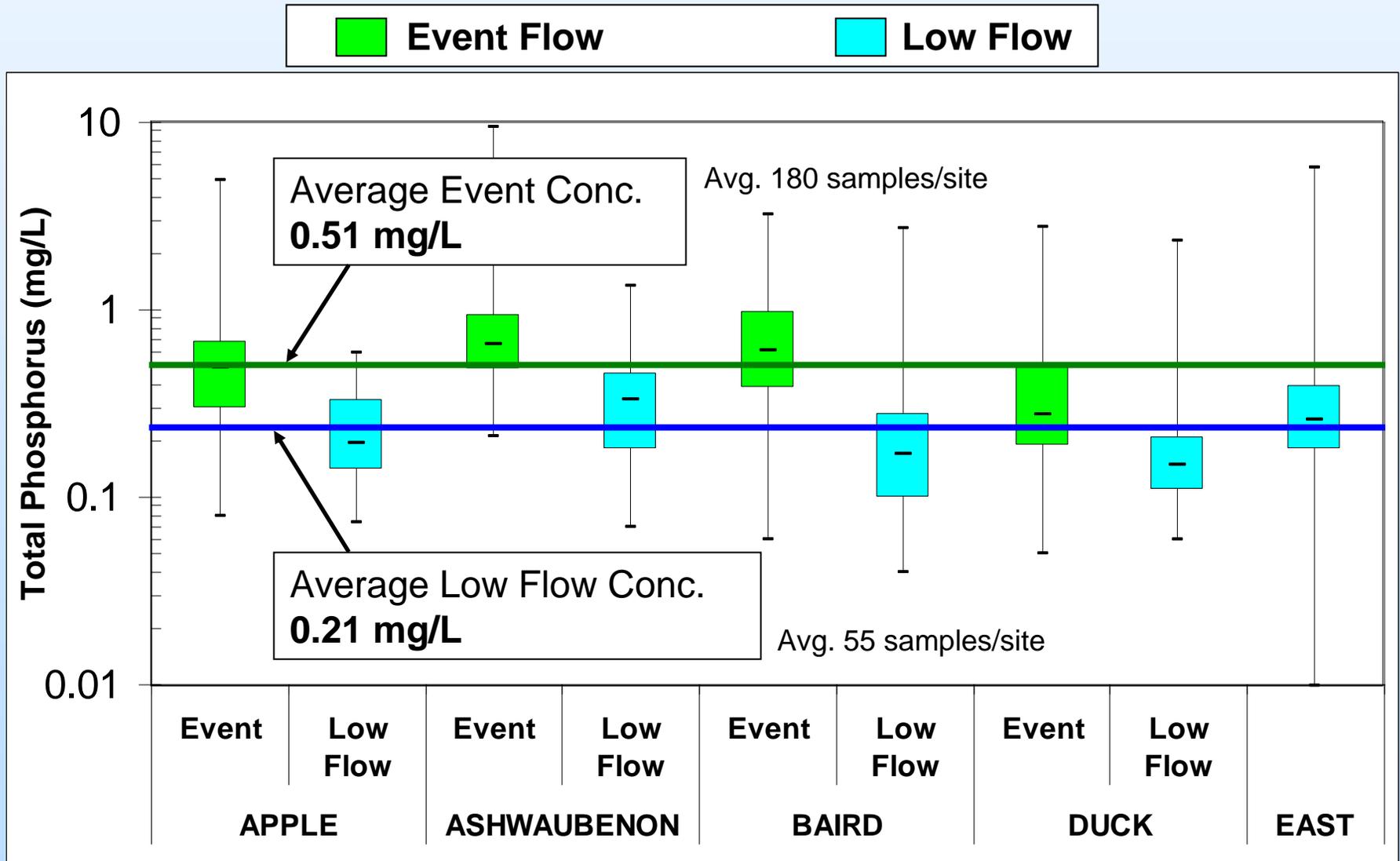
Lower Fox River Sub-Basin and Monitoring Sites

-  Apple Creek
-  Ashwaubenon Creek
-  Baird Creek
-  Duck Creek
-  East River

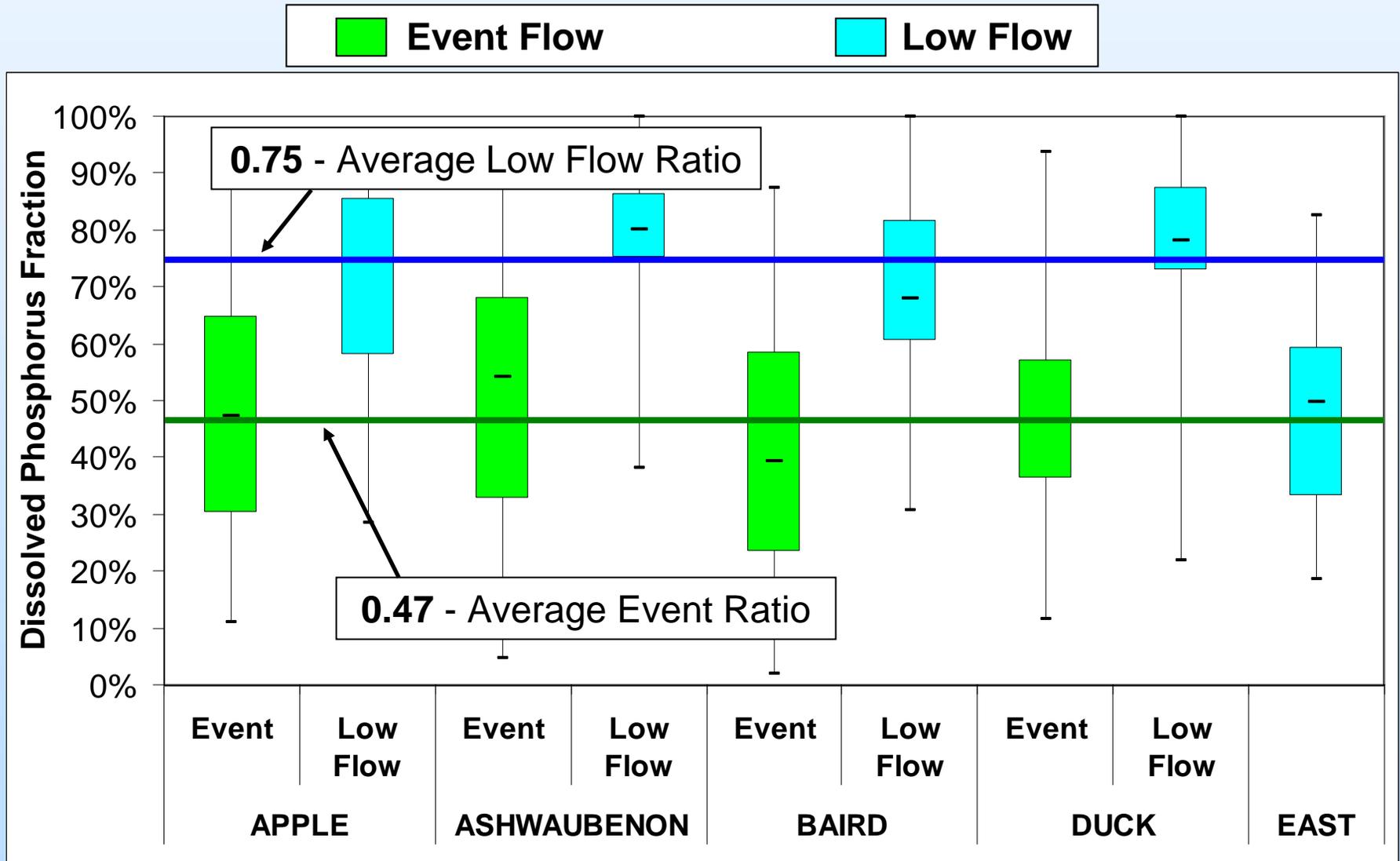
Results

Tributary Monitoring WY 2004-2006

Total Phosphorus (mg/L) 2004-2006



Dissolved Phosphorus Fraction 2004-2006



Tributary Monitoring Conclusions: WY 2004-2006

- Dissolved phosphorus fraction is significant during event runoff (40-54%)
- Annual DP loads (avg. for 4 tribs.)
 - 2004: 42%
 - 2005: 54%
- Where do we go from here?
 - What is the dominate form at smaller scales?
 - What implications does this have for BMPs?

Phosphorus Forms Study: Apple Creek



P-Forms Objectives

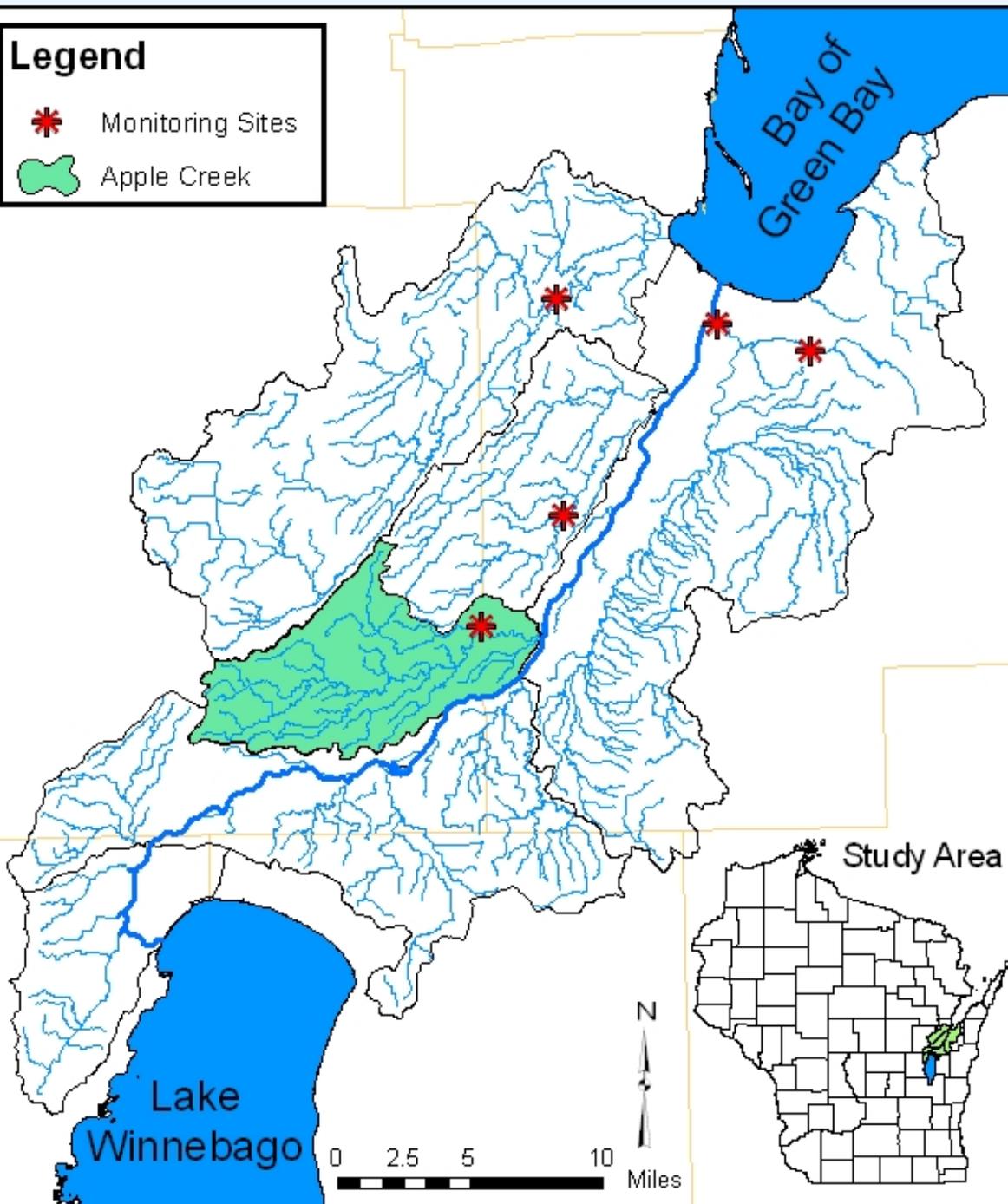
- Determine DP & TP concentrations and the DP fraction in streams at different scales
- Relate results to watershed characteristics (i.e. soils, topography, and land management)
- Apply Wisconsin P Risk Index to source areas and compare to water quality

Legend

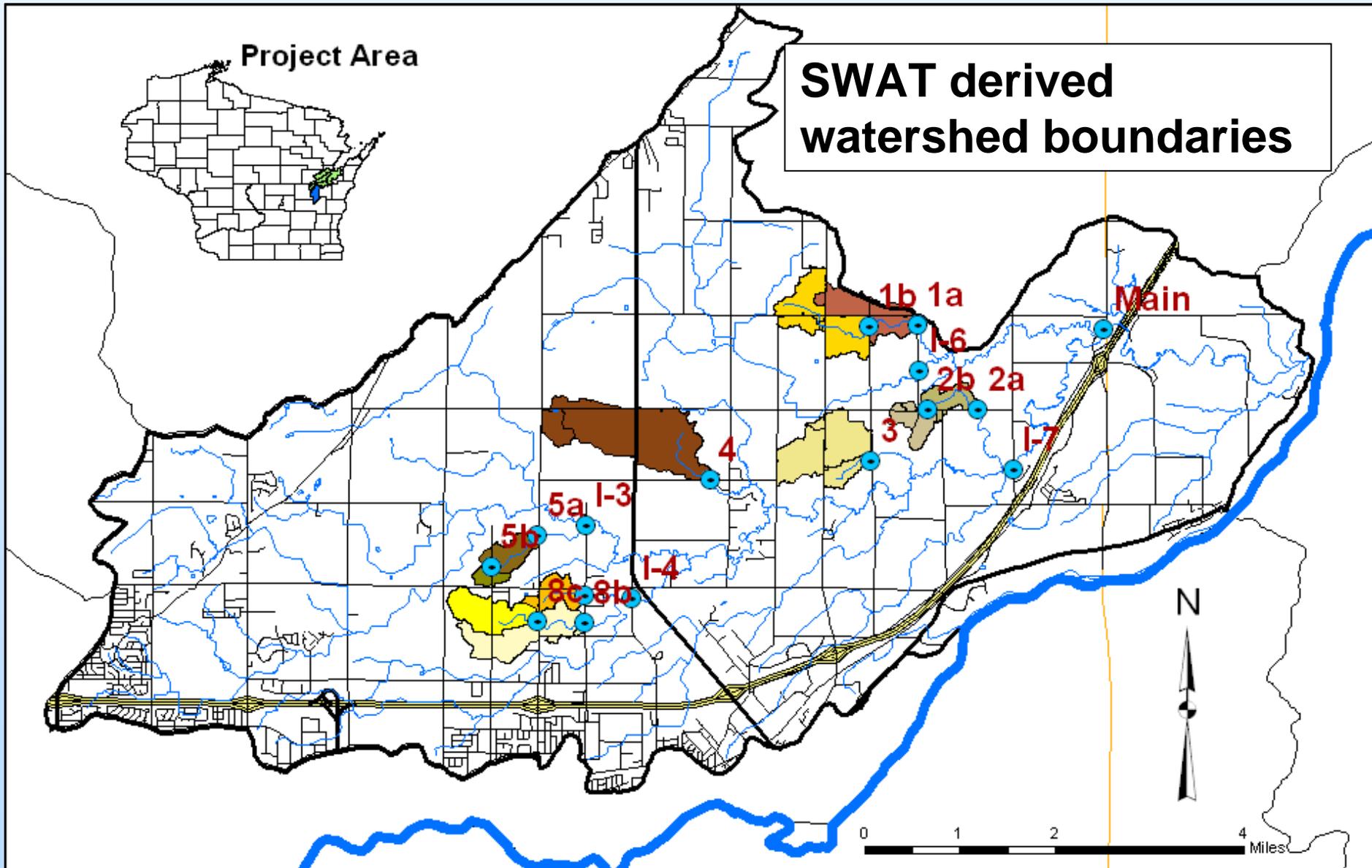
-  Monitoring Sites
-  Apple Creek

Apple Creek Watershed

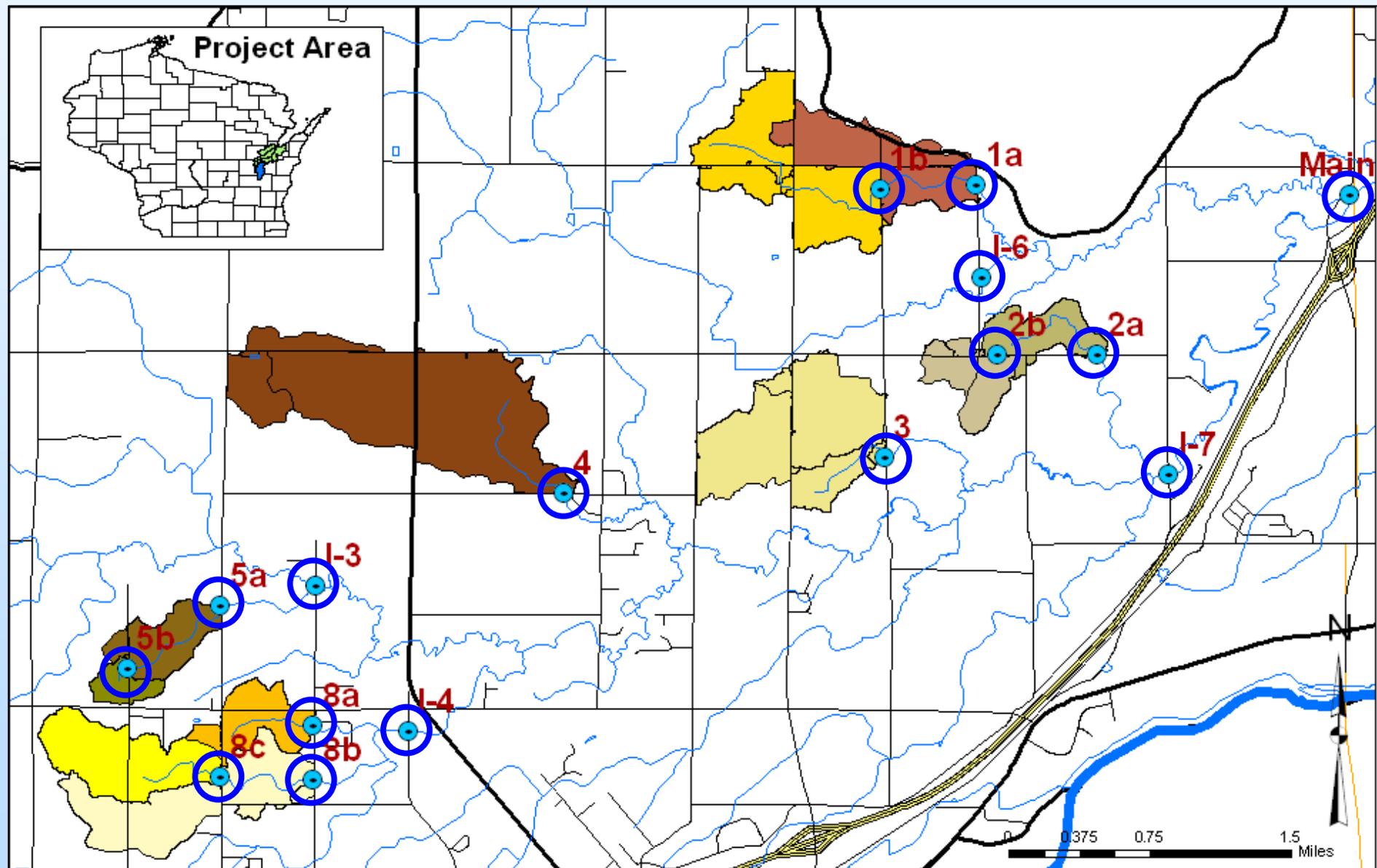
-  117 km²
-  63% Agriculture
-  26% urban development
-  Rapidly urbanizing southern section



Apple Creek P-Forms Study Sites



Apple Creek P-Forms Study Sites – Close up



P-Forms Methods



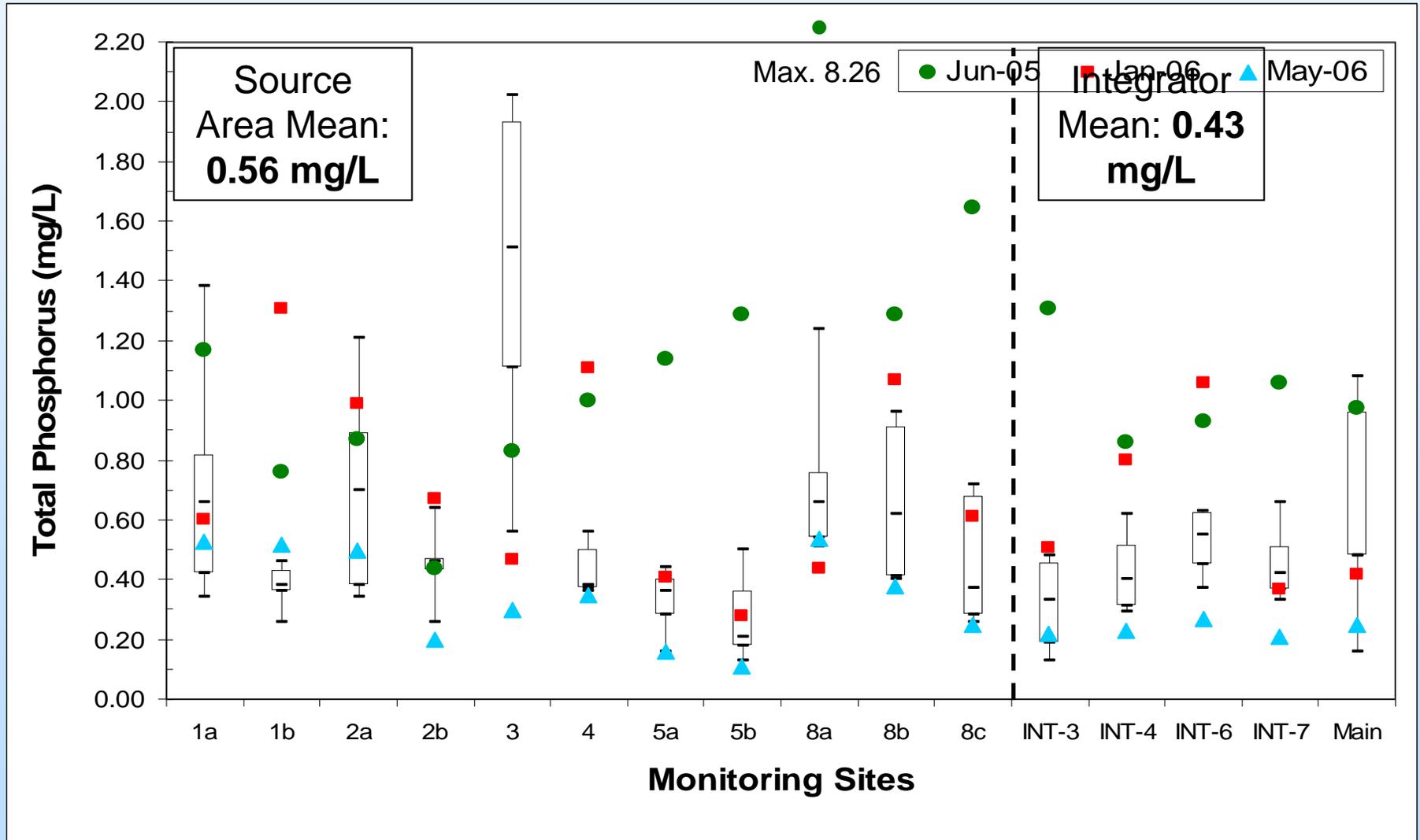
Monitoring Methods

- Study Period: 2004 – 2006
- EVENT SAMPLING: Targeted uniform precipitation events
 - Grab samples at 11 source area (0.2 to 2.3 km²) and 4 integrator sites (12 to 85 km²), at or near peak flow
- Main stem USGS site: Continuous discharge & automated sample collection (117 km²)
- TSS, TP, and DP analysis at Green Bay Metropolitan Sewage District Lab

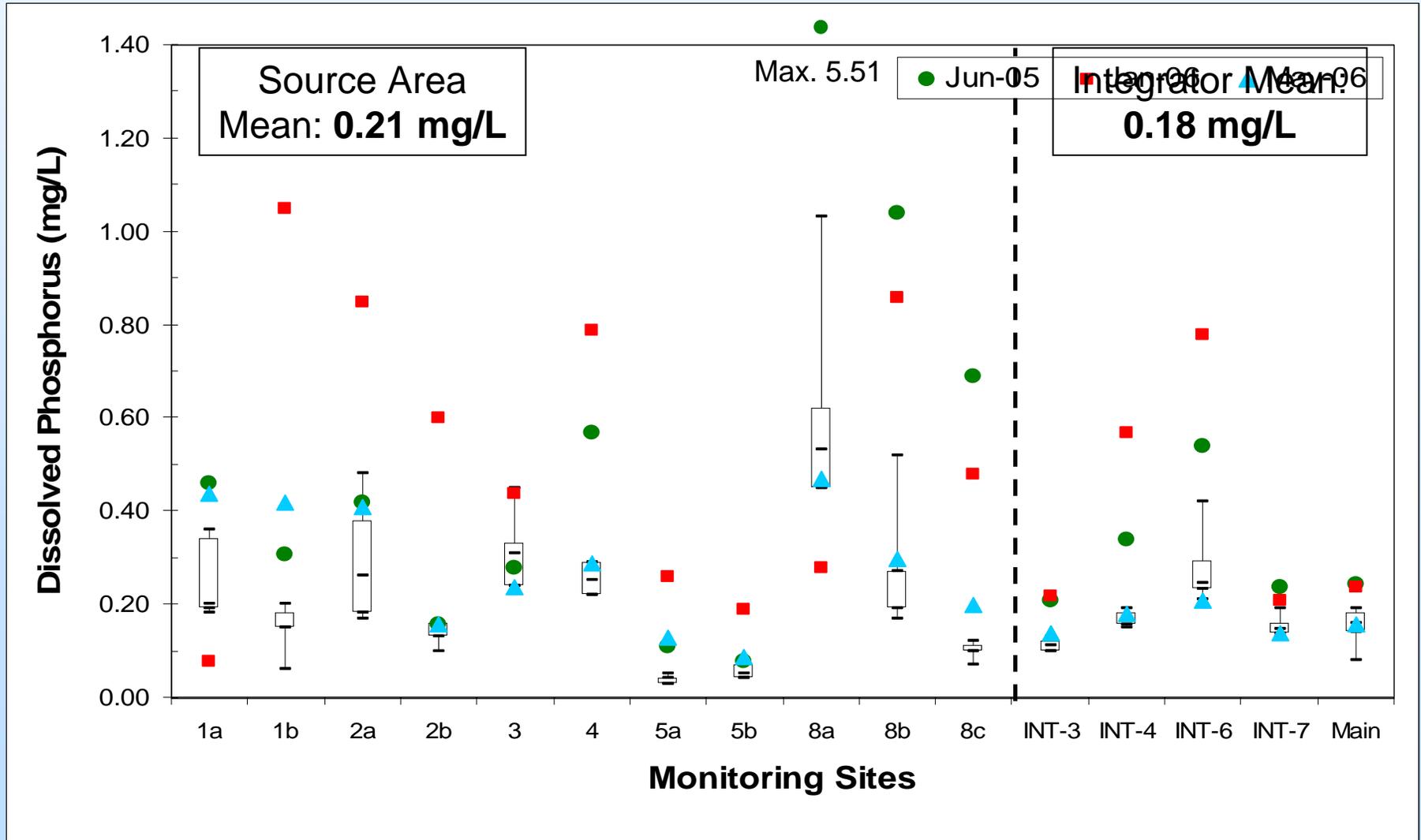
Results

P-Forms Study
WY 2004-2006

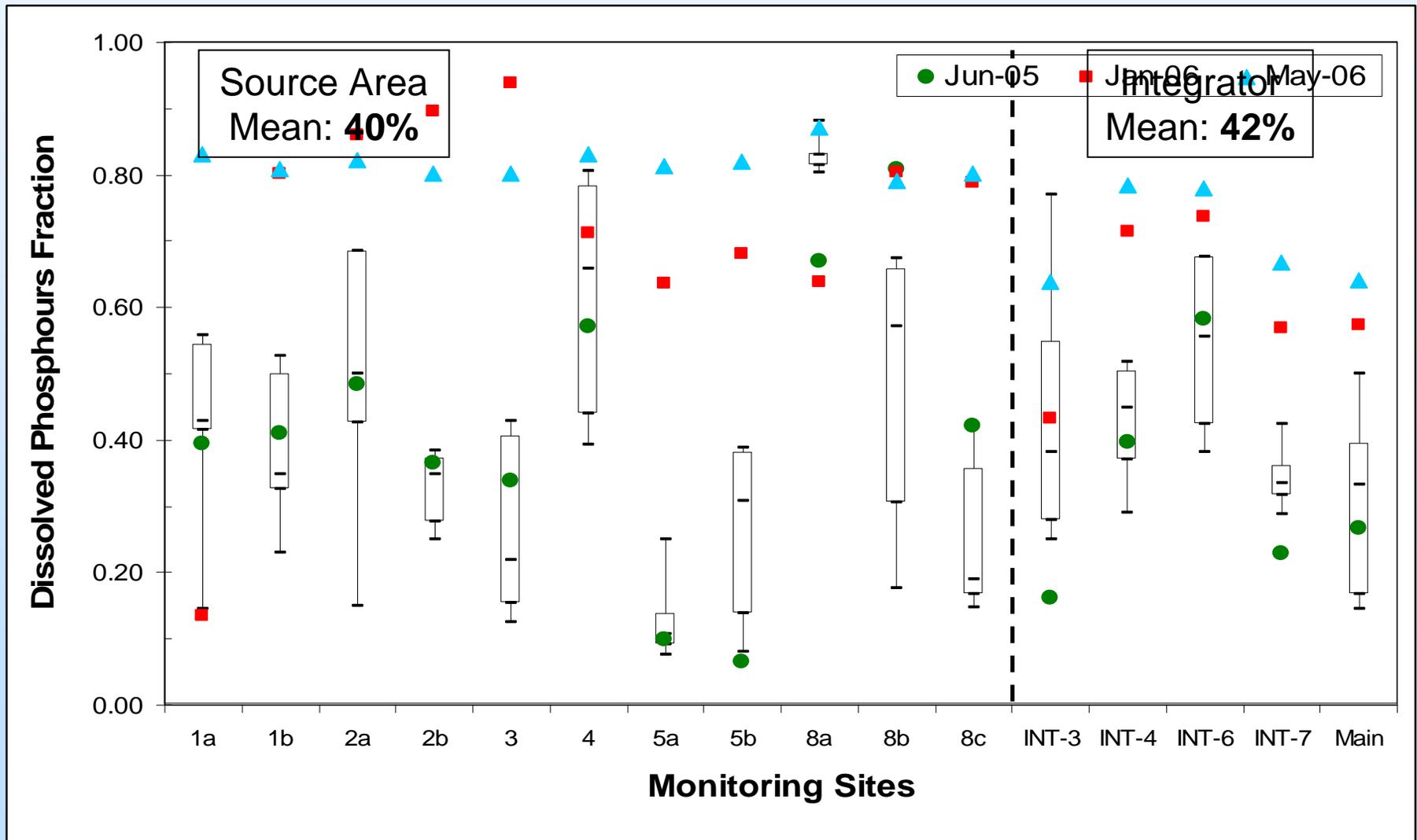
Total Phosphorus (mg/L) – 2004 - 2006



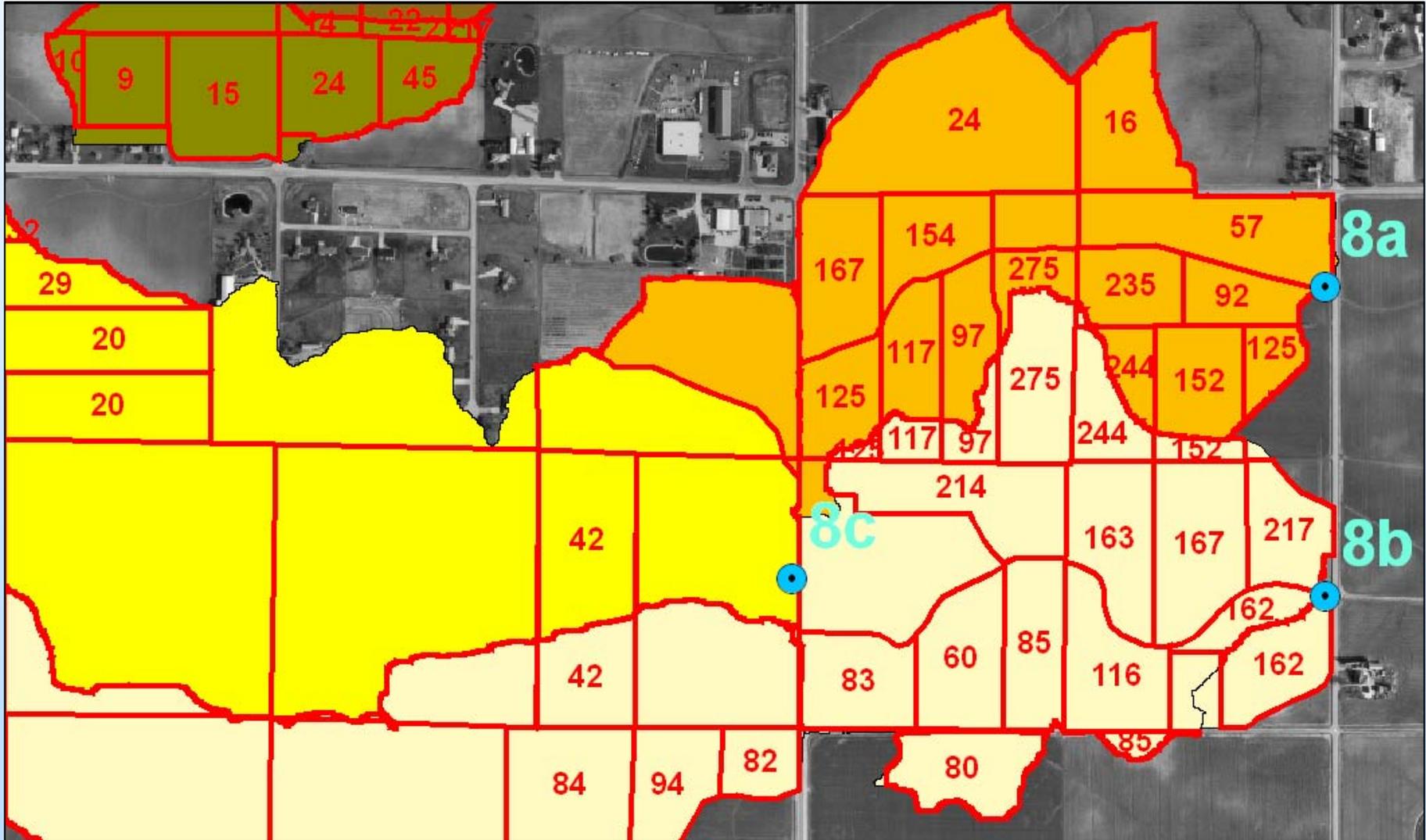
Dissolved Phosphorus (mg/L) – 2004 - 2006



Dissolved/Total Phosphorus Ratio – 2004- 2006



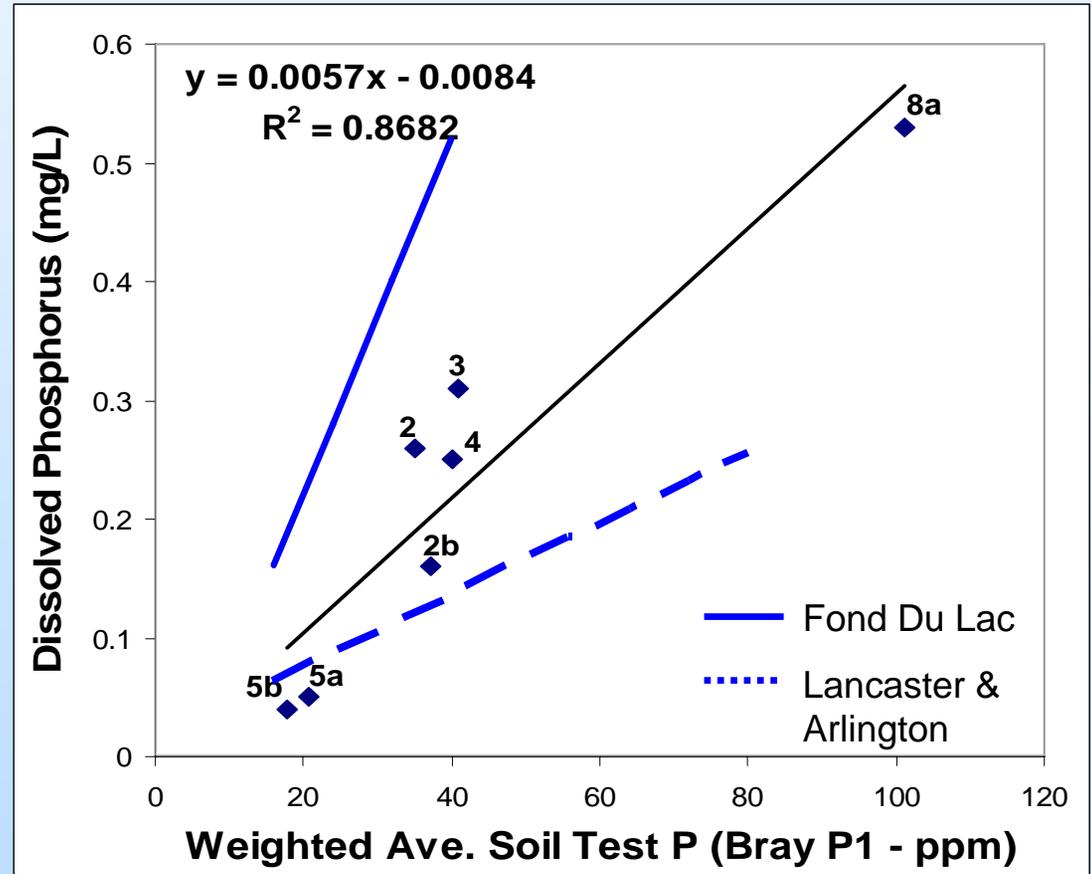
Soil-Test P levels in Apple Creek Sub-Watershed (ppm Bray-P1)



Soil Test P vs. DP in Streams

💧 Strong response to increasing STP on DP in streams

💧 Andraski and Bundy. 2002. JEQ



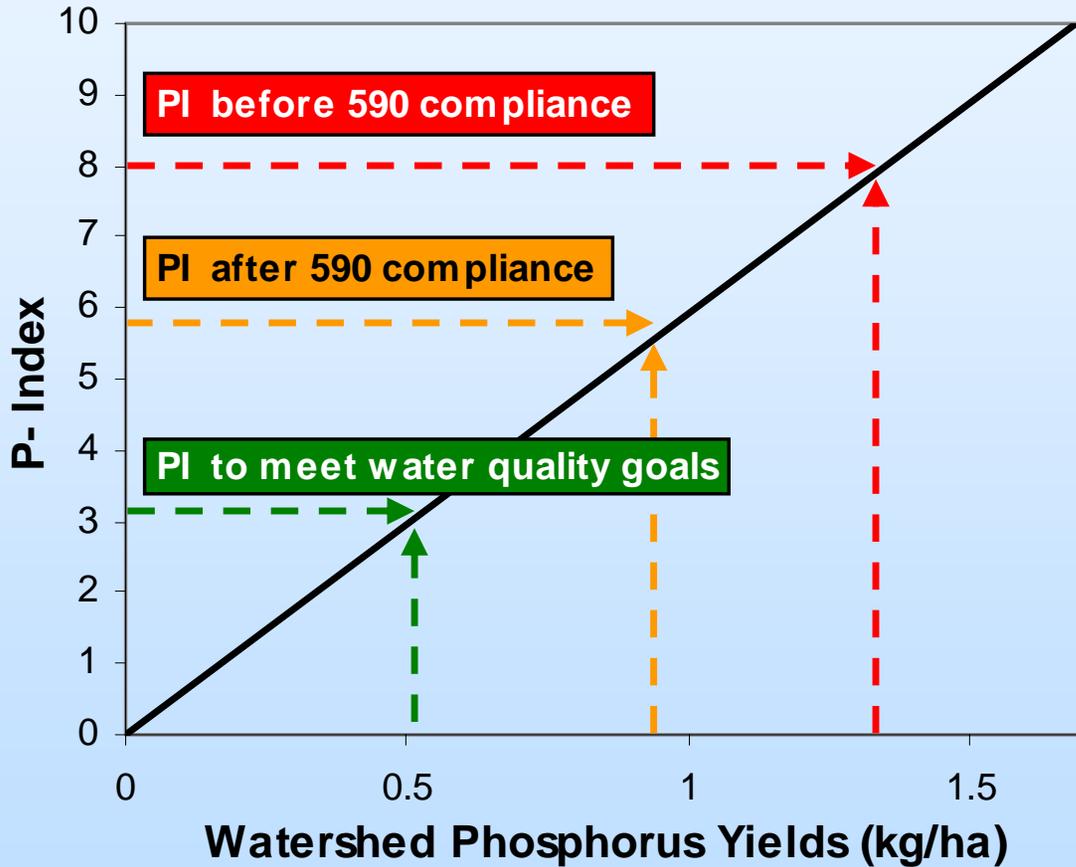
SNAP-Plus and Farm Field Analysis

Wisconsin P-Index



Photo: Snap-Plus Users Manual Version 1.119

P-Index Analysis Primary Goal



💧 Will compliance with 590 standards meet water quality goals

💧 Can Snap-Plus be used as a tool to accurately predict water quality at the multi-field scale

SNAP-Plus Analysis

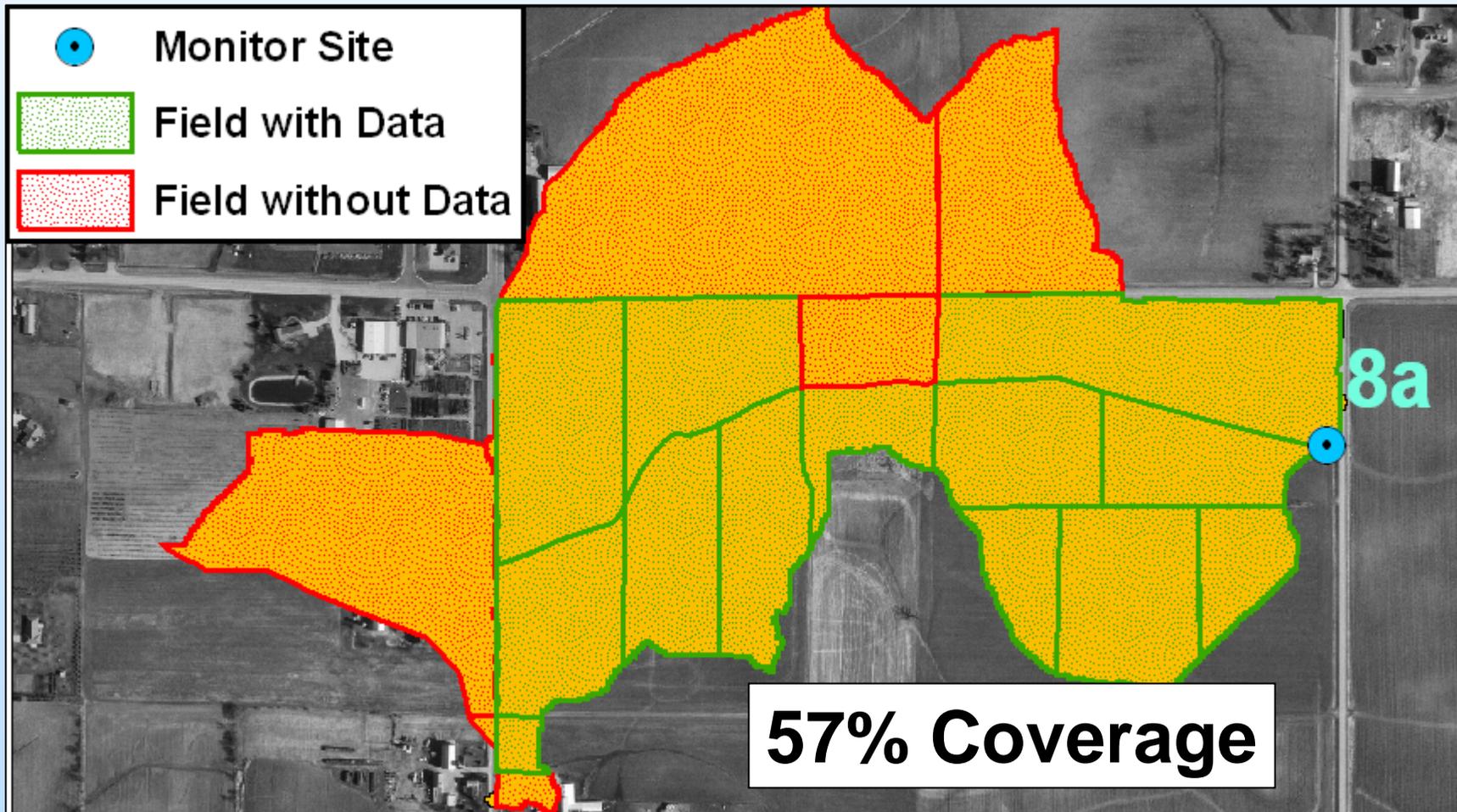
💧 Samples collected

- **2004: 5 events (March to June)**
 - 2005: 1 event (June)
 - 2006: 2 events (January and May)
- } Excluded from current analysis

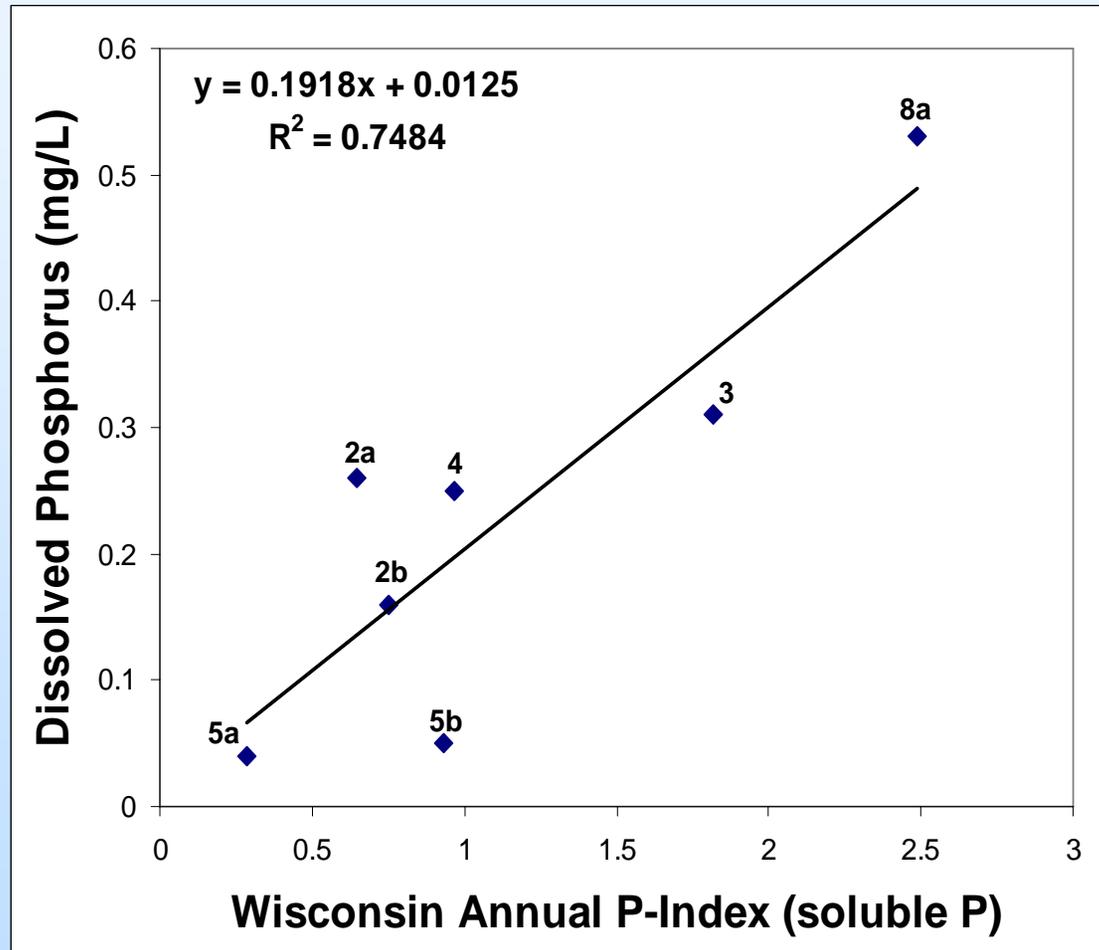
💧 Land management data for Snap-Plus

- Nutrient management plans
- Crop consultants
- 6 out of 11 sites with good coverage (> 50%)

Coverage Map – Apple 8a

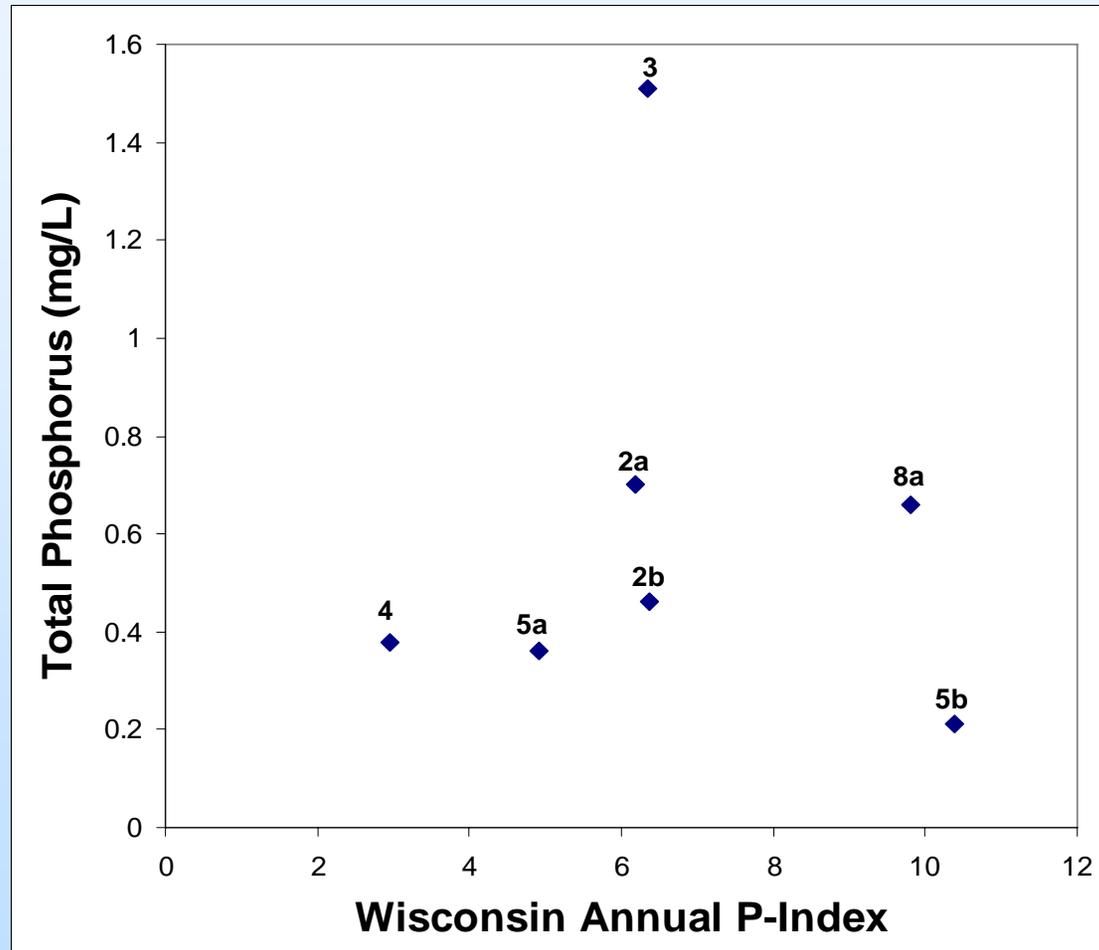


Soluble PI vs. Dissolved P in Stream



- Relationship between Soluble P-Index and median DP concentrations at sub-watershed outlets (5 events - 2004)

P-Index vs. Total P in Stream



- No relationship between P-Index and median TP concentrations at sub-watershed outlets (5 events -2004)

Scale Comparison on Clay Loam Soils in Wisconsin

Scale	Size	TP	DP	DP:TP	SS
Andraski & Bundy	1 m ²	2.49 ± 0.45	0.68 ± 0.24	28% ± 10%	2600 ± 1219
Discovery Farms (Kewaunee)	10-20ha	0.78 ± 0.66	0.38 ± 0.41	45% ± 21%	181 ± 306
Source Areas	20-230ha	0.70 ± 0.91	0.40 ± 0.61	50% ± 26%	267 ± 375
Apple Creek	11,700ha	0.61 ± 0.60	0.24 ± 0.13	47% ± 22%	238 ± 334

DP is significant in other studies

Conclusions

- DP fraction is high at main stem sites (40-70%)
 - Similar to earlier findings in LFR Sub-Basin
- DP fractions were similar at the small scale to previous findings
- In stream DP conc. predicted well by soil test P (Bray-P1) and P-Index
- No obvious net concentration change observed at different scales
Main stem → Integrator → Source Areas
- In some areas, managing nutrients (i.e. lowering STP) may be the most effective means of reducing TP in streams

Acknowledgements

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Questions?

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THE LOWER FOX RIVER



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