Franklin Research and Demonstration Farm Report 2010-2011

The Nature Conservancy

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Research and Demonstration Farm Report 2010-2011

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Overview

The Research and Demonstration Farm, located in Lexington, IL is a collaborative effort between The Nature Conservancy, University of Illinois Champaign-Urbana (UIUC), Illinois State University (ISU), McLean County Soil and Water Conservation District (SWCD), McLean County Natural Resources Conservation Service (NRCS) and the Franklin family. The goals of the Research and Demonstration Farm project are to (1) study methods designed to reduce nutrient loading in tile drained agricultural systems of Illinois, (2) demonstrate a wide variety of on-the-ground conservation practices in the context of a working farm to local landowners, agency personnel, policy makers and the general public, and (3) restore woodland, savanna, prairie and wetland habitats to increase the biodiversity of plants and animals coexisting within an agricultural landscape.

The following report is an update of the above listed goals at the Research and Demonstration Farm during 2010 and 2011. Also included are fauna/flora observations, crop reports, science report, and outreach events, tours and media articles.

A view of the west wetland complex in late summer

Installation of New Conservation Practices

The Research and Demonstration Farm showcases a variety of traditional USDA cost-share conservation practices that improve soil and water quality while benefiting plant and animal communities. These practices are also tailored to fit the existing landscape and the desires of the landowners. In March of 2010, 30-foot wide field borders were seeded on the perimeter of all cropland areas using funds from the Conservation Reserve Program. The borders were seeded with a mixture of native warm season grasses and forbs (wildflowers). Vegetative field borders are designed to enhance wildlife habitat while also reducing the impacts of soil erosion and the movement of sediment, nutrients, and pesticides from farm fields.

Throughout the spring and fall of 2010, the Franklin family planted 130 new trees (approximately 4-5 feet in height) along the gravel lane entrance to the farm, in the upland woods and in the bottomlands near the Mackinaw River. The young trees, consisting of a mixture of oak and other native species, are protected from deer browsing using biodegradable materials and are mulched at the base to conserve water and suppress weeds. In cooperation with a local livestock producer, the Franklin family fenced off an area of the upland woods adjacent to the Mackinaw River and introduced a small number of cattle as part of a rotational grazing program and to limit understory growth in the woodlands. New fencing and locking gates were also installed at all entrances to the farm to limit access and protect scientific equipment.

In 2011, a small degraded grassed waterway (300 feet long, 20 feet wide) located on the northwest side of the farm was reseeded using cost-share funds from the Environmental Quality Incentive Program. A winter cover crop of cereal rye and radish was also planted on 13 acres on the east side of the farm that drains into the east experimental wetlands. In August, 85 farmers and landowners attended an open house that demonstrated cover crop seeding using a modified hi-boy that distributes seeds into standing corn. This event was sponsored by McLean County NRCS, SWCD, and TNC. The cover crop project is funded in part by an Illinois NRCS Conservation Innovation Grant to monitor the effectiveness of cover crops in sequestering nutrients and reducing tile nutrient runoff.

Modified Ro-Gator ready to plant cover crops on the East side of the farm

2010-2011 Crop Report

The Central Illinois region experienced warm temperatures and drier than normal conditions throughout the months of April and May in 2010, followed by frequent storms and heavy rainfall in June. Above normal temperatures returned in July and a prolonged period without significant precipitation continued throughout the region. Rainfall returned in mid-August and soybean yields ranged from good to exceptional. Soil conditions were excellent and the farm's soybean crop was no-tilled into existing corn residue on May 2nd. Seed emergence was hastened by warm growing conditions and resulted in optimal stands. The hot, dry summer months were ideal for the vegetative stage of growth, resulting in low disease pressure and high seed pod counts. An isolated storm late in the growing season allowed seed to reach maximum size and weight and the soybean crop was harvested under ideal conditions on the 27th and 28th of September. The spring of 2011 began with several periodic rainfalls and thunderstorms, but conditions were dry enough for a smooth planting season for corn. Rainfall diminished by June, leading to considerably dry conditions in summer and fall. Harvest was underway by September with little to no interruptions by weather, leading to another successful season.

2010: soybeans	2011: corn
Crop Acres: 121	Crop Acres: 121
Dry Bushels: 6461	Yield: 171 bu/acre
Yield: 53.4 bu/acre	

Bob Moseley, Director of Conservation with The Nature Conservancy, takes a turn harvesting at the Research and Demonstration Farm

The 2010 soybean harvest continues into the night on the Research and Demonstration Farm

Wetlands

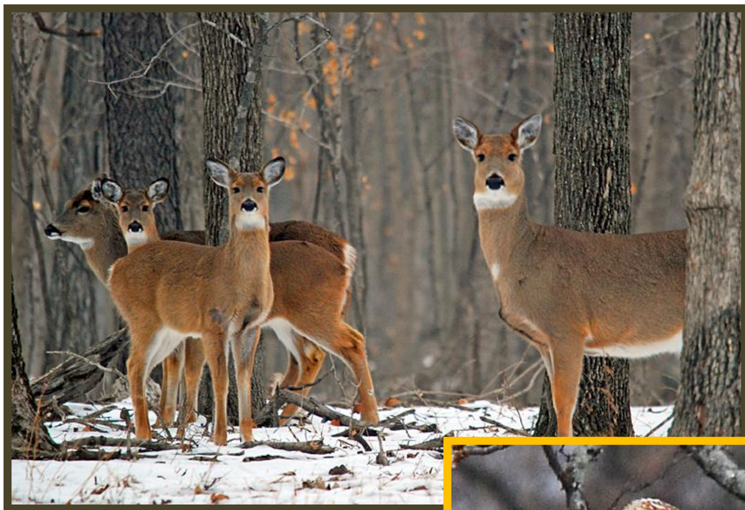
Wetlands are low-lying areas of land that are either permanently or seasonally wet. Wetlands are valuable in terms of reducing flood damage, contributing to groundwater and surface water recharge, improving water quality, and supporting habitat for fish and wildlife, as well as providing educational, recreational, and research opportunities. Recent studies indicate that the nation has lost more than half of the wetlands that existed in the contiguous United States since European settlement began and Illinois has lost over 90% of its original wetland acreage[1,2].

Three experimental subsurface tile-drained wetland systems totaling 5.2 acres were constructed on the Demonstration farm in the summer of 2005 and an additional 7 acres of floodplain and upland wetlands were completed in the fall. The experimental wetlands were funded, in part, by enrolling the land in the Conservation Reserve Program. Areas surrounding the wetlands were seeded with a mixture of native grasses and forbs to provide a natural buffer and habitat for wildlife in 2009.

A pair of Great Egrets feed in the west wetland series

The richness and abundance of wetland plant and bird species observed at the Demonstration farm continue to increase as the wetlands mature. In late summer, scores of blue lobelia blanketed the buffers surrounding the gully wetlands, while broadleaf arrowhead and American pondweed plants covered the surface of the west wetlands. Management strategies designed to eliminate invasive cattails have been very effective, reducing the cattail population enough to allow more native species to flourish. See Appendix A and B for a complete listing of birds and plants sighted at the wetland and woodlands area of the Demonstration Farm.

<u>**Wildlife on the Demonstration Farm**</u>



Left to right, top to bottom: White-tail deer, Little Blue Heron, Black-crowned Night Heron, immature Red-tail Hawk, Sora Rail, Green Darner, Dekay's Brown Snake

Savanna Restoration

The term 'savanna' refers to an open-canopy deciduous woodland that usually has a moderate or abundant herbaceous layer (small, seasonal, non-woody plants), often composed of both forest and grassland species[3]. Savannas are typically transitional communities found between forests and grasslands and are among the world's most threatened ecosystems[4,5]. Prior to European settlement, oak savanna covered approximately 32 million acres of the Midwest; however, over 99% of the original savanna has been lost nationwide to agriculture, fire suppression and over grazing[6]. The rarity of remaining oak savannas has led to them being listed as critically endangered[5].

Restoration of a degraded oak and hickory savanna on the Demonstration Farm began in 2005 with the manual removal of small invasive shrubs and trees in the forest understory. This removal was performed mechanically the following year using a Geo-Boy, which was made available for rent through funds from a USDA Forest Service grant. Cut plants and stumps were treated with a non-selective herbicide to prevent re-growth and a prescribed burn program was implemented to maintain an open understory and promote oak and hickory regeneration. In the future, the savanna restoration area will be expanded into surrounding degraded savanna remnants through continued prescribed burning and removal and treatment of invasive species.

Common ironweed and Golden wing-stem bloom in late summer in the oak/hickory savanna

Prairie Nursery

"Prairie" is a French word for meadow, or a sunny opening in a forest[7]. European settlers used this term to name the broad, treeless plains they found in central North America. As recently as the 1820s, prairie covered about 22 million acres in Illinois[8]. Today, less than 2500 acres of high-quality prairie remain, over 99.99% having been lost to plowing and paving[8]. The vast prairie exists now mainly in scattered remnants, often found in pioneer cemeteries, along railroad rights-of-way, and on steep bluffs high above rivers.

In the spring of 2005, a 12-acre soybean field on the Demonstration farm was seeded with a mixture of nine native grasses and sixty-one forbs species collected from local prairie remnants. To date, forty-five forbs and seven species of grass have been identified growing from the original seeding. In March of 2010, the prairie was successfully burned for the first time. Periodic burning is essential to maintaining a healthy prairie ecosystem by removing invasive and non-native shrubs and trees without harming the substantial root system of the perennial prairie plants. Fire also helps burn away dead foliage giving younger forbs and grasses a chance to establish. The prairie was successfully burned again in the spring of 2011. As the prairie matures, additional native plants will be introduced and eventually the seed will be harvested and marketed for commercial sale.

Left to right: Prescribed burn on the prairie nursery – March 2010; Smooth aster appeared for the first time in late August 2010

Science

In addition to serving as a showcase for agricultural conservation practices, the Research and Demonstration Farm also provides an outdoors experimental laboratory to study wetlands and winter cover crops. This research is a collaborative partnership between The Nature Conservancy, University of Illinois and Illinois State University. In 2006, housing units for automatic water samplers were installed at each of three wetland complexes at the inlets and outlets of each wetland. Monitoring of tile flow and nutrient loading began in 2007 with the goal of determining wetland to watershed ratios needed to see reductions in nitrogen and phosphorus. Between 2009 and 2011, researchers from Illinois State University's Geology Department conducted experiments to determine the how long water stays in each wetland cell (i.e., residence time) and also the role that groundwater plays in the removal or addition of nitrogen these constructed wetlands. Illinois State University's Biology Department is currently investigating the potential of denitrification in the wetland complexes, which is the reduction of nitrate to nitrogen gas by bacteria. A full detailed report regarding the research being performed at the Demonstration Farm can be found in Appendix D.

Tours & Publicity

A key objective at the Franklin Research and Demonstration Farm is to conduct tours that demonstrate on-the-ground conservation practices and economics to local farmers, the public, agency personnel and policy makers.

2010 Tours:

- March - Illinois State Water Survey staff
- May - NOW Foods Group representatives
- June - The Nature Conservancy: Staff Retreat
- August - Environmental Defense Fund staff, Iowa Department of Agriculture and Land Stewardship Alliance representatives
- September – (a) Eureka College Environmental Studies Program students (b) September - McLean County Master Naturalists Club (c) Congressman Tim Johnson staff (d) Bloomington Normal Arts and History Club (e) McKnight Foundation representative
- October - Walton Family Foundation representative
- December - Environmental Defense Fund staff

Naturalist, Robert J. Reber

Members of the NOW Foods group tour the Research and Demonstration Farm

2011 Tours:

● May - (a) Indiana Nature Conservancy, Prairie Rivers Network, and Conservation Technology Information Center (b) Trustees from Illinois Nature Conservancy's Conservation Committee (c) Environmental Defense Fund and Walton Family Foundation representatives
● June - CBS reporter
● July - Brazil Nature Conservancy staff
● August - (a) Associated Press reporter (b) Cover crop seeding demonstration: 85 attendees (c) Congressional staff from Congressman Johnson's office
● September - Council of Better Management Practices members
● October – (a) Eureka College conservation biology students (b) Lead philanthropy staff from Illinois Nature Conservancy
● November—Lumpkin Family Foundation staff

2010 and 2011 Publicity: *(these can be made available by request)*

● *USDA-NRCS New release*. Paige Buck. 2009 NRCS Normal Team of the Year is Anything BUT Normal! Article published online on January 13, 2010. The McLean County Team comprised of Natural Resources Conservation Service and Soil and Water Conservation District staffs were awarded the "Team of the Year" for 2009 by Illinois NRCS for their outstanding conservation work in McLean County. Mentioned was their work with The Nature Conservancy in the Mackinaw River watershed.

- *McLean County Chamber of Commerce – News and Resources*. Article published January 26, 2010. McLean County Chamber of Commerce's Annual Agricultural Awards Dinner awarded the Franklin Family Partnership and Barbara Franklin-Allsup with the 2009 Outstanding Conservationist Award in part due to their partnership with The Nature Conservancy in the development of the Research and Demonstration Farm on their land in Lexington, Illinois.
- *Pantagraph*. Chamber Honors Ag leaders at Awards Dinner. Article posted February 15, 2010. McLean County Chamber of Commerce's Annual Agricultural Awards Dinner awarded the Franklin Family Partnership and Barbara Franklin-Allsup with the 2009 Outstanding Conservationist Award.
- *TNC National magazine*. 2010 Winter Issue. World View section highlighted the Franklin Demonstration Farm.
- *The Nature Conservancy 2010 Annual Report*. On Target: Improving water quality with experimental wetlands.
- *Pantagraph*. Steve Hoffman. Farmers get an eyeful of new machinery. Covered the Cover Crop Demonstration Day at the Research and Demonstration Farm in Lexington, Illinois. Posted 19 August 2011 online at: http://www.pantagraph.com/business/local/article_2a8d3440-cab3-11e0-8610-001cc4c03286.html
- *WEEK News 25*. Marc Strauss. The next big thing on the farm. Covered the Cover Crop Demonstration Day at the Research and Demonstration Farm in Lexington, Illinois. Posted 19 August 2011 online at: http://www.centralillinoisnewscenter.com/news/local/The-Next-Big-Thing-On-The-Farm-128093413.html
- *Illinois Annual Report 2011*. Natural Solutions. Highlighted the partnership and progress of the new Drinking Watersheds Project in the Mackinaw River. Cover photo taken by Tim Lindenbaum at the Research and Demonstration Farm. Published online at: http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/illinois/ilfo-annual-fy11-final-lowres-with-links.pdf

2010 and 2011 Presentations:

- Lemke, A. M., K. G. Kirkham, T. T. Lindenbaum, W. L. Perry, E. G. Bekele, Y. Lian, M. Demissie, M. P. Wallace, and D. A. Kovacic. 2010. Evaluating practices to mitigate nutrient transport in a tile-drained subwatershed of the Mackinaw River, Illinois. Poster presentations at (a) The Nature Conservancy's Central United States Region Science and Stewardship Conference in Corpus Christi, Texas, (b) Soil and Water Conservation Society Meeting in St. Louis, Missouri, and (c) Midwest-Great Lakes Chapter of the Society for Ecological Restoration in Madison, Wisconsin.
- Lemke, A. M. 2010. Overview of the Mackinaw River Project. Presentations for (a) NOW Foods tour of the Demonstration Farm, (b) Nature Conservancy staff retreat held at Lake Bloomington, Illinois, (c) multiple meetings with Environmental Defense Fund staff with regards to conservation efforts in the Lake Bloomington and Evergreen watersheds, and (d) staff of Congressman Johnson in conjunction with a tour of the Demonstration Farm.

● Lemke, A.M. 2011. (Invited) Targeted implementation and evaluation of constructed wetlands in agricultural watersheds to reduce nutrient loadings, improve drinking water quality, and address hypoxia in the Gulf of Mexico. Presented at the 32nd Annual Indiana Water Resources Association Conference, Ball State University, Muncie, Indiana
● Lemke, A. M., R. M. Twait. 2011. (Invited) Critical challenge: Water quality improvements in highly agricultural watersheds. Presented at the Midwest Natural Resources Group Spring Roundtable, Peoria, Illinois
● Lemke, A. M., R. M. Twait. 2011. (Invited) Targeted implementation and evaluation of constructed wetlands to reduce agricultural nutrient exports and improve drinking water quality in subwatersheds of the Mackinaw River, Illinois. Presented at the Illinois River Governor's Conference, Peoria, Illinois
● Lemke, A. M., K. G. Kirkham, T. T. Lindenbaum, W. L. Perry, E. G. Bekele, Y. Lian, M. P. Wallace, D. A. Kovacic, Kent Bohnhoff. Targeted implementation and evaluation of constructed wetlands in agricultural watersheds to reduce nutrient loadings, improve drinking water quality, and address hypoxia in the Gulf of Mexico. Presented at the (a) 3rd Annual Midwest-Great Lakes Society of Ecological Restoration Chapter Meeting, Springfield, Illinois; (b) The Nature Conservancy's Freshwater Conference, Austin, Texas; (c) Conservation Committee Meeting, Lexington, Illinois
● Lemke, A. M. 2011. Targeted implementation and evaluation of constructed wetlands to reduce nutrient exports and improve drinking water quality in subwatersheds of the Mackinaw River, Illinois. Presented at the Board of Trustees Meeting, Chicago, Illinois, December 2011.
● Lemke, A. M. 2011. (Invited) Pecha Kucha of the Mackinaw River. Presented at the Vital Lands Illinois 2011 Summit, Decatur, Illinois

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(5) Reed, N. F., E. T. LaRoe III, and J. M. Scott. (no date). Endangered Ecosystems of the United States: A Preliminary Assessment of Loss and Degradation. Retrieved from http://biology.usgs.gov/pubs/ecosys.htm
(6) Nuzzo, V. A. 1986. Extent and Status of Midwest Oak Savanna: Presettlement and 1985. Natural Areas Journal 6(2): 6-36.
(7) Prairie—Word History. (no date). Retrieved from http://www.word-origins.com/definition/prairie.html
(8) Robertson, K. (no date). The Tallgrass Prairie of Illinois--Settlement. Retrieved from http://www.inhs.uiuc.edu/~kenr/prairiesettlement.html

A full 'Harvest' Moon rises over the Demonstration farm on September 24, 2010

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We would like to acknowledge the Franklin family for their participation in the Demonstration Farm Project. Funding for this project was provided through a grant from the Illinois Department of Natural Resources Conservation 2000 - Ecosystem Program, DNR Project # MRP002-04, McLean County Soil and Water Conservation Service, Monsanto, and USDA NRCS Conservation Innovation Grant. AGREM LLC donated time and equipment to survey the farm for tile installation design using Real Time Kinetic technology. Drainage tile was installed by AGREM LLC, Anchor, Illinois, and wetland construction was by Dave Leake Land Improvement, Lexington Illinois. The Demonstration Farm logo was designed by, and is used courtesy of Ebony Murrell. All photos in this and previous reports were taken by Tim Lindenbaum of The Nature Conservancy.

Appendix A. Woodland and wetland plants identified at the Demonstration Farm. The list was developed based on observation and identification by Mike Wallace and Tim Lindenbaum, but no official survey has been conducted. CC = coefficient of conservationism, with CC of 1-3 meaning the plant is ruderal (found in disturbed areas, as in old fields or roadsides) and a CC or 9-10 meaning the plant is very conservative and is restricted to limited sites and/or conditions; * indicates that the plants are non-native.

Scientific name	Common Name	CC
Woodland Plants		
Acalypha rhomboidea	Three-seeded mercury	0
Agastache nepetoides	Yellow giant hyssop	5
Agrimonia pubescens	Soft agrimony	4
Alliaria petiolata	Garlic mustard	*
Ambrosia artemisiifolia	Common ragweed	0
Ambrosia trifida	Giant ragweed	0
Anemone quinquefolia	Wood anemone	6
Arctium minus	Common burdock	*
Aster drummondii	Drummond's aster	3
Bidens vulgata	Tall beggar's ticks	0
Campanula americana	American bellflower	4
Carex sp.		
Carya ovata	Shagbark hickory	4
Celtis occidentalis	Hackberry	3
Chamaesyce maculata	Nodding spurge	0
Cirsium discolor	pasture thistle	3
Conyza canadensis	Horseweed	0
Cryptotaenia canadensis	Honewort	1
Daucus carota	Queen Anne's lace	*
Dianthus ameria	Deptford pink	*
Elymus canadensis	Canada wild rye	4
Erigeron annuus	Annual fleabane	1
Eupatorium altissimum	Tall boneset	2
Eupatorium rugosum	white snakeroot	2
Eupatorium serotinum	Late boneset	1
Festuca sp.		
Fragaria virginiana	Wild strawberry	2
Galium boreale	Northern bedstraw	5
Geum canadense	White avens	2
Gleditsia triacanthos	Honey locust	2

Helenium autumnale	Sneezeweed	3
Hordeum jubatum	Squirrel-tail grass	*
Hypericum punctatum	Spotted St. John's-wort	3
Lactuca sp.		
Laportea canadensis	Canada wood nettle	2
Lobelia siphilitica	Great blue lobelia	4
Lonicera maackii	Amur bush honeysuckle	*
Lysimachia nummularia	Moneywort	*
Monarda fistulosa	Wild bergamot	4
Oenothera biennis	Common evening primrose	1
Oxalis stricta	Tall wood sorrel	0
Panicum sp.		
Parthenocissus quinquefolia	Virginia creeper	2
Phalaris arundinacea	Reed canary grass	*
Phytolacca americana	Pokeweed	1
Pilea pumila	Clearweed	3
Plantago rugelii	Red-stalked plantain	0
Poa sp.		
Poinsettia dentata	Toothed spurge	0
Polygonum cristatum	Copse bindweed	4
Polygonum virginianum	Jumpseed	3
Prunus serotina	Wild cherry	1
Pycnanthemum pilosum	Hairy mountain mint	6
Quercus alba	White oak	6
Quercus macrocarpa	Bur oak	5
Ranunculus fascicularis	Early buttercup	6
Ribes missouriense	Missouri gooseberry	2
Rosa multiflora	Multiflora rose	*
Rubus occidentalis	Black raspberry	2
Rudbeckia laciniata	Wild golden glow	3
Ruellia strepens	Smooth ruellia	6
Sanicula canadensis	Canadian black snakeroot	4
Sanicula gregaria	Clustered black snakeroot	2
Scirpus sp.		
Scrophularia marilandica	Late figwort	4
Sida spinosa	Prickly sida	*
Smilax hispida	Bristly green brier	3
Solanum carolinense	Horse nettle	0
Solanum ptycanthum	Black nightshade	0
Solidago canadensis	Canada goldenrod	1

Spiranthes ovalis var. erostellata	Oval ladies' tresses	8
Symphoricarpos orbiculatus	Coralberry	1
Taraxacum officinale	Common dandelion	*
Teucrium canadense	Germander	3
Toxicodendron radicans	Poison ivy	1
Trifolium pratense	Red clover	*
Trifolium repens	White clover	*
Triosteum aurantiacum	Early horse gentian	5
Ulmus americana	American elm	5
Ulmus rubra	Slippery elm	3
Verbascum thapsus	Woolly mullein	*
Verbena stricta	Hoary vervain	2
Verbena urticifolia	White vervain	3
Verbesina alternifolia	Wingstem	4
Vernonia fasciculata	Common ironweed	5
Vernonia gigantea	Tall ironweed	4
Vernonia missourica	Missouri ironweed	5
Viola pubescens	Yellow wood violet	5
Viola sororia	Woolly blue violet	3
Zanthoxylum americanum	Prickly ash	4
Zizia aurea	Golden Alexander	7

Wetland Plants

Abutilon theophrasti	Velvet leaf	*
Cyperus esculentus	Yellow nutsedge	2
Helenium autumnale	Sneezeweed	3
Lobelia inflate	Indian tobacco	4
Lobelia siphilitica	Great blue lobelia	3
Mimuls ringens	Monkey flower	5
Polygonum amphibium	Water knotweed	3
Potamogeton nodosus	American pondweed	7
Sagittaria latifolia	Broadleaf arrowhead	3
Typha angustifolia	Narrow-leaved cattail	*
Typha latifolia	Broad-leaved cattail	1
Xanthium strumarium	Cocklebur	0

Appendix B: Bird count conducted by Angelo Capparella and Matthew Winks on June 20, 2009 at the Demonstration Farm and adjacent ParkLands Foundation West Lexington Preserve complex. Weather: clear, 70s, light breeze

Scientific name	Common Name	Count
Agelaius phoeniceus	Red-winged Blackbird	15
Aix sponsa	Wood Duck	1
Anas platyrhynchos	Mallard (pair)	2
Archilochus colubris	Ruby-throated Hummingbird	1
Ardea herodias	Great Blue Heron	2
Baeolophus bicolor	Tufted Titmouse	3
Bombycilla cedrorum	Cedar Waxwing	6
Buteo jamaicensis	Red-tailed Hawk (all adults)	3
Butorides virescens	Green Heron	1
Cathartes aura	Turkey Vulture	8
Chaetura pelagica	Chimney Swift	1
Charadrius vociferus	Killdeer	20
Coccyzus americanu	Yellow-billed Cuckoo	3
Colaptes auratus	Northern Flicker	2
Columba livia	Rock Pigeon	1
Contopus virens	Eastern Wood-Pewee	5
Corvus brachyrhynchos	American Crow	5
Cyanocitta cristata	Blue Jay	5
Dendroica petechia	Yellow Warbler	2
Dumetella carolinensis	Gray Catbird	8
Geothlypis trichas	Common Yellowthroat	8
Hirundo rustica	Barn Swallow	6
Icterus galbula	Baltimore Oriole	1
Icterus spurius	Orchard Oriole	3
Megaceryle alcyon	Belted Kingfisher	2
Melanerpes carolinus	Red-bellied Woodpecker	3
Melospiza melodia	Song Sparrow	2
Molothrus ater	Brown-headed Cowbird	10
Myiarchus crinitus	Great Crested Flycatcher	2
Parula americana	Northern Parula	1
Passerina cyanea	Indigo Bunting	16
Petrochelidon pyrrhonota	Cliff Swallow	40
Pheucticus ludovicianus	Rose-breasted Grosbeak	1
Picoides pubescens	Downy Woodpecker	1

Picoides villosus	Hairy Woodpecker	3
Pipilo erythrophthalmus	Eastern Towhee	1
Poecile atricapillus	Black-capped Chickadee	5
Polioptila caerulea	Blue-gray Gnatcatcher	3
Progne subis	Purple Martin	1
Quiscalus quiscula	Common Grackle	10
Riparia riparia	Bank Swallow	1
Sialia sialis	Eastern Bluebird	2
Sitta carolinensis	White-breasted Nuthatch	3
Spinus tristis	American Goldfinch	8
Spiza americana	Dickcissel	8
Spizella passerina	Chipping Sparrow	1
Spizella pusilla	Field Sparrow	8
Stelgidopteryx serripennis	Northern Rough-winged Swallow	1
Sturnella magna	Eastern Meadowlark	5
Sturnus vulgaris	European Starling	12
Tachycineta bicolor	Tree Swallow	4
Thryothorus ludovicianus	Carolina Wren	2
Troglodytes aedon	House Wren	5
Turdus migratorius	American Robin	12
Tyrannus tyrannus	Eastern Kingbird	7
Vireo gilvus	Warbling Vireo	2
Zenaida macroura	Mourning Dove	1

Addendum to Appendix B: Additional birds observed at the Demonstration farm not included in the 2009 survey as compiled by Krista Kirkham, Tim Lindenbaum, Maria Lemke and Mike Wallace.

Scientific name	Common Name
Accipiter cooperii	Cooper's Hawk
Actitis macularius	Spotted Sandpiper
Anas discors	Blue-wing Teal
Ardea alba	Great Egret
Branta canadensis	Canada Goose
Bubo virginianus	Great Horned Owl
Bucephala albeola	Bufflehead
Cardinalis cardinalis	Northern Cardinal
Carpodacus mexicanus	House Finch
Certhia americana	Brown Creeper
Circus cyaneus	Northern Harrier
Egretta caerulea	Little Blue Heron
Eremophila alpestris	Horned Lark
Falco sparverius	American Kestrel
Fulica americana	American Coot
Grus canadensis	Sandhill Crane
Haliaeetus leucocephalus	American Bald Eagle
Hylocichla mustelina	Wood Thrush
Junco hyemalis	Dark-eyed Junco
Melanerpes erythrocephalus	Red-headed Woodpecker
Meleagris gallopavo	Wild Turkey
Mimus polyglottos	Northern Mockingbird
Nycticorax nycticorax	Black-crowned Night Heron
Phasianus colchicus	Ring-neck Pheasant
Pluvialis dominica	American Golden Plover
Porzana Carolina	Sora Rail
Scolopax minor	American Woodcock
Strix varia	Barred Owl
Toxostoma rufum	Brown Thrasher
Tringa flavipes	Lesser Yellowlegs
Tringa solitaria	Solitary Sandpiper
Zonotrichia albicollis	White-throated Sparrow

Appendix C. Plants identified in the prairie nursery at the Demonstration Farm. The list was developed based on observation and identification by Tim Lindenbaum, but no official survey has been conducted. CC = coefficient of conservationism, with CC of 1-3 meaning the plant is ruderal (found in disturbed areas, as in old fields or roadsides) and a CC or 9-10 meaning the plant is very conservative and is restricted to limited sites and/or conditions; * indicates that the plants are non-native.

Scientific name	Common Name	CC
Achillea millefolium	Common yarrow	*
Ambrosia artemisiifolia	Common ragweed	0
Amorpha canescens	Leadplant	8
Andropogon gerardii	Big bluestem	5
Asclepias syriaca	Common milkweed	0
Asclepias tuberose	Butterfly weed	5
Aster azureus	Sky blue aster	7
Aster ericoide	Heath aster	4
Aster novae-angliae	New England aster	4
Astragalus canadensis	Canada milk vetch	7
Baptisia leucantha	White wild indigo	6
Bouteloua curtipendula	Side oats grama	5
Bromus inermis	Smooth brome	*
Cassia fasciculate	Partridge pea	2
Ceanothus americanus	New Jersey tea	8
Cirsium arvense	Canada thistle	*
Coreopsis palmate	Prairie coreopsis	6
Dalea purpurea	Purple prairie clover	8
Daucus carota	Queen Anne’s lace	*
Desmanthus illinoensis	Illinois bundleflower	4
Desmodium illinoense	Illinois tick trefoil	5
Echinacea pallida	Pale purple coneflower	7
Echinacea purpurea	Purple coneflower	5
Elymus canadensis	Canada wild rye	4
Elymus virginicu	Virginia wild rye	4
Erigeron annuus	Annual fleabane	1
Erigeron strigosus	Daisy fleabane	2
Eryngium yuccifolium	Rattlesnake master	7
Eupatorium serotinum	Late boneset	1
Helianthus grosseserratus	Sawtooth sunflower	2
Helianthus rigidus	Prairie sunflower	4

Lactuca canadensis	Wild lettuce	1
Lespedeza capitata	Round-headed bush clover	4
Liatris aspera	Rough blazing star	7
Liatris pycnostachya	Prairie blazing star	6
Monarda fistulosa	Wild bergamot	4
Oenothera biennis	Common evening primrose	1
Parthenium integrifolium	Wild quinine	8
Penstemon digitalis	Beardtounge	6
Physalis heterophylla	Clammy ground cherry	2
Physostegia virginiana	Obedient plant	6
Ratibida pinnata	Yellow coneflower	4
Rudbeckia hirta	Black-eyed Susan	2
Rudbeckia triloba	Brown-eyed Susan	3
Schizachyrium scoparium	Little bluestem	5
Silphium integrifolium	Rosinweed	5
Silphium laciniatum	Compass plant	5
Silphium terebinthinaceum	Prairie dock	4
Solanum carolinense	Horse nettle	0
Solidago canadensis	Canada goldenrod	1
Solidago nemoralis	Old field goldenrod	2
Solidago rigida	Rigid goldenrod	4
Sorghastrum nutan	Indian grass	4
Symphyotrichum leave	Smooth aster	5
Verbena stricta	Hoary vervain	2
Zizia aurea	Golden Alexander	6

Along with promoting and demonstrating better management and conservation practices, the Research and Demonstration Farm is also an experimental wetland research site. In 2005, three wetland complexes (East, West, and Gully) were constructed to intercept tile drainage in the goal of determining the minimum wetland size needed in an agricultural landscape to significantly reduce high nutrient loading, specifically nitrate-nitrogen (NO_3-N) and orthophosphate (ORP). Researchers from The Nature Conservancy, University of Illinois, and Illinois State University are investigating the effectiveness of these constructed wetlands at the Demonstration Farm in terms of quantifying nutrient reductions, denitrification potentials, retention time, and groundwater interactions. Updates from 2010 and 2011 regarding ongoing research projects are provided in this appendix.

Nutrient reductions in constructed wetlands

Researchers from the University of Illinois continued to collect water samples from the inlets and outlets of each wetland cell at the East, West and Gully wetland complexes. Each wetland complex is comprised of 3 wetland cells, each representing 3%, 6%, and 9% of the surrounding land that is drained by tiles (Fig. 1). Water samples were collected using ISCO 6712C portable automatic water samplers, each equipped with a submerged probe that measured water flow and volume entering and exiting each wetland cell. Subsamples were analyzed primarily for total suspended solids, NO_3-N, and ORP.

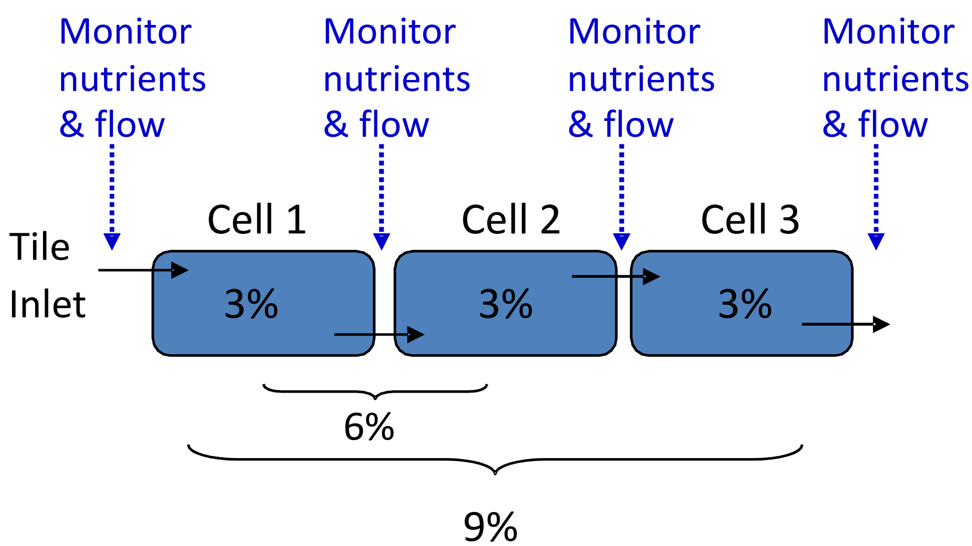

***Figure 1.** Diagram of an experimental wetland complex showing individual wetland cells, each representing 3% of the drainage area. Also shown are monitoring sites located at the inlets and outlets of each wetland cell.*

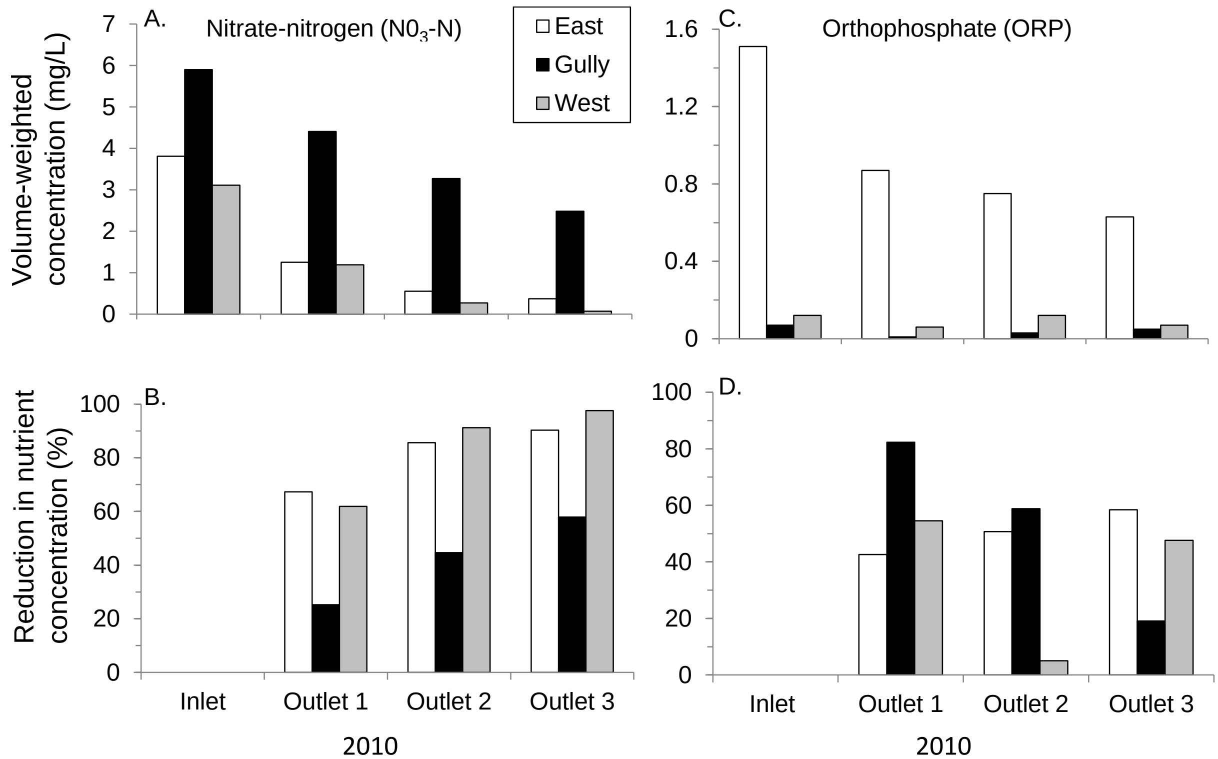

Figure 2. *2010 data showing volume-weighted nutrient concentrations from tiles draining soybean fields for nitrate-nitrogen (A), percent reduction in nitrate-nitrogen concentrations (B), orthophosphate concentrations (C) and reductions in orthophosphate concentrations (D) at the inlet and outlets of all wetland cells at the East, Gully, and West wetland complexes. Note the scale differences for the y-axes of graphs A and B for nutrient concentrations.*

In 2010, volume-weighted NO_3-N concentrations coming into the inlet of the first wetland cell from tile water ranged from 3.11 mg L^{-1} in the West wetland complex to 5.90 mg L^{-1} in the Gully wetland complex (Fig. 2A). Nitrate concentrations were reduced by 67%, 25% and 62% in the first wetland cell of the East, Gully and West wetlands, respectively (Fig. 2B). Data show that as tile water moved through the third wetland cell, representing 9% of the surrounding tile-drained farmland, nitrate concentrations were reduced by 90% (East), 58% (Gully) and 98% (West). Final NO_3-N concentrations at the outlet of the third wetland cell of each complex were 0.37 mg L^{-1} (East), 2.48 mg L^{-1} (Gully), and 0.07 mg L^{-1} (West). Orthophosphate concentrations draining from the field tiles into the first wetland cell of each complex ranged from 0.07 mg L^{-1} in the Gully wetlands to 1.51 mg L^{-1} in the East wetland complex (Fig. 2C) and were reduced by 43%, 82% and 55% in the first wetland cell of the East, Gully and West wetlands, respectively (Fig. 2D). Data show that as tile water moved through the third wetland cell, ORP concentrations at the outlet of the third cell of each site was 0.63 mg L^{-1}, 0.05 mg L^{-1}, and 0.07 mg L^{-1} at the East, Gully and West wetland complexes, respectively (Fig. 2C).

Volume-weighted NO_3-N concentrations coming into the inlets of the first wetland cells from tile water were much higher in 2011 than for 2010, ranging from 16.7 mg L^{-1} in the Gully wetland complex to 30.3 mg L^{-1} in the East wetland complex (Fig. 3A). Nitrate concentrations were reduced by 47%, 16% and 27% in the first wetland cell of the East, Gully and West wetlands, respectively (Fig. 3B). Data show that as tile water moved through the third wetland cell, representing 9% of the surrounding tile-drained farmland, nitrate concentrations were reduced by 73% (East), 67% (Gully) and 86% (West). Final NO_3-N concentrations at the outlet of the third wetland cell of each complex were 8.1 mg L^{-1} (East), 5.6 mg L^{-1} (Gully), and 3.3 mg L^{-1} (West). Orthophosphate concentrations draining from the field tiles into the first wetland cell of each complex ranged from 0.13 mg L^{-1} in the Gully wetlands to 1.81 mg L^{-1} in the East wetland complex (Fig. 3C) and were reduced by 57%, 48% and 85% in the first wetland cell of the East, Gully and West wetlands, respectively (Fig. 3D). Data show that ORP concentrations at the outlet of the third wetland cell of each complex were 0.07 mg L^{-1}, 0.24 mg L^{-1}, and 0.06 mg L^{-1} at the East, Gully and West wetland complexes, respectively (Fig. 3C). The increase of ORP in the second and third cells of the Gully wetland is assumed to be associated with groundwater entering the Gully wetland complex at these sites. However, even with the lower removal rate of ORP by the Gully wetlands, the five-year cumulative removal for the combined wetlands is still 59% in the second cell (representing 6% wetland-to-watershed ratio).

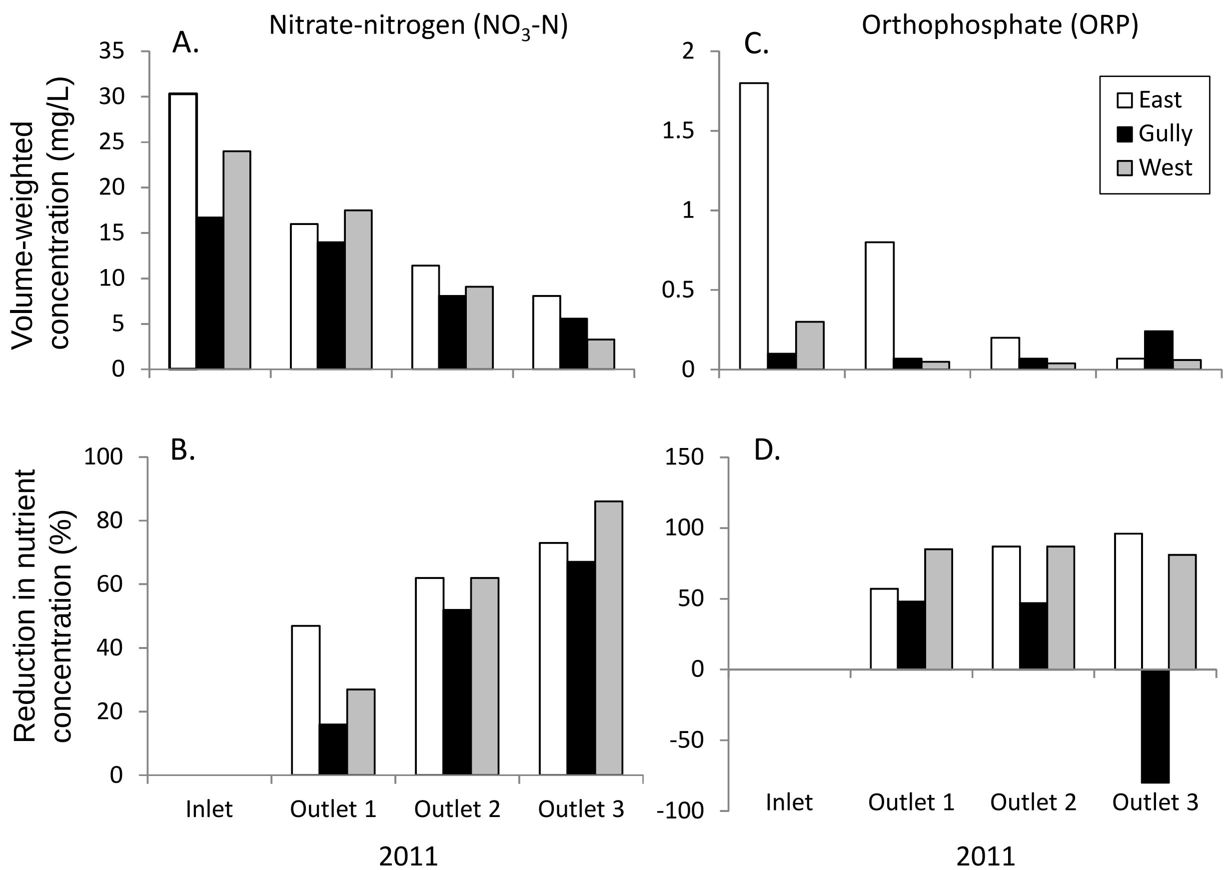

Figure 3. *2011 data showing volume-weighted nutrient concentrations from tiles draining soybean fields for nitrate-nitrogen (A), percent reduction in nitrate-nitrogen concentrations (B), orthophosphate concentrations (C) and reductions in orthophosphate concentrations (D) at the inlet and outlets of all wetland cells at the East, Gully, and West wetland complexes. Note the scale differences for the y-axes of graphs A and B for nutrient concentrations.*

All wetlands lose and/or gain water from interactions with groundwater sources. These interactions can complicate experimental measures of nutrient loss, in that nutrients can be lost or gained in a wetland cell through groundwater (e.g., ORP in the Gully wetland) as well as from denitrification processes in the wetland cell itself. Thus total nutrient removal (kg) from these experimental wetlands can be calculated in two ways: straight mass balance approach using measures from inlets and outlets, or mass balance that includes seepage adjustments. The more conservative approach is to include seepage adjustments, since this represents reductions that occur only in the wetland cell itself, and not losses due to seepage of water out of the wetland into groundwater. Five-year cumulative data show that reductions in NO_3-N loadings (kg) calculated using straight mass balance measures ranged from 48-65% (3% cell), 49-83% (6% cell) and 56-94% (9% cell). Calculations of NO_3-N cumulative 5-y loading reductions that account for seepage ranged from 12-34% (3% cell), 29-49% (6% cell) and 41-58% (9% cell) (Fig. 4). Five-year cumulative data show that reductions in ORP loadings (kg) calculated using straight mass balance measures for the East and West cells ranged from 67-93% (3% cell) to 92-99% (9% cell). Estimates cumlative 5-y loading reductions for ORP in the East and West wetlands that take into account seepage ranged from 44-65% (3% cell), 55-79% (6% cell) and 63-86% (9% cell) (Fig. 4).

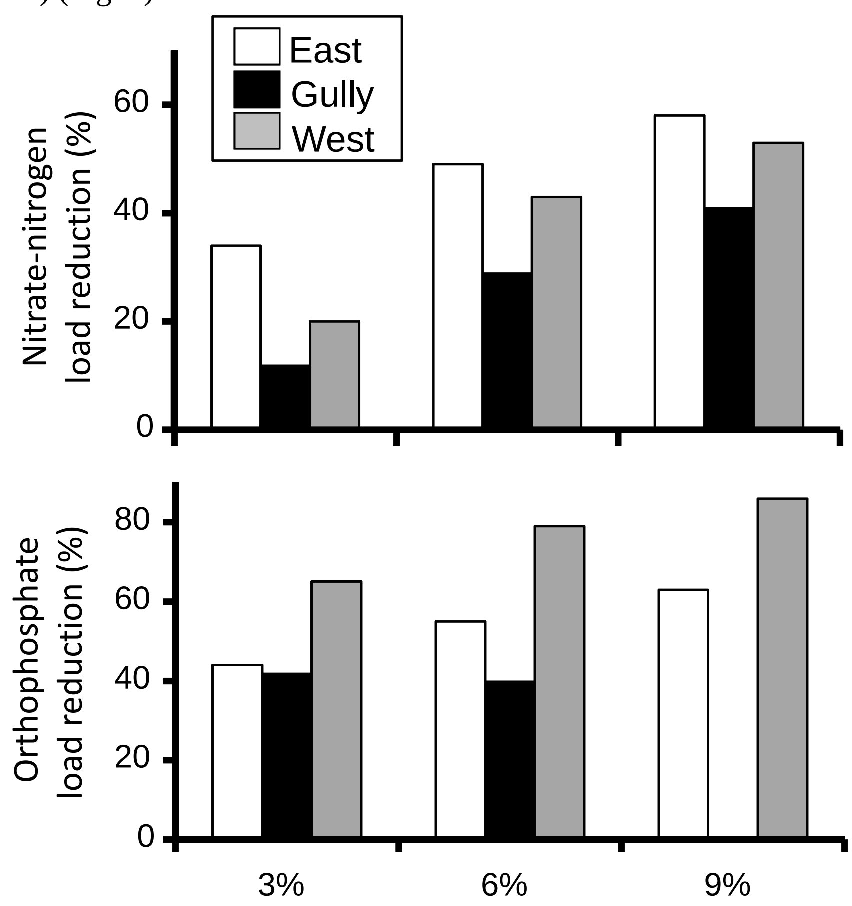

Figure 4. *Five-year (2007-2011) cumulative percent load reductions (kg) for nitrate-nitrogen and orthophosphate from individual cells of the East, Gully, and West wetland complexes, each cell representing 3%, 6%, and 9% of the surrounding tile-drained farmland.*

As previously discussed, the Gully wetlands appear to have extensive interactions with groundwater that is transporting nutrients into the wetland cells somewhere between cells 2 and 3. Calculations show an initial 42% reduction in ORP coming into the first cell from tile water (with seepage adjustments); however, no further reductions in the second cell and an overall lack of reduction between water entering the first cell and the exiting the wetland complex (Fig. 4).

Whether the effectiveness of these experimental wetland at reducing nutrients are estimated in terms of the whole system (wetland + groundwater interactions) or only as the wetland cell alone, they have proven to be very effective at reducing NO_3-N export from agricultural fields that would otherwise be entering directly into the Mackinaw River. Overall these wetland systems (wetland + groundwater interactions) removed a 5-y average minimum of 48-65% in the smallest wetland and a maximum of 56-94% in the largest wetland of the total NO_3-N from the tile water leaving the farmland. The East and West wetlands were also very effective at removing ORP export, reducing total loss by 67-93% in the smallest wetlands and 92-99% in the largest wetlands. These results show that wetlands, as a conservation practice, could move the scale forward in our attempts to reduce nutrients from agricultural tile water in a way that minimizes impacts on downstream drinking water quality, biotic diversity and hypoxia.

Water residence times, groundwater interactions, and nitrogen removal mechanisms in constructed wetlands

Illinois State University researchers from the Geology and Biology departments conducted research experiments at the Research and Demonstration Farm in 2010 to investigate (a) residence time of water in the wetland cells, and (b) groundwater interactions in the Gully and West wetland complexes, and (c) denitrification potential. Some study results on nitrogen fluxes between groundwater and the wetland cells, denitrification and nitrogen uptake are documented in the 2009 Farm Report and are currently being summarized into manuscript form by Dr. Stephen Van der Hoven (currently Senior Hydrogeologist, Environmental Services, CA).

<u>Water residence times</u>

West wetland.- During 2011, Dr. William Perry's research team installed 10 groundwater monitoring wells, 30 surface and 6 subsurface water samplers in and around each wetland cell in the West wetland complex. Using this sampling design, the team conducted a tracer test to quantify residence time and groundwater interactions in the West wetland complex. During the tracer test, bromide (the tracer) was detected in samplers beneath all three wetland cells, indicating that there was flow out of the bottom of these cells into the underlying groundwater. Data are still being analyzed to determine the extent of these groundwater interactions.

From April 23 to June 22, 2011, an injected tracer test was conducted in the West wetland to understand how surface water moved through the wetland cells. Bromide was injected at a rate of 0.5 l/min over 96 hours and samples were collected from surface, subsurface and groundwater wells at frequencies of 2 to 6-hour intervals. Preliminary results suggest that much of the water moved through the first cell in an average of 8 hours; however, a significant fraction of the water flows towards the edges of the cell and takes days to weeks to reach the outlet. It should be mentioned that during the tracer test, there were significant amounts of heavy rain and, thus, high flows through the system.

Gully wetland.- A similar injected tracer test was conducted in the Gully wetland in May 2010 to estimate average residence times of water in the wetland cells. High flow through the wetland cells from three storm events during the time of the test created some difficulty in calculating the residence times; however, estimates provided evidence of a 2-day residence time in each of the three cells. These results compare to estimates of a 12-hour residence time during the 2009 tracer test. These differences in residence times were attributed to differences in the amount of vegetation in the wetlands between 2009 and 2010. During 2009, there was a considerable growth of vegetation when the test began in July. The dye added at the start of the injection could be seen following a relatively discrete flow path through the vegetation from inlet to outlet of the cell. The bulk of the water appeared to follow this path, resulting in a relatively short residence time. However, water that dispersed out of this flow path took weeks to reach the outlet. In contrast, there was little vegetation during the 2010 tracer study and the injected dye dispersed more evenly throughout the cell. This resulted in increased residence times, despite the three storm events that occurred during the experiment.

Groundwater interactions

Two students from Illinois State University began research in 2010 specifically to address the issue of groundwater inflow-outflow in the wetlands on a yearly timescale. One student used physical measurements (hydraulic gradient and seepage rates) to quantify groundwater interactions. The hypothesis was that there is a relationship between the slope of the water table adjacent to the wetlands and the net groundwater interaction with the wetlands such that as the slope increases, the groundwater flow into the wetlands also increases. Contrary to this hypothesis, there was no relationship found between the water table slope and the net groundwater interaction. Further research included installation of seepage meters to measure the magnitude and direction of water flow across the bottom of the wetlands and the installation of 7 additional monitoring wells around the Gully wetlands to better understand the groundwater conditions surrounding the wetland cells.

A second student tested the hypothesis that variations in isotopic composition of oxygen (O) and hydrogen (H) molecules can be used to calculate the percentage of groundwater inflow to the wetlands. The isotopic composition of O and H in water molecules has been widely used to calculate the percentage of two sources of water (e.g., tile discharge and groundwater input). Water entering the wetlands is a combination of tile water and groundwater, thus, it was hypothesized that the tile water will vary seasonally and will usually be isotopically different then the groundwater. If this is so, it is possible to calculate the percentage that each source contributes to the wetlands. So far, 2 rounds of samples have been collected from the tile inlets, groundwater wells and surface water of the Gully wetlands. In October 2009 samples, the isotopic composition of the tile water and groundwater were not distinctly different. In July, 2010, high rates of evaporation complicated isotopic calculations. Thus, percentages of these two sources could not be calculated. However, these data were used to estimate a 20-30% loss of water due to evaporation as water passes through the 3 cells. This evaporative loss had not been previously recognized and can have a significant impact of water balance and nitrogen loss calculations.

Nitrogen removal mechanisms

Since November, 2008, four sets of samples have been collected for isotopic analyses from each of the 4 annual seasons. During each season, samples for nitrogen isotopic analyses were collected from surface water, wetland vegetation, and wetland sediments. Nitrogen isotopes can be used to identify and quantify nitrogen cycling processes in these wetland components, such as the rates of uptake and denitrification. Preliminary data clearly indicate that denitrification is the dominant process removing nitrate from the surface water in the wetlands. In the Gully wetlands it was found that over 90% of the nitrogen that flowed out to groundwater was removed by denitrification in the subsurface sediments. Ongoing monitoring at the Demonstration Farm has shown that each wetland complex removes a large proportion of incoming nitrate. Researchers at Illinois State University are working on methods to manipulate wetland conditions for the purpose of enhancing denitrification. Experiments by these researchers indicate that denitrification in these wetlands may be limited by the availability of carbon in the wetland sediments.