Science Assessment Supporting the Illinois Nutrient Loss Reduction Strategy

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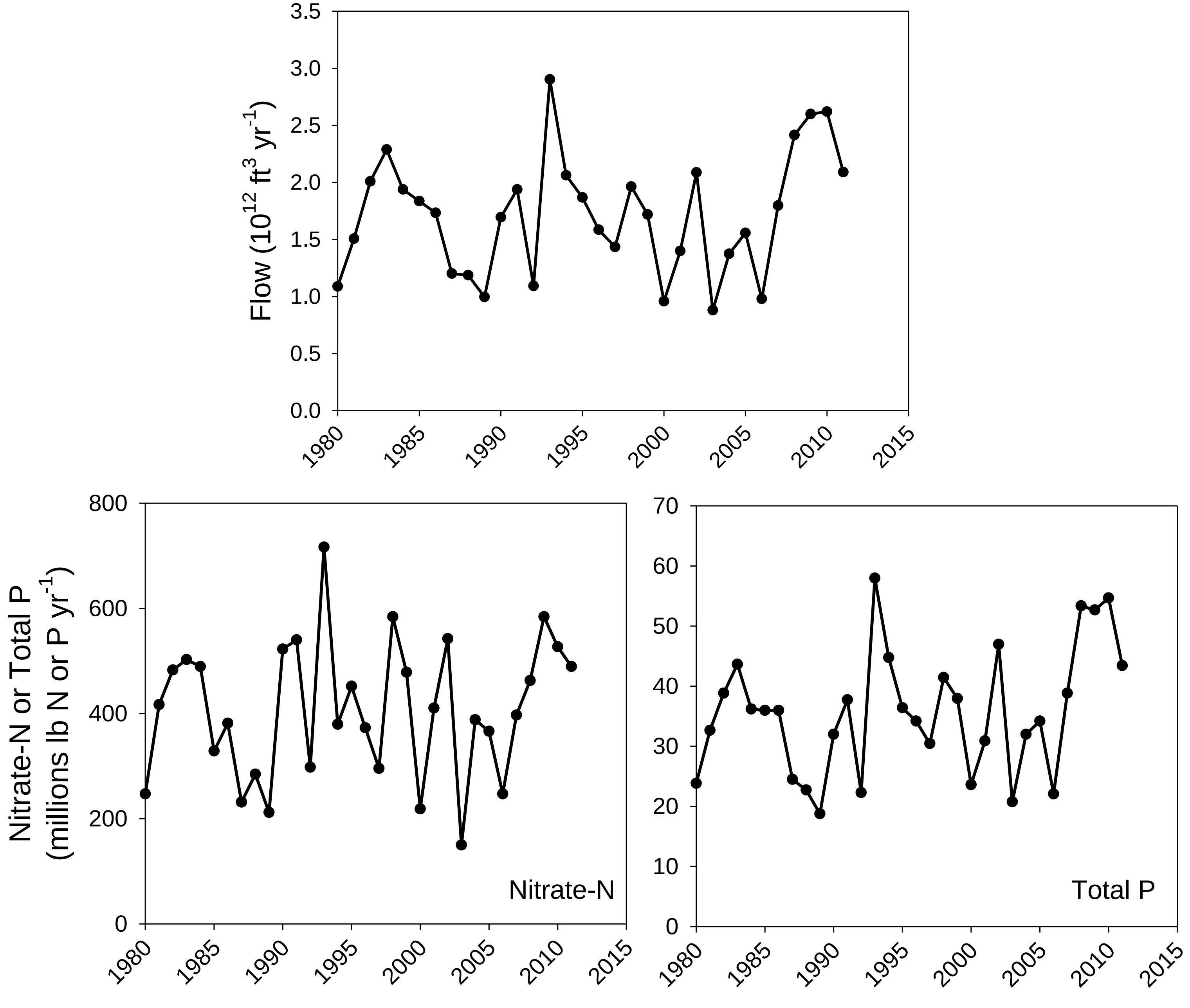
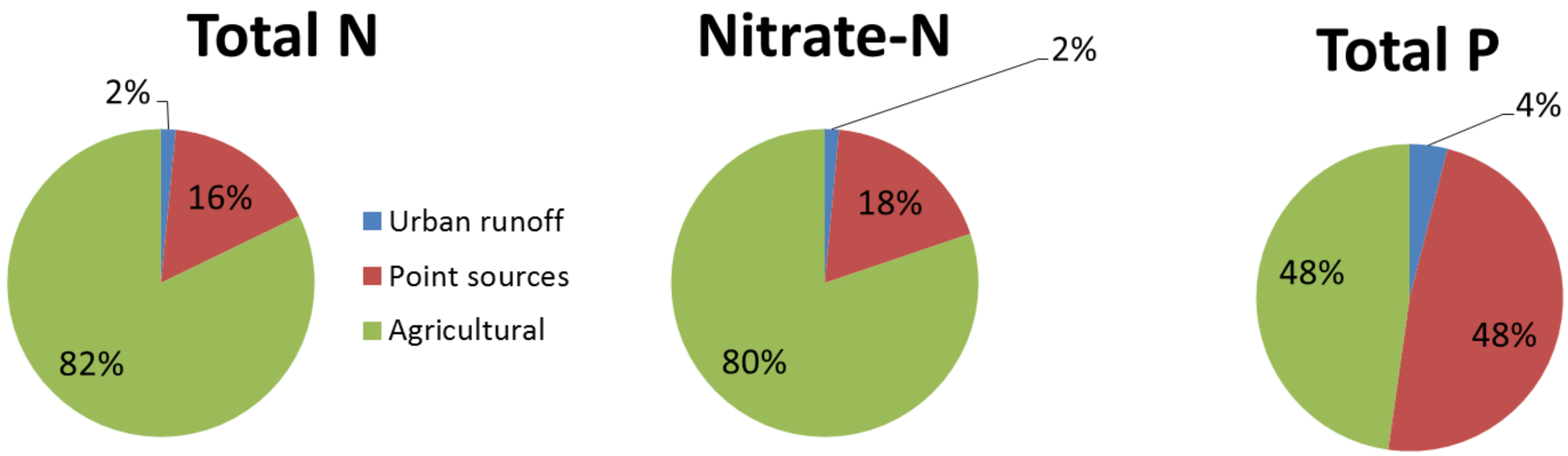
What we did

- science based technical assessment of:
  - current conditions in Illinois of nitrogen and phosphorus sources and export by rivers
  - methods that could be used to reduce these losses and their effectiveness
  - estimates of the costs to reduce nutrient losses to meet local and Gulf of Mexico goals

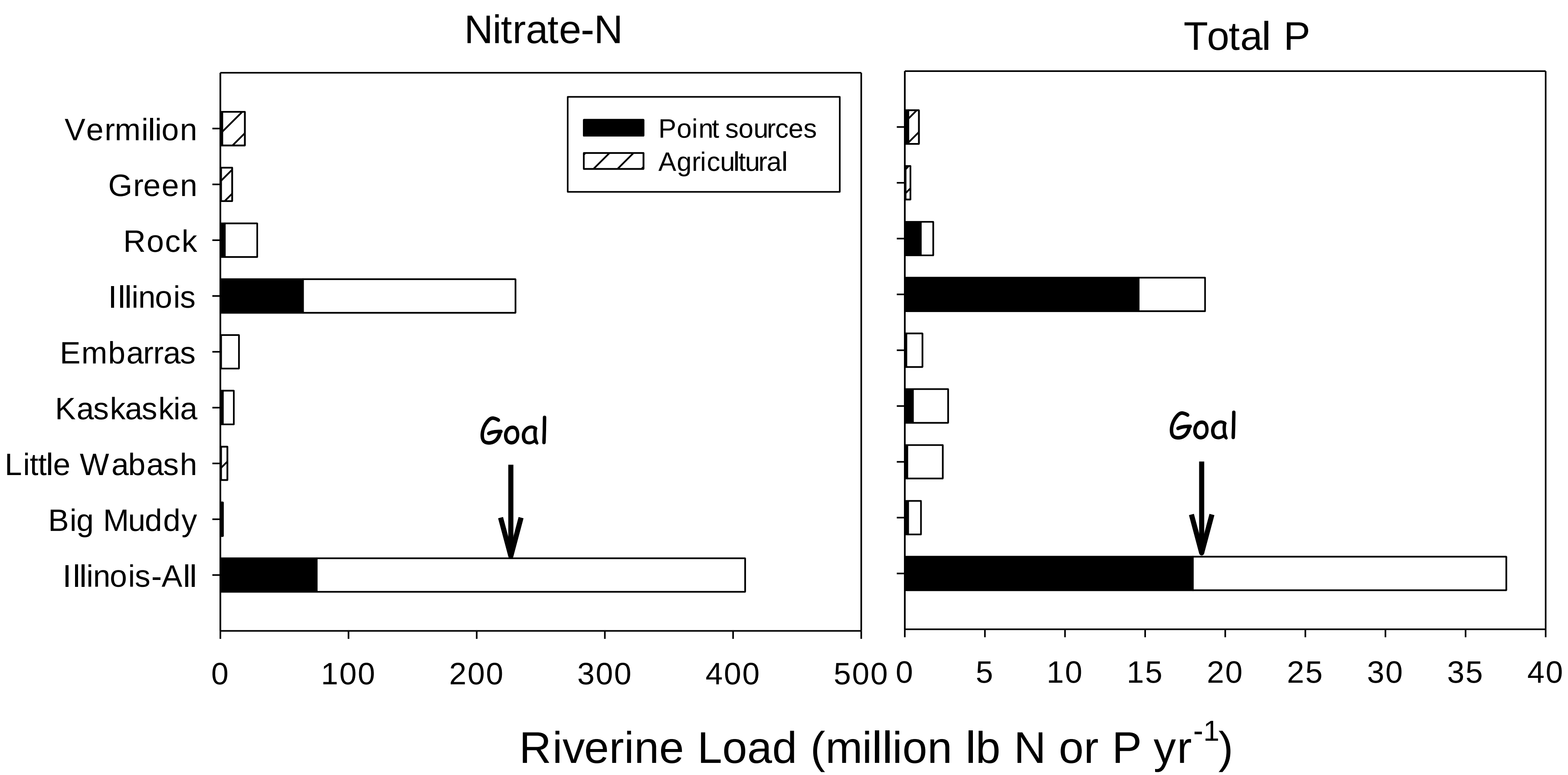
Water and nutrients leaving state are variable



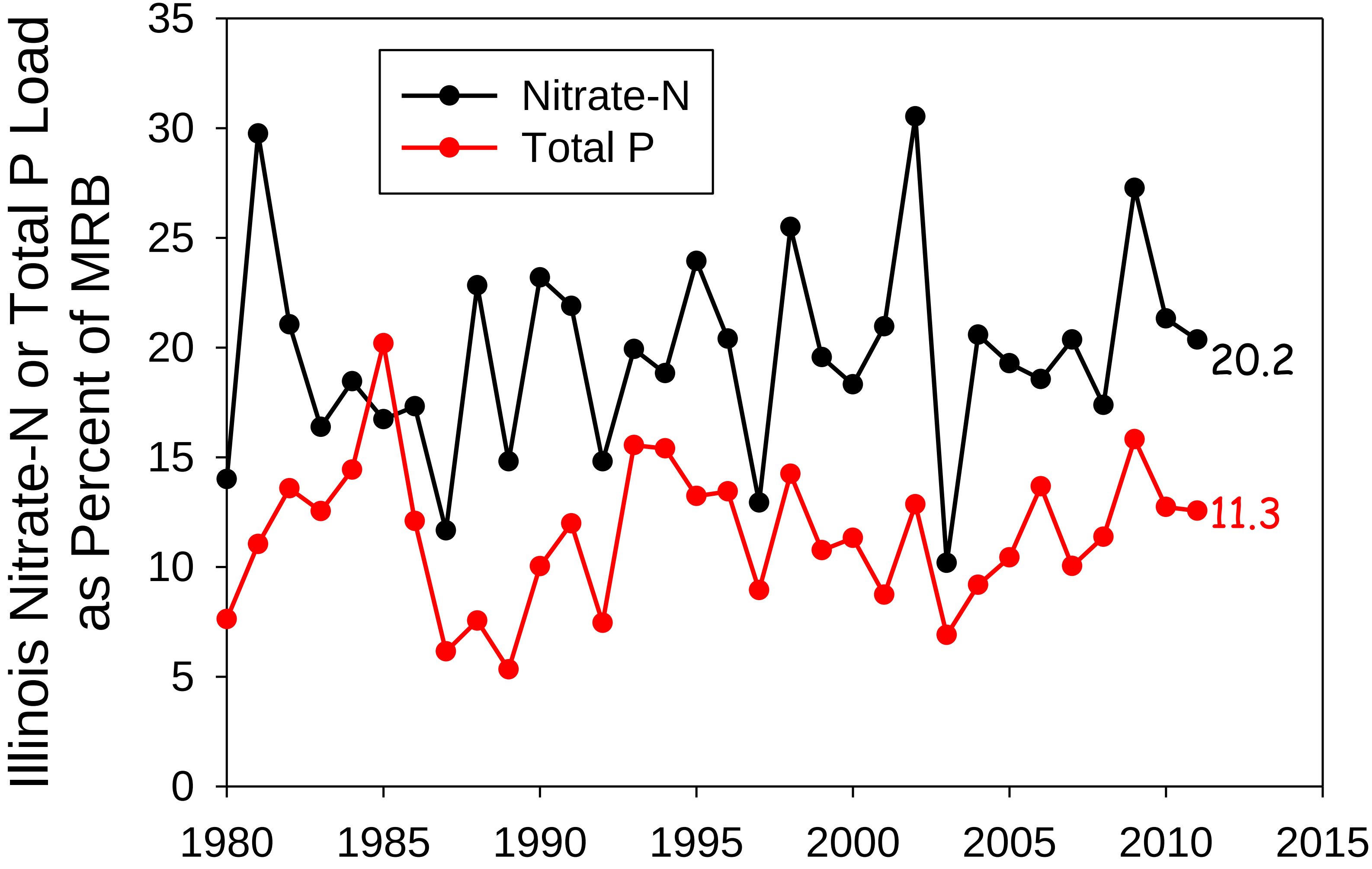
Illinois Nutrient Sources



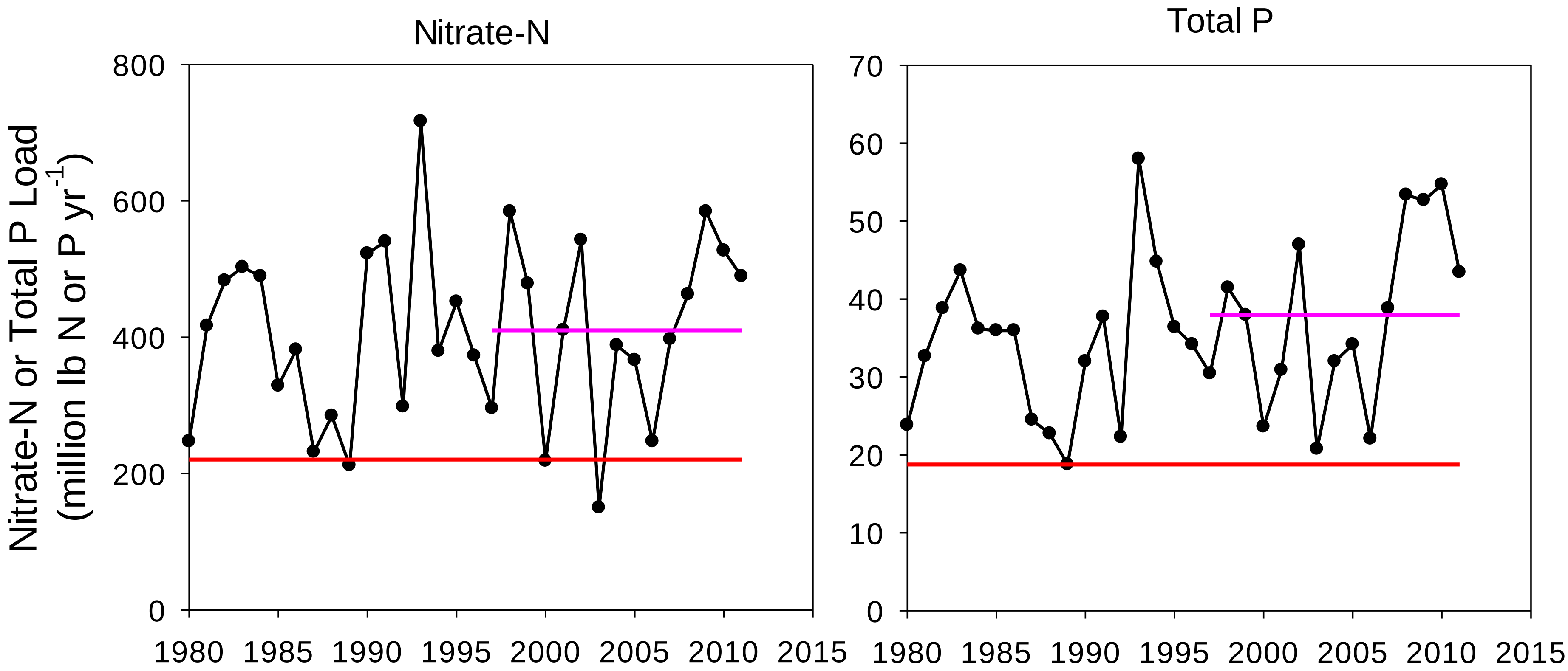
Point and agricultural sources



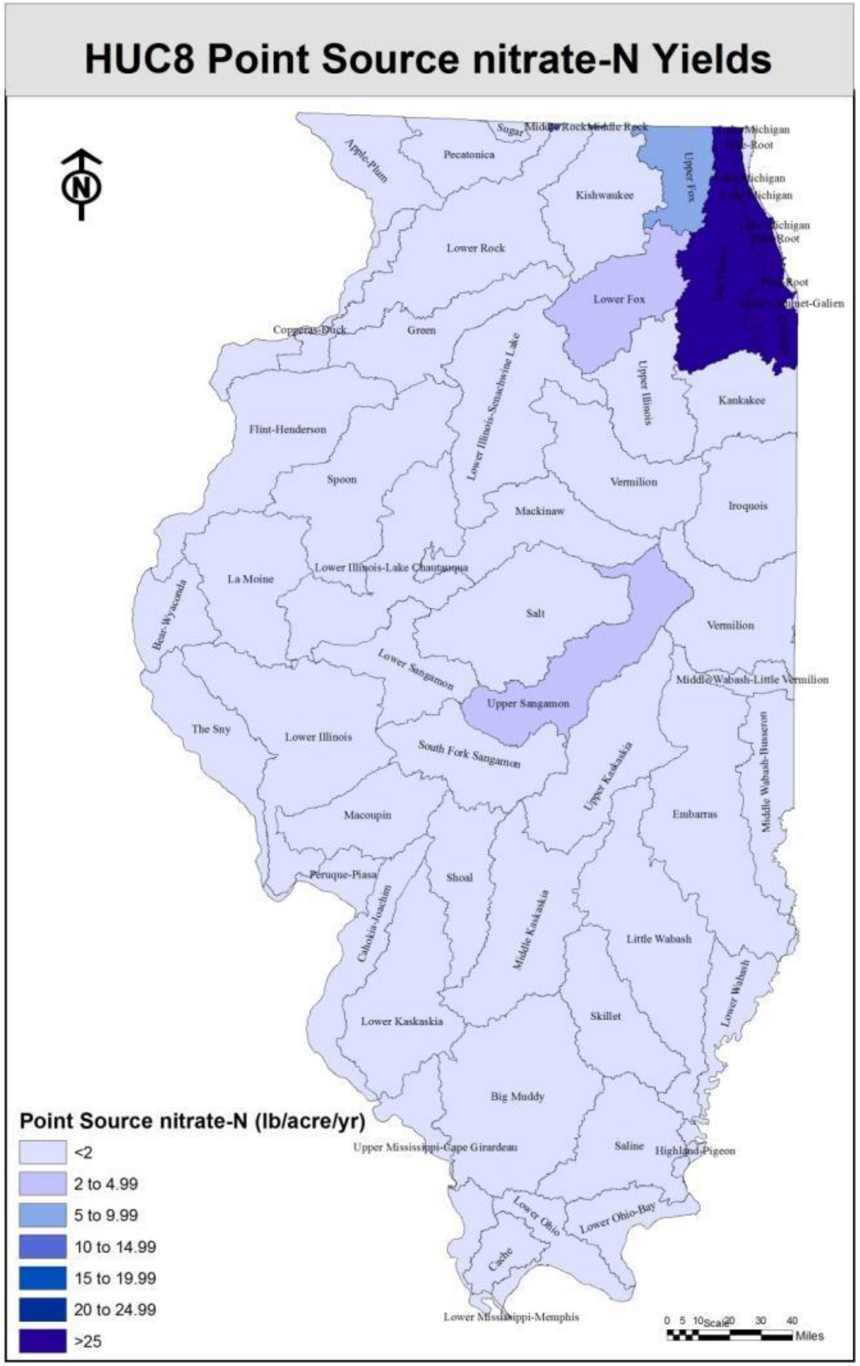
Illinois as % of MRB

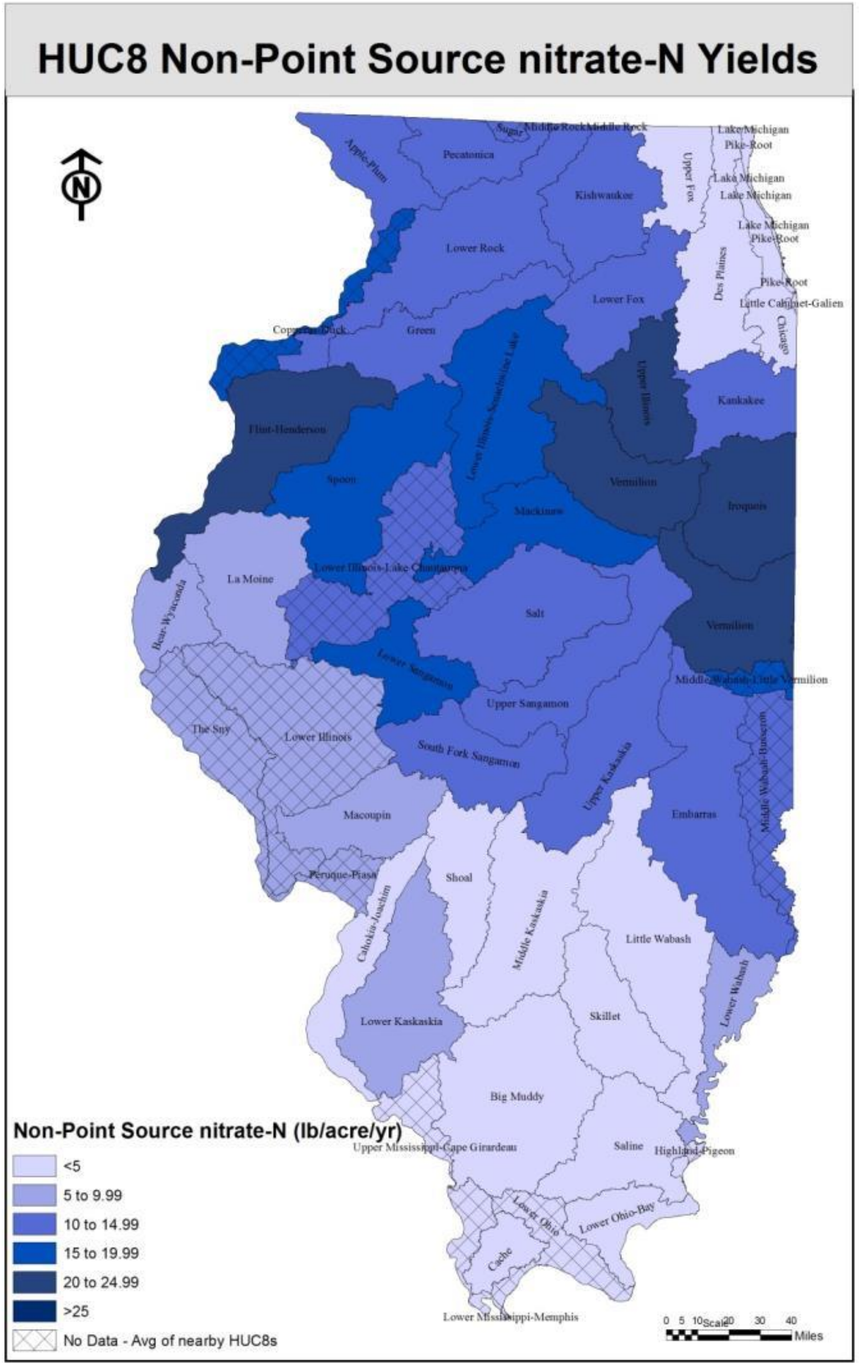


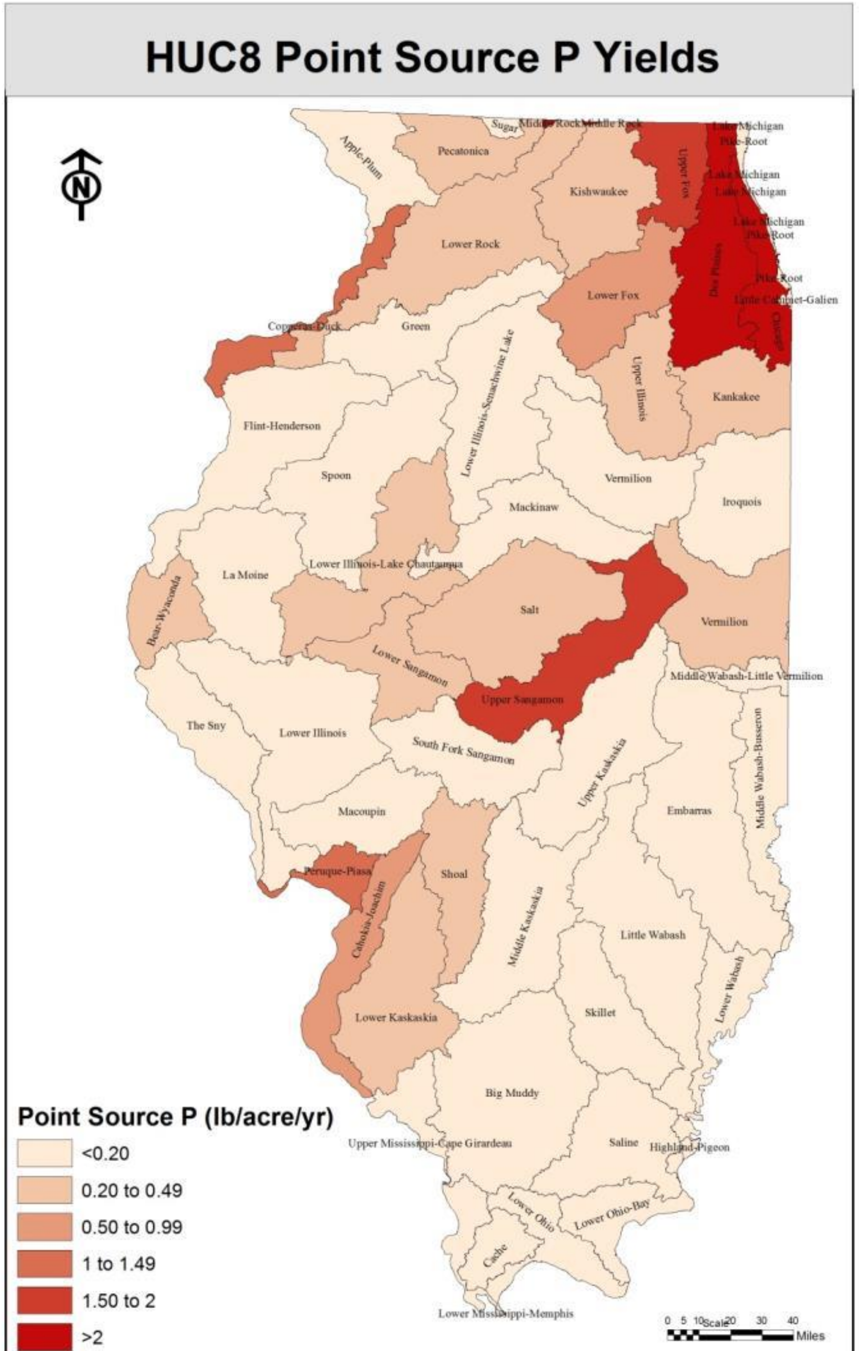
Targets call for large reductions

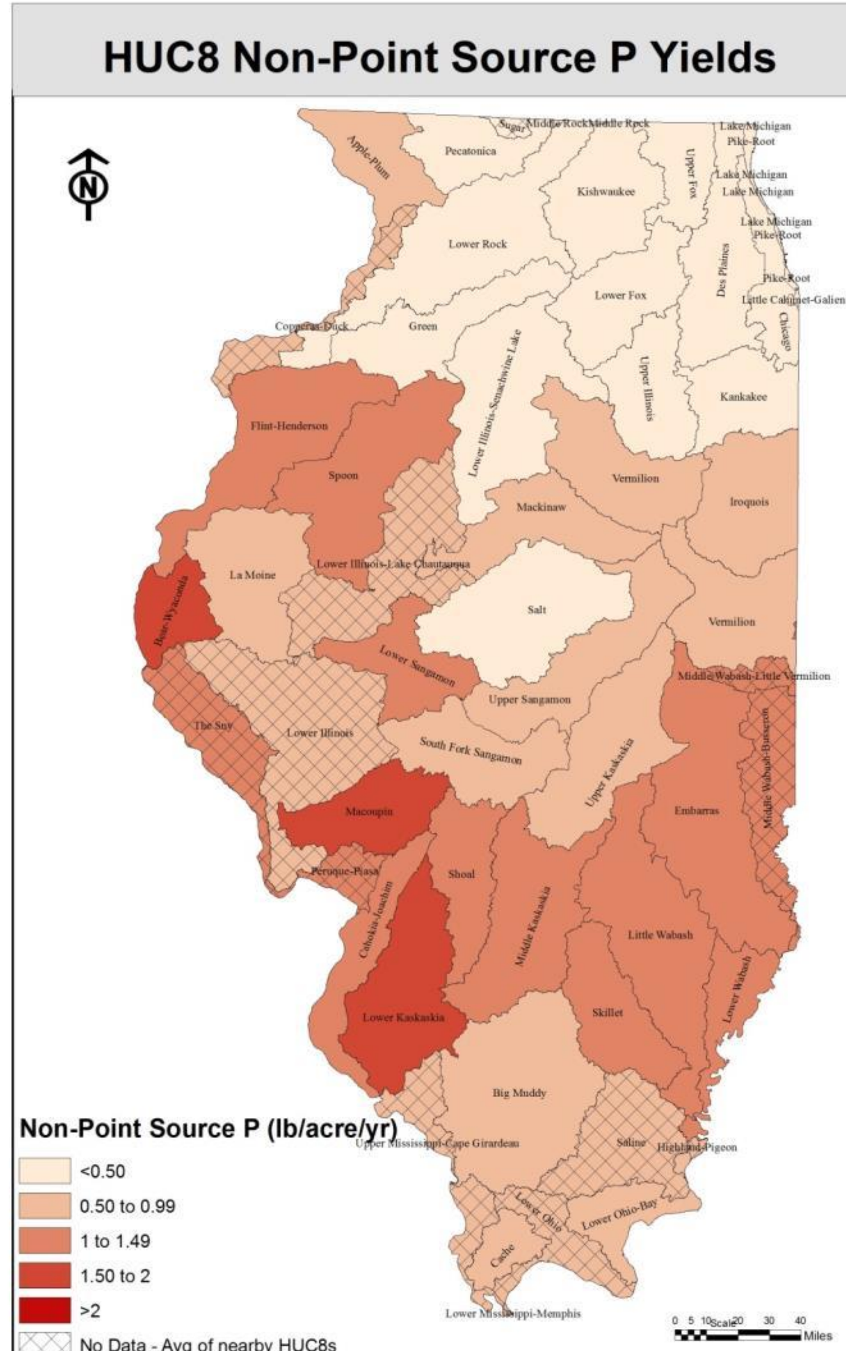


Red line is target, purple is average 1997 to 2011


HUC8 Point Source nitrate-N Yields
N
Pecatonica
Kishwaukee
Upper Fox
Lower Rock
Lower Fox
Green
Upper Illinois
Kankakee
Flint-Henderson
Spoon
Mackinaw
Vermilion
Iroquois
La Moine
Lower Illinois-Lake Chautauqua
Salt
Vermilion
Lower Sangamon
Middle Wabash-Little Vermilion
Upper Sangamon
The Sny
Lower Illinois
South Fork Sangamon
Upper Kaskaskia
Embarras
Macoupin
Shoal
Middle Kaskaskia
Little Wabash
Lower Kaskaskia
Skillet
Big Muddy
Upper Mississippi-Cape Girardeau
Saline
Highland-Pigeon
Lower Ohio
Lower Ohio-Bay
Cache
Lower Mississippi-Memphis
Point Source nitrate-N (lb/acre/yr)
<2
2 to 4.99
5 to 9.99
10 to 14.99
15 to 19.99
20 to 24.99
>25
0 5 10 20 30 40
Miles


HUC8 Non-Point Source nitrate-N Yields
N
Pecatonica
Kishwaukee
Upper Fox
Lower Rock
Lower Fox
Des Plaines
Green
Upper Illinois
Kankakee
Flint-Henderson
Spoon
Mackinaw
Vermilion
Iroquois
La Moine
Lower Illinois-Lake Chautauqua
Salt
Vermilion
Lower Sangamon
Middle Wabash-Little Vermilion
Upper Sangamon
The Sny
Lower Illinois
South Fork Sangamon
Upper Kaskaskia
Embarras
Macoupin
Shoal
Middle Kaskaskia
Little Wabash
Lower Kaskaskia
Skillet
Big Muddy
Upper Mississippi-Cape Girardeau
Saline
Highland-Pigeon
Lower Ohio
Lower Ohio-Bay
Cache
Lower Mississippi-Memphis
Non-Point Source nitrate-N (lb/acre/yr)
<5
5 to 9.99
10 to 14.99
15 to 19.99
20 to 24.99
>25
No Data - Avg of nearby HUC8s
0 5 10 20 30 40
Miles


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


HUC8 Non-Point Source P Yields
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
Apple-Plum
Pecatonica
Sugar
Middle Rock
Kishwaukee
Upper Fox
Lake Michigan
Pike-Root
Lower Rock
Lower Fox
Des Plaines
Little Calumet-Galien
Chicago
Copperas-Duck
Green
Upper Illinois
Kankakee
Lower Illinois-Senachwine Lake
Flint-Henderson
Spoon
Mackinaw
Vermilion
Iroquois
La Moine
Lower Illinois-Lake Chautauqua
Bear-Wyaconda
Salt
Lower Sangamon
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Lower Illinois
South Fork Sangamon
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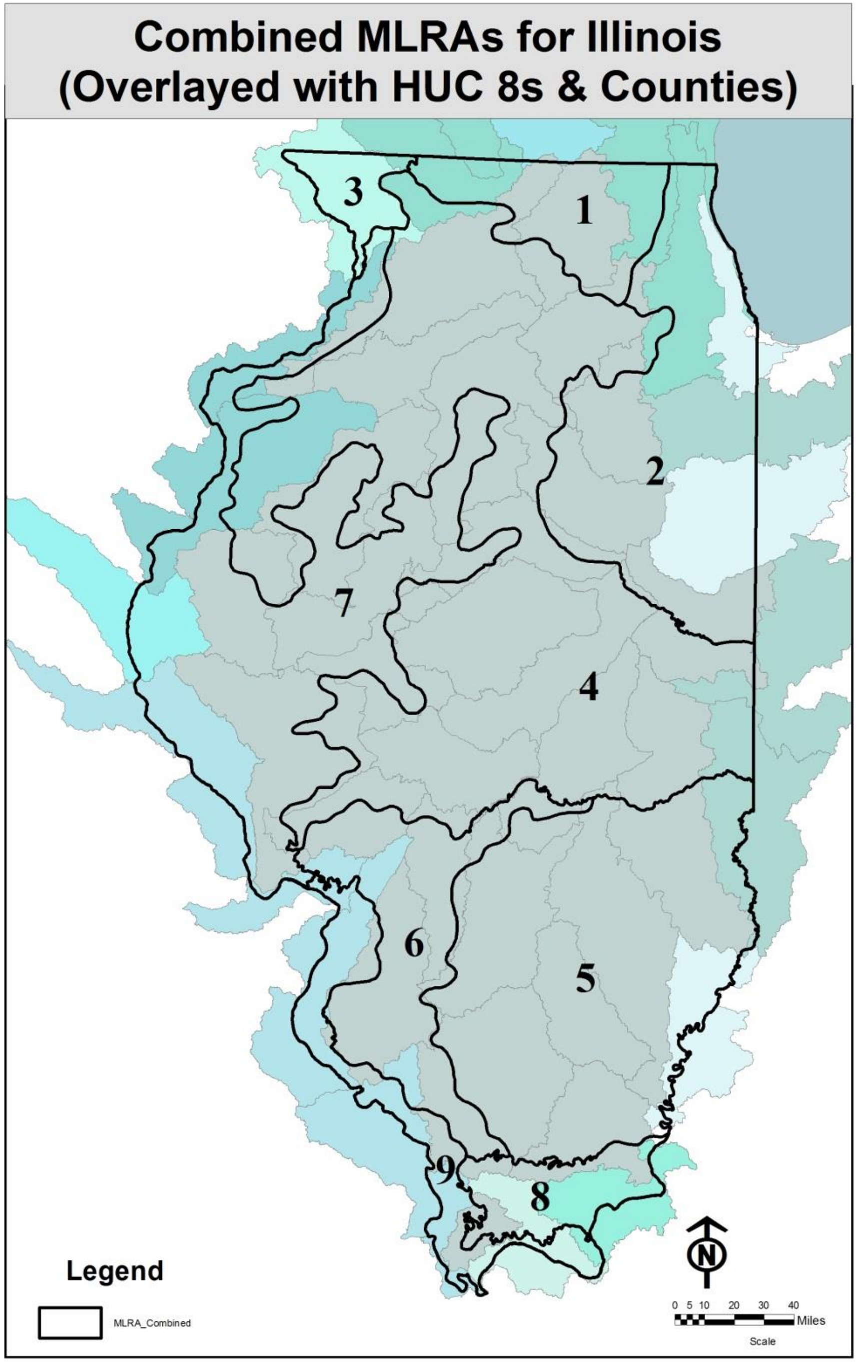
Peruque-Piasa
Shoal
Cahokia-Joachim
Middle Kaskaskia
Little Wabash
Lower Kaskaskia
Skillet
Lower Wabash
Big Muddy
Upper Mississippi-Cape Girardeau
Saline
Highland-Pigeon
Lower Ohio
Lower Ohio-Bay
Cache
Lower Mississippi-Memphis
0 5 10 Scale 20 30 40
Miles

Major Land Resource Areas (MLRAs) from NRCS

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)

Compiled agricultural data at various scales, combined using GIS to nine MLRAs



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	

Nitrate Yield by MLRA

Combined MLRA	Description	Drained cropland (acres)	Nitrate-N yield per row crop acre (lb N/acre/yr)	Nitrate-N yield per tile drained acre (lb N/acre/yr)	Nitrate-N yield from non-tiled land (lb 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

Nitrate Yield by MLRA

Combined MLRA	Description	Drained cropland (acres)	Nitrate-N yield per row crop acre (lb N/acre/yr)	Nitrate-N yield per tile drained acre (lb N/acre/yr)	Nitrate-N yield from non-tiled land (lb N/acre/yr)
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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

Agricultural Cost Estimates

- No changes in corn and soybean yields across scenarios
- No reduction in nitrogen application rates with timing changes
- Up front costs amortized over 20 years at 6% interest rate

Agricultural practices then applied by MLRA

Conservation practices

- nutrient-use efficiency (4Rs)
  - right source, rate, time, and place
- in-field management
  - cover crops, drainage water management, buffers strips, perennials
- off-site measures
  - bioreactors, wetlands, saturated lateral buffers, two stage ditches

Example Statewide Results for N

	Practice/Scenario	Nitrate-N reduction per acre (%)	Nitrate-N reduced (million lb N)	Nitrate-N Reduction % (from baseline)	Cost ($/lb N removed)
	Baseline		410		
In-field	Reducing N rate from background to the MRTN (10% of acres)	10	2.3	0.6	-4.25
	Nitrification inhibitor with all fall applied fertilizer on tile-drained corn acres	10	4.3	1.0	2.33
	Split (50%) fall and spring (50%) on tile-drained corn acres	7.5 to 10	13	3.1	6.22
	Fall to spring on tile-drained corn acres	15 to 20	26	6.4	3.17
	Cover crops on all corn/soybean tile-drained acres	30	84	20.5	3.21
	Cover crops on all corn/soybean non-tiled acres	30	33	7.9	11.02

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	Cover crops on all corn/soybean tile-drained acres	30	84	20.5	3.21
	Cover crops on all corn/soybean non-tiled acres	30	33	7.9	11.02
Edge-of-field	Bioreactors on 50% of tile-drained land	25	35	8.5	2.21
	Wetlands on 35% of tile-drained land	50	49	11.9	4.05
	Buffers on all applicable crop land (reduction only for water that interacts with active area)	90	36	8.7	1.63

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	Cover crops on all corn/soybean tile-drained acres	30	84	20.5	3.21
	Cover crops on all corn/soybean non-tiled acres	30	33	7.9	11.02
Edge-of-field	Bioreactors on 50% of tile-drained land	25	35	8.5	2.21
	Wetlands on 35% of tile-drained land	50	49	11.9	4.05
	Buffers on all applicable crop land (reduction only for water that interacts with active area)	90	36	8.7	1.63
Land use change	Perennial/energy crops equal to pasture/hay acreage from 1987	90	10	2.6	9.34
	Perennial/energy crops on 10% of tile-drained land	90	25	6.1	3.18

Example Statewide Results for N

	Practice/Scenario	Nitrate-N reduction per acre (%)	Nitrate-N reduced (million lb N)	Nitrate-N Reduction % (from baseline)	Cost ($/lb N removed)
	Baseline		410		
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	Split (50%) fall and spring (50%) on tile-drained corn acres	7.5 to 10	13	3.1	6.22
	Fall to spring on tile-drained corn acres	15 to 20	26	6.4	3.17
	Cover crops on all corn/soybean tile-drained acres	30	84	20.5	3.21
	Cover crops on all corn/soybean non-tiled acres	30	33	7.9	11.02
Edge-of-field	Bioreactors on 50% of tile-drained land	25	35	8.5	2.21
	Wetlands on 35% of tile-drained land	50	49	11.9	4.05
	Buffers on all applicable crop land (reduction only for water that interacts with active area)	90	36	8.7	1.63
Land use change	Perennial/energy crops equal to pasture/hay acreage from 1987	90	10	2.6	9.34
	Perennial/energy crops on 10% of tile-drained land	90	25	6.1	3.18
Point source	Point source reduction to 10 mg nitrate-N/L		14	3.4	3.30
	Point source reduction in N due to biological nutrient removal for P		8	1.8	

Example Statewide Results for P

	Practice/Scenario	Total P reduction per acre (%)	Total P reduced (million lb P)	Total P Reduction % (from baseline)	Cost ($/lb P removed)
	Baseline		37.5		
In-field	Convert 1.8 million acres of conventional till eroding >T to reduced, mulch or no-till	50	1.8	5.0	-16.60
In-field	P rate reduction on fields with soil test P above the recommended maintenance level	7	1.9	5.0	-48.75
In-field	Cover crops on all corn/soybean acres	30	4.8	12.8	130.40
In-field	Cover crops on 1.6 million acres eroding>T currently in reduced, mulch or no-till	50	1.9	5.0	24.50
Edge-of-field	Wetlands on 25% of tile-drained land	0	0	0.0	
Edge-of-field	Buffers on all applicable crop land	25-50	4.8	12.9	11.97
Land use change	Perennial/energy crops equal to pasture/hay acreage from 1987	90	0.9	2.5	102.30
Land use change	Perennial/energy crops on 1.6 million acres>T currently in reduced, mulch or no-till	90	3.5	9.0	40.40
Land use change	Perennial/energy crops on 10% of tile-drained land	50	0.3	0.8	250.07
Point source	Point source reduction to 1.0 mg total P/L (majors only)		8.3	22.1	13.71

USLE method

Example Statewide N & P Scenarios

Name	Combined Practices and/or Scenarios	Nitrate-N (% reduction)	Total P (% reduction)	Cost of Reduction ($/lb)	Annualized Costs (million $/year)
NP1	MRTN, fall to spring, bioreactors 50%, wetlands 35%, no P fert. on 12.5 million ac above STP maintenance, reduced till on 1.8 million ac conv. till eroding > T, buffers on all applicable lands, point source to 1.0 mg TP/L and 10 mg nitrate-N/L	35	45	**	438
NP2	MRTN, fall to spring, bioreactors 50%, wetlands 10%, no P fert. on 12.5 million ac above STP maintenance, reduced till on 1.8 million ac conv. till eroding > T, cover crops on all CS, point source to 1.0 mg TP/L and 10 mg nitrate-N/L	45	45	**	878
NP3	MRTN, fall to spring, bioreactors 30%, no P fert. on 12.5 million ac above STP maintenance, reduced till on 1.8 million ac conv. till eroding > T, cover crops on 87.5% of CS, buffers on all applicable lands, perennial crops on 1.6 million ac >T, and 0.9 million additional ac.	45	45	**	827

Example Statewide N & P Scenarios

Name	Combined Practices and/or Scenarios	Nitrate-N (% reduction)	Total P (% reduction)	Cost of Reduction ($/lb)	Annualized Costs (million $/year)
NP1	MRTN, fall to spring, bioreactors 50%, wetlands 35%, no P fert. on 12.5 million ac above STP maintenance, reduced till on 1.8 million ac conv. till eroding > T, buffers on all applicable lands, point source to 1.0 mg TP/L and 10 mg nitrate-N/L	35	45	**	438
NP2	MRTN, fall to spring, bioreactors 50%, wetlands 10%, no P fert. on 12.5 million ac above STP maintenance, reduced till on 1.8 million ac conv. till eroding > T, cover crops on all CS, point source to 1.0 mg TP/L and 10 mg nitrate-N/L	45	45	**	878
NP3	MRTN, fall to spring, bioreactors 30%, no P fert. on 12.5 million ac above STP maintenance, reduced till on 1.8 million ac conv. till eroding > T, cover crops on 87.5% of CS, buffers on all applicable lands, perennial crops on 1.6 million ac >T, and 0.9 million additional ac.	45	45	**	827
NP4	MRTN, fall to spring N, bioreactors 53%, no P fert. on 12.5 million ac above STP maintenance, reduced till on 1.8 million ac conv. till eroding > T, buffers on 80% of all applicable land	20	20	**	76
NP5	MRTN, fall to spring N, bioreactors 45%, wetlands 15%, no P fert. on 12.5 million ac above STP maintenance, reduced till on 1.8 million ac conv. till eroding > T, point source to 1.0 mg TP/L and 10 mg nitrate-N/L on 45% of discharge	20	20	**	173
NP6	MRTN, fall to spring N, no P fert. on 12.5 million ac above STP maintenance, reduced till on 1.8 million ac conv. till eroding > T, cover crops on 1.6 million ac eroding >T and 40% of all other CS	24	20	**	244

Practice list

- what we included:
  - fertilizer amounts, timing, placement
  - reduced tillage
  - cover crops
  - bioreactors
  - wetlands
  - riparian buffers
  - perennials
- also consider:
  - drainage water management
  - sidedressing fertilizer

no one practice works for every acre, but every acre needs at least one new practice

Thank you

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