Science Assessment to Support an Illinois Nutrient Reduction Strategy

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Technical Tasks

- develop a science based technical assessment of:
  - current conditions in Illinois of nutrient sources and export by rivers in the state from point and non-point sources
  - methods that could be used to reduce these losses and estimates of their effectiveness throughout Illinois
  - estimates of the costs of statewide and watershed level application of these methods to reduce nutrient losses to meet TMDL and Gulf of Mexico goals

Steps we will take

1. determine current conditions
2. identify critical watersheds
3. estimate potential reductions and costs
4. develop scenarios

1. Current Conditions

- nutrient (nitrate and total P) loads from major river basins of Illinois
  - estimates of point and non-point sources
  - compare 1980-1996 with 1997-2011
  - determine direction of loads

- determine current agricultural management practices across the state
  - nutrient inputs and management (fertilizers and manure)
  - current cropping practices
  - N and P loads and yields from water quality data

Riverine N and P Fluxes

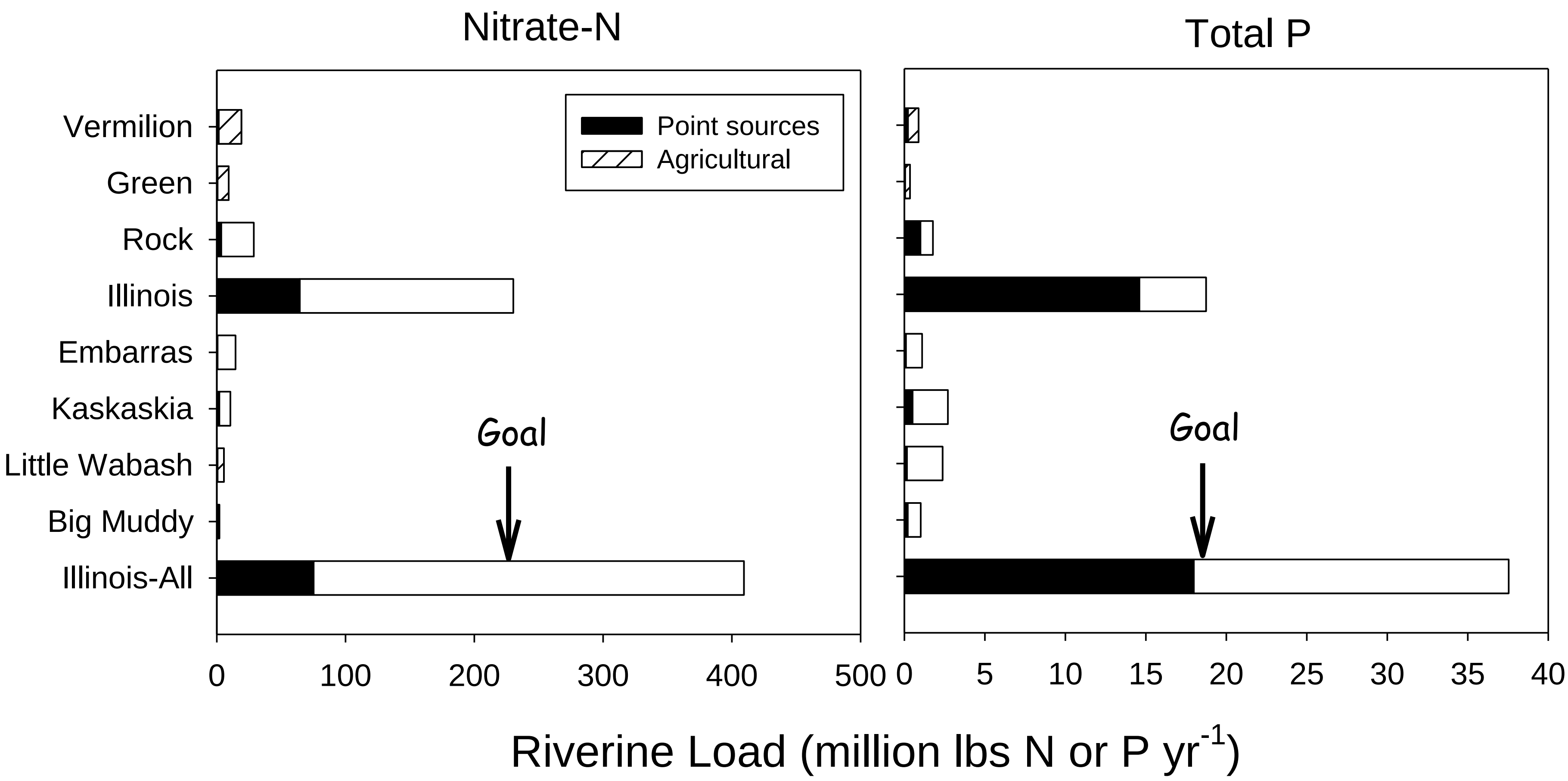
	Water	Nitrate-N	Total N	DRP	Total P
	10^9 m^3 yr^{-1}	million lbs N or P yr^{-1}			
David & Gentry (2000)	47		538		31.3
1980-1996	48.2	404	527	15.4	34.0
1997-2011	48.8	410	536	18.5	37.5
Point sources		75.2	87.3		18.1
		Percent of 1997-2011 load			
Point sources		18.4	16.3		48
David & Gentry (2000)			16		47

Goal or Target

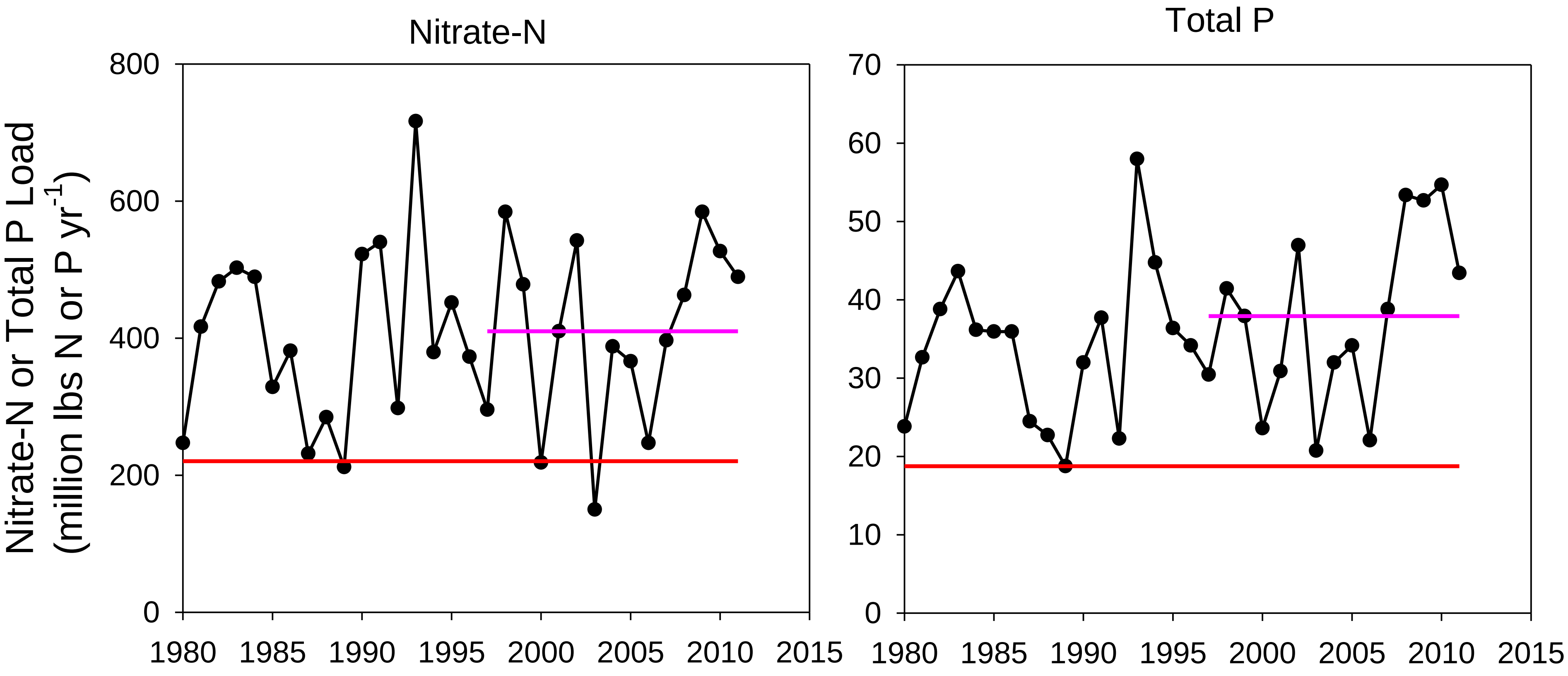
- 45% reduction in 1980 to 1996 loads
  - nitrate-N target of 222 million lbs N yr^{-1}
  - total P target of 18.7 million lbs P yr^{-1}

- larger reductions needed from 1997 to 2011 average loads
  - 410/188 million lbs N as nitrate-N needed (46%)
  - 37.5/18.8 million lbs total P needed (50%)

Point and agricultural sources
(1997-2011)



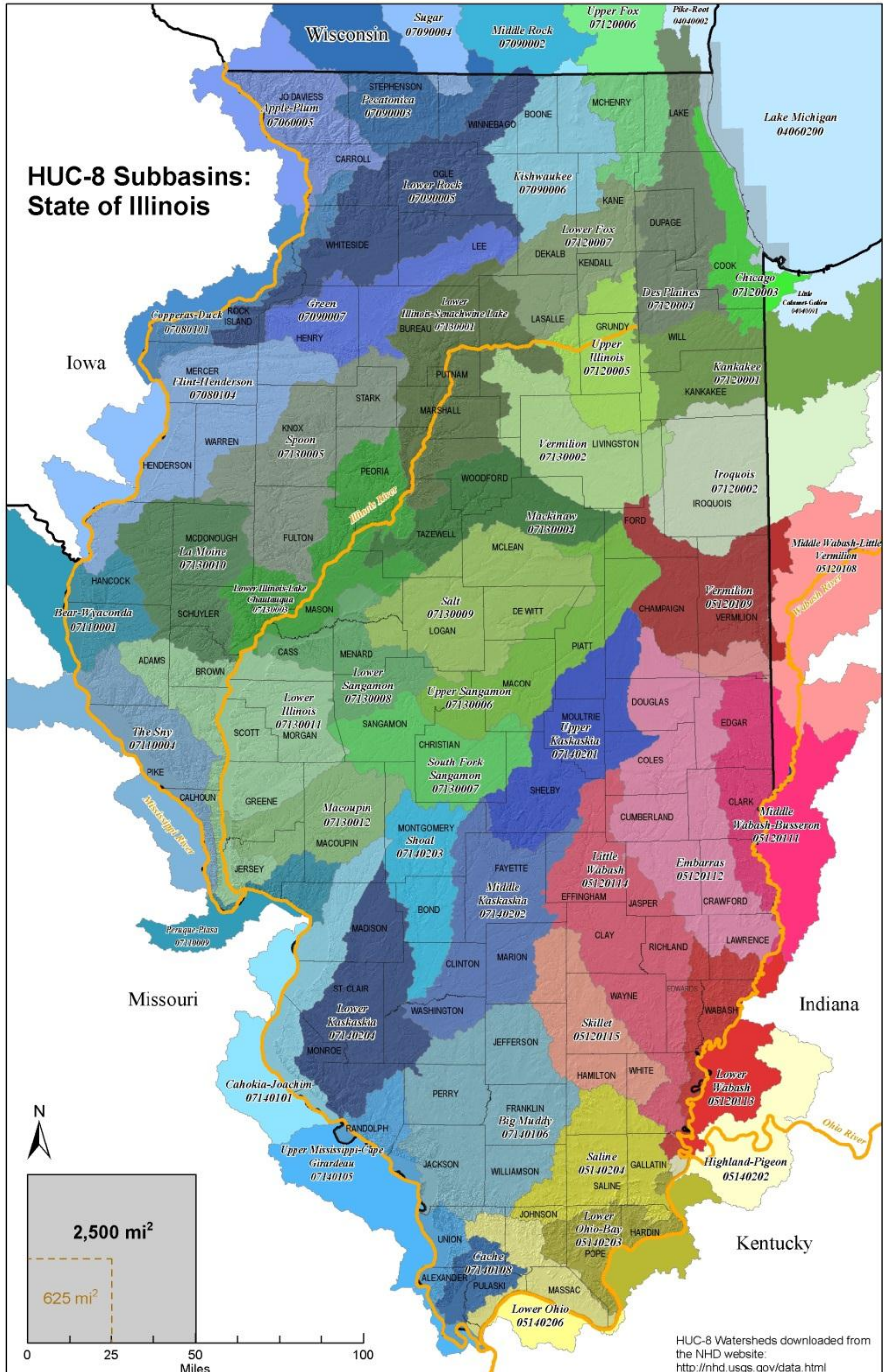
Nitrate-N and Total P Targets



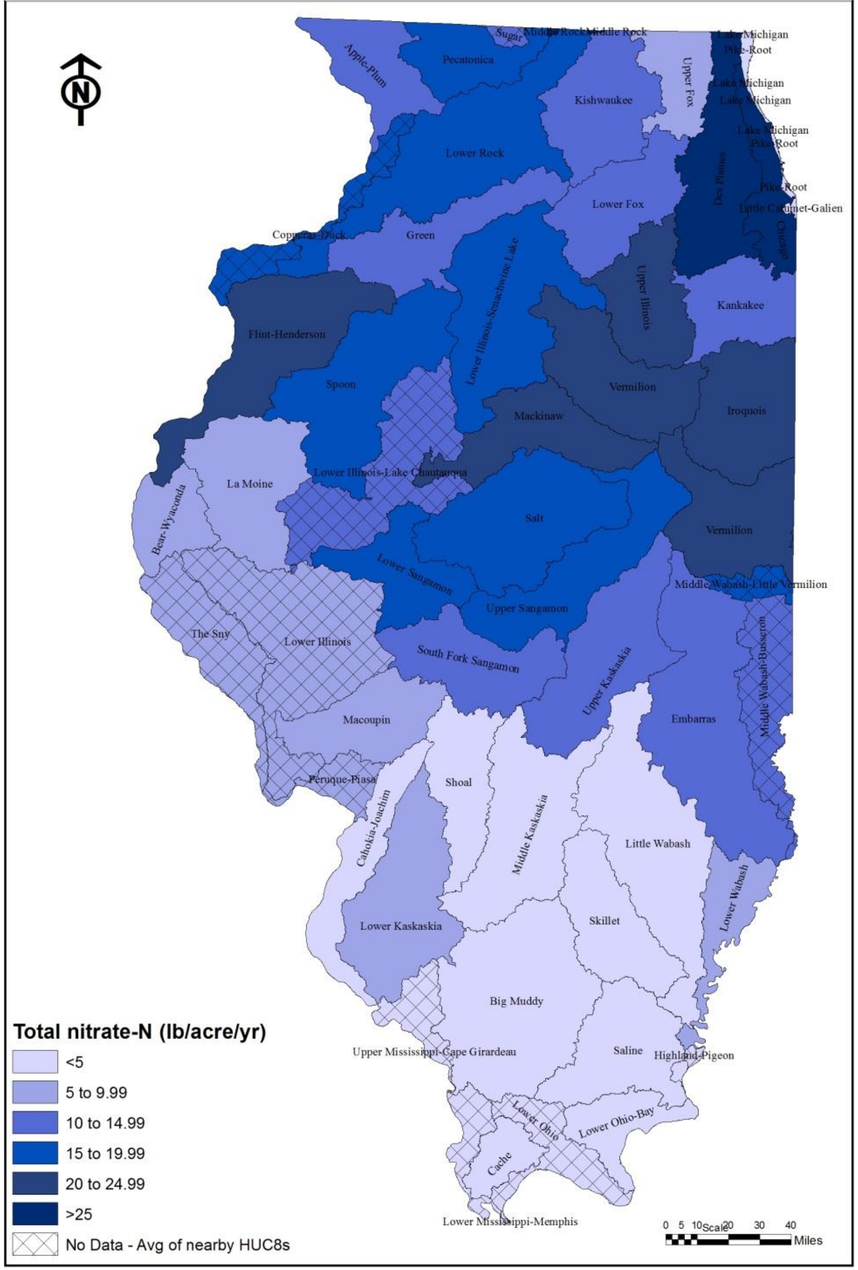
Red line is target, purple is average 1997 to 2011

2. Critical Watershed Identification

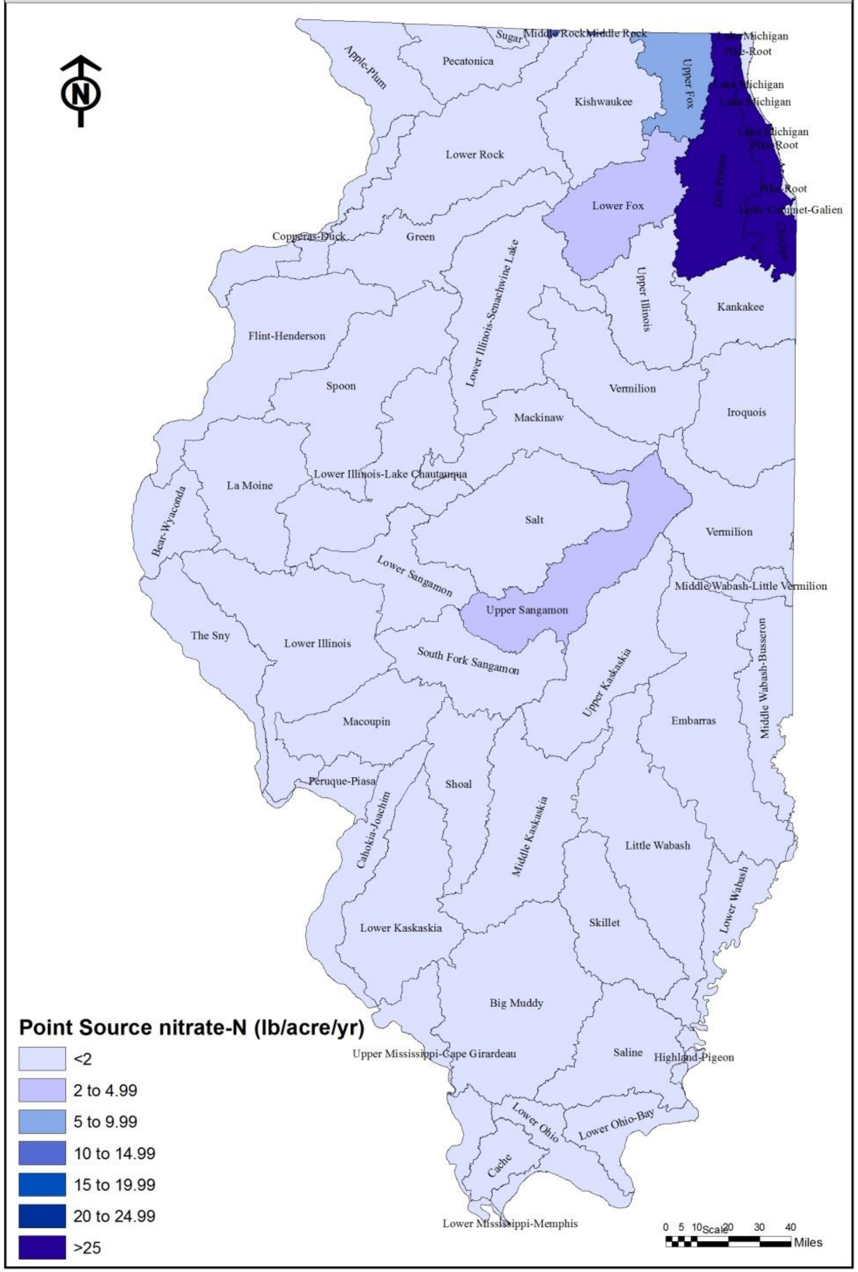
- identify 8 digits HUCs with the highest nutrient yields and loads to the Gulf of Mexico
- identify watersheds with nutrient impaired water bodies (303d list)
- determine overlap
- estimate point and non-point sources of N and P within watersheds


HUC-8 Subbasins: State of Illinois
Wisconsin
Sugar 07090004
Middle Rock 07090002
Upper Fox 07120006
Pike-Root 04040002
Lake Michigan 04060200
Apple-Plum 07060005
Pecatonica 07090003
Lower Rock 07090005
Kishwaukee 07090006
Lower Fox 07120007
Des Plaines 07120004
Chicago 07120003
Little Calumet-Galien 04040001
Copperas-Duck 07080101
Green 07090007
Lower Illinois-Senachwine Lake 07130001
Upper Illinois 07120005
Kankakee 07120001
Iowa
Flint-Henderson 07080104
Spoon 07130005
Vermilion 07130002
Iroquois 07120002
Mackinaw 07130004
La Moine 07130010
Lower Illinois-Lake Chautauqua 07130003
Bear-Wyaconda 07110001
Salt 07130009
Vermilion 05120109
Middle Wabash-Little Vermilion 05120108
Lower Sangamon 07130008
Upper Sangamon 07130006
Lower Illinois 07130011
The Sny 07110004
Upper Kaskaskia 07140201
South Fork Sangamon 07130007
Macoupin 07130012
Shoal 07140203
Middle Wabash-Busseron 05120111
Little Wabash 05120114
Embarras 05120112
Middle Kaskaskia 07140202
Peruque-Piasa 07110009
Missouri
Indiana
Lower Kaskaskia 07140204
Skillet 05120115
Cahokia-Joachim 07140101
Lower Wabash 05120113
Big Muddy 07140106
Upper Mississippi-Cape Girardeau 07140105
Saline 05140204
Highland-Pigeon 05140202
Lower Ohio-Bay 05140203
Kentucky
Cache 07140108
Lower Ohio 05140206
Illinois River
Mississippi River
Wabash River
Ohio River
JO DAVIESS
STEPHENSON
WINNEBAGO
BOONE
MCHENRY
LAKE
CARROLL
OGLE
KANE
DUPAGE
WHITESIDE
LEE
DEKALB
KENDALL
COOK
ROCK ISLAND
HENRY
BUREAU
LASALLE
GRUNDY
WILL
MERCER
PUTNAM
STARK
MARSHALL
KANKAKEE
KNOX
WARREN
HENDERSON
PEORIA
WOODFORD
LIVINGSTON
IROQUOIS
FORD
MCDONOUGH
FULTON
TAZEWELL
MCLEAN
HANCOCK
SCHUYLER
MASON
DE WITT
CHAMPAIGN
VERMILION
LOGAN
CASS
MENARD
PIATT
ADAMS
BROWN
MACON
DOUGLAS
SANGAMON
MOULTRIE
EDGAR
SCOTT
MORGAN
CHRISTIAN
COLES
PIKE
CALHOUN
SHELBY
CLARK
GREENE
MONTGOMERY
CUMBERLAND
MACOUPIN
JERSEY
FAYETTE
EFFINGHAM
JASPER
CRAWFORD
BOND
MADISON
CLAY
RICHLAND
LAWRENCE
CLINTON
MARION
ST. CLAIR
WAYNE
EDWARDS
WABASH
WASHINGTON
MONROE
JEFFERSON
HAMILTON
WHITE
RANDOLPH
PERRY
FRANKLIN
JACKSON
WILLIAMSON
GALLATIN
SALINE
JOHNSON
HARDIN
POPE
UNION
ALEXANDER
PULASKI
MASSAC
N
2,500 mi²
625 mi²
0 25 50 100
Miles
HUC-8 Watersheds downloaded from the NHD website: http://nhd.usgs.gov/data.html

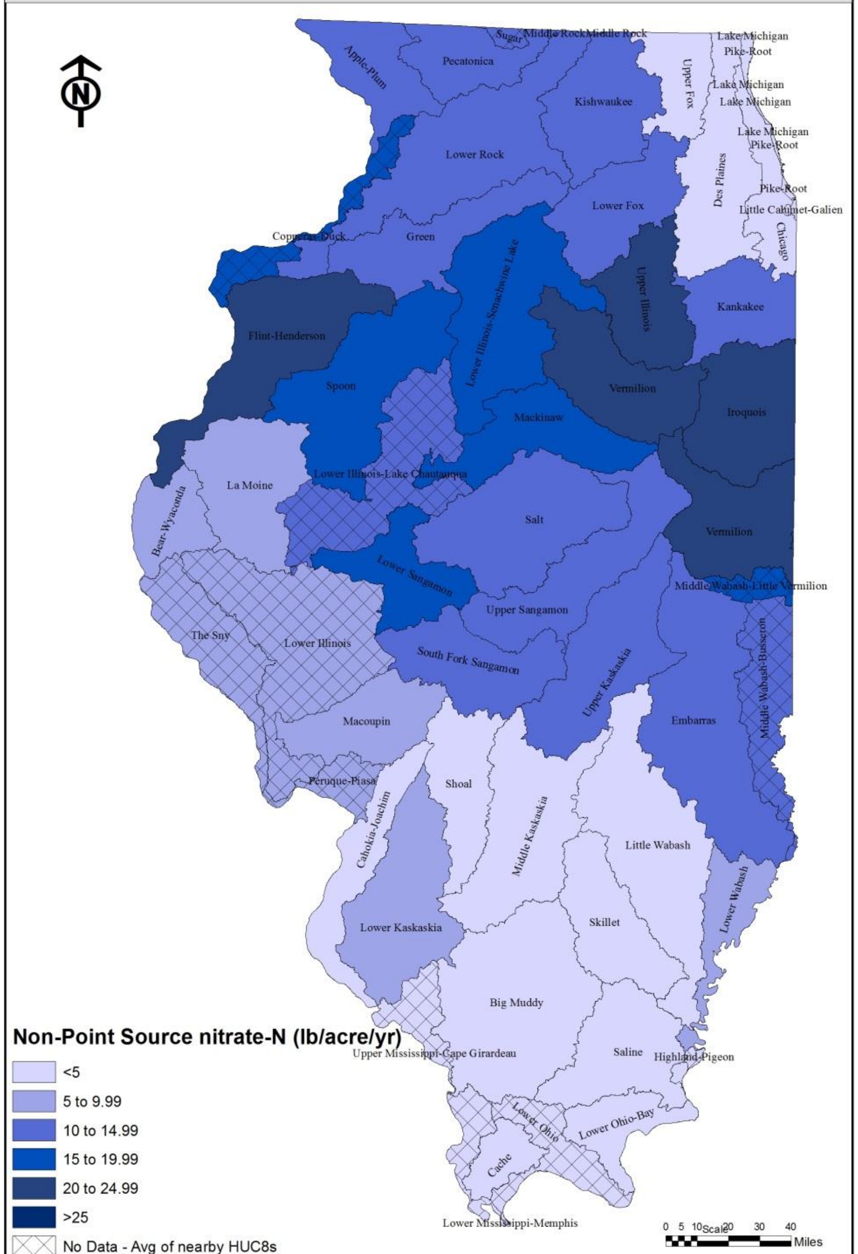
HUC8 Total nitrate-N Yields



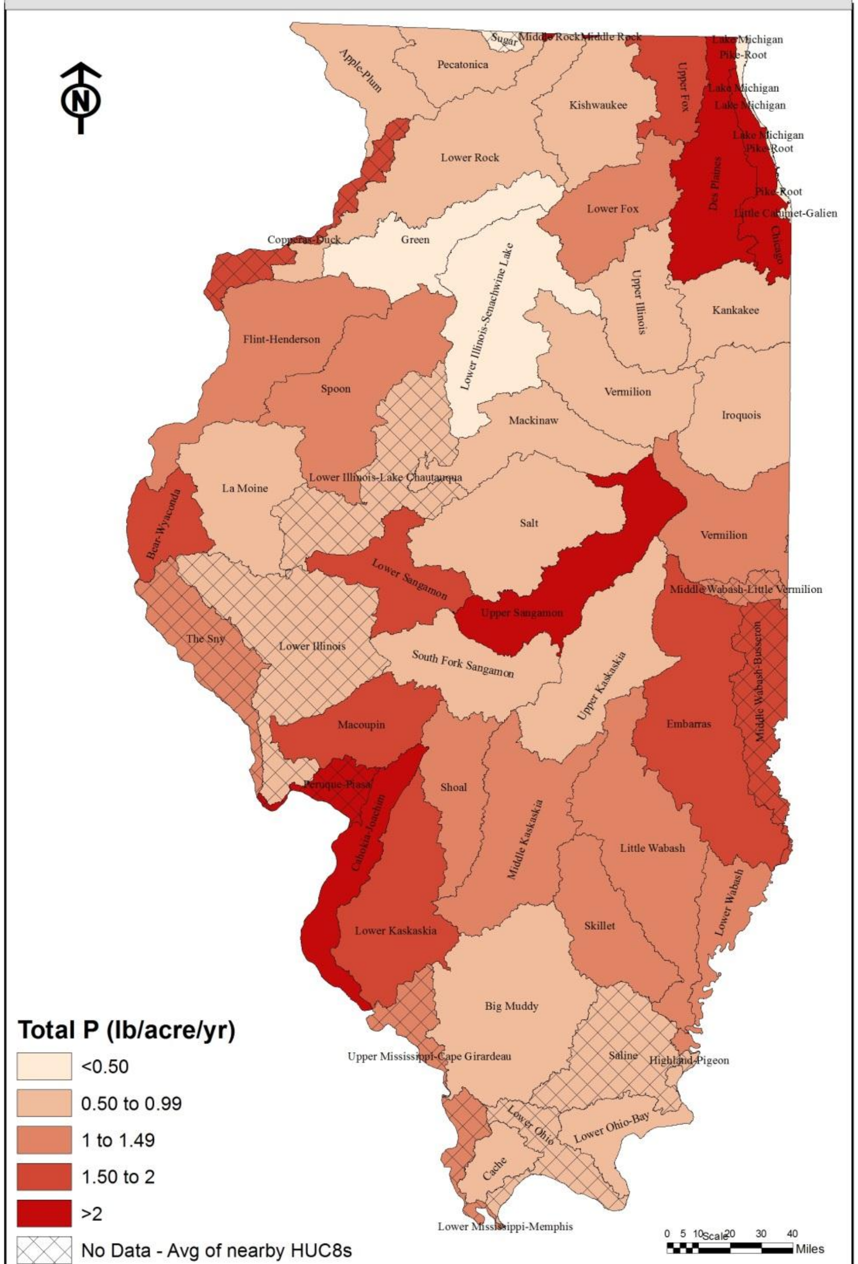
HUC8 Point Source nitrate-N Yields



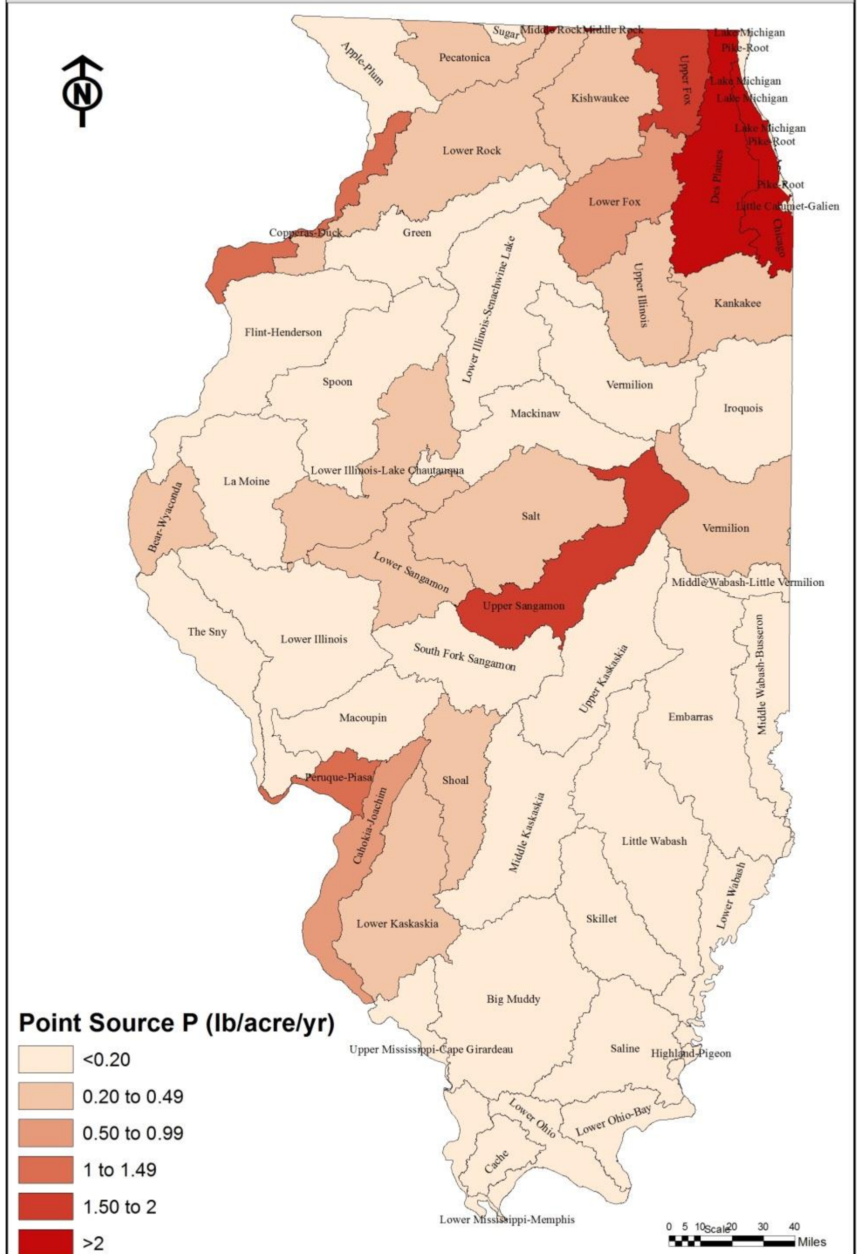
HUC8 Non-Point Source nitrate-N Yields



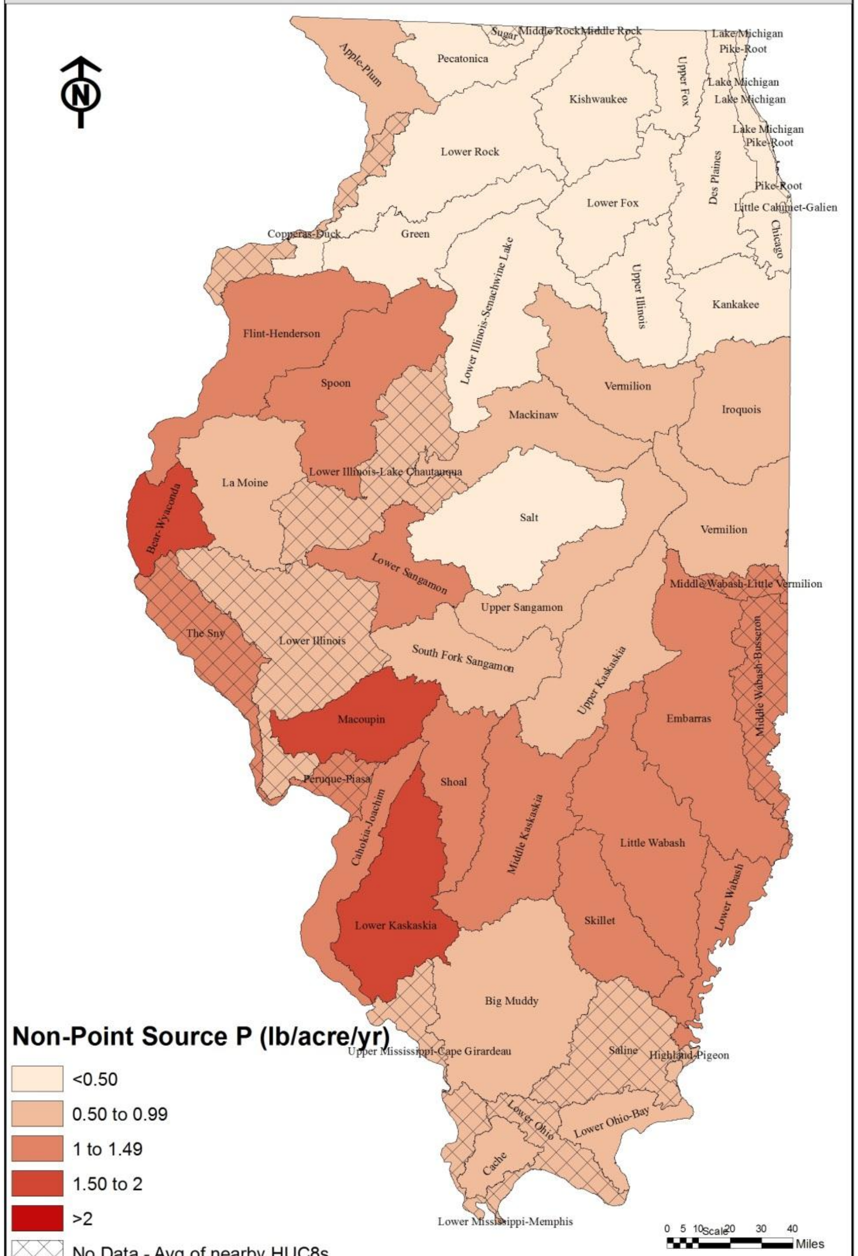
HUC8 Total P Yields

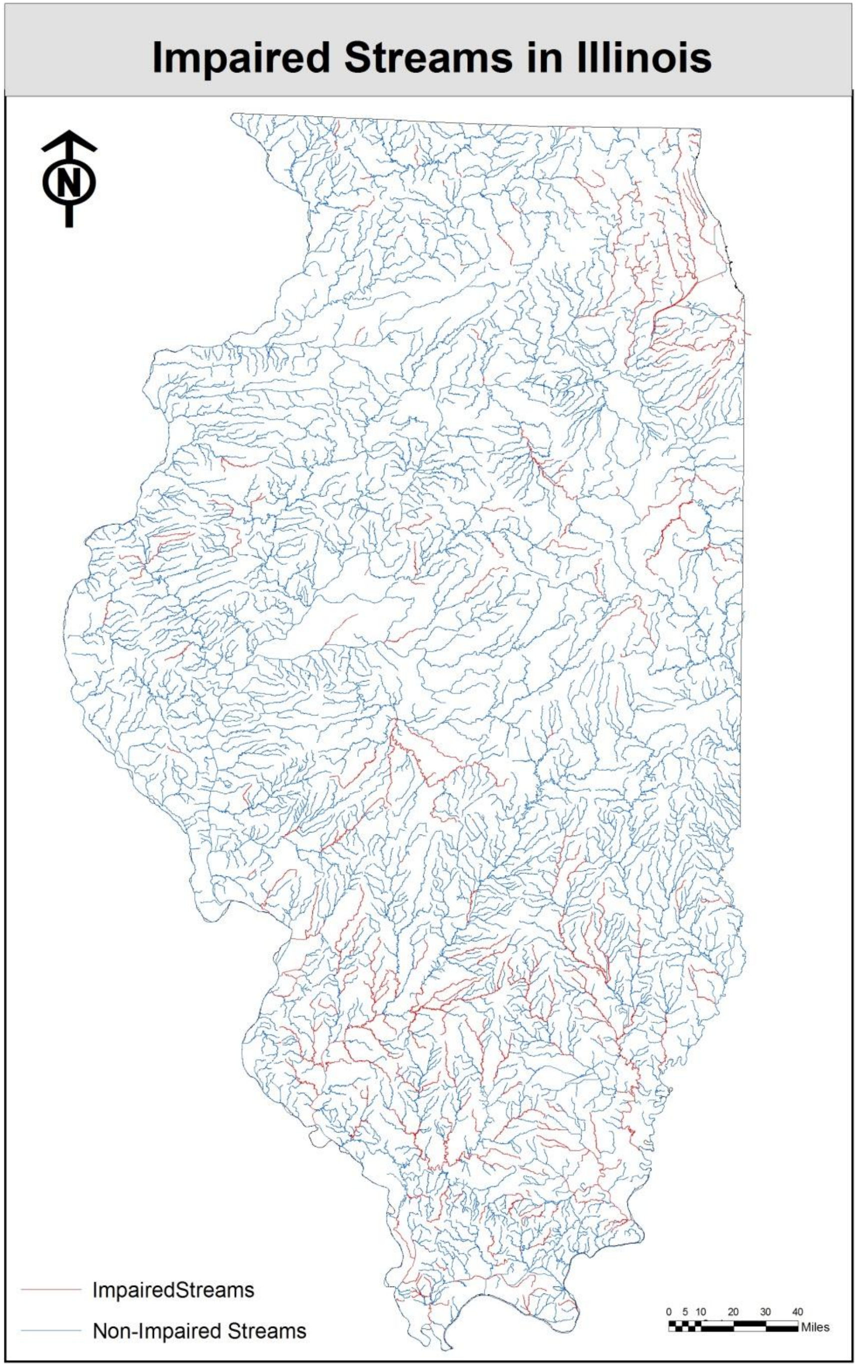


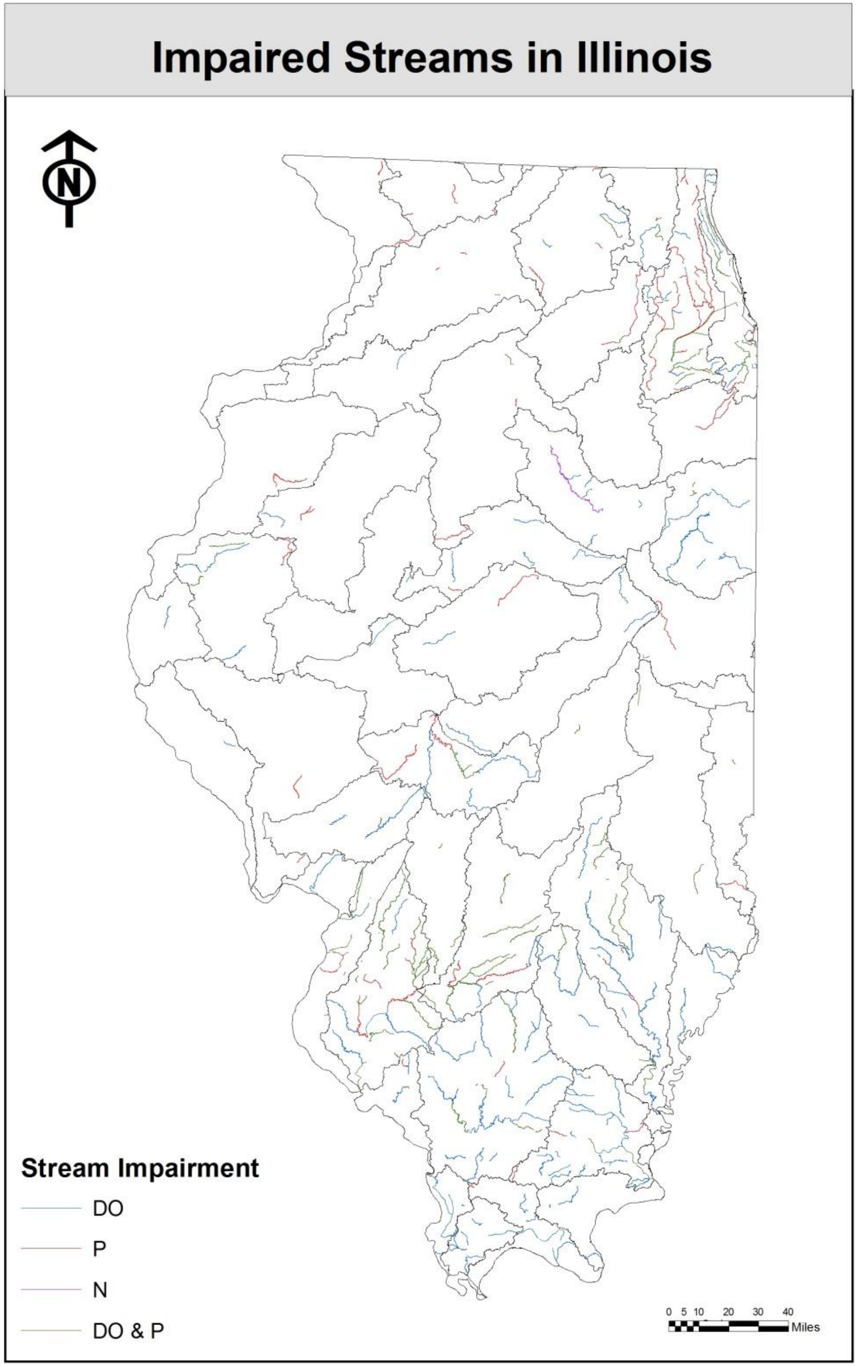
HUC8 Point Source P Yields



HUC8 Non-Point Source P Yields



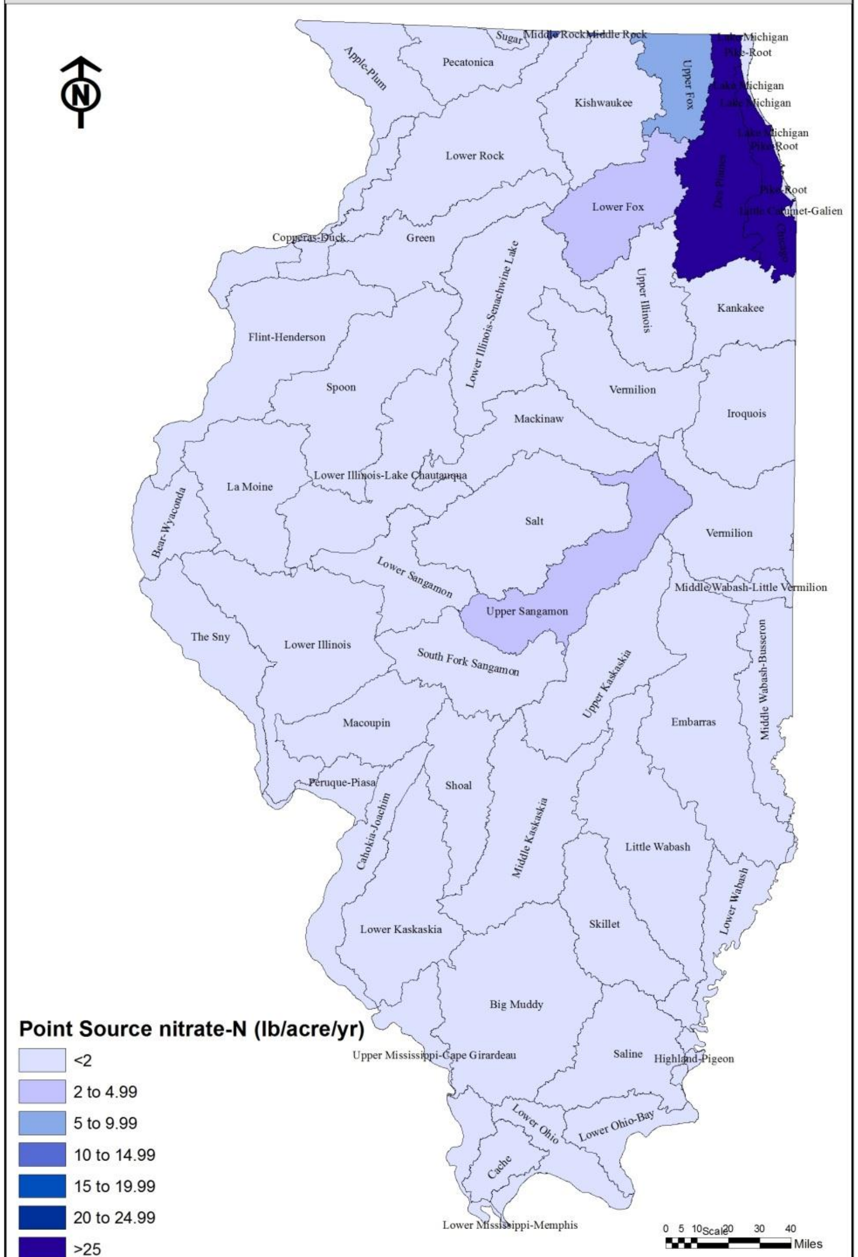

Impaired Streams in Illinois
N
ImpairedStreams
Non-Impaired Streams
0 5 10 20 30 40
Miles


Impaired Streams in Illinois
N
Stream Impairment
DO
P
N
DO & P
0 5 10 20 30 40
Miles

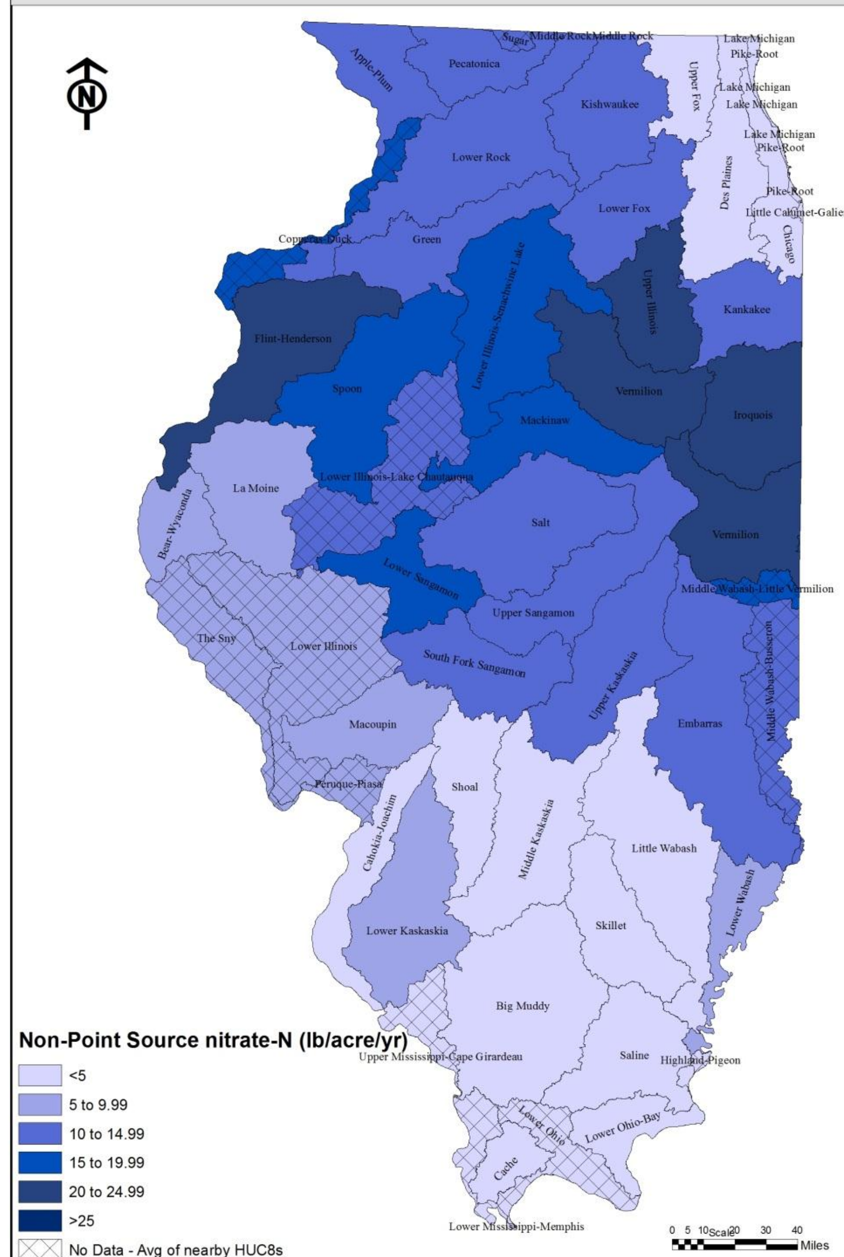
Relationship of 303d miles to N and P

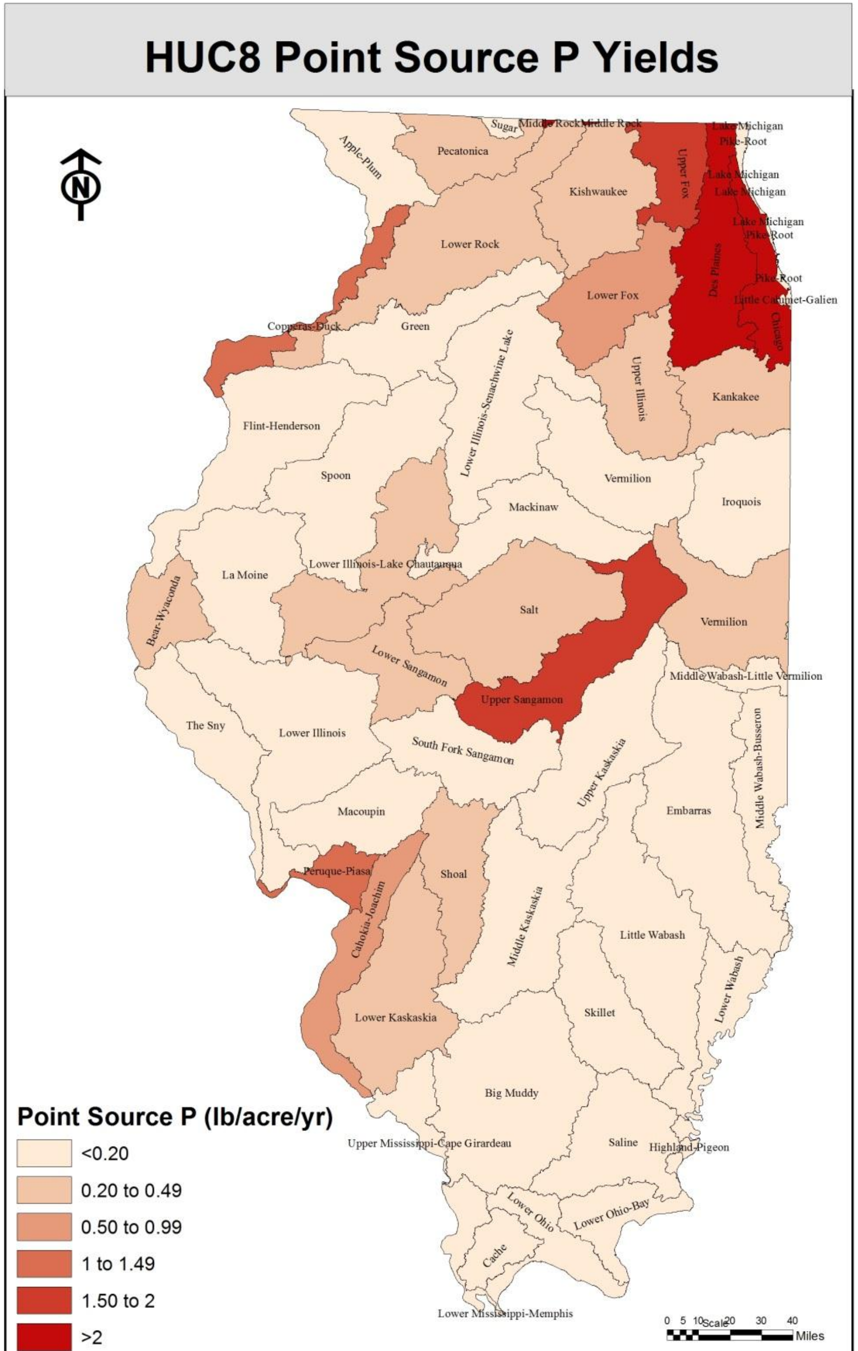
- weak overall
- Dissolved oxygen impairments may not be due to nutrients
- best correlation ($p=0.03$) of 303d miles with point source N
- next with point source P ($p=0.09$)
- non-point source N correlated, but negatively ($p=0.002$)

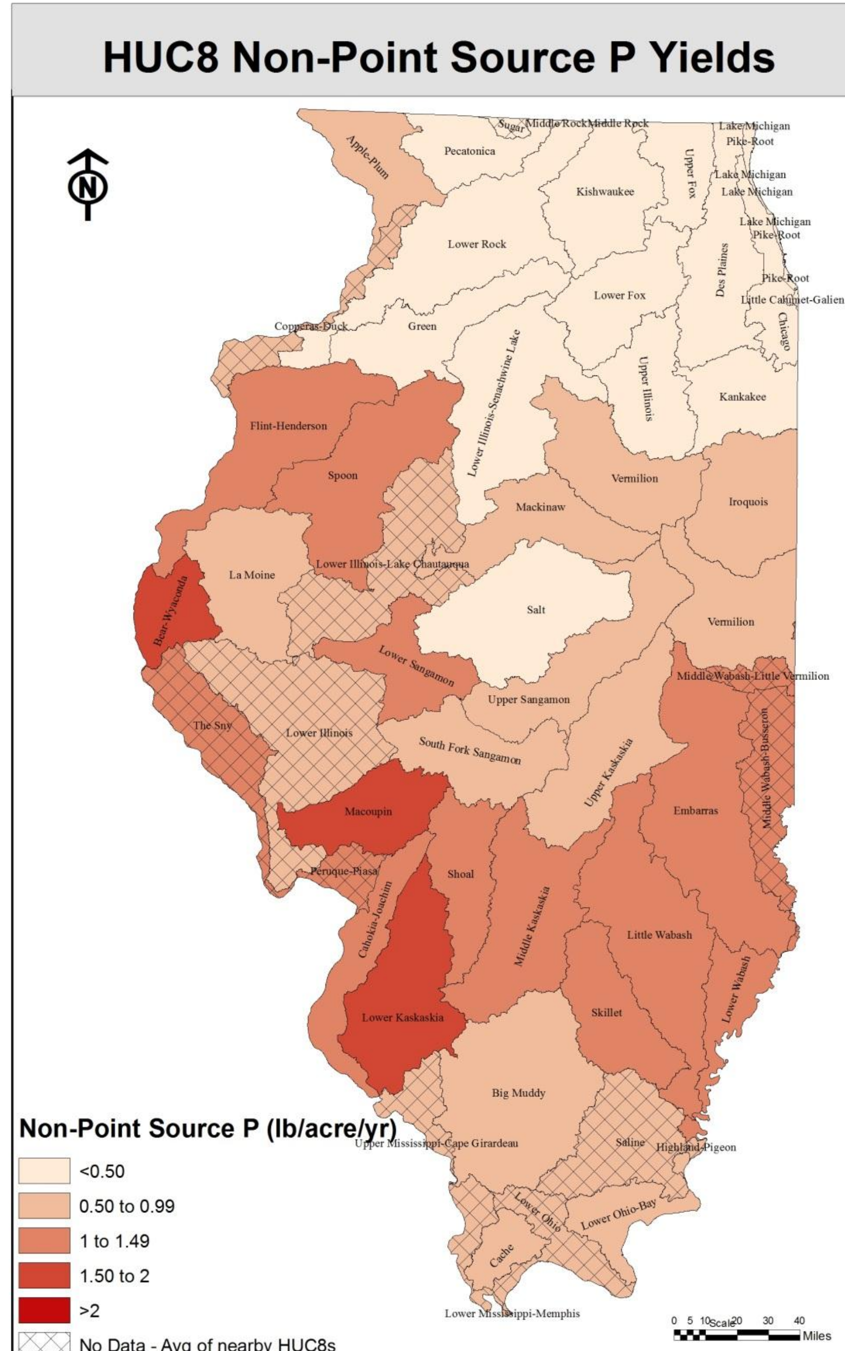
HUC8 Point Source nitrate-N Yields



HUC8 Non-Point Source nitrate-N Yields




HUC8 Point Source P Yields
N
Sugar
Middle Rock
Middle Rock
Lake Michigan
Pike-Root
Apple-Plum
Pecatonica
Upper Fox
Lake Michigan
Lake Michigan
Kishwaukee
Lake Michigan
Pike-Root
Lower Rock
Des Plaines
Pike-Root
Lower Fox
Little Calumet-Galien
Chicago
Copperas-Duck
Green
Lower Illinois-Senachwine Lake
Upper Illinois
Kankakee
Flint-Henderson
Spoon
Vermilion
Mackinaw
Iroquois
Lower Illinois-Lake Chautauqua
La Moine
Bear-Wyaconda
Salt
Vermilion
Lower Sangamon
Middle Wabash-Little Vermilion
Upper Sangamon
The Sny
Lower Illinois
South Fork Sangamon
Upper Kaskaskia
Middle Wabash-Busseron
Embarras
Macoupin
Peruque-Piasa
Shoal
Cahokia-Joachim
Middle Kaskaskia
Little Wabash
Skillet
Lower Wabash
Lower Kaskaskia
Big Muddy
Upper Mississippi-Cape Girardeau
Saline
Highland-Pigeon
Lower Ohio
Lower Ohio-Bay
Cache
Lower Mississippi-Memphis
Point Source P (lb/acre/yr)
<0.20
0.20 to 0.49
0.50 to 0.99
1 to 1.49
1.50 to 2
>2
0 5 10 Scale 20 30 40
Miles


HUC8 Non-Point Source P Yields
N
Sugar
Middle Rock
Middle Rock
Lake Michigan
Pike-Root
Apple-Plum
Pecatonica
Upper Fox
Lake Michigan
Lake Michigan
Kishwaukee
Lake Michigan
Pike-Root
Lower Rock
Des Plaines
Pike-Root
Lower Fox
Little Calumet-Galien
Chicago
Copperas-Duck
Green
Lower Illinois-Senachwine Lake
Upper Illinois
Kankakee
Flint-Henderson
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Lower Illinois-Lake Chautauqua
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Vermilion
Lower Sangamon
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Lower Illinois
South Fork Sangamon
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Middle Wabash-Busseron
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Peruque-Piasa
Shoal
Cahokia-Joachim
Middle Kaskaskia
Little Wabash
Skillet
Lower Wabash
Lower Kaskaskia
Big Muddy
Upper Mississippi-Cape Girardeau
Saline
Highland-Pigeon
Lower Ohio
Lower Ohio-Bay
Cache
Lower Mississippi-Memphis
Non-Point Source P (lb/acre/yr)
<0.50
0.50 to 0.99
1 to 1.49
1.50 to 2
>2
No Data - Avg of nearby HUC8s
0 5 10 Scale 20 30 40
Miles

3. Estimate Potential Reductions and Costs

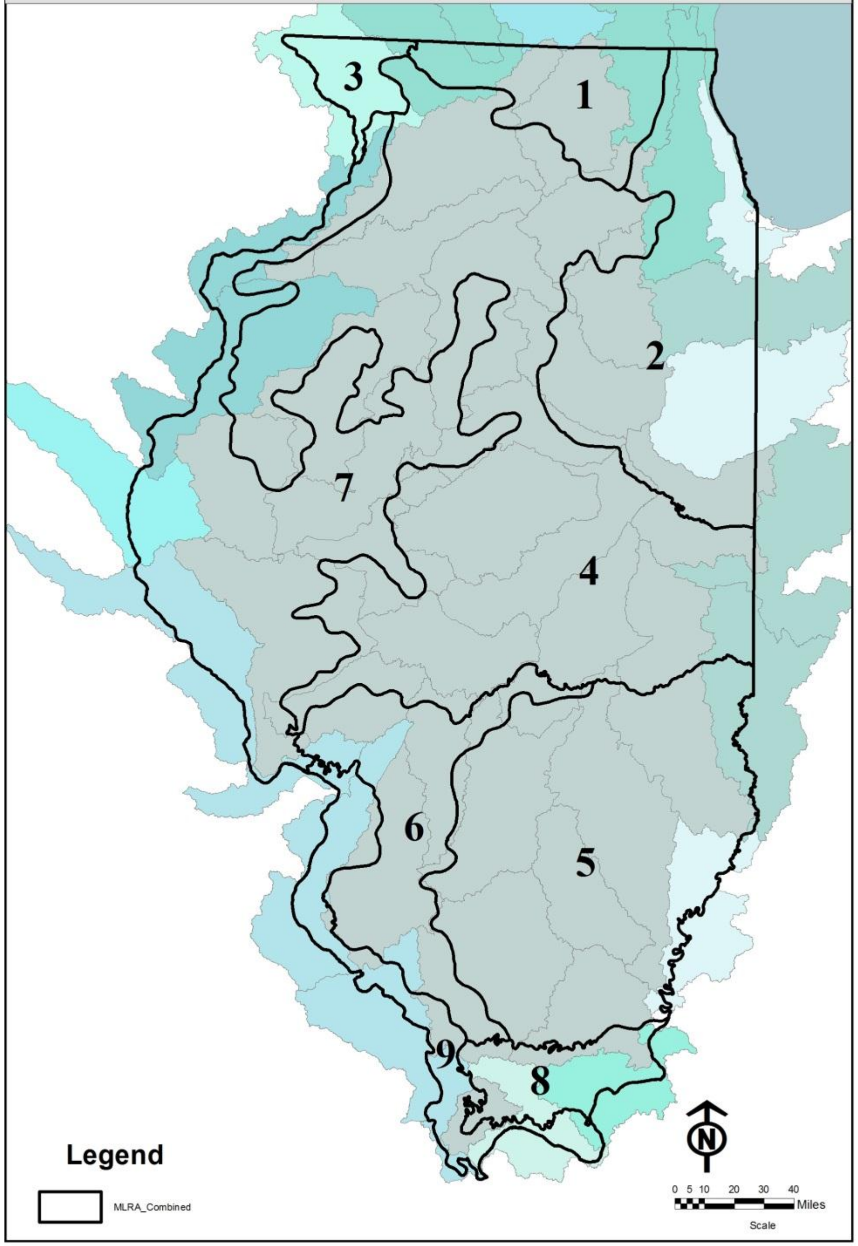
- estimate field-level effectiveness of various agricultural management practices
  - utilize SAB, Iowa, and Lake Bloomington Project estimates
  - knowledge in Illinois
- determine possible point source reductions
- estimate costs
  - Gary Schnitkey (agricultural economist) will lead
  - initial investments
  - likely to annualize costs over 25 years

Combined MLRA's

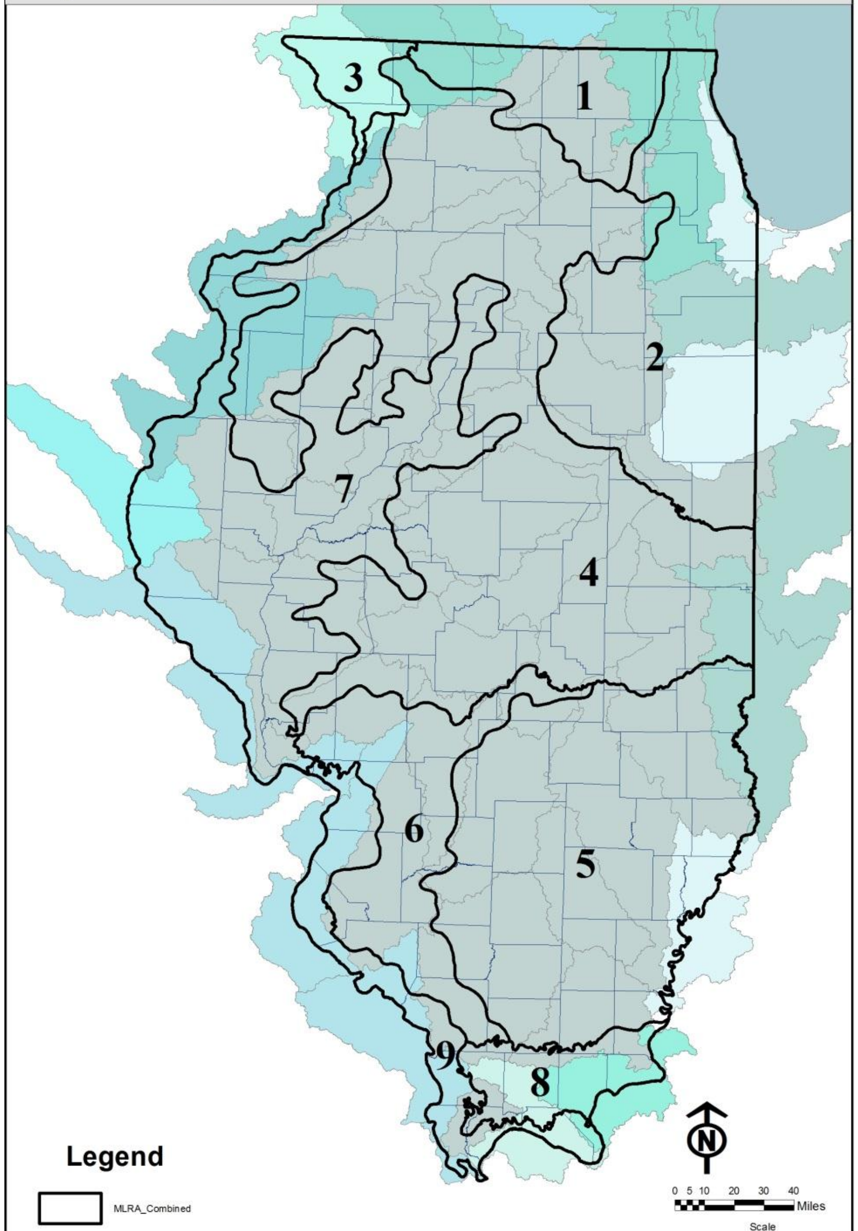
Major Land Resource Areas (MLRAs) in Illinois, showing combinations to be used for analysis (15 combined into 9). Bold MLRAs are the numbers that will be used throughout our analysis.

		Landscape		Climate		
MLRA	**Description**	**Elevation m (ft)**	**Local Relief m (ft)**	**Precipitation mm (inches)**	**Annual Temperature °C (°F)**	**Freeze Free Days**
95B	Southern Wisconsin and Northern Illinois Drift Plain	200 to 300 (660 to 980)	8 (25)	760 to 965 (30 to 38)	6 to 9 (43 to 48)	170
97	Southwestern Michigan Fruit and Truck Crop Belt	200 to 305 (600 to 1000)	2 to 5 (5 to 15)	890 to 1,015 (35 to 40)	8 to 11 (47 to 52)	200
98	Southern Michigan and Northern Indiana Drift Plain	175 to 335 (570 to 1,100)	15 (5)	735 to 1,015 (29 to 40)	7 to 10 (44 to 50)	175
110	Northern Illinois and Indiana Heavy Till Plain	200 (650)	3 to 8 (10 to 25)	785 to 1,015 (31 to 40)	7 to 11 (42 to 52)	185
105	Northern Mississippi Valley Loess Hills	200 to 400 (660 to 1,310)	3 to 6 (10 to 20)	760 to 965 (30 to 38)	6 to 10 (42 to 50)	175
108A	Illinois and Iowa Deep Loess and Drift, Eastern Part	200 to 300 (660 to 985)	1 to 3 (3 to 10)	890 to 1,090 (35 to 43)	8 to 12 (47 to 54)	195
108B	Illinois and Iowa Deep Loess and Drift, East-Central Part	200 to 300 (660 to 985)	1 to 3 (3 to 10)	840 to 990 (33 to 39)	8 to 12 (47 to 54)	185
113	Central Claypan Areas	200 (660)	1.5 to 3 (5 to 10)	915 to 1,170 (36 to 46)	11 to 14 (51 to 57)	205
115A	Central Mississippi Valley Wooded Slopes, Eastern Part	100 to 310 (320 to 1,020)	3 to 15 (10 to 50)	1,015 to 1,195 (40 to 47)	11 to 14 (53 to 57)	210
114B	Southern Illinois and Indiana Thin Loess and Till Plain, Western Part	105 to 365 (350 to 1,190)	3 to 15 (10 to 50)	940 to 1,170 (37 to 46)	11 to 14 (52 to 56	210
115C	Central Mississippi Valley Wooded Slopes, Northern Part	130 to 270 (420 to 885)	3 to 6 (10 to 20)	865 to 1,015 (34 to 40)	9 to 13 (48 to 55)	200
120A	Kentucky and Indiana Sandstone and Shale Hills and Valleys, Southern Part	105 to 290 (345 to 950)	Varies widely	1,145 to 1,370 (45 to 54)	13 to 14 (55 to 58)	210
115B	Central Mississippi Valley Wooded Slopes, Western Part	100 to 310 (320 to 1,020)	3 to 15 (10 to 50)	965 to 1,220 (38 to 48)	12 to 14 (53 to 57)	205
131A	Southern Mississippi River Alluvium	0 to 100 (0 to 330	Max 5 (15)	1,170 to 1,525 (46 to 60)	14 to 21 (56 to 69)	210 (North)
134	Southern Mississippi Valley Loess	25 to 185 (80 to 600)	3 to 6 (10 to 20)	1,195 to 1,525 (47 to 60)	14 to 20 (57 to 68)	215 (North)

Combined MLRAs for Illinois (Overlayed with HUC 8s & Counties)



Combined MLRAs for Illinois (Overlayed with HUC 8s & Counties)



Agricultural Management by MLRA

Combined MLRA	Description	Corn (acres)	Soybean (acres)	Wheat (acres)	Drained acres (% of crop acres)	Corn yield (bushels /acre)	Soybean yield (bushels /acre)
MLRA 1	Northern Illinois drift plain	515,905	224,186	20,192	288,491 (39)	161	48
MLRA 2	Northeastern Illinois heavy till plain	1,532,100	1,111,885	42,404	2,063,695 (78)	150	39
MLRA 3	Northern Mississippi Valley	163,507	52,432	1,975	20,942 (10)	160	50
MLRA 4	Deep loess and drift	5,579,980	3,343,444	76,078	5,437,807 (61)	164	52
MLRA 5	Claypan	1,609,633	1,991,939	352,839	310,087 (9)	128	39
MLRA 6	Thin loess and till	664,242	689,773	161,180	226,971 (17)	130	42
MLRA 7	Central Mississippi Valley, Northern Part	2,058,853	1,288,686	73,884	1,284,588 (38)	155	49
MLRA 8	Sandstone and shale hills and valleys	83,969	115,244	10,658	49,565 (25)	103	33
MLRA 9	Central Mississippi Valley, Western Part	203,736	314,662	78,250	23,769 (5)	125	39
Sum		12,411,925	9,132,251	817,460	9,705,916 (43)		

Average crop acres and yields 2008 through 2012

Agricultural N Management by MLRA

Combined MLRA	Description	Estimated corn fertilizer (lbs N/acre/yr)	Estimated corn fertilizer + manure (lbs N/acre/yr)	Row crops (acres)	Nitrate-N yield per row crop acre (lbs N/acre/yr)
MLRA 1	Northern Illinois drift plain	152	168	760,283	20.4
MLRA 2	Northeastern Illinois heavy till plain	158	164	2,686,389	25.0
MLRA 3	Northern Mississippi Valley	135	158	217,914	31.3
MLRA 4	Deep loess and drift	150	159	8,999,502	19.6
MLRA 5	Claypan	180	196	3,954,411	6.6
MLRA 6	Thin loess and till	156	170	1,515,195	7.4
MLRA 7	Central Mississippi Valley, Northern Part	155	169	3,421,423	24.5
MLRA 8	Sandstone and shale hills and valleys	209	219	209,871	3.9
MLRA 9	Central Mississippi Valley, Western Part	192	204	596,648	4.0
Sum		157	168	22,361,636	

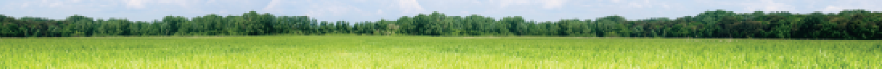
Corn Fertilizer N by MLRA

Combined MLRA	Description	Estimated CS fertilizer + manure (lbs/acre/yr)	MRTN (10 to 1) CS (lbs N/acre/yr)	Estimated CC fertilizer + manure (lbs/acre/yr)	MRTN (10 to 1) CC (lbs N/acre/yr)
MLRA 1	Northern Illinois drift plain	156	146	196	199
MLRA 2	Northeastern Illinois heavy till plain	151	155	190	197
MLRA 3	Northern Mississippi Valley	146	146	184	199
MLRA 4	Deep loess and drift	147	155	185	197
MLRA 5	Claypan	181	171	227	189
MLRA 6	Thin loess and till	157	171	198	189
MLRA 7	Central Mississippi Valley, Northern Part	156	163	197	194
MLRA 8	Sandstone and shale hills and valleys	202	171	254	189
MLRA 9	Central Mississippi Valley, Western Part	188	171	237	189

MRTN is Maximum Return to N

Nitrate Yield by MLRA

Combined MLRA	Description	Drained cropland (acres)	Nitrate-N yield per row crop acre (lbs N/acre/yr)	Nitrate-N yield per tile drained acre (lbs N/acre/yr)	Nitrate-N yield from non-tiled land (lbs N/acre/yr)
MLRA 1	Northern Illinois drift plain	288,491	20.4	43	6.6
MLRA 2	Northeastern Illinois heavy till plain	2,063,695	25.0	29	10.8
MLRA 3	Northern Mississippi Valley	20,942	31.3		31.3
MLRA 4	Deep loess and drift	5,437,807	19.6	26	9.9
MLRA 5	Claypan	310,087	6.6		6.6
MLRA 6	Thin loess and till	226,971	7.4	30	3.5
MLRA 7	Central Mississippi Valley, Northern Part	1,284,588	24.5	46	11.8
MLRA 8	Sandstone and shale hills and valleys	49,565	3.9		3.9
MLRA 9	Central Mississippi Valley, Western Part	23,769	4.0		4.0



Iowa Strategy to Reduce Nutrient Loss: Nitrogen Practices

This table lists practices with the largest potential impact on nitrate-N concentration reduction (except where noted). Corn yield impacts associated with each practice also are shown as some practices may be detrimental to corn production. If using a combination of practices, the reductions are not additive. Reductions are field level results that may be expected where practice is applicable and implemented.

	Practice	Comments	% Nitrate-N Reduction+	% Corn Yield Change++
			Average (SD*)	Average (SD*)
Nitrogen Management	Timing	Moving from fall to spring pre-plant application	6 (25)	4 (16)
		Spring pre-plant/sidedress 40-60 split Compared to fall-applied	5 (28)	10 (7)
		Sidedress – Compared to pre-plant application	7 (37)	0 (3)
		Sidedress – Soil test based compared to pre-plant	4 (20)	13 (22)**
	Source	Liquid swine manure compared to spring-applied fertilizer	4 (11)	0 (13)
		Poultry manure compared to spring-applied fertilizer	-3 (20)	-2 (14)
	Nitrogen Application Rate	Nitrogen rate at the MRTN (0.10 N:corn price ratio) compared to current estimated application rate. (ISU Corn Nitrogen Rate Calculator – http://extension.agron.iastate.edu/soilfertility/nrate.aspx can be used to estimate MRTN but this would change Nitrate-N concentration reduction)	10	-1
	Nitrification Inhibitor	Nitrapyrin in fall – Compared to fall-applied without Nitrapyrin	9 (19)	6 (22)
	Cover Crops	Rye	31 (29)	-6 (7)
		Oat	28 (2)	-5 (1)
	Living Mulches	e.g. Kura clover – Nitrate-N reduction from one site	41 (16)	-9 (32)
Land Use	Perennial	Energy Crops – Compared to spring-applied fertilizer	72 (23)	
		Land Retirement (CRP) – Compared to spring-applied fertilizer	85 (9)	
	Extended Rotations	At least 2 years of alfalfa in a 4 or 5 year rotation	42 (12)	7 (7)
	Grazed Pastures	No pertinent information from Iowa – assume similar to CRP	85	
Edge-of-Field	Drainage Water Mgmt.	No impact on concentration	33 (32)	
	Shallow Drainage	No impact on concentration	32 (15)	
	Wetlands	Targeted water quality	52	
	Bioreactors		43 (21)	
	Buffers	Only for water that interacts with the active zone below the buffer. This would only be a fraction of all water that makes it to a stream.	91 (20)	

+ A positive number is nitrate concentration or load reduction and a negative number is an increase.

++ A positive corn yield change is increased yield and a negative number is decreased yield. Practices are not expected to affect soybean yield.

* SD = standard deviation. Large SD relative to the average indicates highly variable results.

** This increase in crop yield should be viewed with caution as the sidedress treatment from one of the main studies had 95 lb-N/acre for the pre-plant treatment but 110 lb-N/acre to 200 lb-N/acre for the sidedress with soil test treatment so the corn yield impact may be due to nitrogen application rate differences.

Water Quality Improvement Case Study: Assessment of the Lake Bloomington Watershed

Final Report, March 10, 2008

Nitrogen reduction practices (tile drainage)

Practice	Expected reduction (%)
nitrification inhibitors	10
spring vs. fall fertilization	20
recommended rate vs. above[1]	
no-till vs. conventional	0
cover crops	25
water table management	40
shallow or wide tiles	25
conversion to CRP	95
conversion to perennial crops	80
constructed wetlands (20:1)	50
bioreactors	no data available

Example Statewide Results

Practice/Scenario	% reduction per acre	Nutrient reduced (million lbs)	Total Load (million lbs)	Nutrient Reduction % (from baseline)
Baseline				
Nitrogen or phosphorus management in field				
Edge-of-field				
Landscape change				
Point source management				

Example Statewide Results for N

	Practice/Scenario	% Nitrate-N reduction per acre	Nitrate-N reduced (million lbs N)	Total Load (million lbs N)	Nitrate-N Reduction % (from baseline)
	Baseline		188	410	
In-field	Reducing N rate from background to the MRTN (10% of acres)	10	4		1.0
	Nitrification inhibitor with all fall applied fertilizer	10	6		1.5
	Split (50%) fall and spring (50%) on tile-drained corn acres	7.5 to 10	10		2.5
	Fall to spring on tile-drained corn acres	15 to 20	21		5.0
	Cover crops on all corn/soybean tile-drained acres	30	84		20.5
	Cover crops on all corn/soybean non-tiled acres	30	32		7.9
Edge-of-field	Bioreactors on 50% of tile-drained land	40	56		13.6
	Wetlands on 25% of tile-drained land	40	35		8.5
	Buffers on all applicable crop land (reduction only for water that interacts with active area)	90			
Land use change	Perennial/energy crops equal to pasture/hay acreage from 1987	90	10		2.5
	Perennial/energy crops on 10% of tile-drained land	90	25		6.1
Point source	Point source reduction to 6 mg nitrate-N/L		35		8.5
	Point source reduction in N due to biological nutrient removal for P		8		1.8

Agricultural P Management by MLRA

Combined MLRA	Description	Estimated fertilizer (lbs P/acre/yr)	Estimated manure (lbs P/acre/yr)	Row crops (acres)	Total P yield per row crop acre (lbs P/acre/yr)
MLRA 1	Northern Illinois drift plain	14.9	3.9	760,283	0.71
MLRA 2	Northeastern Illinois heavy till plain	13.4	1.3	2,686,389	0.68
MLRA 3	Northern Mississippi Valley	13.4	5.4	217,914	1.72
MLRA 4	Deep loess and drift	13.6	2.3	8,999,502	0.96
MLRA 5	Claypan	11.7	2.4	3,954,411	1.74
MLRA 6	Thin loess and till	11.3	2.5	1,515,195	2.09
MLRA 7	Central Mississippi Valley, Northern Part	13.6	3.4	3,421,423	1.45
MLRA 8	Sandstone and shale hills and valleys	11.3	1.3	209,871	2.82
MLRA 9	Central Mississippi Valley, Western Part	11.0	1.6	596,648	2.82
Sum				22,361,636	

Iowa Strategy to Reduce Nutrient Loss: Phosphorus Practices

Practices below have the largest potential impact on phosphorus load reduction. Corn yield impacts associated with each practice also are shown, since some practices may increase or decrease corn production. If using a combination of practices, the reductions are not additive. Reductions are field level results that may be expected where practice is applicable and implemented.

	Practice	Comments	% P Load Reduction[a]	% Corn Yield Change[b]
			Average (SD[c])	Average (SD[c])
Phosphorus Management Practices	Phosphorus Application	Applying P based on crop removal – Assuming optimal STP level and P incorporation	0.6[d]	0
		Soil-Test P – No P applied until STP drops to optimum	17[e]	0
	Source of Phosphorus	Liquid swine, dairy, and poultry manure compared to commercial fertilizer – Runoff shortly after application	46 (45)	-1 (13)
		Beef manure compared to commercial fertilizer – Runoff shortly after application	46 (96)	
	Placement of Phosphorus	Broadcast incorporated within 1 week compared to no incorporation, same tillage	36 (27)	0
		With seed or knifed bands compared to surface application, no incorporation	24 (46)	0
	Cover Crops	Winter rye	29 (37	-6 (7)
	Tillage	Conservation till – chisel plowing compared to moldboard plowing	33 (49)	0 (6)
		No till compared to chisel plowing	90 (17)	-6 (8)
Land Use Change	Perennial Vegetation	Energy Crops		
		Land Retirement (CRP)		
		Grazed pastures		
Erosion Control and Edge-of-Field Practices	Terraces			
	Buffers			
	Control	Sedimentation basins or ponds		

[a] - A positive number is P load reduction and a negative number is increased P load.
[b] - A positive corn yield change is increased yield and a negative number is decreased yield. Practi
[c] - SD – standard deviation. Large SD relative to the average indicates highly variable results.
[d] - Maximum and average estimated by comparing application of 200 and 125 kg P_2O_5/ha, respective requirements) (Mallarino et al., 2002).
[e] - Maximum and average estimates based on reducing the average STP (Bray-1) of the two highes (Mallarino et al., 2011a), respectively, to an optimum level of 20 ppm (Mallarino et al., 2002). Minimu
[f] - P retention in wetlands is highly variable and dependent upon such factors as hydrologic loading

Iowa State University
Extension and Outreach

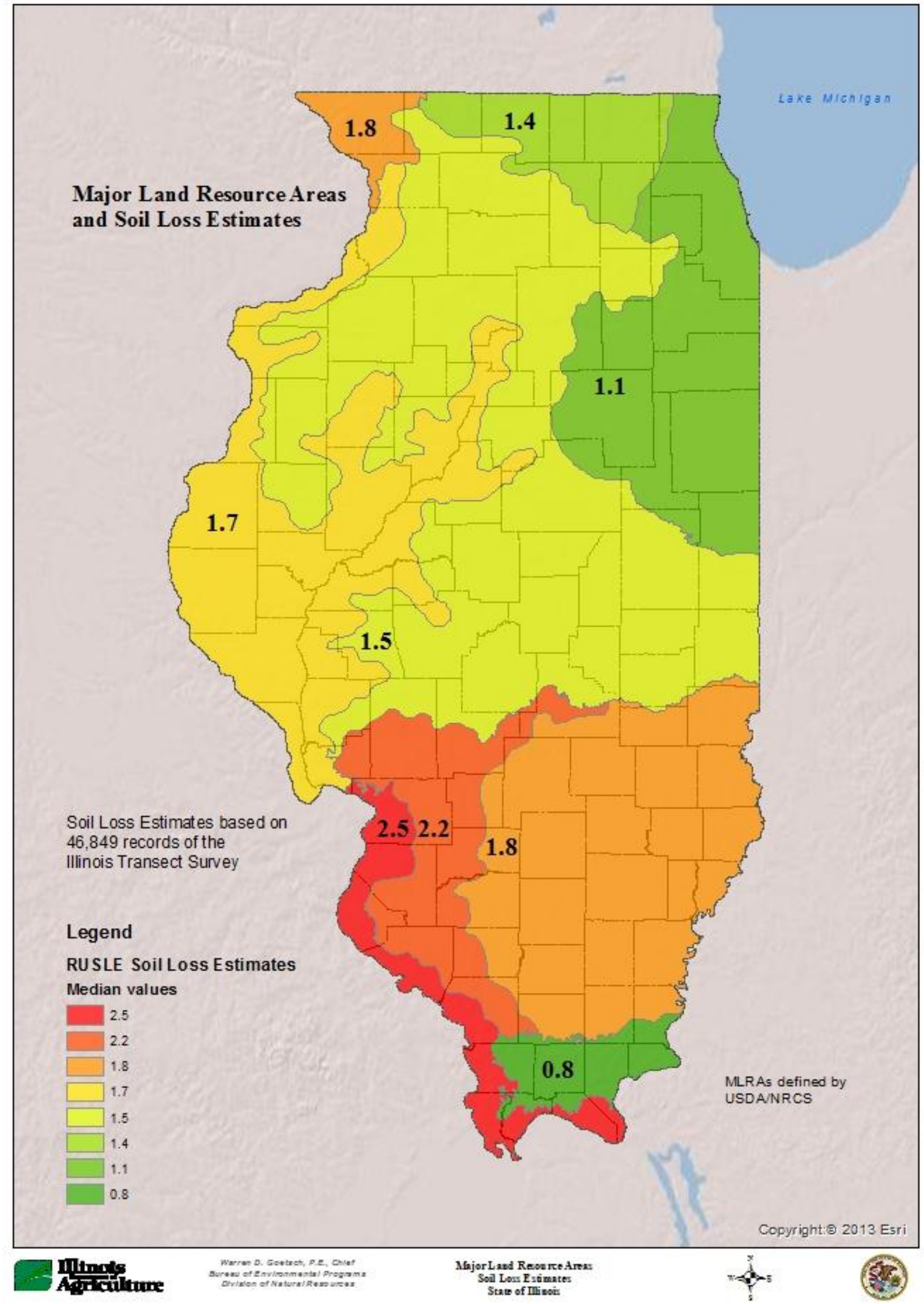
Water Quality Improvement Case Study: Assessment of the Lake Bloomington Watershed

Final Report, March 10, 2008

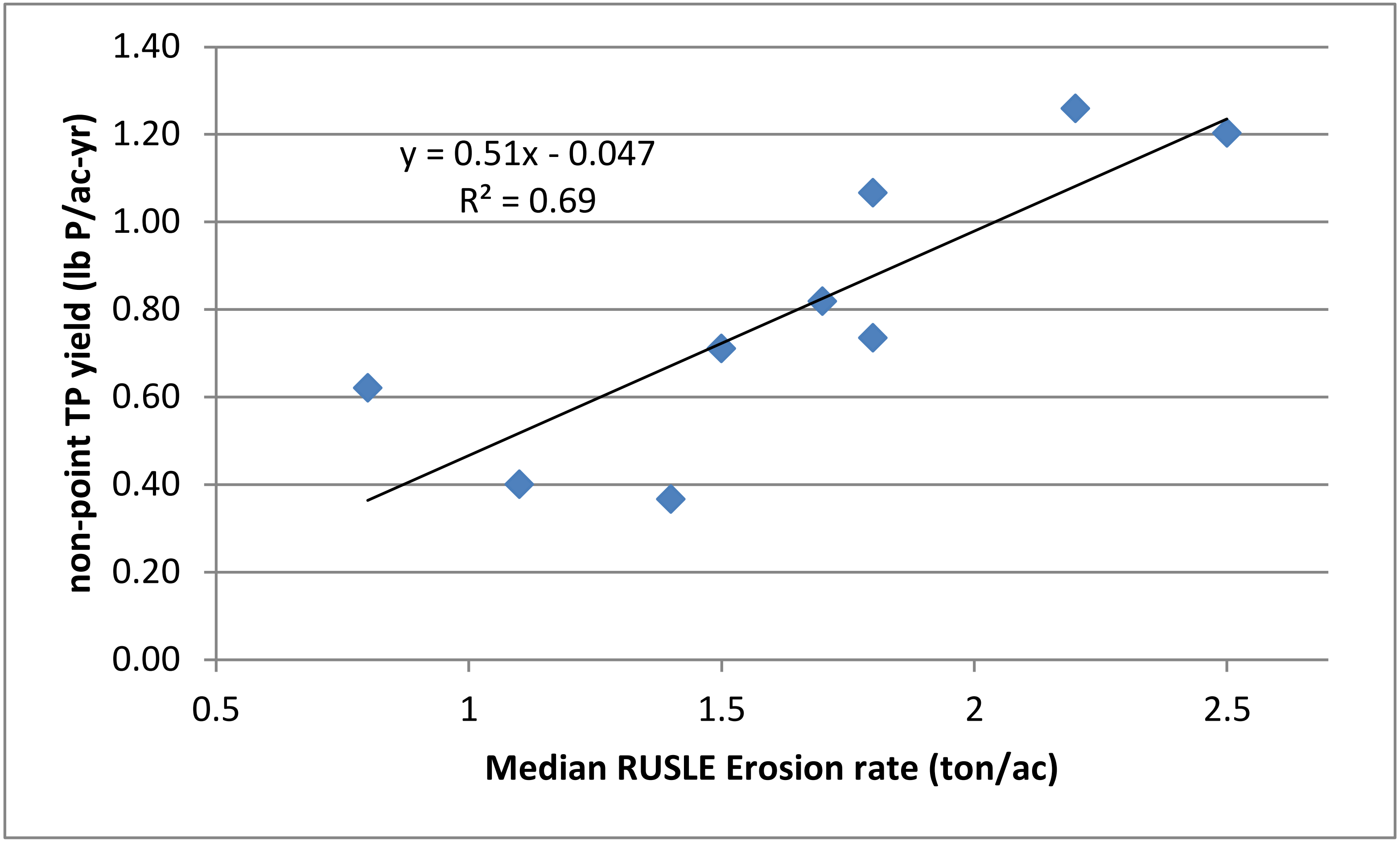
Phosphorus reduction practices

Practice	Expected reduction % Tile drainage	Surface runoff
recommended rate vs. above		5
subsurface vs. surface broadcast		20
cover crops	5	25
shallow or wide tiles	+	-
conversion to CRP	50	75
conversion to perennial crops	50	95
WASCOB installation		75
sedimentation basins		95[1]
riparian buffers		50[2]
constructed wetlands		20[3]

Illinois Dept. of Ag Transect Survey Median Soil Loss Estimates



Non-point TP yield from MLRAs as a function of median soil erosion estimates



Sediment TP Reduction by MLRA

MLRA	% fields > 5 ton/ac	Avg. RUSLE >5 ton/ac (ton/ac)	SDR	TP reduction (million lb/yr)
1	8.0	7.8	0.16	0.08
2	3.3	7.2	0.14	0.05
3	18.3	8.7	0.18	0.10
4	8.2	8.2	0.12	0.72
5	14.1	8.9	0.13	0.50
6	18.6	9.0	0.15	0.35
7	14.9	9.0	0.13	0.74
8	15.3	13.0	0.17	0.08
9	24.3	12.4	0.16	0.36
Total				2.99

Future estimates may be refined by using % of fields eroding>T based on IDOA data and alternative estimates of SDR (e.g., CEAP)

Example Statewide Results for P

	Practice/Scenario	% Total P reduction per acre	Total P reduced (million lbs P)	Total Load (million lbs P)	Total P Reduction % (from baseline)
	Baseline		18.8	37.5	
In-field	Erosion control to 5 tons per acre on all acres		3.0		8.0
In-field	P rate reduction on fields with soil test P above the recommended maintenance level	20			
In-field	Cover crops on all CS acres	30	5.7		15.2
In-field	Incorporation of all P fertilizers	25			
Edge-of-field	Wetlands on 25% of tile-drained land	0	0		0.0
Edge-of-field	Buffers on all applicable crop land	60	7.2		19.2
Land use change	Perennial/energy crops equal to pasture/hay acreage from 1987	90	1.0		2.7
Land use change	Perennial/energy crops on 10% of tile-drained land	50	0.3		0.8
Point source	Point source reduction to 1 mg total P/L limit (0.7 mg P/L actual)		10.6		28.3

4. Develop Scenarios

- provide a range of scenarios to meet reduction targets
  - area needed by practice
  - initial investment and annualized costs
  - point and non-point source reductions
- could have range of targets (20%, 30%, 45%)
- focus reduction practices on most critical watersheds (HUC8s)