

Targeted implementation and Evaluation of Constructed Wetlands to Reduce Nutrient Exports and Improve Drinking Water Quality in Subwatersheds of the Mackinaw River, Illinois

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Collaborators and Partners:

Natural Resources Conservation Service

Soil and Water Conservation District

Farm Service Agency

Environmental Defense Fund

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Private landowners

River restoration in agricultural landscapes



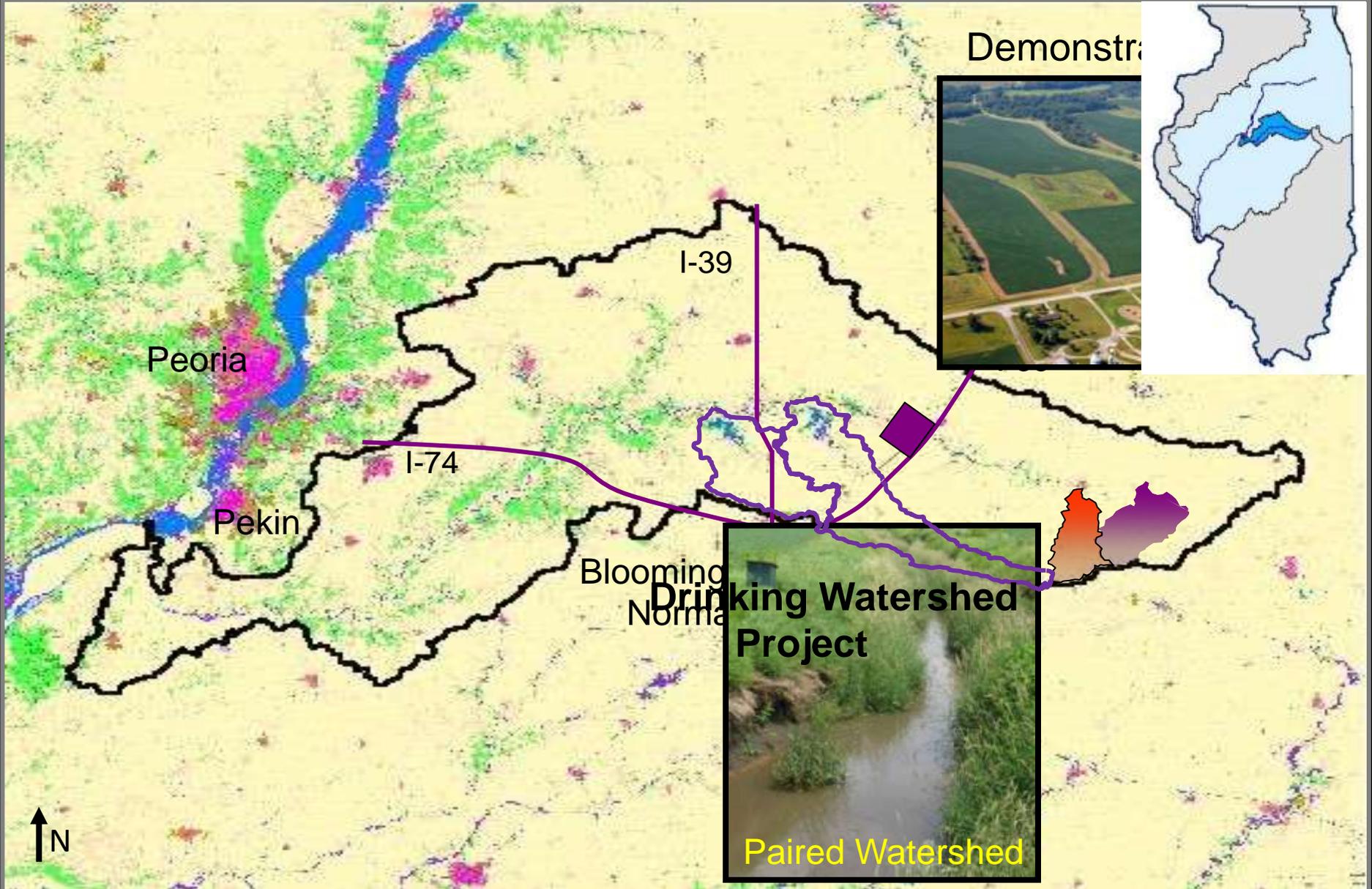
60-70 fish species
25-30 mussel species

High quality stream segments

~ 90% agricultural (corn, soybeans)

Mackinaw River, IL

Mackinaw River Watershed Project Sites

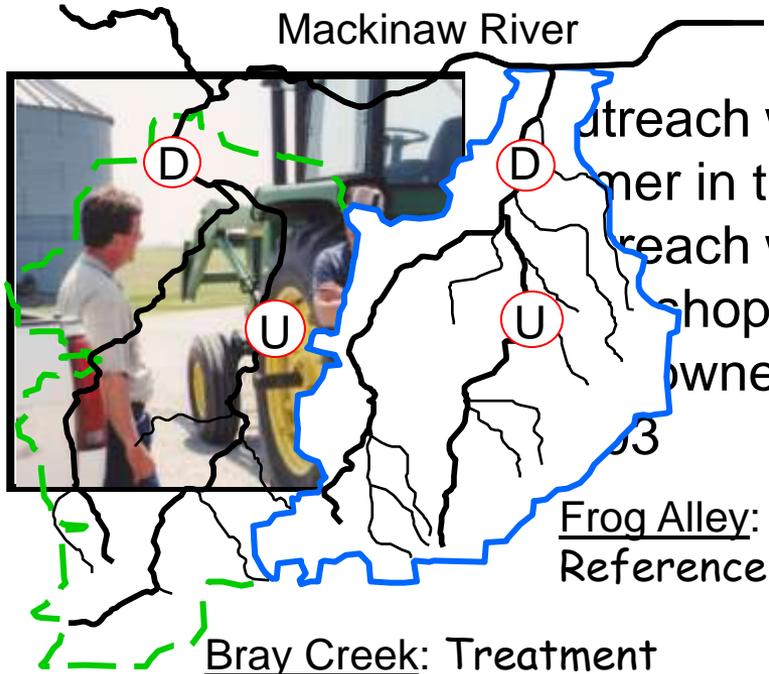


Paired Watershed Project: 2000-2006

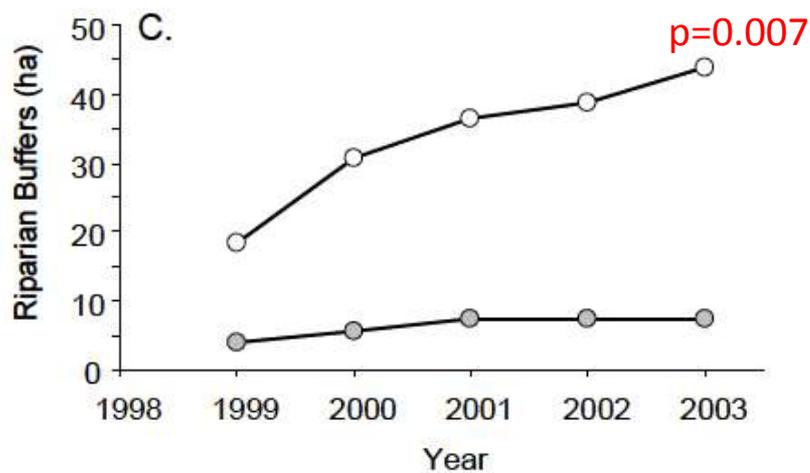
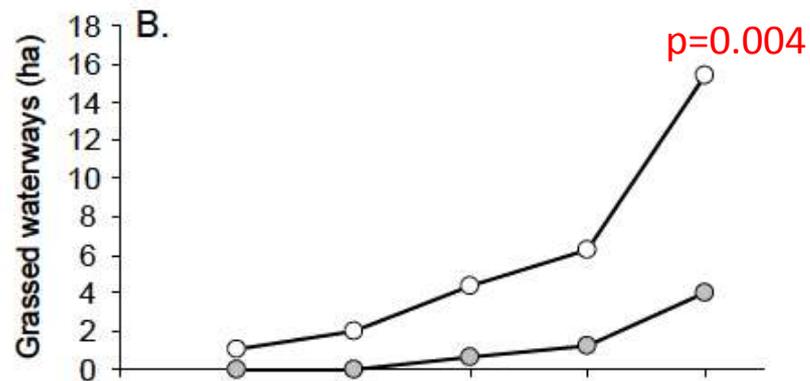
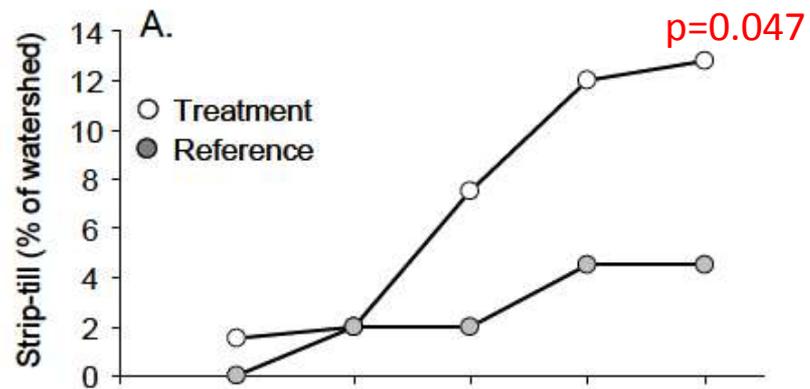
Objectives:

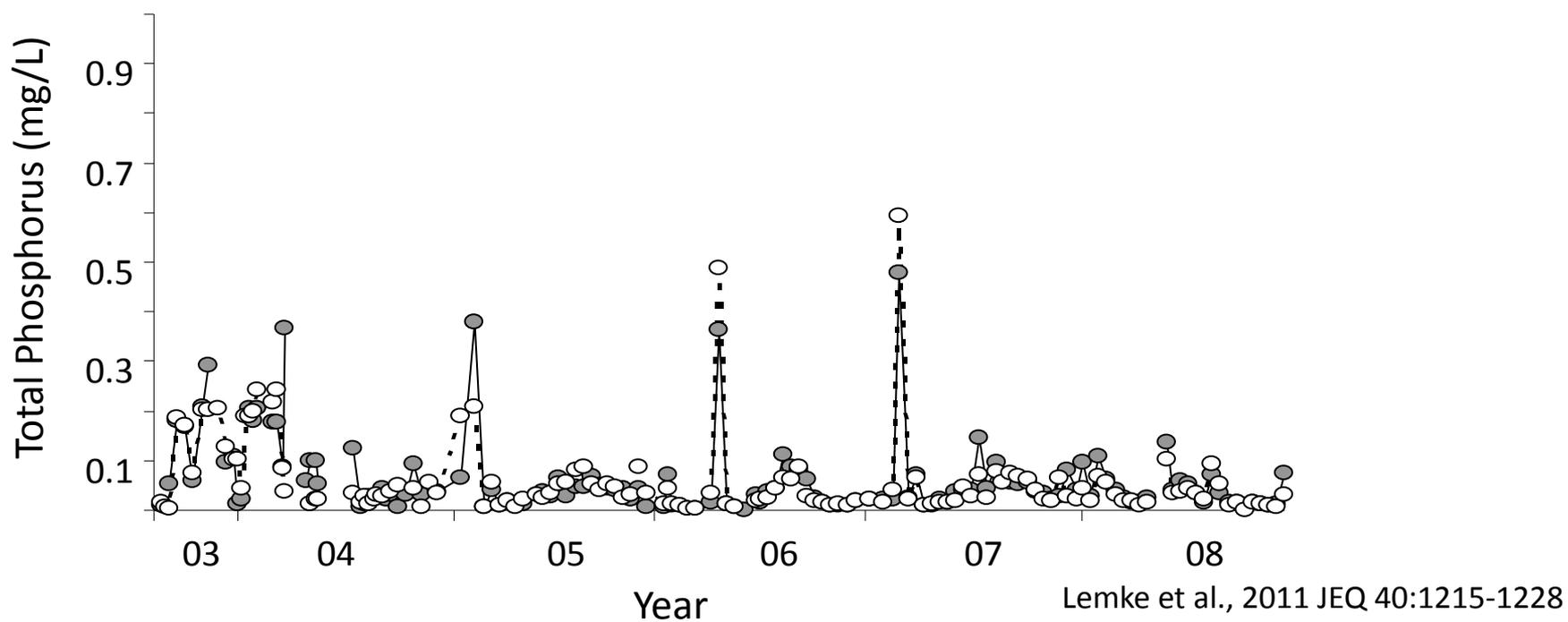
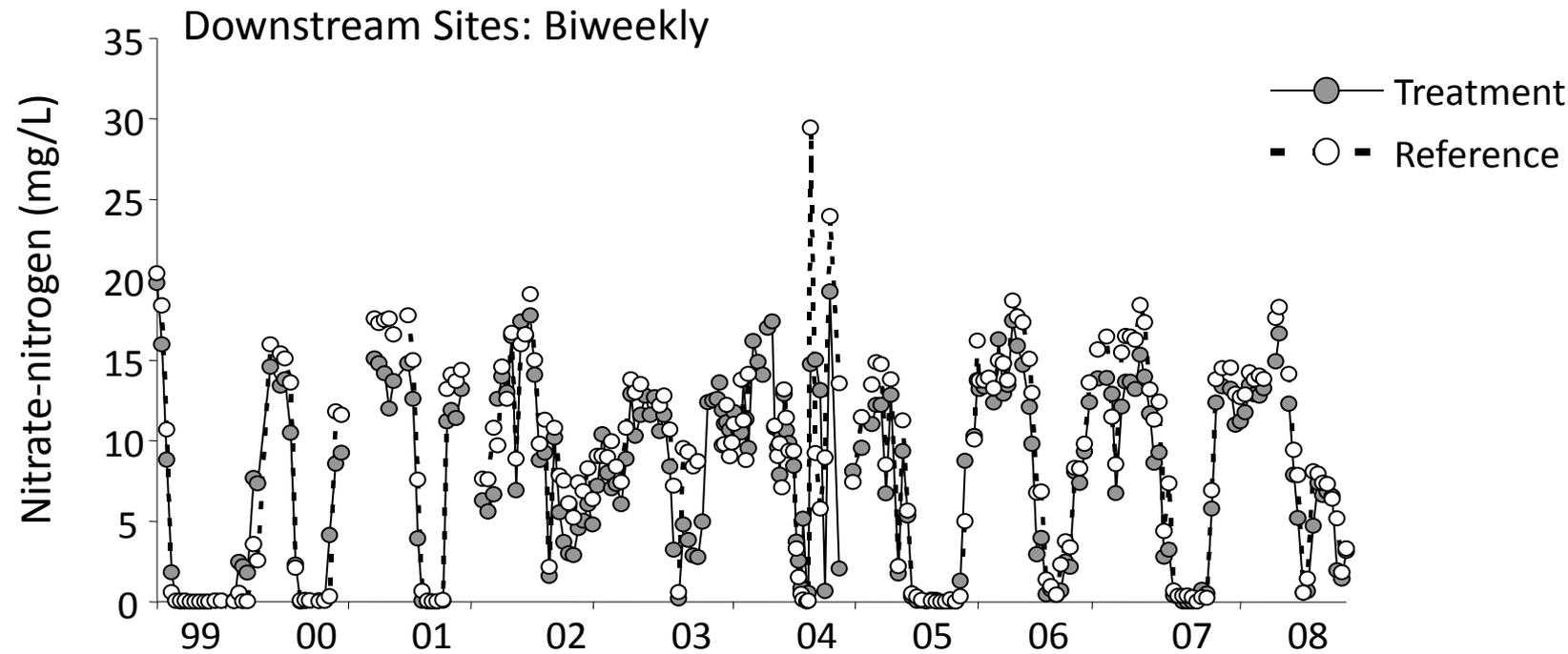
- Measure effectiveness of outreach on implementation of best management practices (BMPs)
- Measure watershed-scale effectiveness of BMPs on water quality, hydrology, and biodiversity
- Document what encourages and discourages producers and landowners from adopting BMPs (Lemke et al., 2010 JSWC 65:304-315)

Methods:



- Biotic surveys (seasonal):
Macrobenthic, Macroinvertebrate, Fish, Mussel, Habitat
- Outreach was conducted by a local landowner and farmer in the treatment watershed from 2000 to 2003
- Outreach was conducted using one-on-one interviews, workshops, demonstrations, flyers and newsletters
- Hydrology: Stage height at 'D' sites
- Water quality: conducted in 2000 and in 2003
Temp, Oxygen, Conductivity, Turbidity @ 'D' sites
Nutrients: biweekly (NH_4^+ , NO_2^- , NO_3^- , SRP, TP)
Total Suspended Sediment (TSS): biweekly
Storm Events for Nutrients and TSS @ 'D' sites

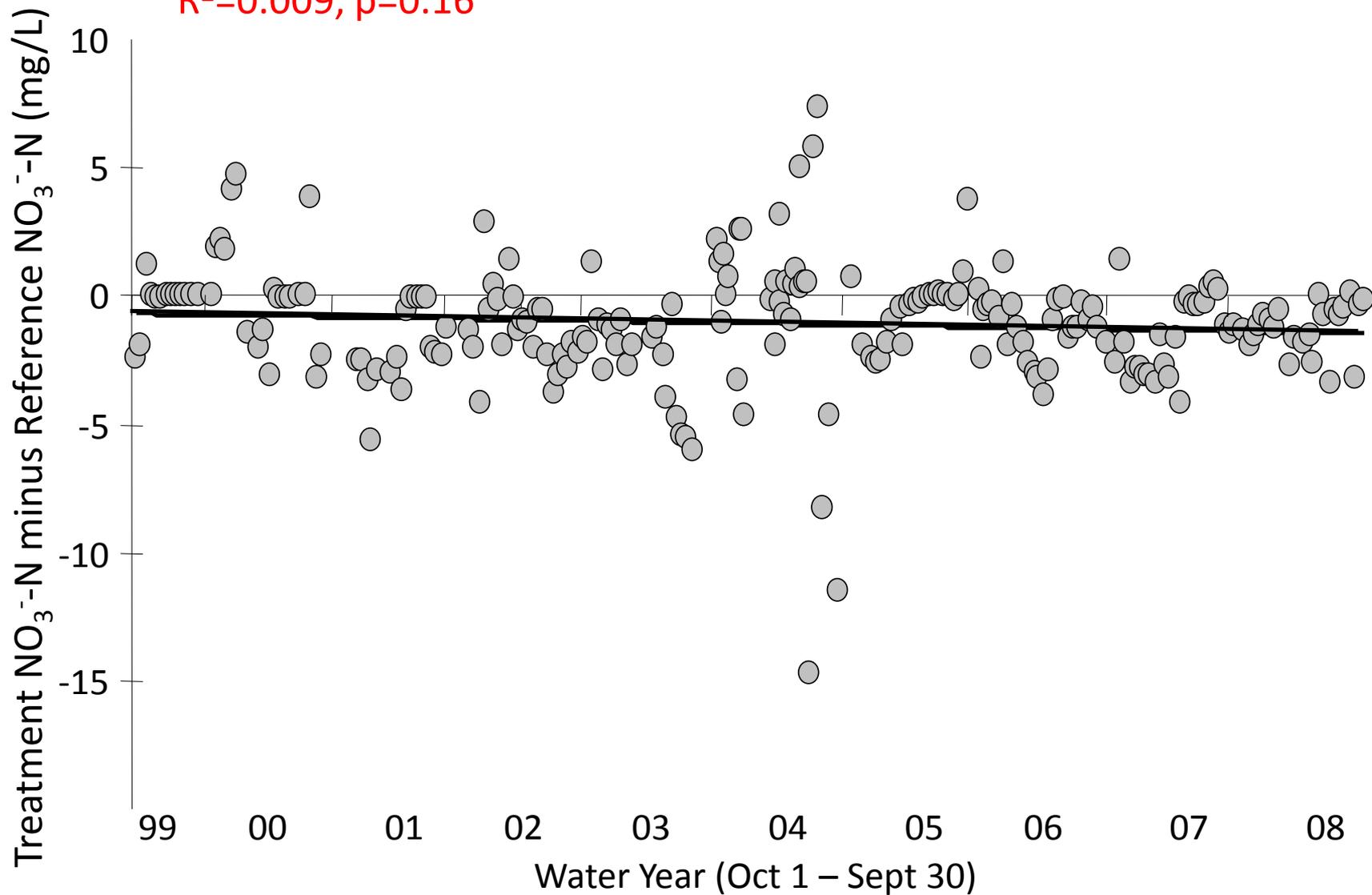




Downstream sites: Biweekly Nitrate-N (mg/L)

(expectation ↓)

$R^2=0.009$, $p=0.16$



Nutrient export (kg ha⁻¹ yr⁻¹) among tile-drained agricultural watersheds in Midwest U.S.

Watershed	Nitrate-nitrogen	Total phosphorus	Reference
Bray Creek (treatment)	10.7-52.0	0.3-1.6	This study
Frog Alley (reference)	9.2-83.6	0.2-1.3	This study
Embarras River, IL	8.9-56.7	0.2-2.1	Royer et al., 2006
Kaskaskia River, IL	7.6-57.6	0.1-1.2	Royer et al., 2006
Sangamon River, IL	9.0-46.8	0.3-0.8	Royer et al., 2006
Walnut Creek, IA	10.4-43.6	---	Schilling, 2002
Squaw Creek, IA	13.0-56.3	---	Schilling, 2002



- *Outreach works*
- *No nutrient/suspended sediment reduction*
- *No impact on hydrology or biota*

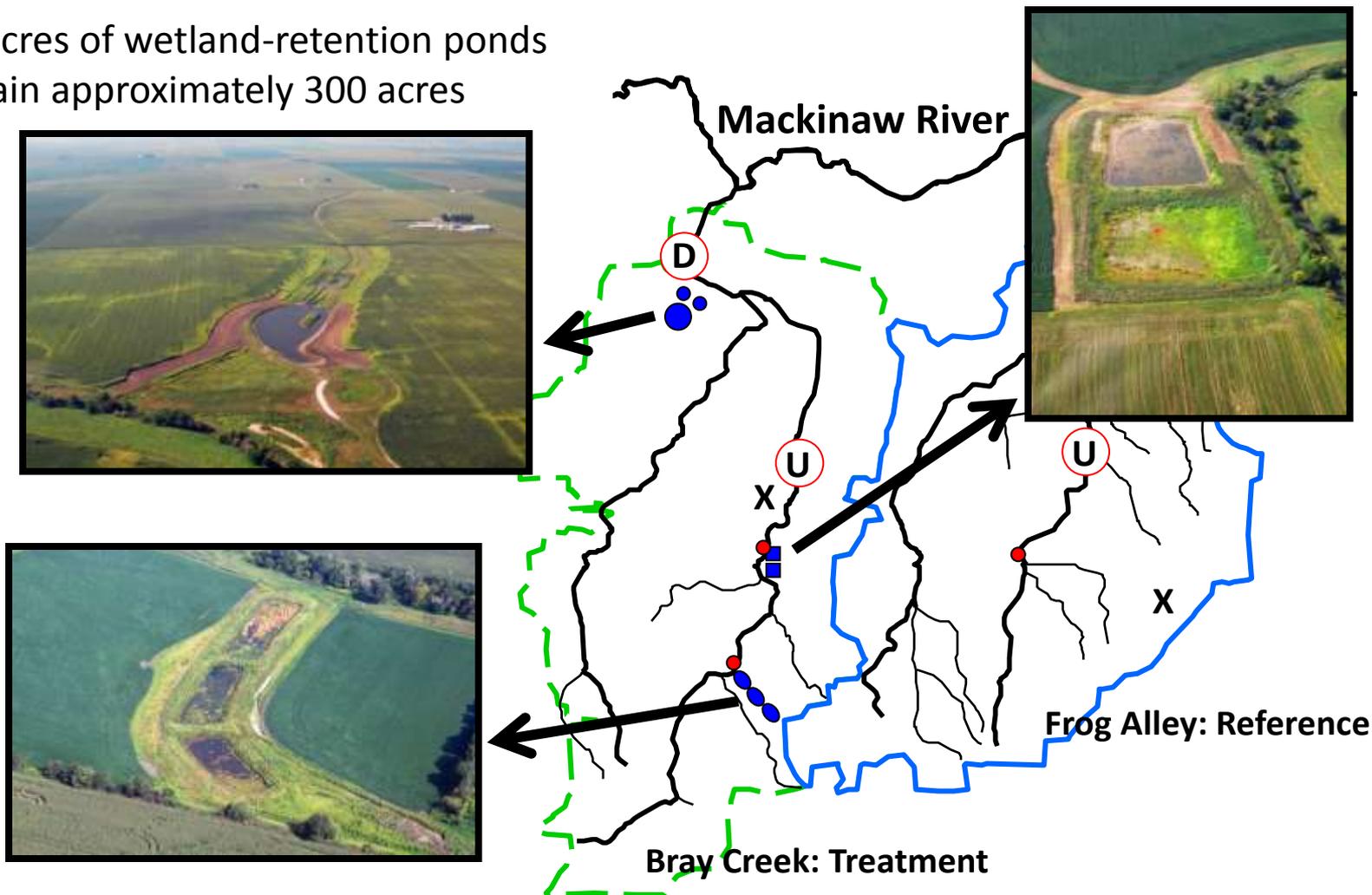


*Need to better retain runoff,
especially from tile drainage*

Paired Watershed Project Expansion

Objective: Quantify effectiveness of tile-retention practices at restoring altered hydrology and reducing nutrient and sediment transport.

- 6 acres of wetland-retention ponds
- Drain approximately 300 acres

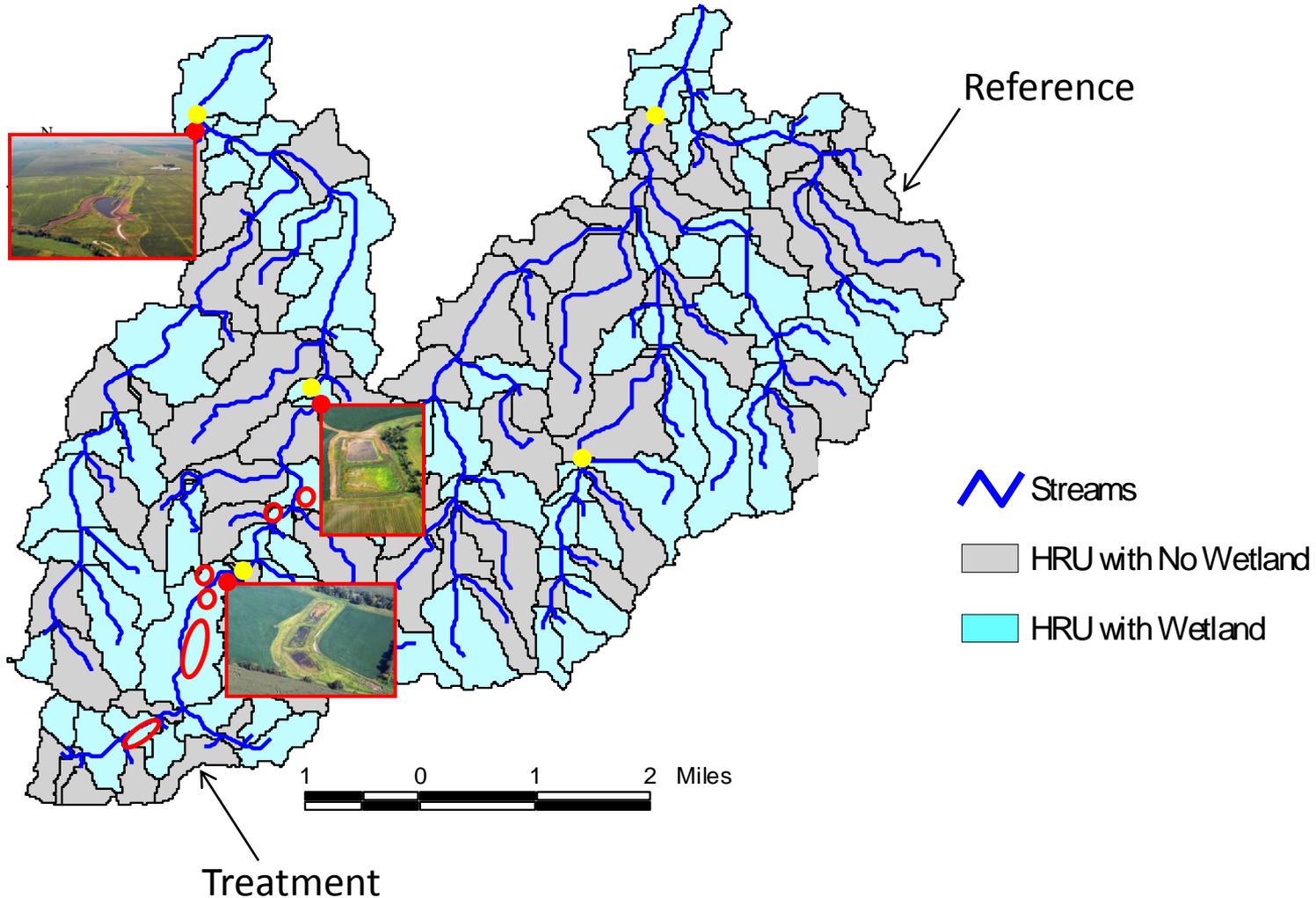


Watershed Hydrologic Model – Illinois State Water Survey

Predicted sites for constructed wetlands for 25-26% reduction in total pollutants

74 hydrologic units

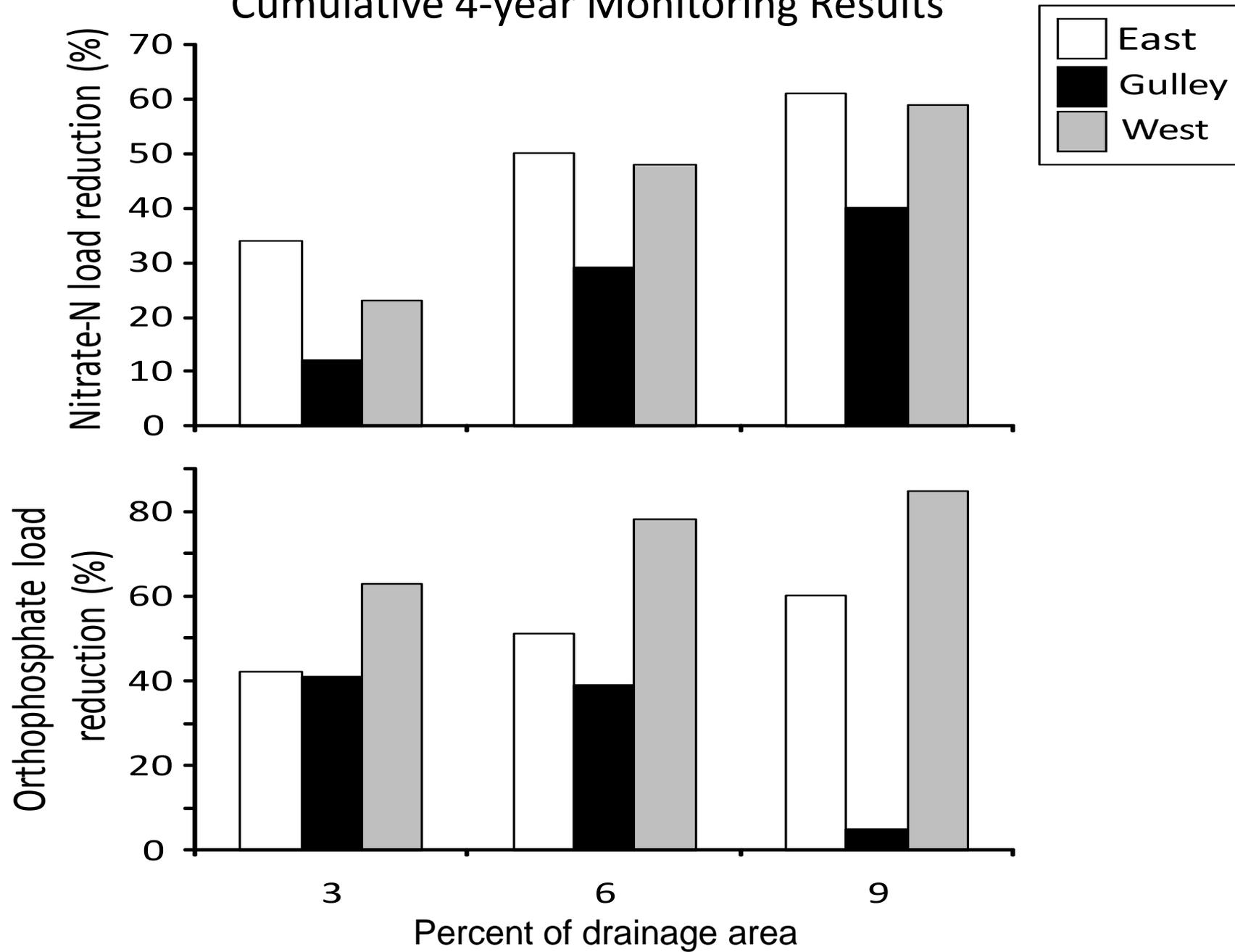
82 hydrologic units



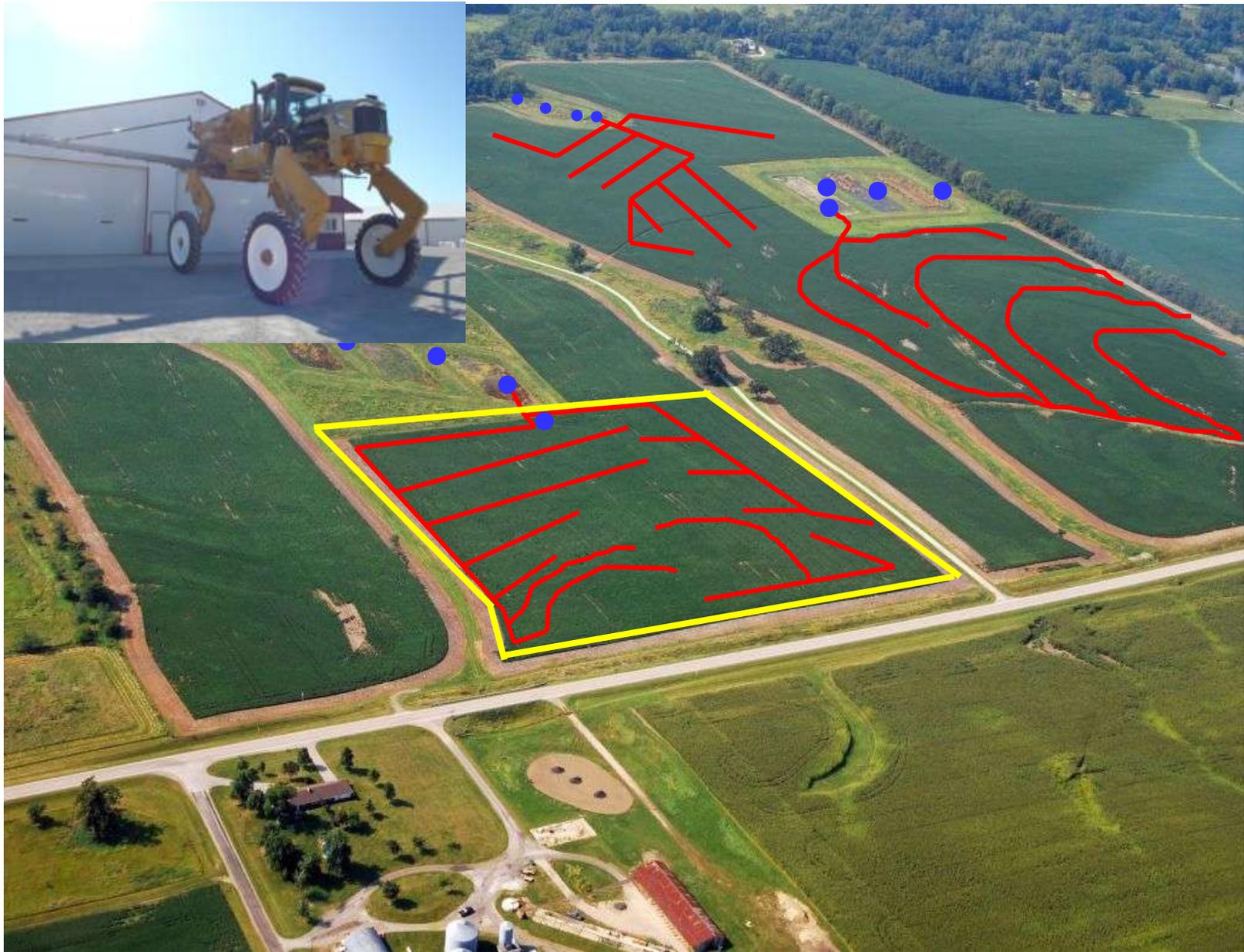


What size of wetland is most effective at reducing nutrients in tile runoff?

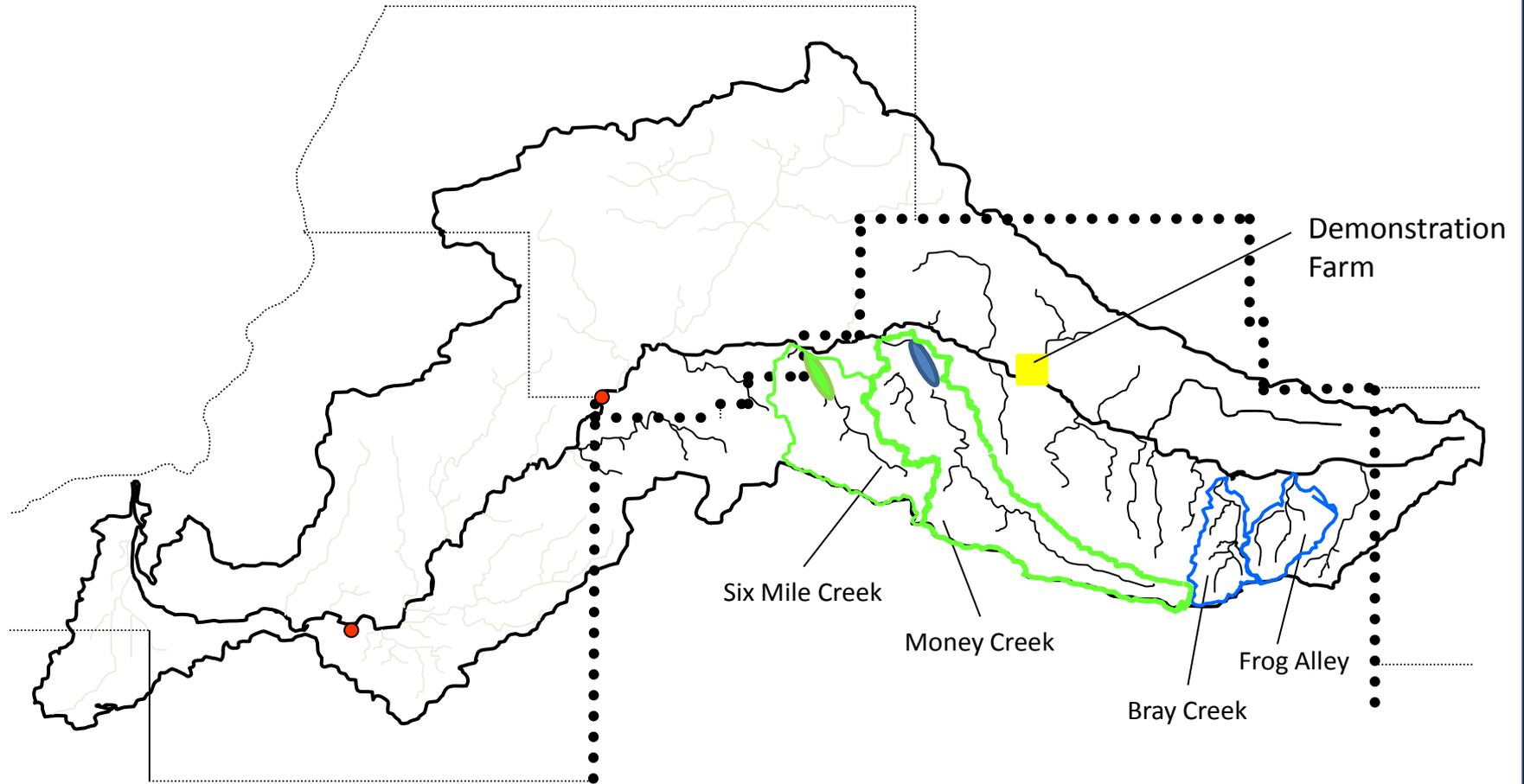
Cumulative 4-year Monitoring Results



How do winter cover crops influence nutrient export from tile-drained farmland?



Apply constructed wetlands to address drinking water supply nutrient concerns

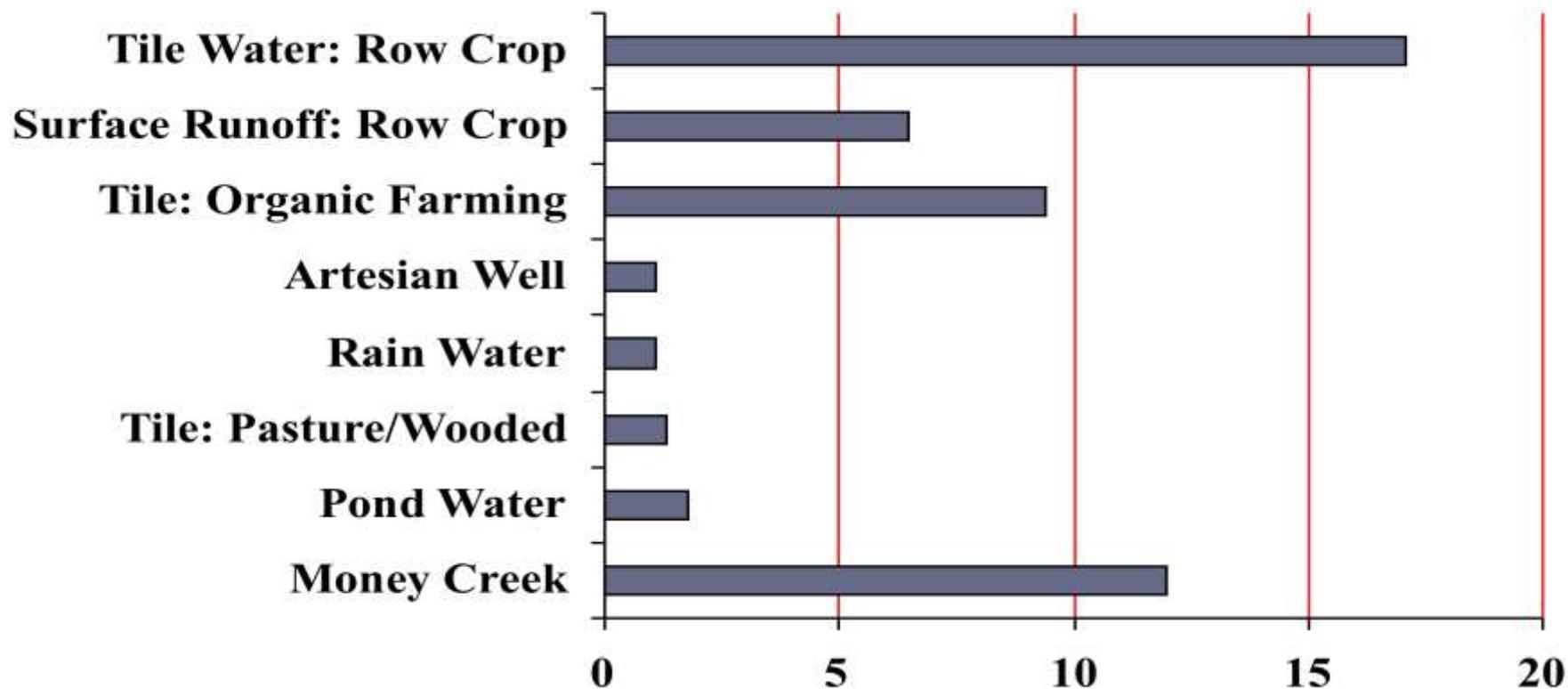


Mackinaw River Watershed

- McLean County
- Lake Evergreen
- Lake Bloomington
- USGS gaging stations

Average Nitrate-N: 1993-1998

Smiciklas & Moore, 1999



Lake Bloomington Constructed Wetland Design

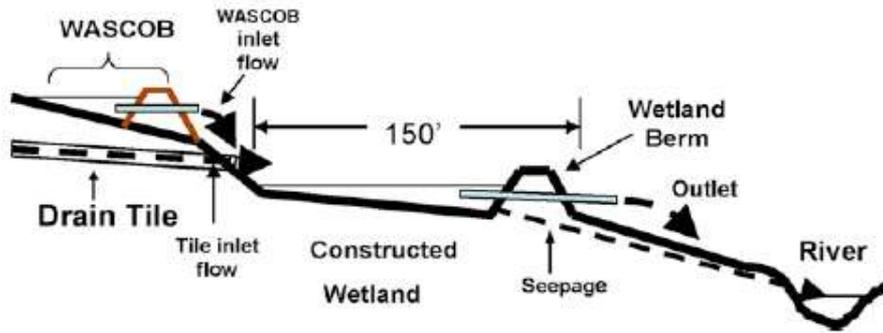
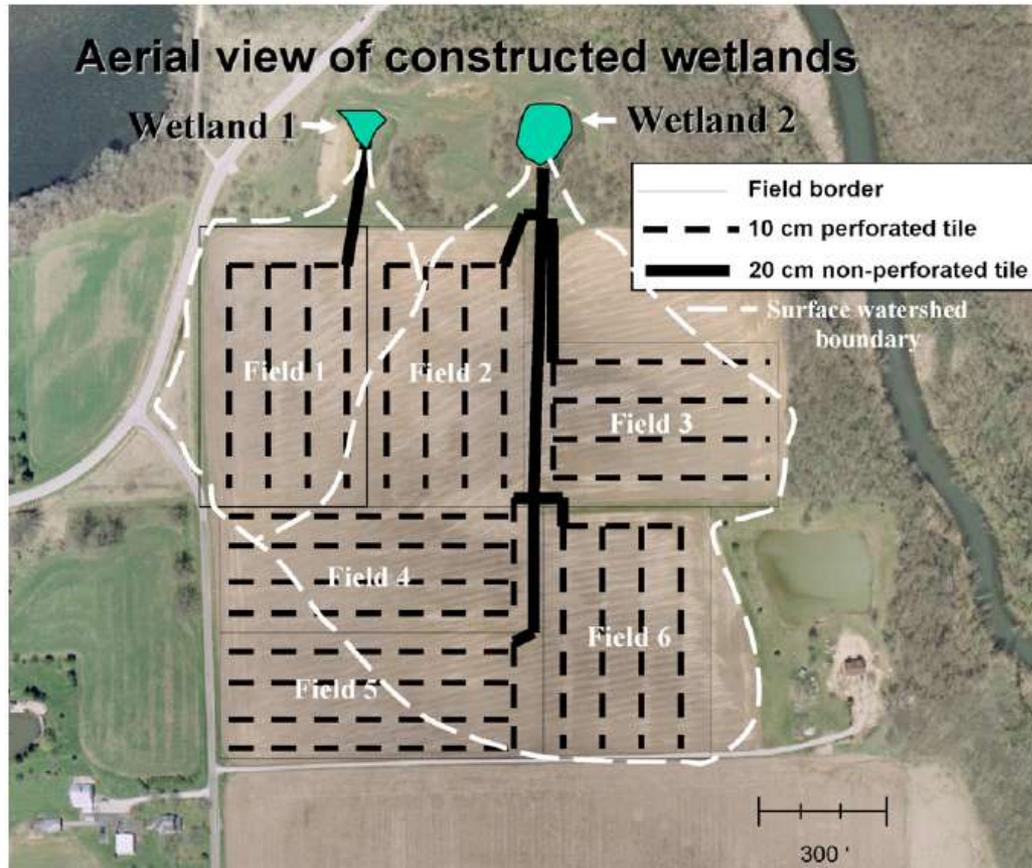


Table 1 – Wetland and watershed size and area description

	Wetland 1	Wetland 2
Average depth (m)	0.48	0.52
Volume (m ³)	660	1780
Surface area to volume	2.42	2.25
Tile drainage area (ha)	2.17	12.1
Surface watershed area (ha)	3.76	12.3
Wetland to tile drainage area	0.07	0.03
Wetland to surface drainage area	0.04	0.03
Wetland area (ha)	0.16	0.4



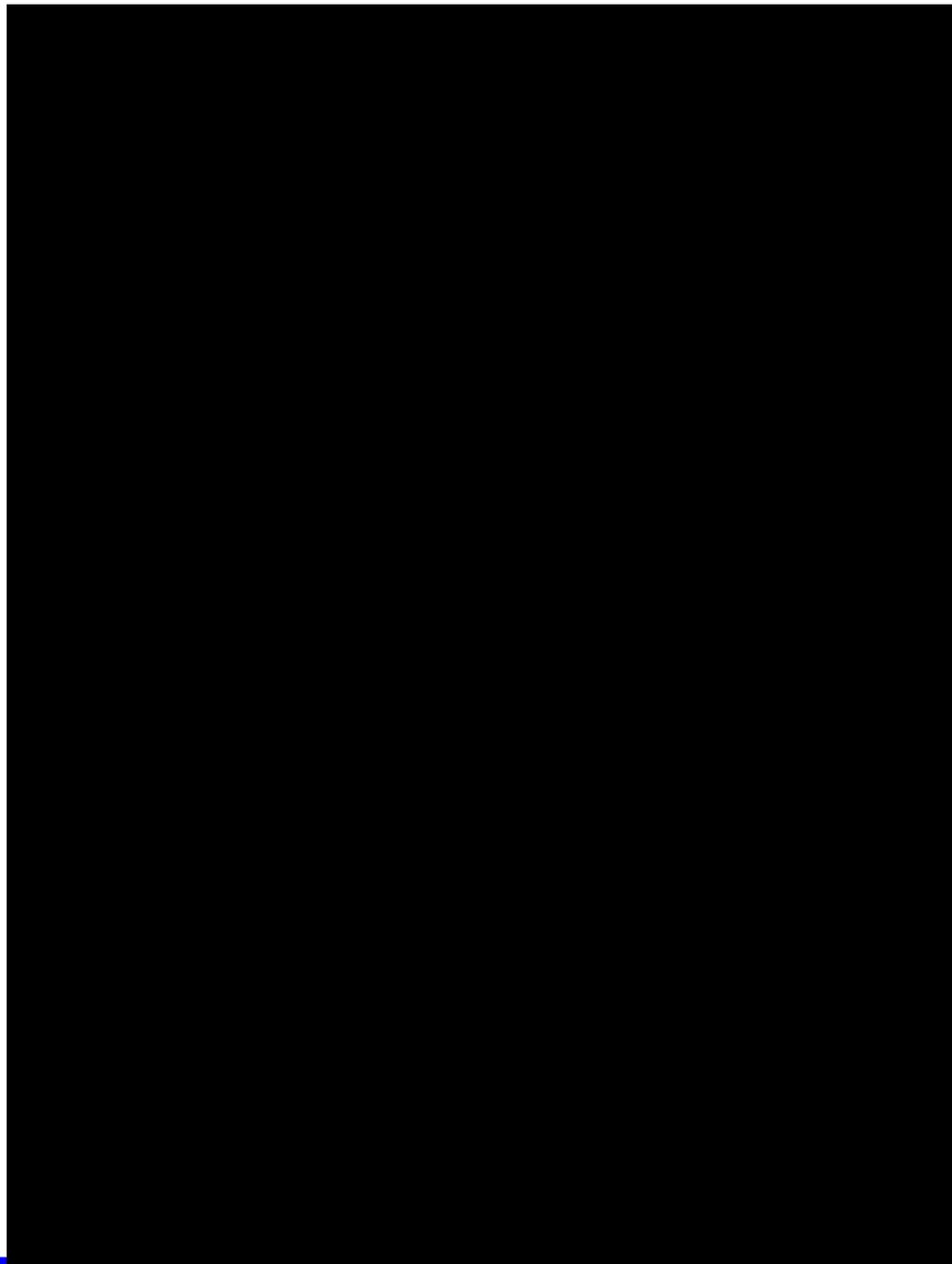
Mackinaw Drinking Watersheds Project



- Innovative partnerships:

The Nature Conservancy, City of Bloomington, Environmental Defense Fund, NRCS, SWCD, FSA, University of Illinois, Illinois State University, local farmers and landowners

- Precision conservation and monitoring: (1) Using GIS, aerial topography, and infrared photography to map existing tile drainage patterns and placement in the watersheds (2) Placement of constructed wetlands in locations where they will effectively retain agricultural tile drainage water and reduce nitrates (3) Monitor wetlands effectiveness (nutrients, hydrology)
- Use of Farm Bill programs: Utilize Farmable Wetlands Program (CP39) within the Conservation Reserve Program
- Agricultural agencies: Outreach (SWCD); Initial survey and site selection (NRCS); Sign-up process (FSA)



oundation

EPA)

