Illinois Nutrient Loss Reduction Strategy

Nutrient Monitoring Council

5th Meeting, July 28, 2016, Urbana, IL

ILLINOIS NUTRIENT LOSS REDUCTION STRATEGY | Improving our water resources with collaboration and innovation

Nutrient Monitoring Council Members (7/28/16)

Illinois EPA
Gregg Good, Rick Cobb

Illinois State Water Survey
Laura Keefer

Aqua Illinois
Kevin Culver

Illinois Natural History Survey
Andrew Casper

Illinois Dept. of Natural Resources
Ann Holtrop

University of Illinois
Paul Davidson

Sierra Club
Cindy Skrukrud

MWRDGC
Justin Vick

Illinois Corn Growers Association
Laura Gentry

U.S. Army Corp of Engineers-Rock Island
~~Marvin Hubbell~~ Chuck Theiling

U.S. Geological Survey
Kelly Warner

National Center for Supercomputing Apps
Jong Lee

Today's Guests???

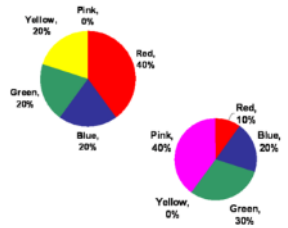
NMC Charges (Revised 10/26/15)

1. Coordinate the development and implementation of monitoring activities (e.g., collection, analysis, assessment) that provide the information necessary to:

   a. Generate estimations of 5-year running average loads of Nitrate-Nitrogen and Total Phosphorus *leaving the state of Illinois* compared to 1980-1996 baseline conditions; and
   b. Generate estimations of Nitrate-Nitrogen and Total Phosphorus loads *leaving selected NLRS identified priority watersheds* compared to 1997-2011 baseline conditions; and
   c. Identify Statewide and NLRS priority watershed *trends in loading over time* using NMC developed evaluation criteria.

2. Document *local water quality outcomes* in selected NLRS identified priority watersheds, or smaller watersheds nested within, where future nutrient reduction efforts are being implemented (e.g., increase in fish or aquatic invertebrate population counts or diversity, fewer documented water quality standards violations, fewer algal blooms or offensive conditions, decline in nutrient concentrations in groundwater).

3. Develop a *prioritized list of nutrient monitoring activities and associated funding* needed to accomplish the charges/goals in (1) and (2) above.



USGS Super Gage Operational Update and Web Display of Nutrient Information

Nutrient Monitoring Council

July 28, 2016

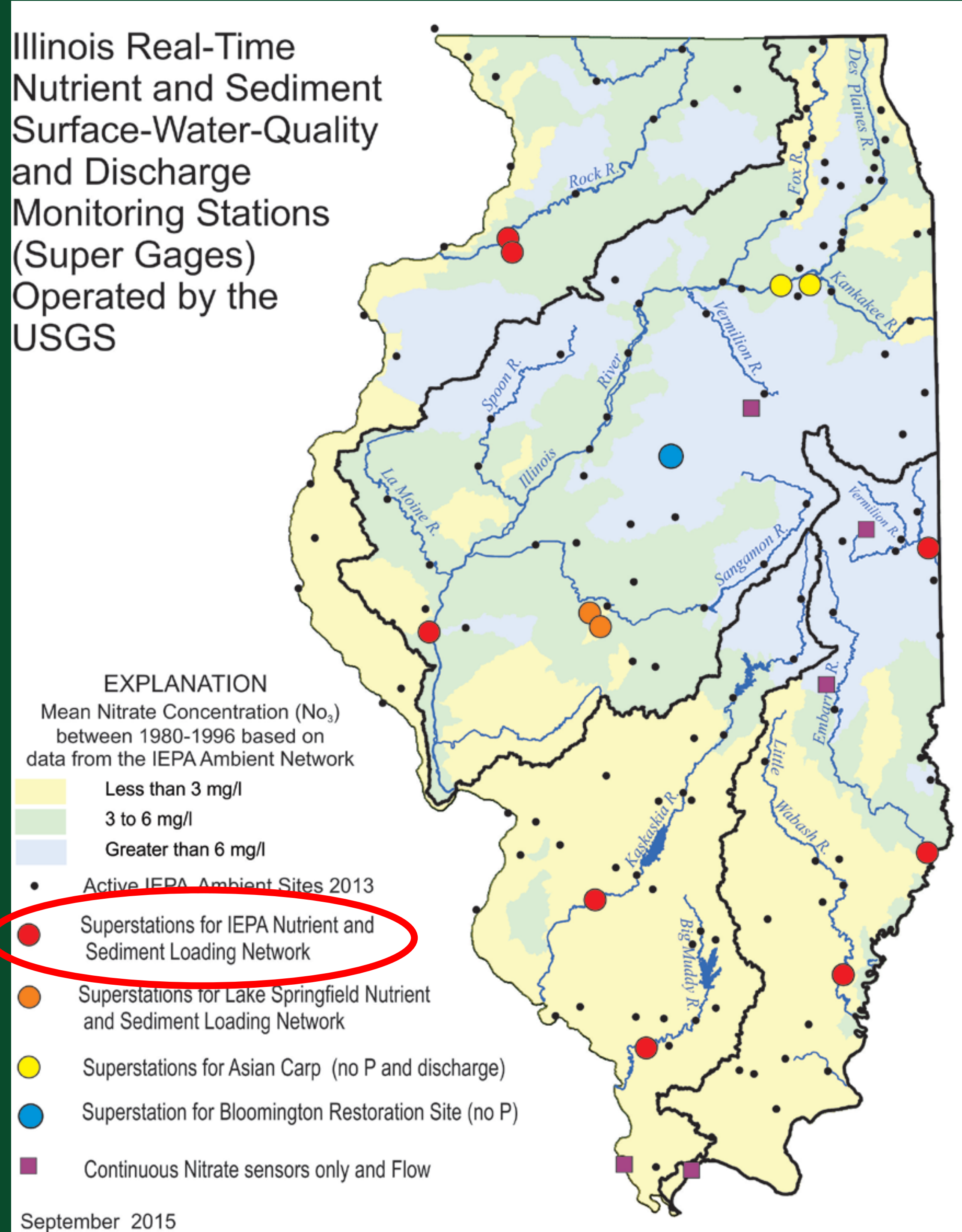
Urbana, IL

Kelly Warner and Isaac Seo, USGS

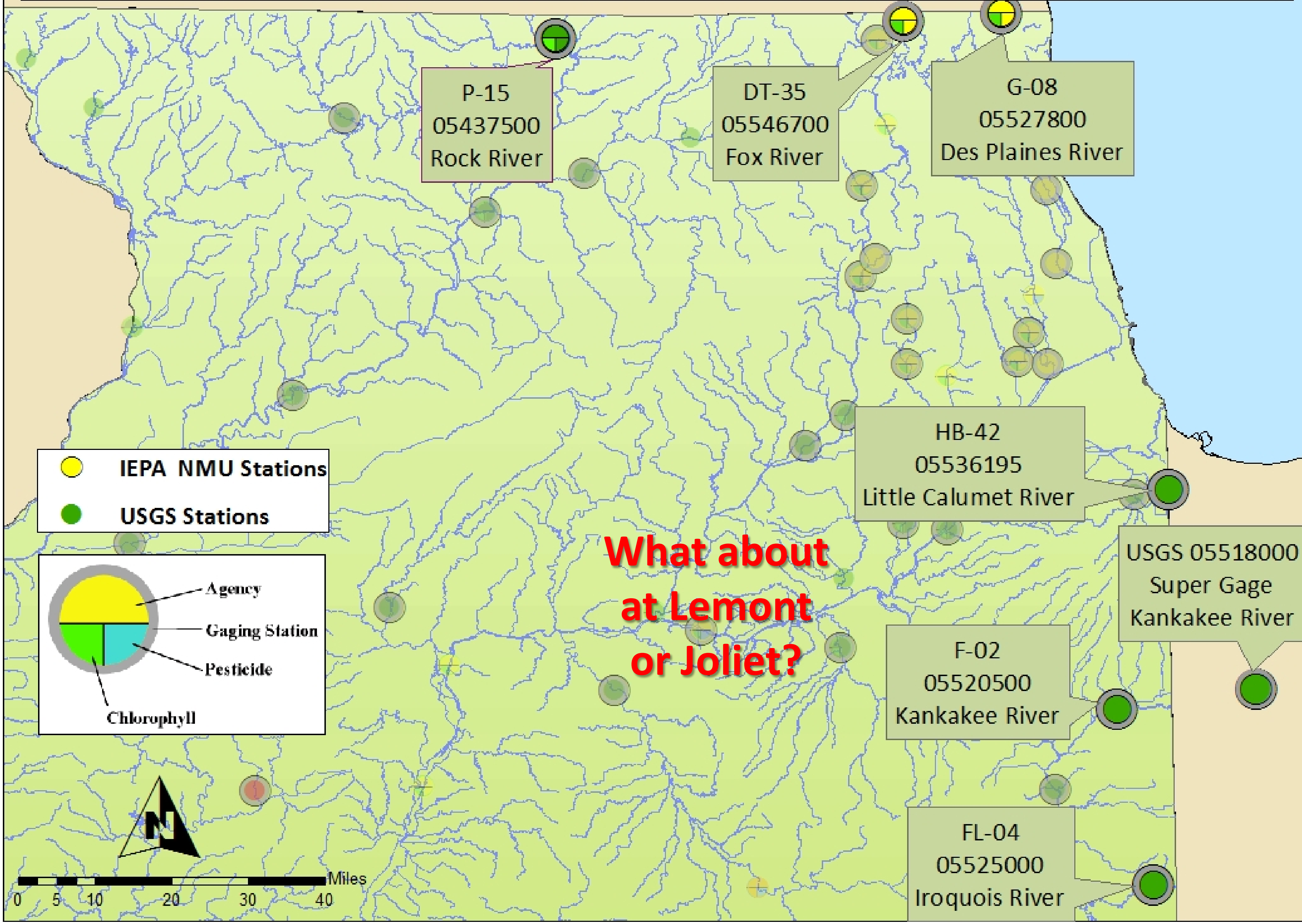
The Plan

- Basins covering almost 75% of area of the State
  - Rock River
  - Green River
  - Illinois River
  - Kaskaskia River
  - Big Muddy
  - Little Wabash
  - Embarras River
  - Vermilion River
- Current USGS gaging station (flow)
- Current IEPA Ambient site/Historical Data

USGS



AWQMN/USGS Gage Stations Located on Streams Entering Illinois



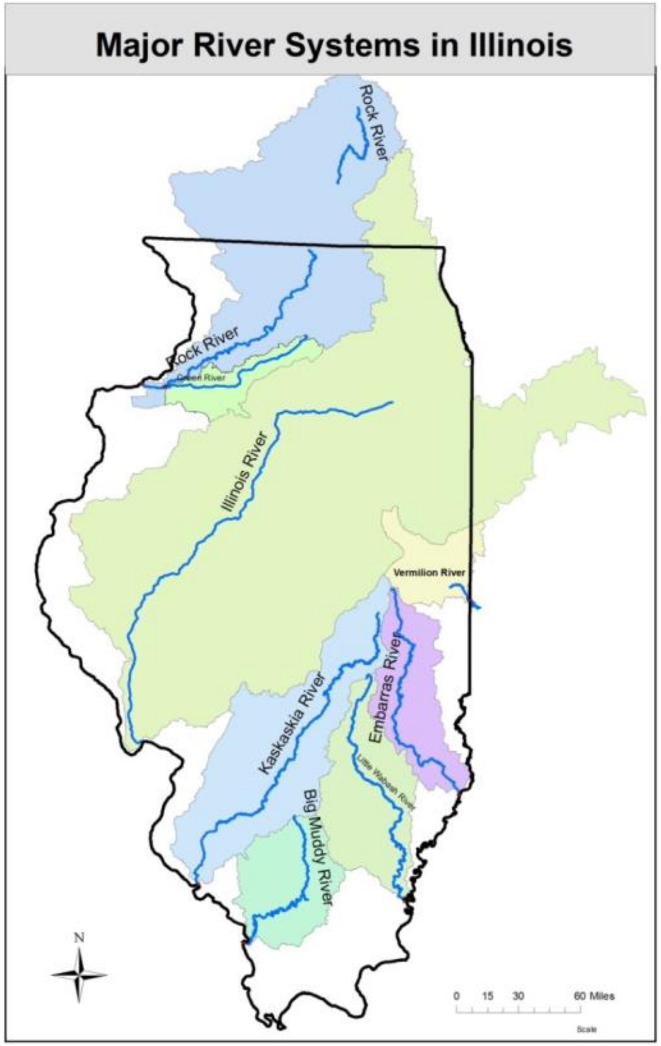
Dr. Mark David (U of I) Offer 3/10/16

- Author of NLRS “Science Assessment”
- Resigning from NMC, Pending Retirement
- Paul Davidson replacing him on Policy Working Group and now, NMC
- Still interesting in working with data
- Send me Nitrate and Total Phosphorus data for 2012-2015
- NLRS Science Assessment was from 1997-2011
- USGS Super Gages taking over in late 2015-2016
- One-time, free offer as gift to the NMC! ☺
- Illinois EPA has sent Dr. David all the data per request

Cool

Nitrate and Total P Export from Illinois Rivers:

1980-2015 Update



Mark B. David, Gregory F. McIsaac
and Corey A. Mitchell
University of Illinois

Prepared for the Illinois Nutrient Monitoring Council, Gregg Good, IL EPA Chair

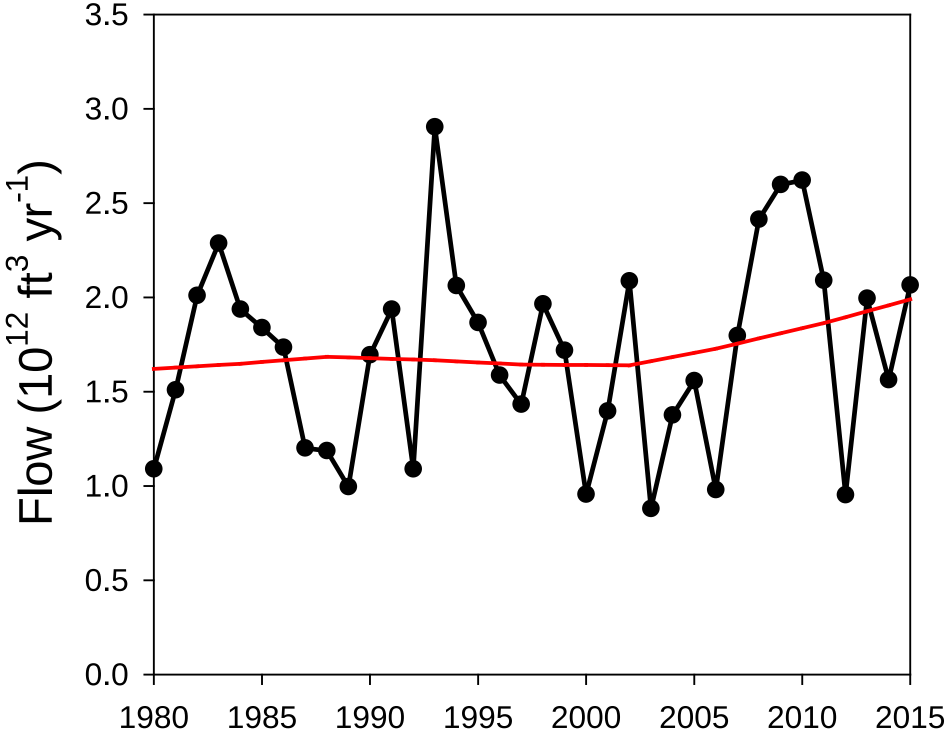
April 21, 2016

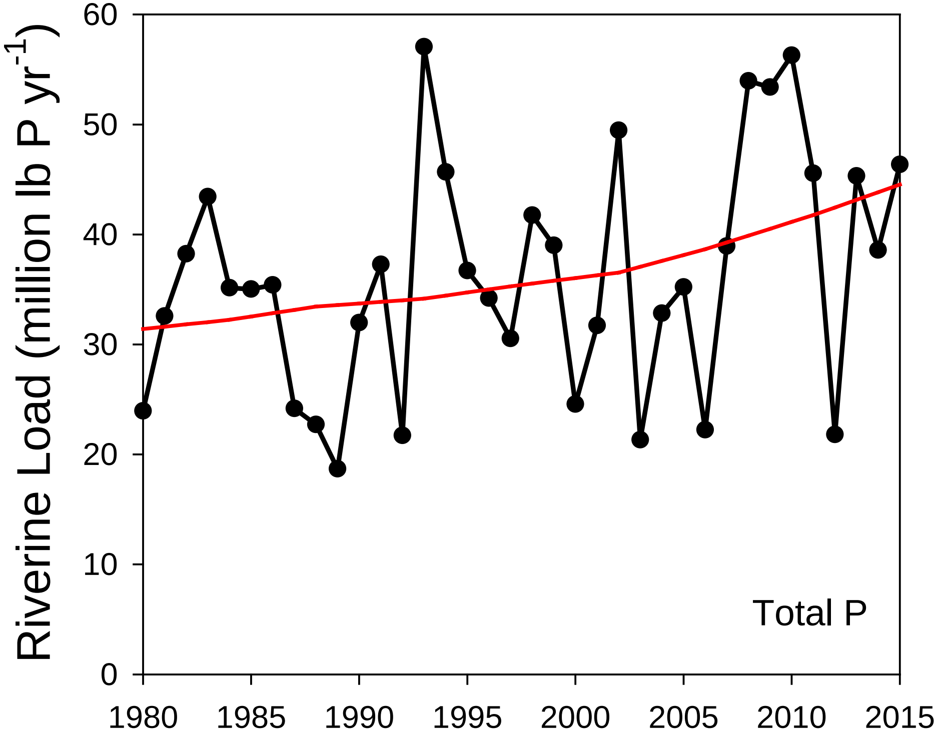
Background

- eight major rivers used to estimate Illinois export of nitrate and total P
  – Rock, Green, Illinois, Kaskaskia, Big Muddy, Little Wabash, Embarras, Vermilion
- previously estimated through 2011
  – added 2012 to 2015 water years
  – same methodology (interpolation for nitrate, WRTDS* for total P)
- examined trends in water, nitrate, and total P
  – compared to 1980-1996 baseline period

*Note: For total P calculated with WRDTS, the greatest uncertainty about loads and concentrations is at the end of the record, so that future estimates for the 2011-2015 period could change when additional data become available.

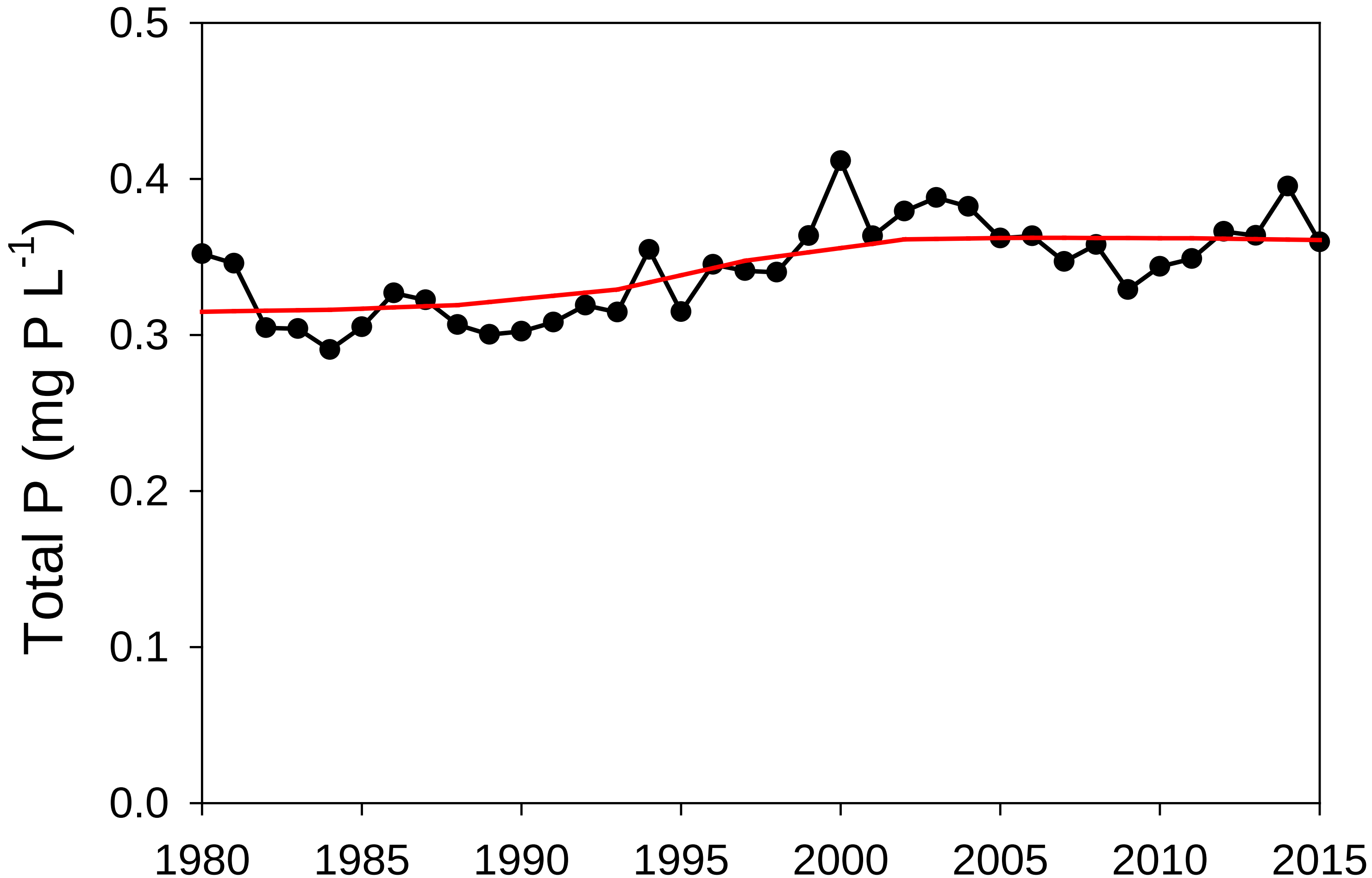
Illinois Export of Water & Total P





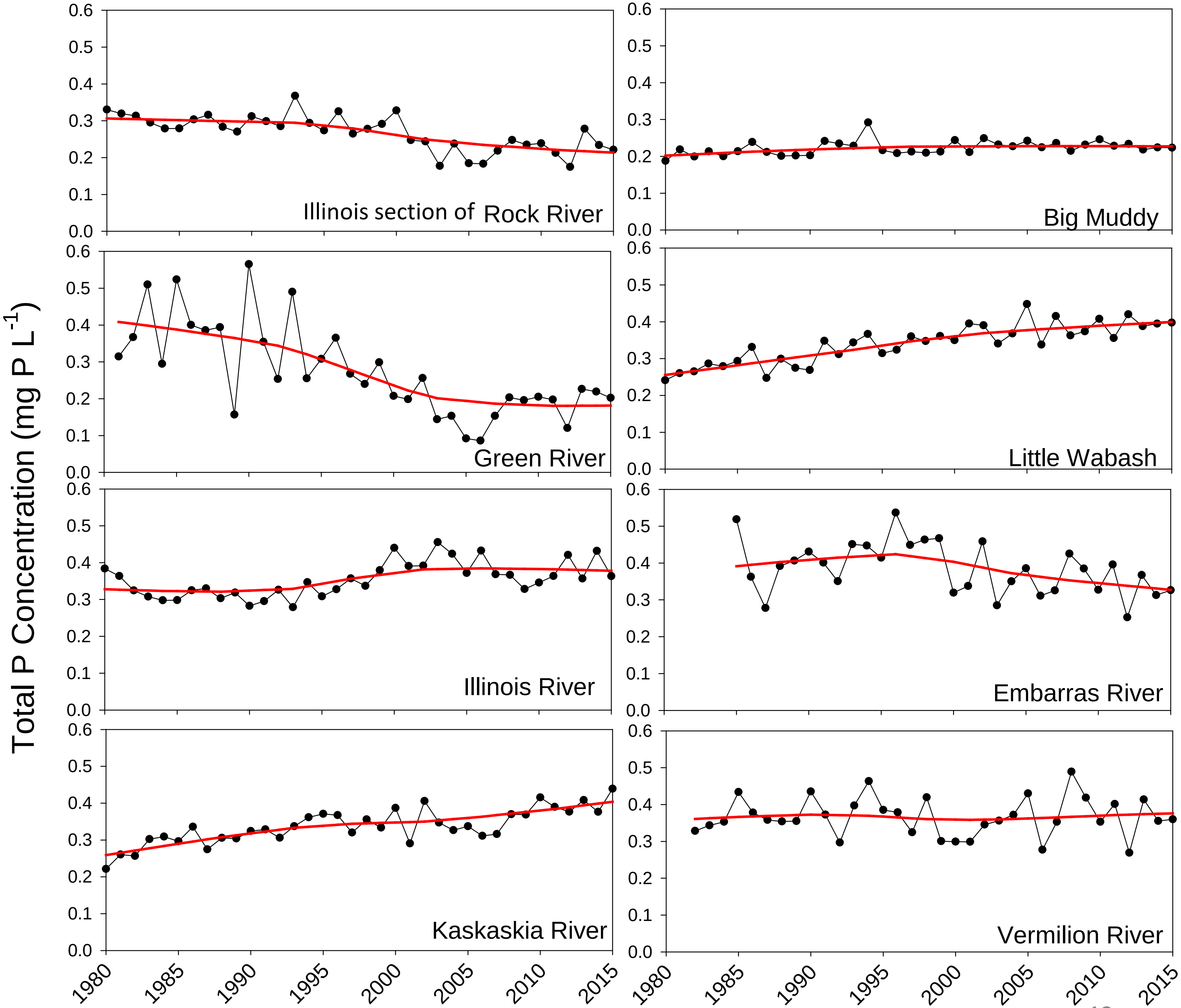
Red lines are "locally weighted regression scatterplot smoothing" (LOESS) trend fit

Annual Flow-Weighted Total P Concentration for Illinois



Red lines are LOESS trend fit

Major River Total P



Red lines are LOESS trend fits

Total P Comparison to 1980-1996

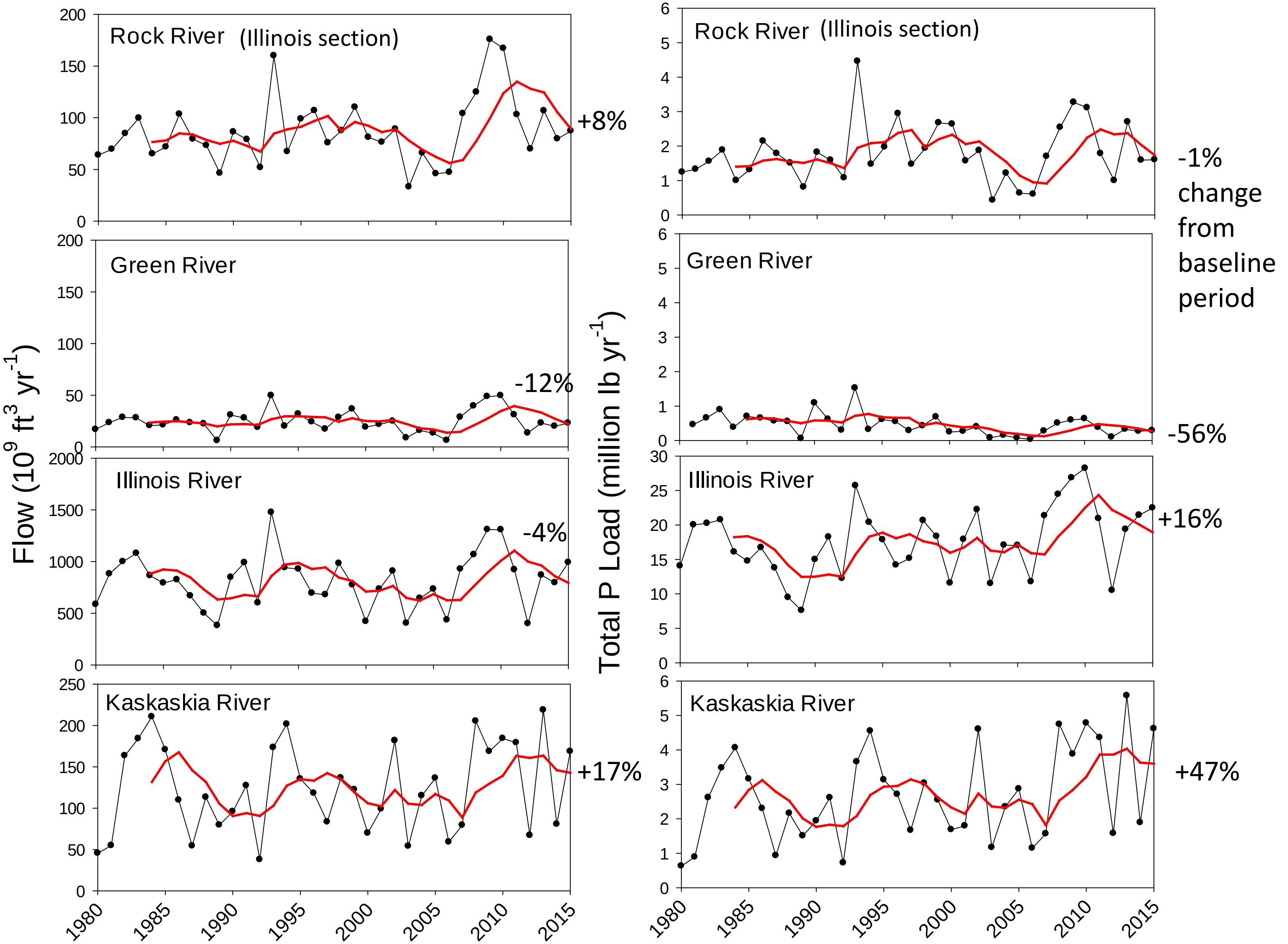
- average total P flux was 33.8 million lb yr^{-1} during 1980-1996
  - last 5 years* (2011-2015) flux was 39.5 million lb yr^{-1}
  - this is about a 17% increase in total P

- water flux was 1.70 x 10^{12} ft^3 yr^{-1} during 1980-1996
  - last 5 years water flux was 1.73 x 10^{12} ft^3 yr^{-1}
  - this is about a 2% increase

- suggests a lot of work to do

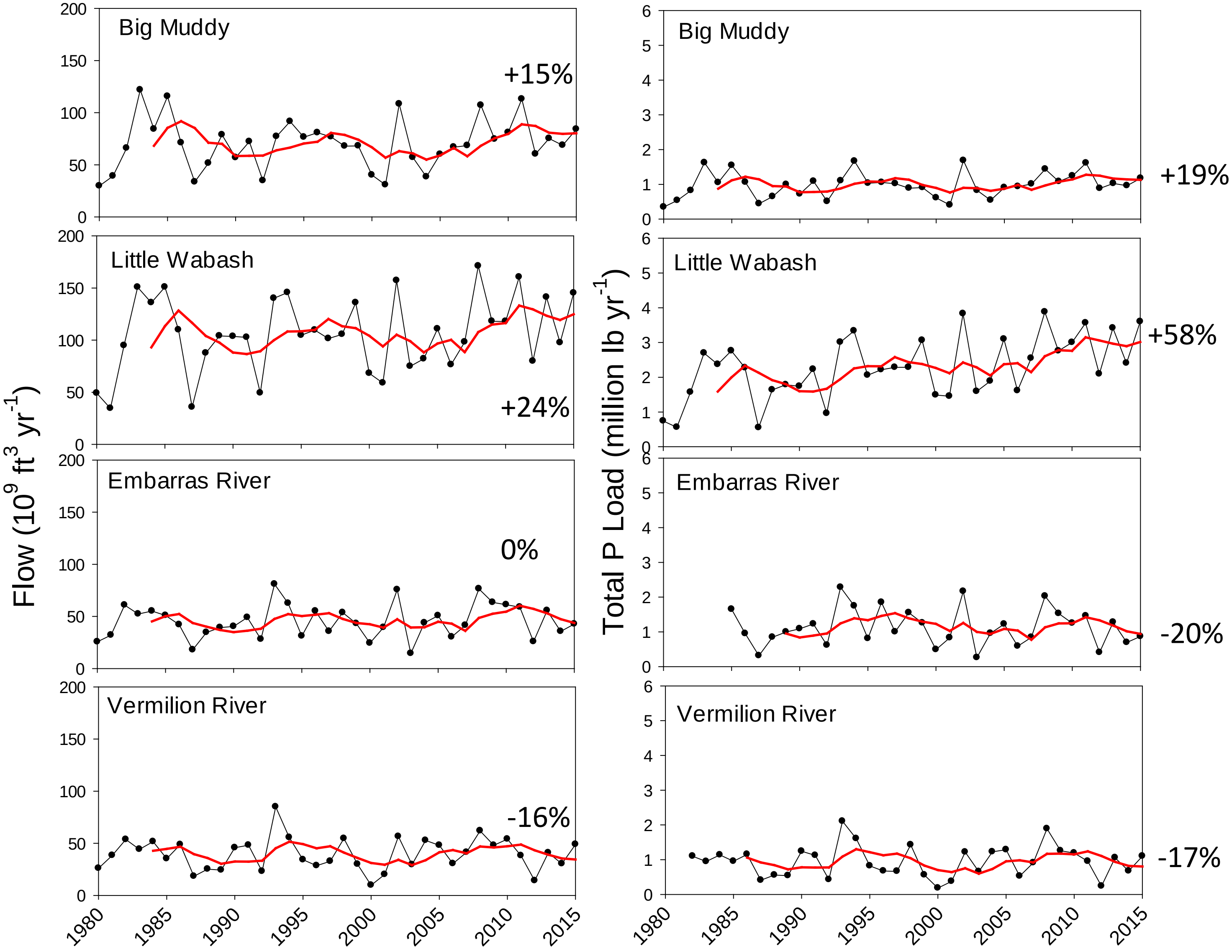
*Note: For total P calculated with WRDTS, the greatest uncertainty about loads and concentrations is at the end of the record, so that future estimates for the 2011-2015 period could change when additional data become available.

Major River Flows and Total P Loads (part 1 of 2)



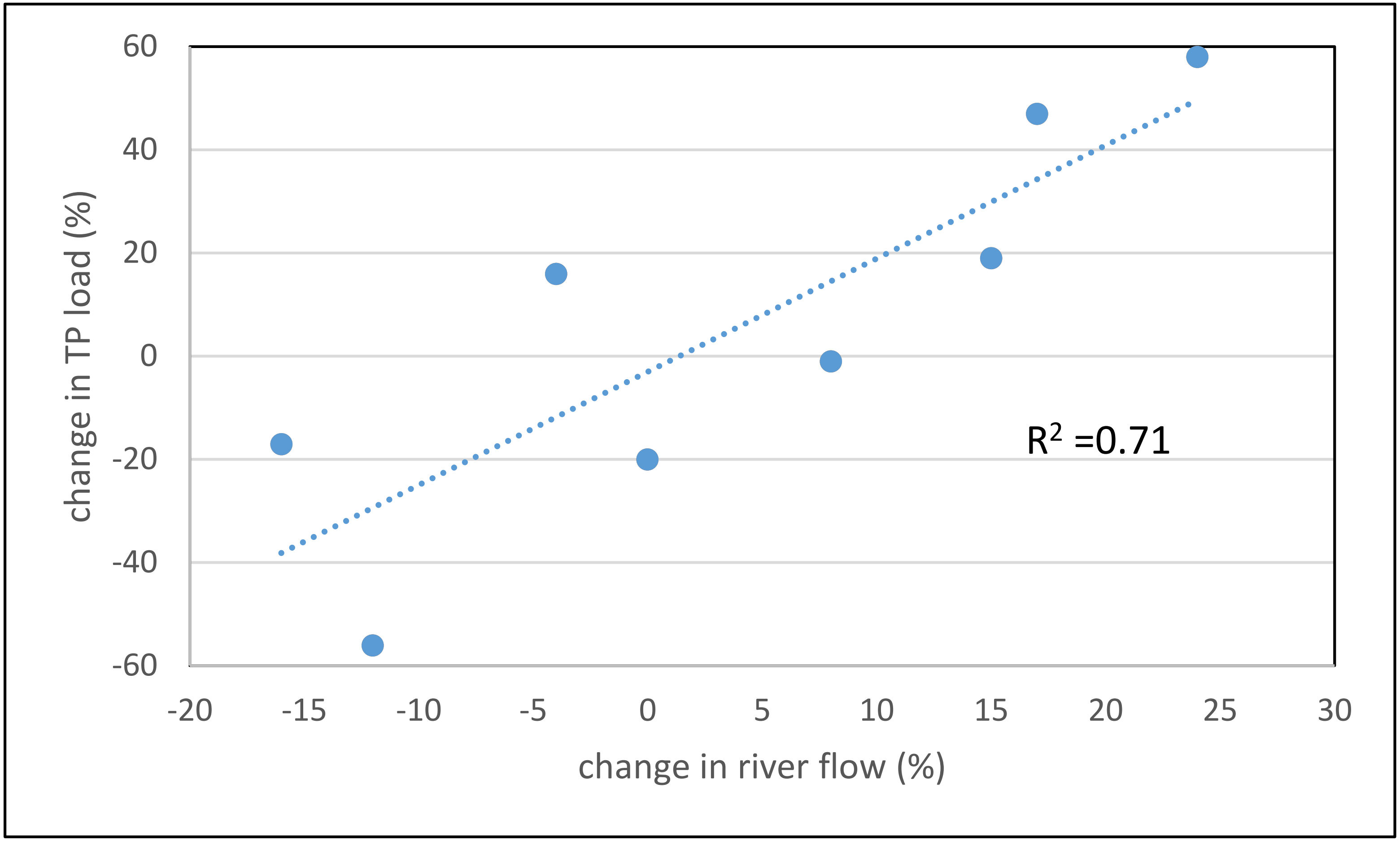
Red lines are 5-year moving average

Major River Flow and Total P Load (part 2 of 2)



Red lines are 5-year moving average

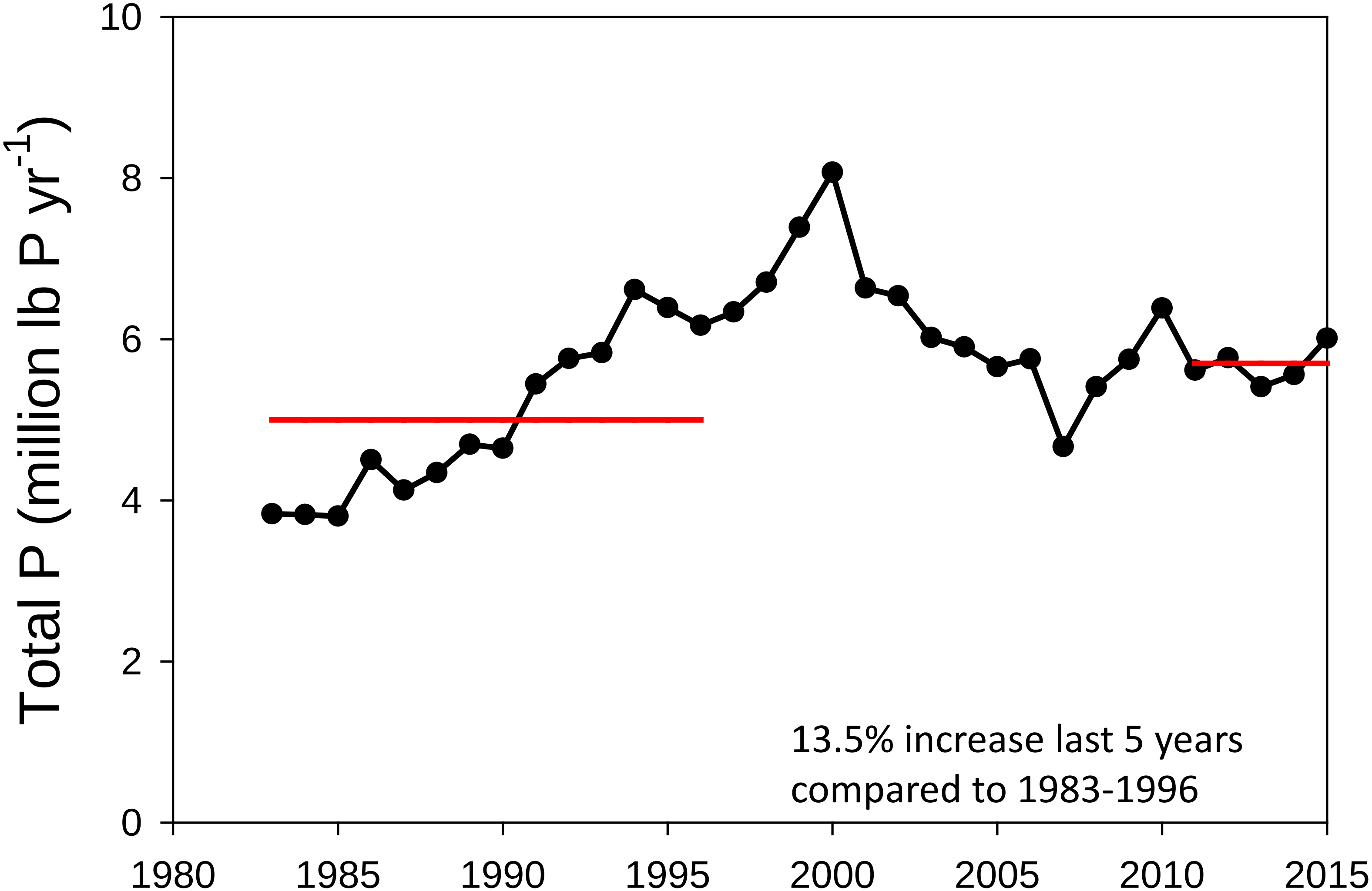
8 Major Rivers
%change in TP load 2011-15 compared to baseline period plotted against %change in river flow



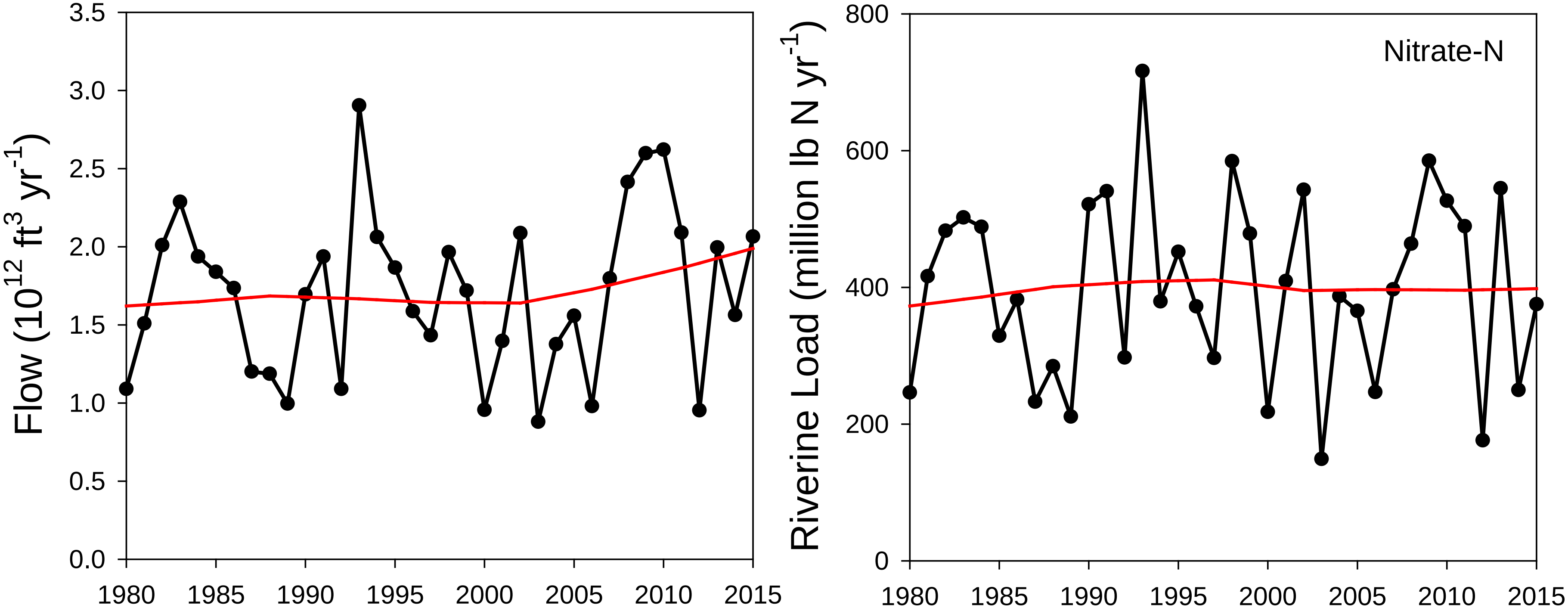
Total P Trends (how are we doing?)

- overall for Illinois
  - total P flux is up
  - flow-weighted total P concentrations increased through ~2000, flat since then
- for the 8 rivers
  - different trends in loads
  - Vermilion, Green, Embarras: down ↓
  - Illinois, Kaskaskia, Little Wabash: up ↑
  - Big Muddy, Rock: no trend →
- why increase?
  - not sure, but several factors may be causal
    - more flow (recent Kaskaskia and Little Wabash flows are 14 and 24% greater)
    - corn ethanol production producing more wastewater effluent high in P?
    - more people and effluent? *(see next slide)*
    - new CAFOs?
- why decrease?
  - less erosion due to less precipitation/flow (recent Green flow down 16%, Vermilion 12%)

MWRDGC Effluent Total P
(7 plant total)

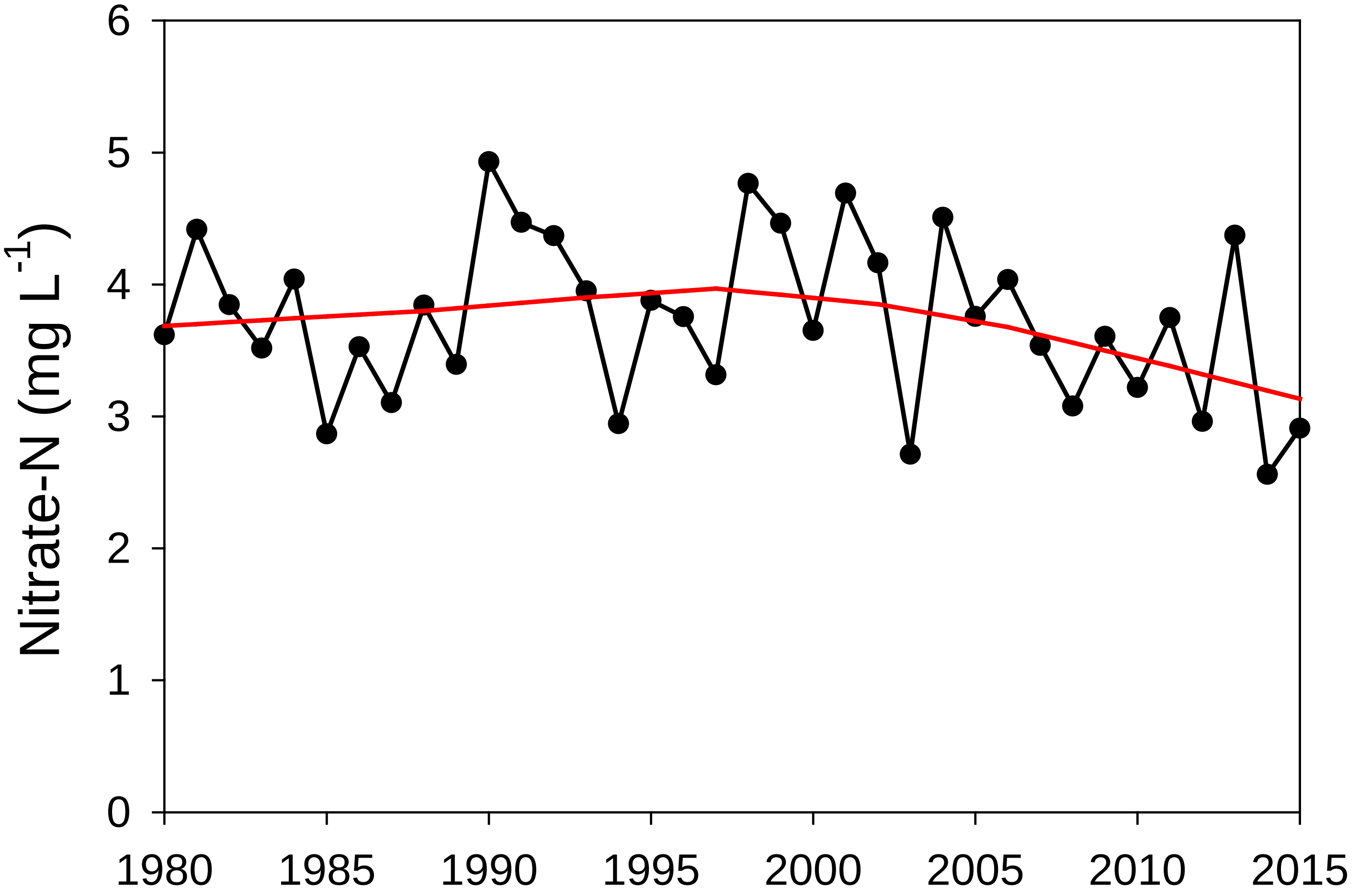


Illinois Export of Water & Nitrate



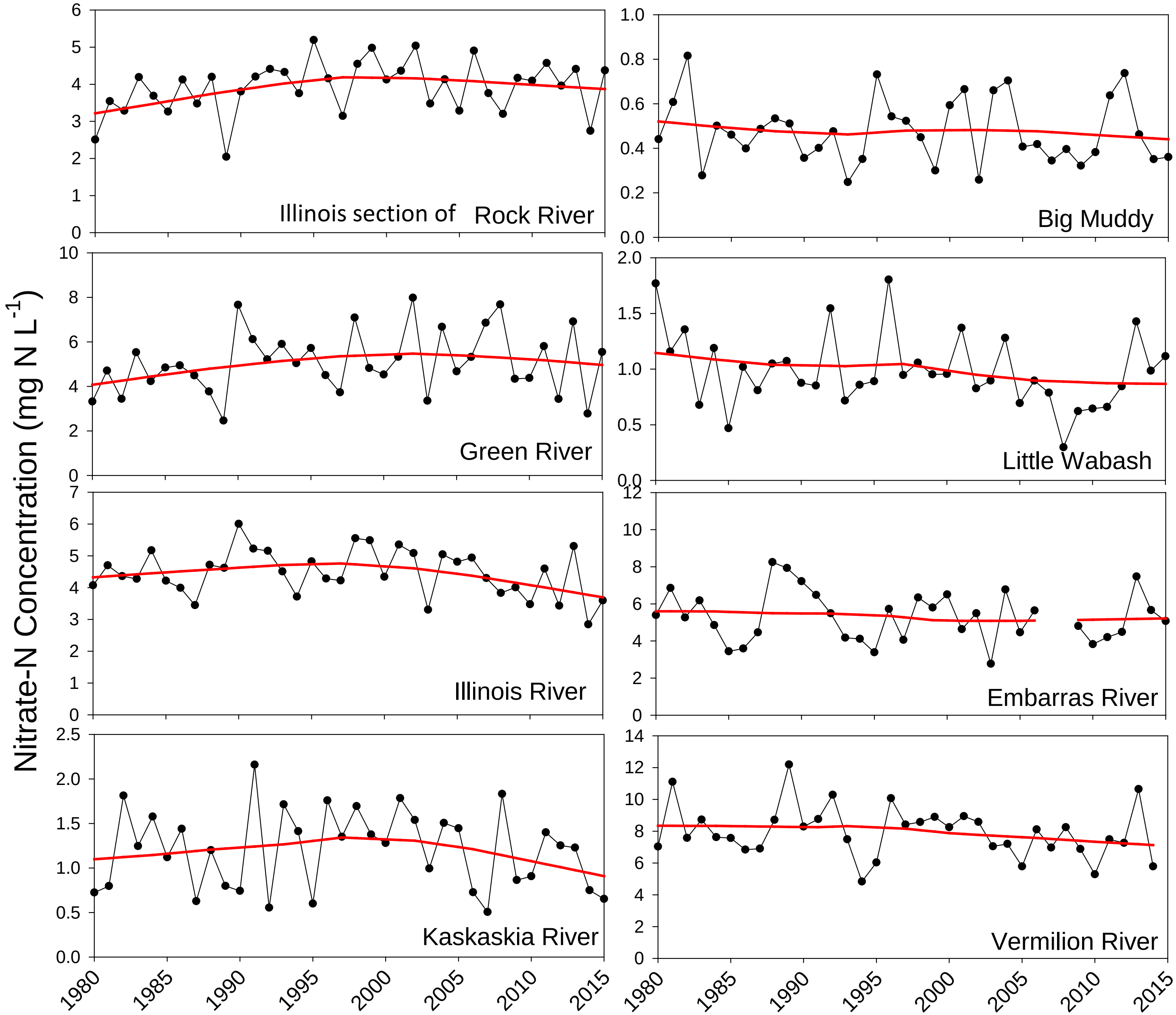
Red lines are LOESS trend fit

Annual Flow-Weighted Nitrate Concentration for Illinois



Red line is LOESS trend fit

Major River Nitrate Conc.

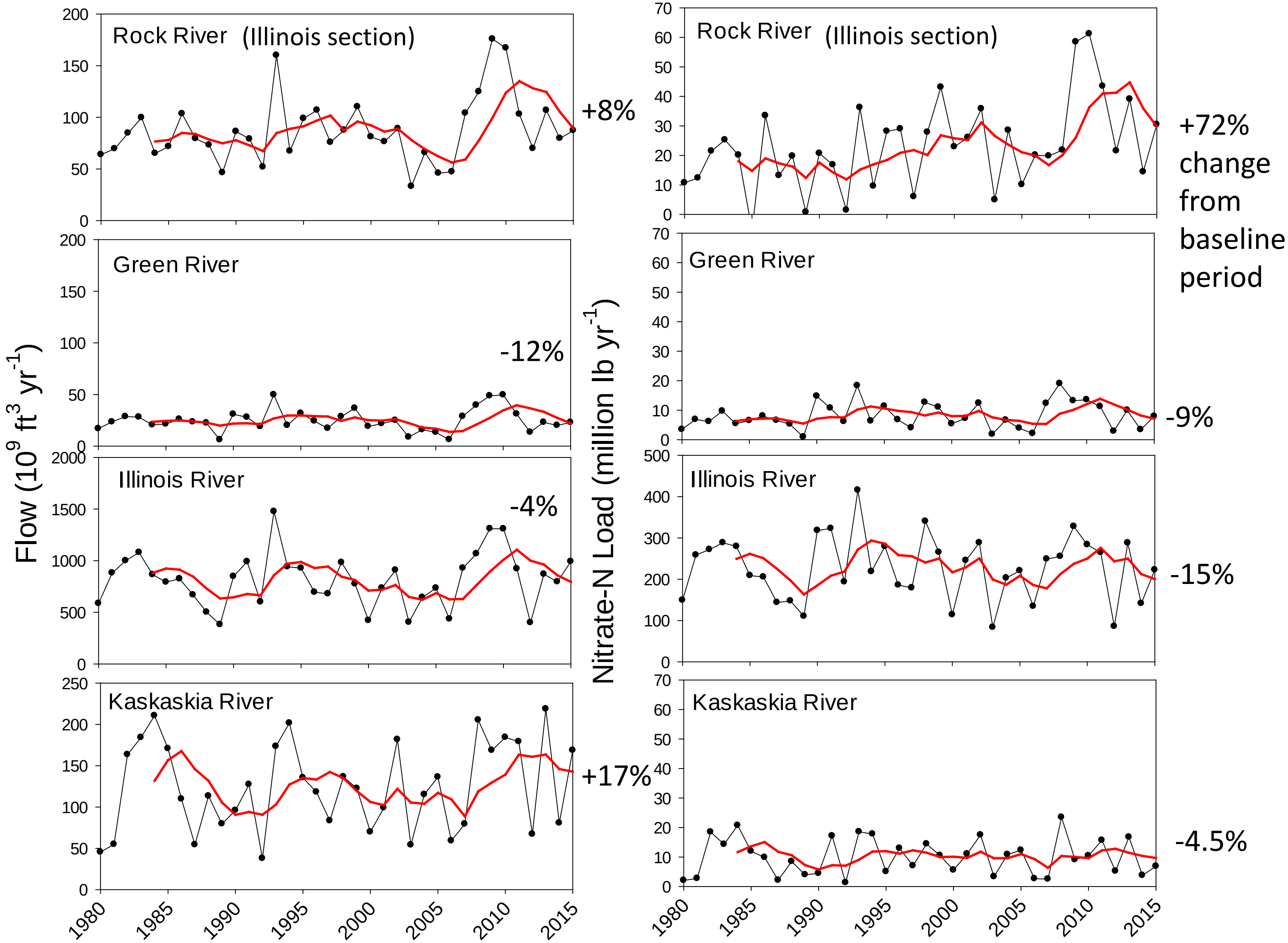


Red lines are LOESS trend fit

Nitrate Comparison to 1980-1996

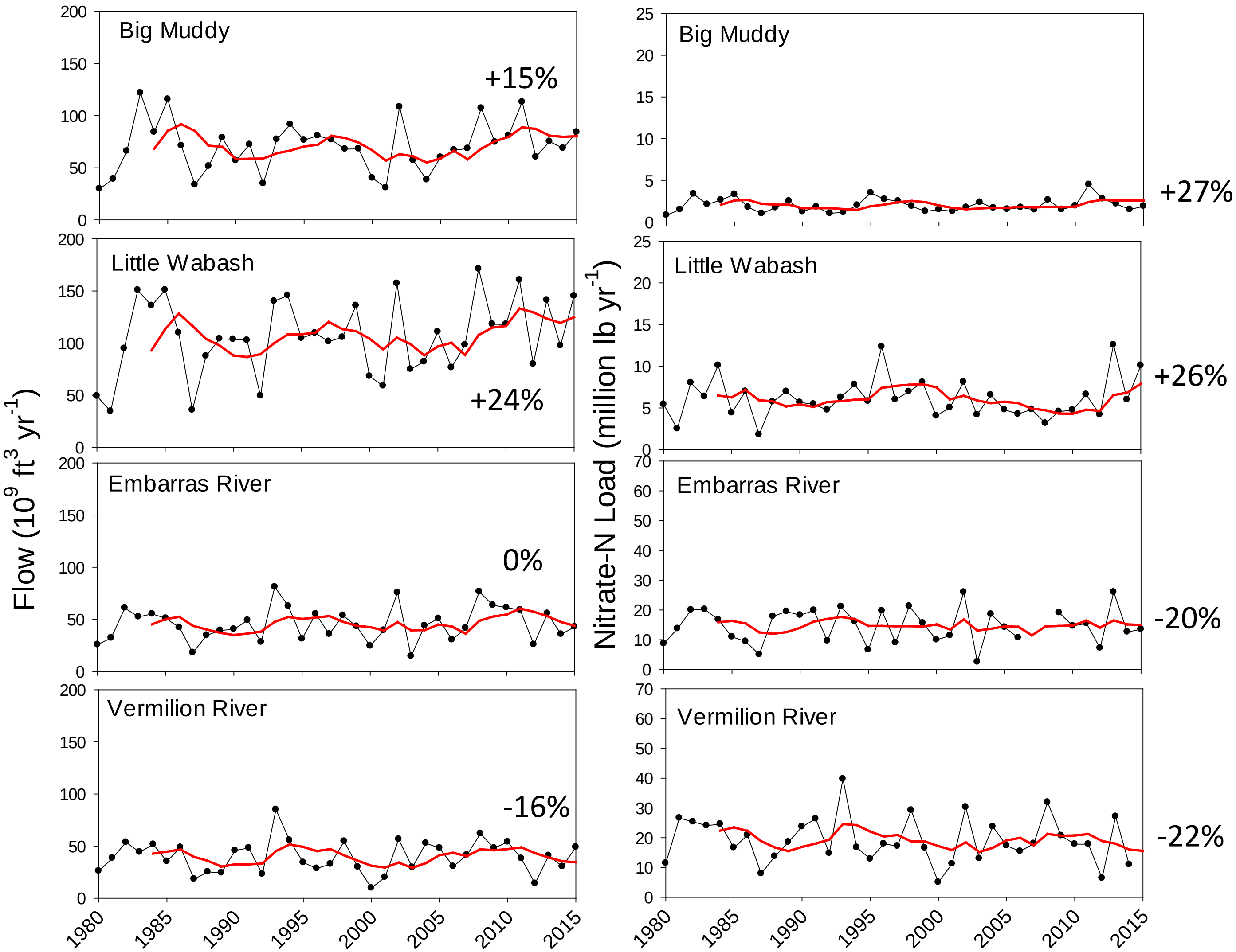
- water flux was 1.70 x 10^{12} ft^3 yr^{-1} during 1980-1996
  - last 5 years water flux was 1.73 x 10^{12} ft^3 yr^{-1}
- average nitrate-N flux was 403 million lb yr^{-1} during 1980-1996
  - last 5 years (2011-2015) flux was 367 million lb yr^{-1}
  - this is about a 10% decrease in nitrate
- suggests progress has been made

Major River Flows and Nitrate-N Loads (part 1 of 2)



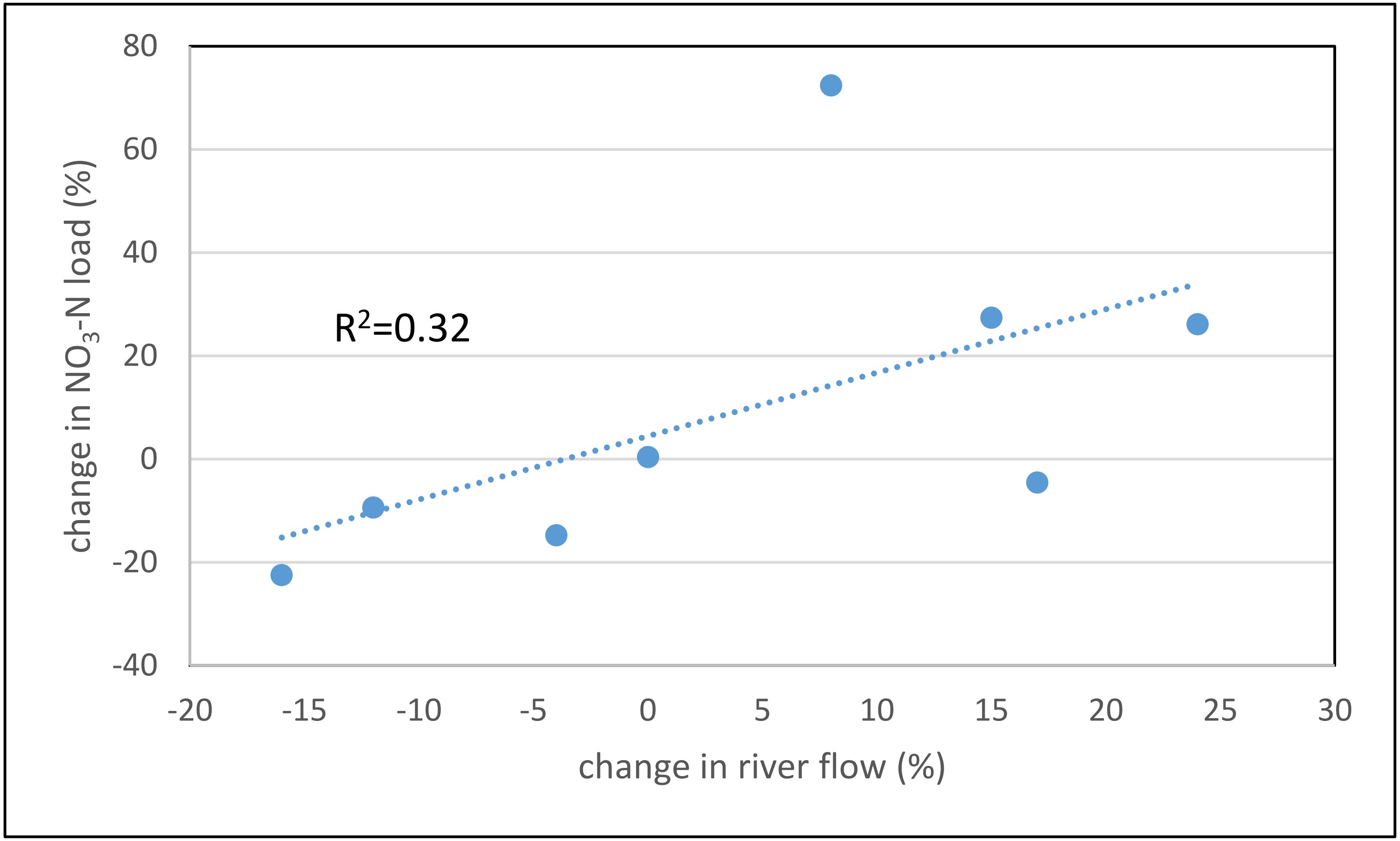
Red lines are 5-year moving average

Major River Flows and Nitrate-N Loads (part 2 of 2)



Red lines are 5-year moving average

8 Major Rivers
%change in Nitrate-N load 2011-15 compared to baseline period plotted against %change in river flow



Nitrate-N Trends (how are we doing?)

- overall for Illinois
  - water flux is up slightly ~2%
  - nitrate-N flux is down ~10%
  - flow-weighted nitrate-N concentration is decreasing

- for the 8 rivers
  - all have downward trends in nitrate-N concentrations, although slight for the Big Muddy and Embarras
  - nitrate loads are variable
    - Increased in the Illinois section of the Rock (72%!!), Big Muddy and Little Wabash
    - Decreased elsewhere

- why?
  - Overall decline may be due to better agricultural N balances
    - fertilizer sales have had little change since 1980, harvest removal of N in grain greatly increased (see McIsaac et al. 2016)
  - changes in flow are also a factor, but does not explain the Rock River
  - Increased loads in the Little Wabash and Big Muddy are associated with increased flows, but loads in these rivers are relatively small contributions to the state total.

Summary

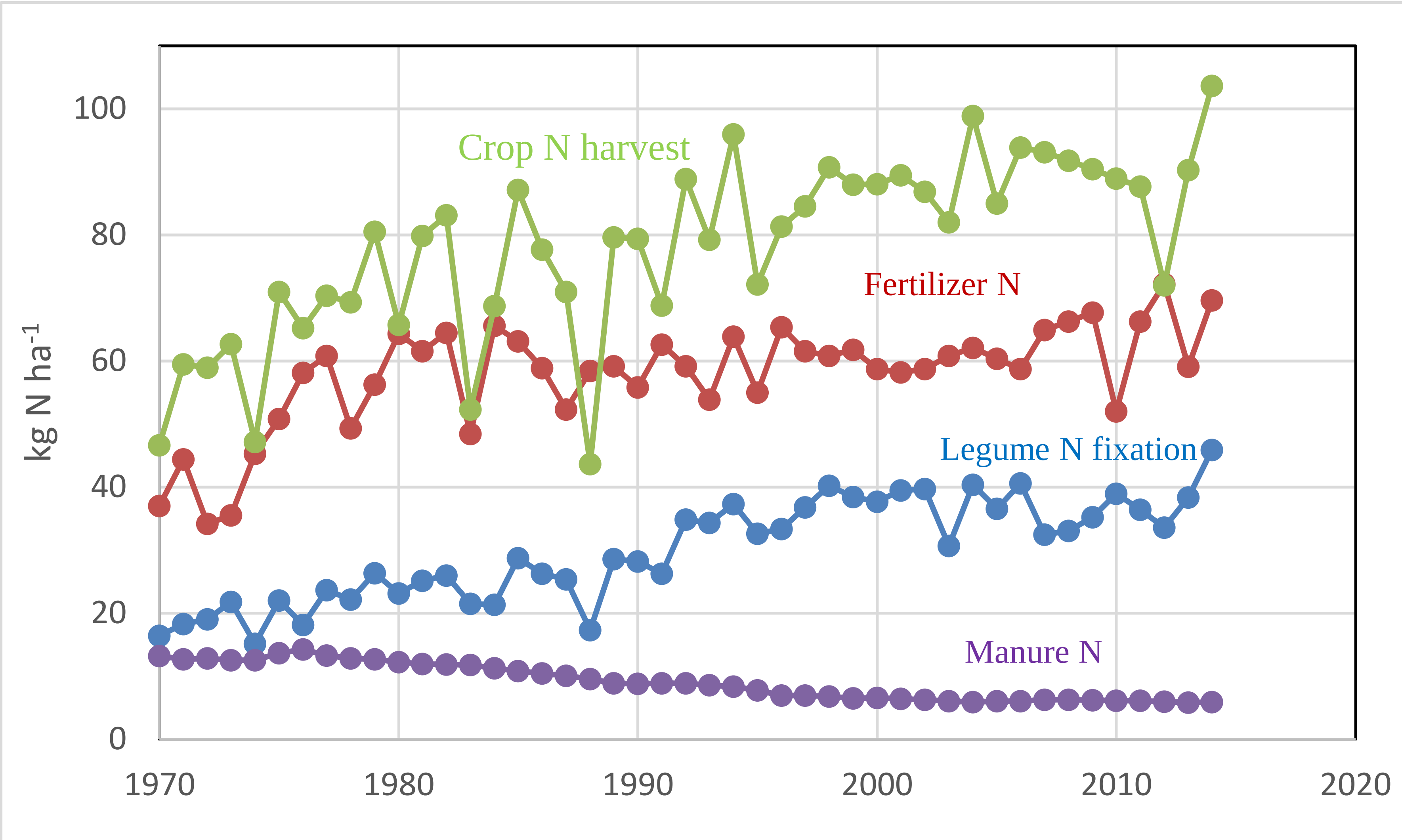
ILLINOIS NUTRIENT LOSS REDUCTION STRATEGY

Improving our water resources with collaboration and innovation

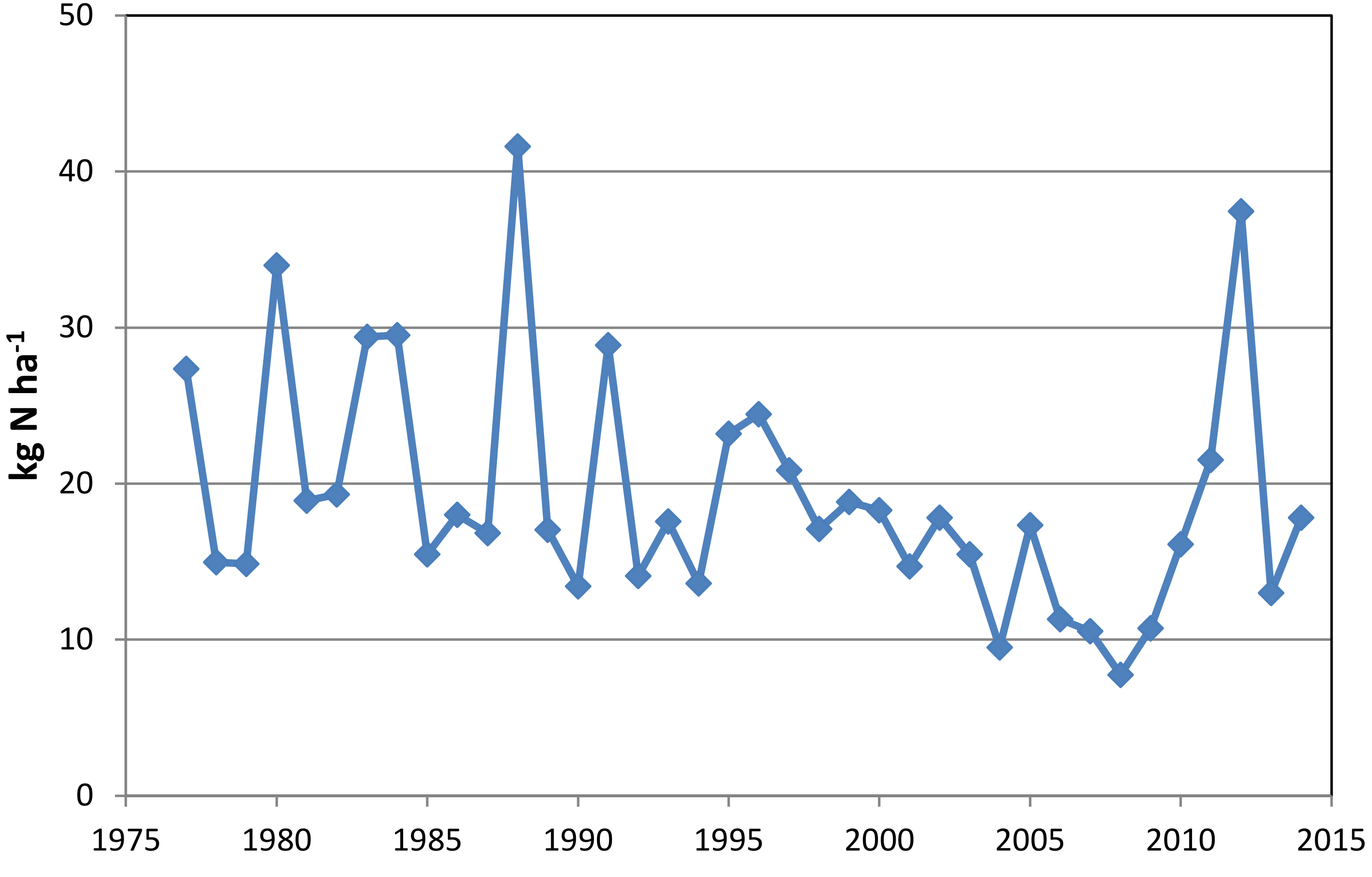
- nitrate losses are decreasing
  - likely due to improved agricultural N balances
- total P losses have increased
  - not clear why this is occurring, although changes in flow and point source P discharges could be large factors
- 5-year averages seem appropriate for evaluating how we are doing
- continue annual load analysis using a 5-yr running averages of loads and river flows

Questions or Comments?

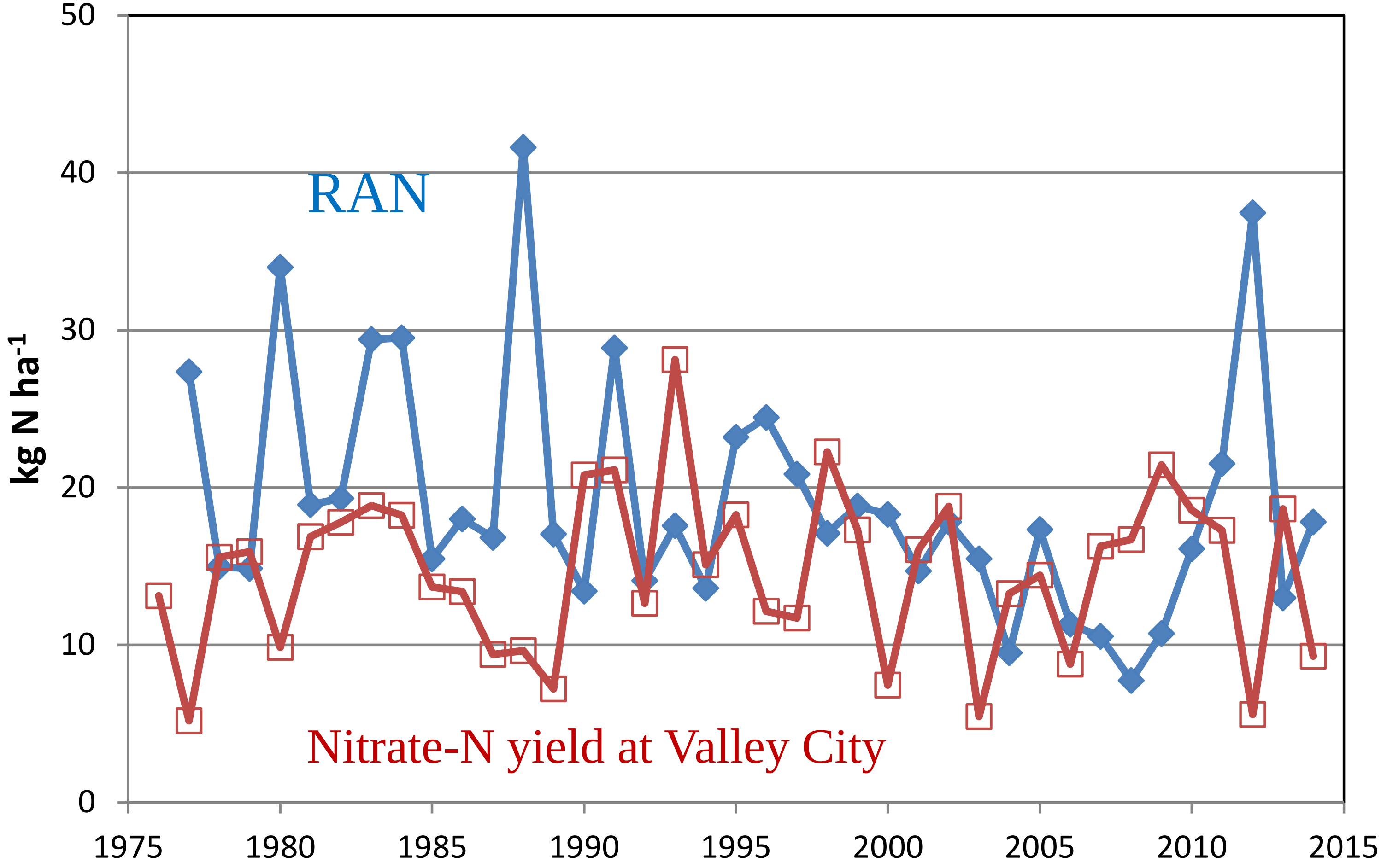
Illinois River Watershed Agricultural N inputs and outputs



Residual Agricultural Nitrogen (RAN) = N Fertilizer + N Fixation + Manure -N Harvested in Grain



Illinois River Watershed
Residual Agricultural N (RAN) in the watershed and riverine nitrate-N yield at Valley City



How to represent the nitrate storage and lag effects in the watershed?

Consider a Cumulative Residual Agricultural N (CRAN) over several years minus the amount of nitrate that flowed down the river during those years

$CRAN_1$ = RAN

$CRAN_2$ = RAN + Previous two year's RAN
– Previous year's river nitrate load

$CRAN_3$ = RAN + Previous three years' RAN
– Previous two years' river nitrate load

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$CRAN_7$ = RAN + Previous seven years' RAN
– Previous six years river nitrate load

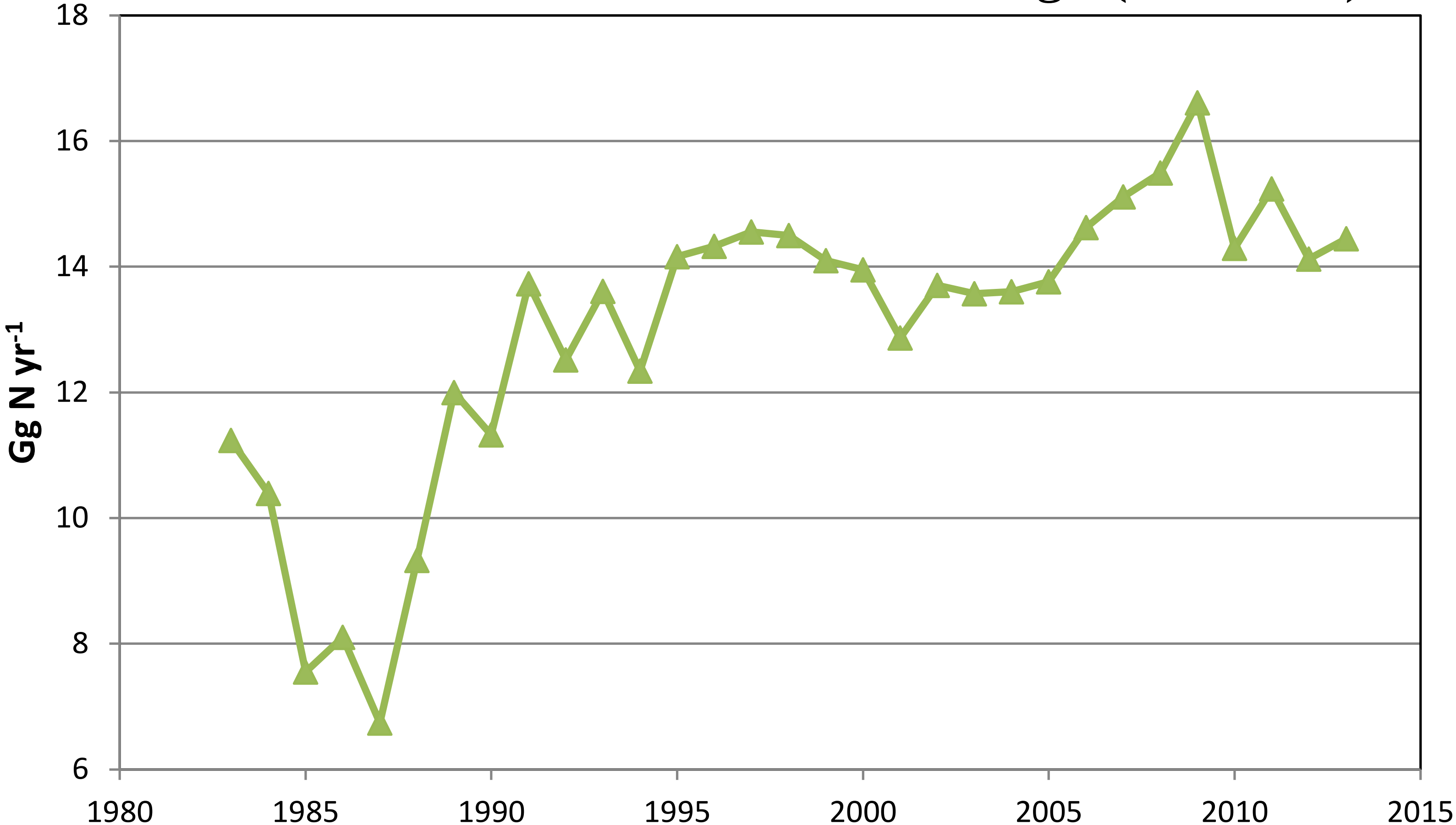
Table 2. Results of multiple regression with annual nitrate-N load (Gg N yr^{-1}) as the dependent variable.

Variable	**Parameter Estimate**	**Standard Error**	**t Value**	**Approx. P > |t|**
Intercept	-43.5	24.3	1.79	0.00
Annual avg. discharge (m^3s^{-1})	0.15	0.013	11.11	<0.0001
November avg. discharge (m^3s^{-1})	-0.016	0.009	1.77	0.09
$CRAN_6$ (Gg N yr^{-1})	0.43	0.14	3.17	0.004
MWRDGC NO_3-N discharge (Gg N yr^{-1})	2.40	1.60	1.51	0.14

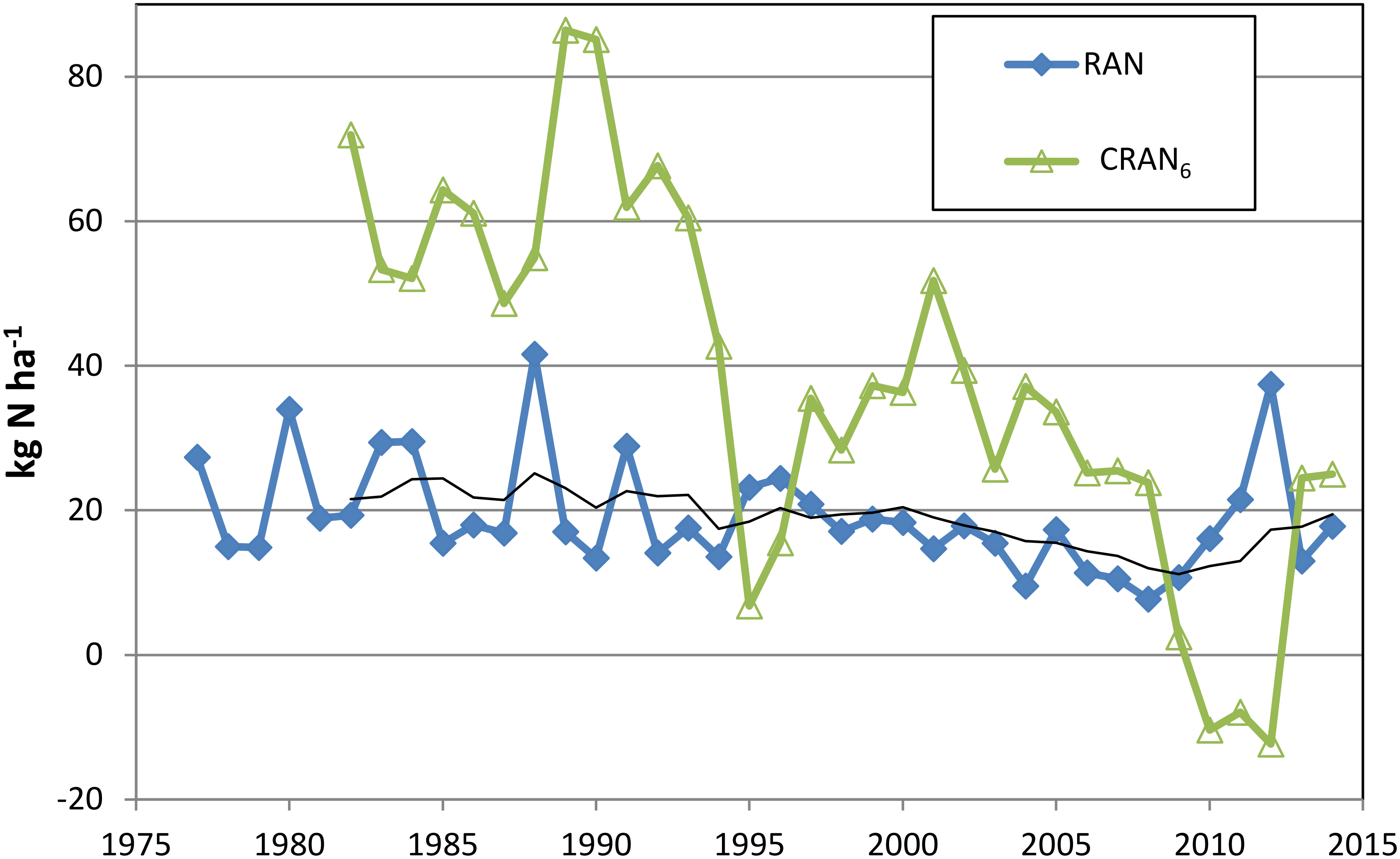
Durbin Watson = 1.90; Critical range at 1% significance 1.509 to 0.897

CRAN6, cumulative residual agricultural nitrogen over the previous six years; MWRDGC, Metropolitan Water Reclamation District of Greater Chicago.

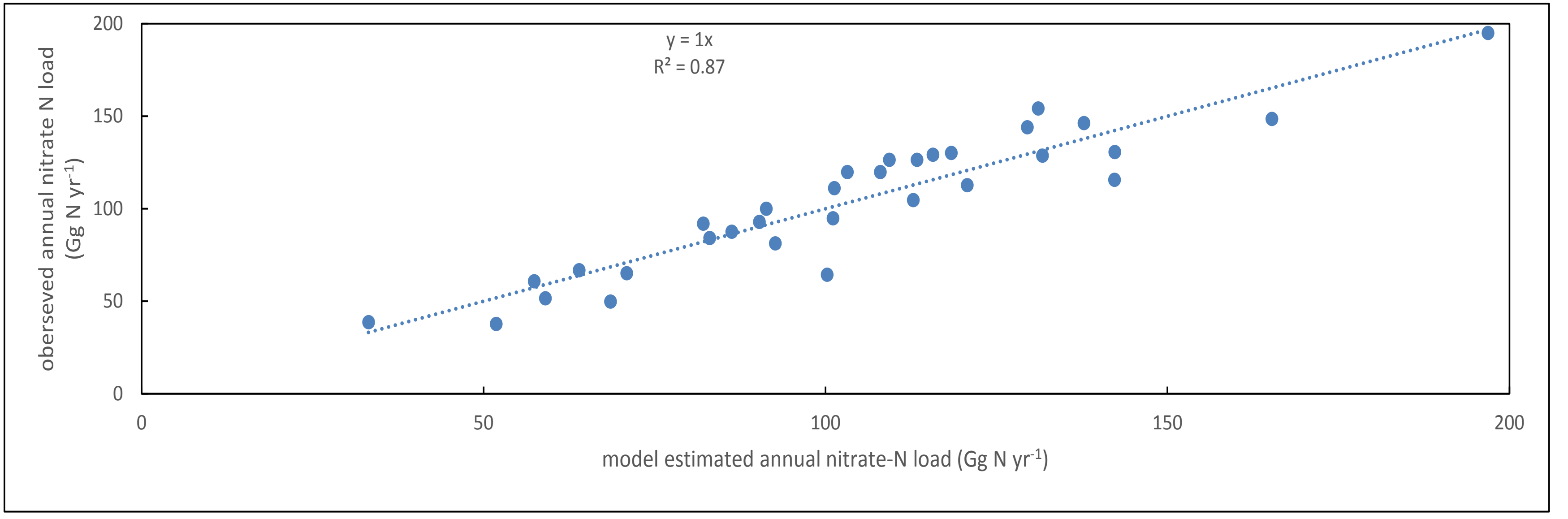
Annual Nitrate-N discharge in treated wastewater from the Water Reclamation District of Greater Chicago (WRDGC)

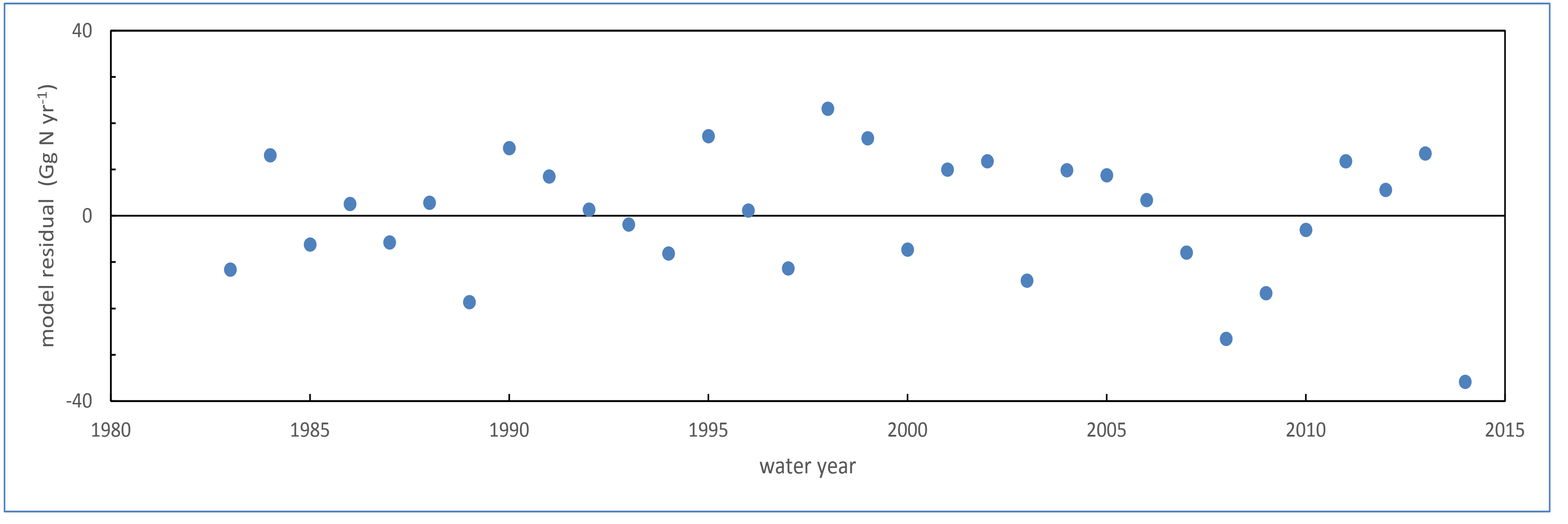


Illinois River Basin Residual Agricultural N (RAN) and Cumulative Residual Agricultural N over 6 years ($CRAN_6$)



Observed vs. model estimated annual nitrate-N loads





Difference between observed and model estimated nitrate-N load plotted by year

GROUNDWATER ASSESSMENT FOR NITRATES

Nutrient Monitoring Council
July 28, 2016

Rick Cobb, P.G.
Deputy Division Manager
Division of Public Water Supplies
and Manager, Groundwater Section

Illinois EPA

Illinois Groundwater Protection Act (1987)

- Interagency Coordinating Committee on Groundwater (Chaired by Illinois EPA) [415 ILCS 55/4(b)(7)]
  - Review, coordinate and evaluate groundwater data collection and analysis
- Governor Appointed Groundwater Advisory Council [415 ILCS 55/5(a)(4)]
  - Review, evaluate and make recommendations regarding groundwater data collection and analyses

ICCG

Environmental Protection Agency (Chair)	Rick Cobb, designee
Department of Natural Resources Office of Water Resources Office of Mines and Minerals	Todd Rettig, designee Wes Cattoor, designee Vickie Broomhead, designee
Department of Public Health	Dave Johnson, designee
Office of the State Fire Marshall	Fred Schneller, designee
Department of Agriculture	Tracy Hurley, designee
Emergency Management Agency, Division of Nuclear Safety	Adnan Khayyat**,**, designee
Department of Commerce and Economic Opportunity	Dan Wheeler, designee

*Also attending the ICCG meetings are: Dan Curtis, **Illinois Department of Transportation's** Division of Highways; Walt Kelly, **Illinois State Water Survey**; Jason Thomason, **Illinois State Geological Survey**; and Kelly Warner, **United States Geological Survey**.*

GAC

Bill Compton (Chair)	**Public Water Supply Interest (Groveland Public Water District)**
Jack Norman	**Environmental Interest (Sierra Club)**
Lauren Lurkins	**Agricultural Interest (Illinois Farm Bureau)**
Paul McNamara	**Regional Planning Interest (Southwestern Illinois Planning Commission)**
C. Pius Weibel	**Environmental Interest**
John Liberg	**Water Well Drilling Interest (Illinois Association of Groundwater Professionals)**
Robert Kohlhase	**Environmental Interest (Farnsworth Group)**
Bob Elvert	**Industrial Interest (Retired Exxon)**
Vacant	**Local Government Interests**
Vacant	**Industrial Interest**
Rick Cobb	**Liaison with the ICCG**

ICCG & GAC Coordinated GW Monitoring

- A Statewide Survey for Agricultural Chemicals in Rural, Private Water-Supply Wells in Illinois in 1992 (the study included pesticides and nitrate);
- The Illinois Generic Management Plan for Pesticides in Groundwater in 2006;
- The Illinois Department of Agriculture (IDA) program for nitrate analysis in a dedicated monitoring well network;
- The IDA program to assess groundwater in the hydrogeologically sensitive Havana Lowlands;

ICCG & GAC Coordinated GW Monitoring

- An ongoing Illinois EPA nitrate trend study of Community Water Supply Wells (reported in the 2014 Integrated Water Quality Report require under the Clean Water Act); and
- The Illinois EPA received a Supplemental Clean Water Act Section 106 Monitoring Grant on July 19, 2016 from U.S. EPA Region V to begin the assessment of the nitrate hot spots in the Havana Lowlands.

Statewide Survey for Agricultural Chemicals in Rural, Private Water-Supply Wells in Illinois

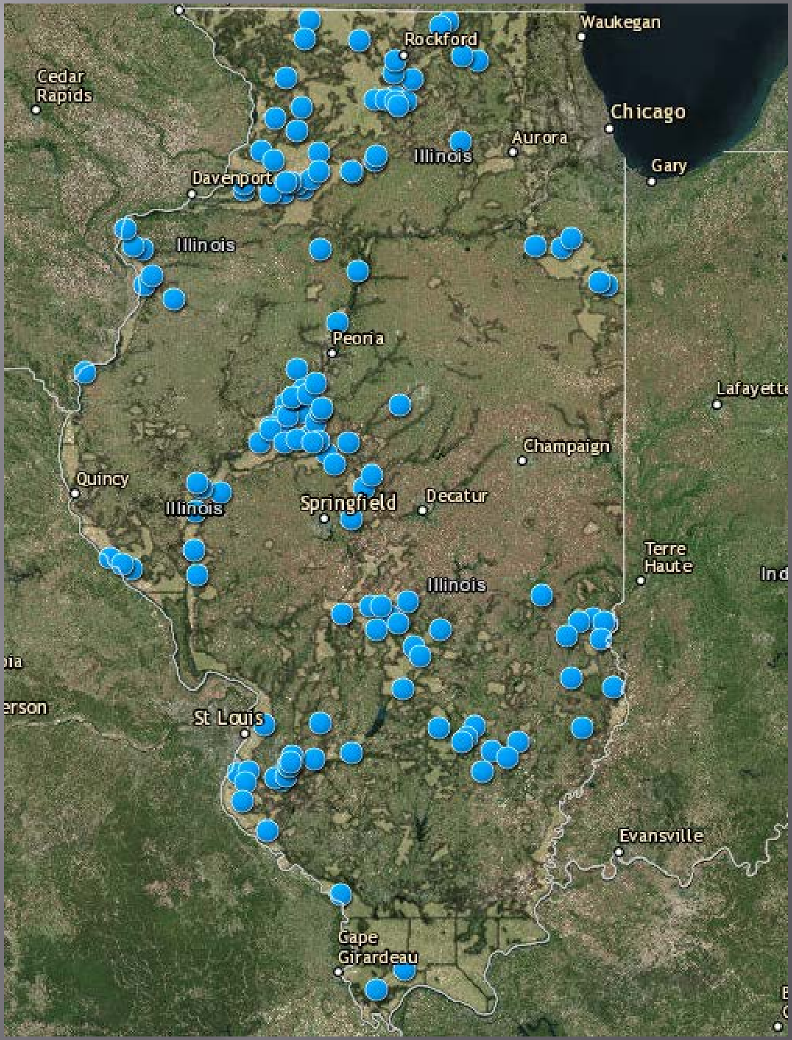
Statewide estimates for percent and number of rural, private wells containing pesticides and nitrate

	Estimated percent of wells	Confidence interval[1]	Estimated number of wells	Confidence interval
Pesticides (one or more detected)	12.1	7.5 --- 16.7	43,600	27,000 --- 60,100
Pesticides (> MCL/HAL)[2]	2.1	0.6 --- 3.6	7,560	2,160 --- 13,000
Nitrate-nitrogen (>10 mg/L)	10.5	6.7 --- 14.3	37,800	24,100 --- 51,500
Nitrate-nitrogen (>3 mg/L)	29.5	20.8 --- 38.3	106,000	74,900 --- 138,000

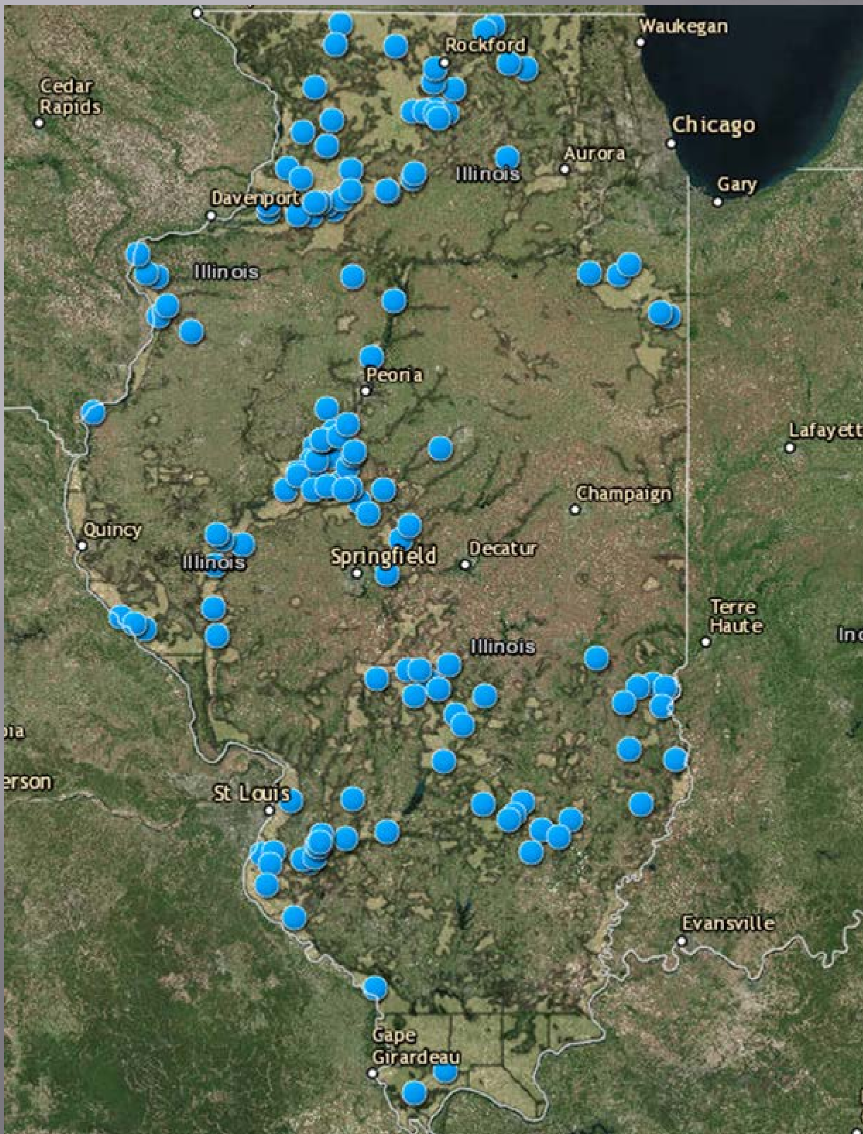
[1] The confidence interval is a statistical measure of the precision of the statewide estimates on the occurrence of pesticides and nitrate in rural private wells. The confidence interval indicates that there is a 95 percent probability that the true percentage of wells statewide is between the lower and upper limits shown. The confidence interval is determined by how the wells were selected for sampling, the number of wells sampled, and the percentage of wells contaminated.

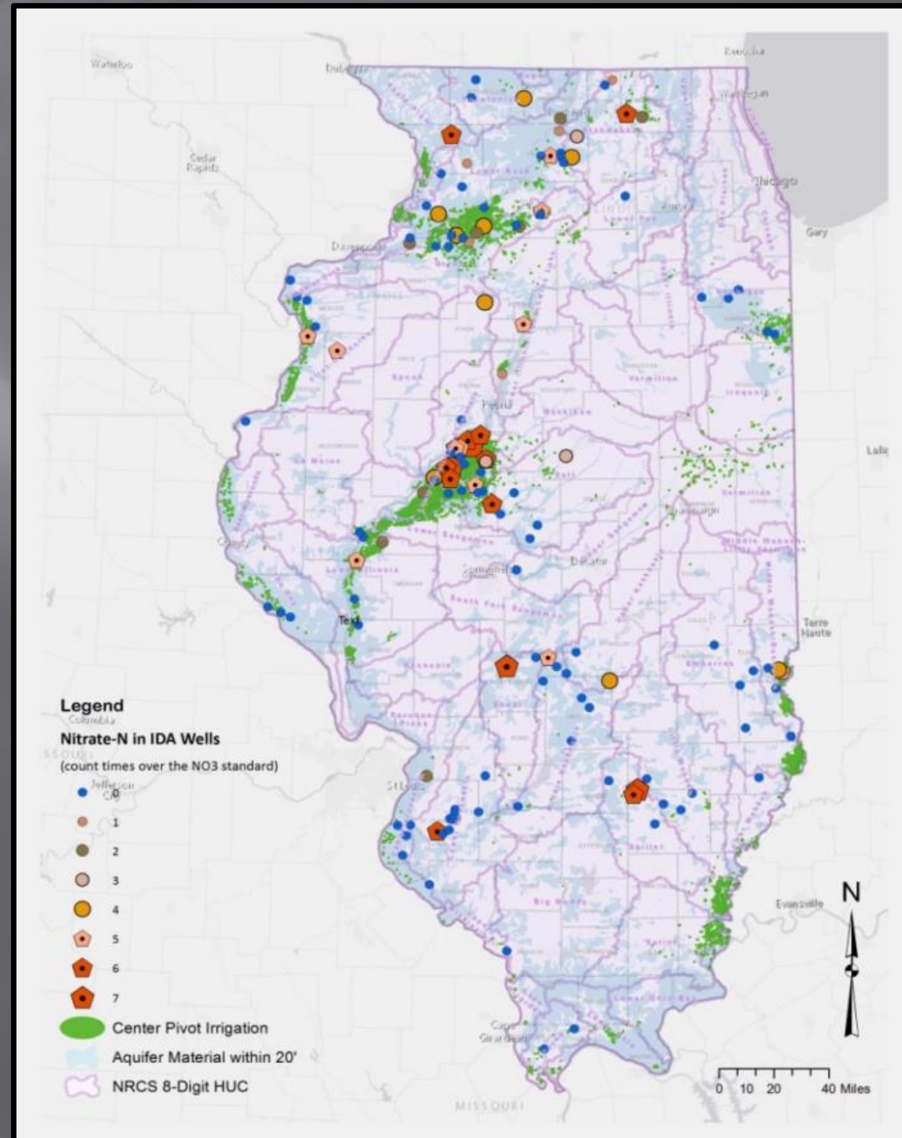
[2] The MCL (maximum contaminant level) is the maximum level of a contaminant permitted in public water supply systems. These enforceable standards do not apply to rural private wells. The HAL (health advisory level) is the concentration of a contaminant in water that may be consumed over a person's lifetime without harmful effects. HALs are non-enforceable health-based guidelines that consider only non-cancer effects. Only pesticides with MCLs or HALs were included in estimating the number of wells containing pesticides above health-based drinking water levels.

Illinois Generic Management Plan for Pesticides in Groundwater

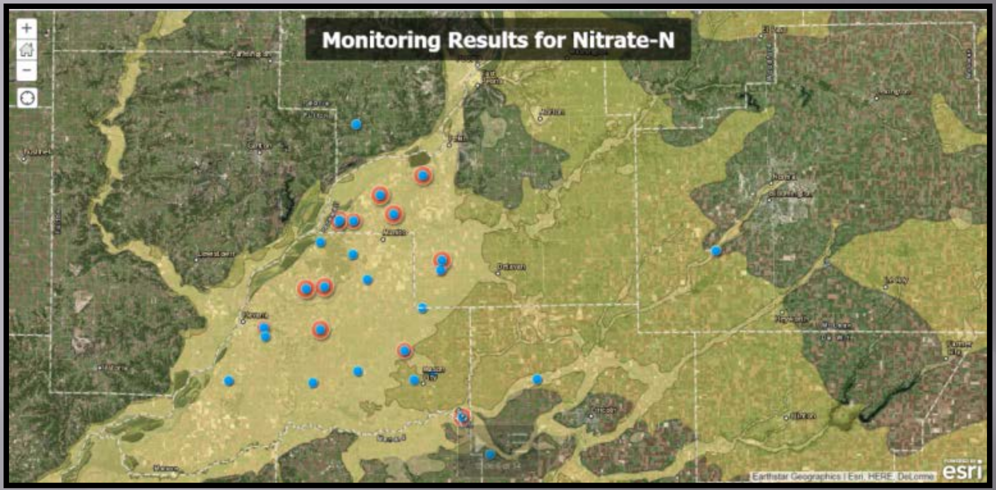


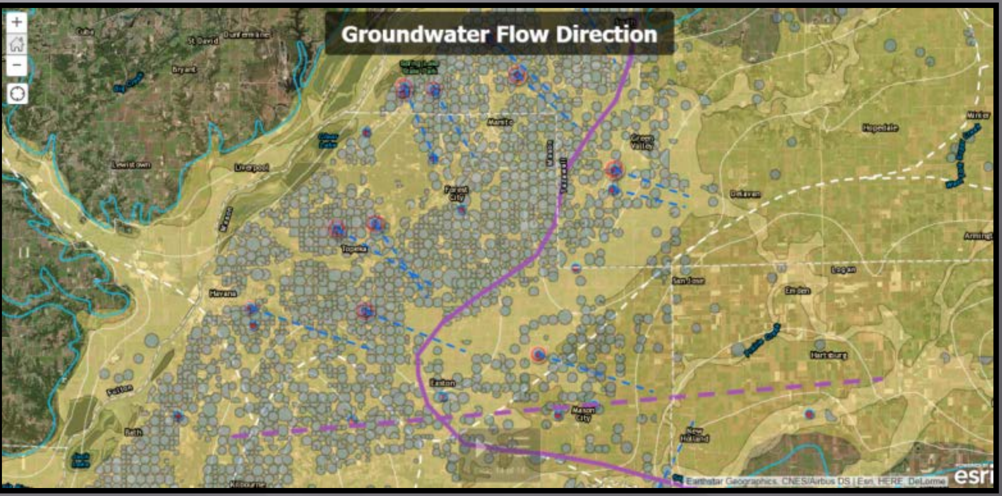
IDA Monitoring Network Nitrate Results





Havana Lowlands (HL)



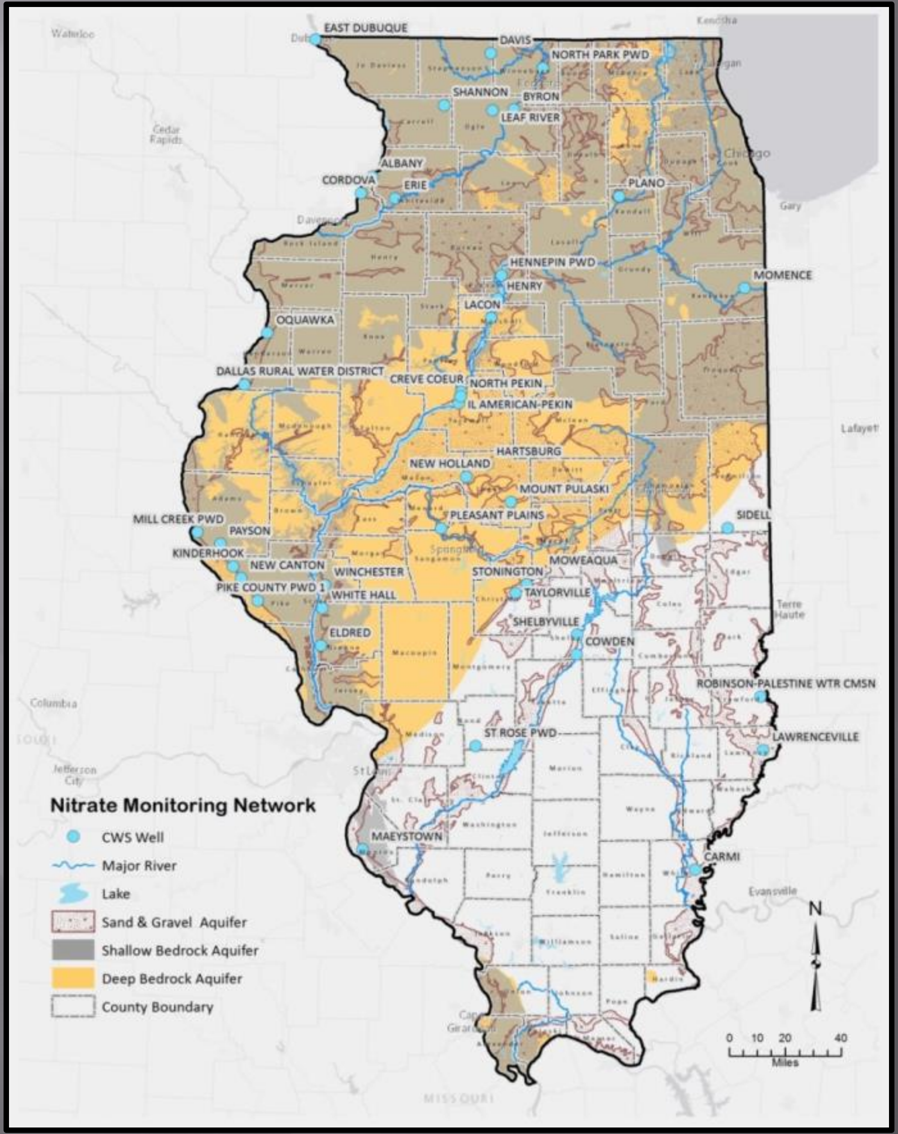


- 99 of 212 (46.6 %) samples analyzed in the HL had Nitrate-N concentrations greater than the numerical Class I GWQS of 10 mg/L;
- 9.2 mg/L of Nitrate-N is the median value of the area; and
- The individual well with the highest detected concentrations of Nitrate-N ranged from 18 to 48 mg/L with a median value concentration of 32 mg/L.

Fertigation

- Means injection of fertilizers, soil amendments, and other water-soluble products into an irrigation system.

CWS Nitrate Monitoring Network



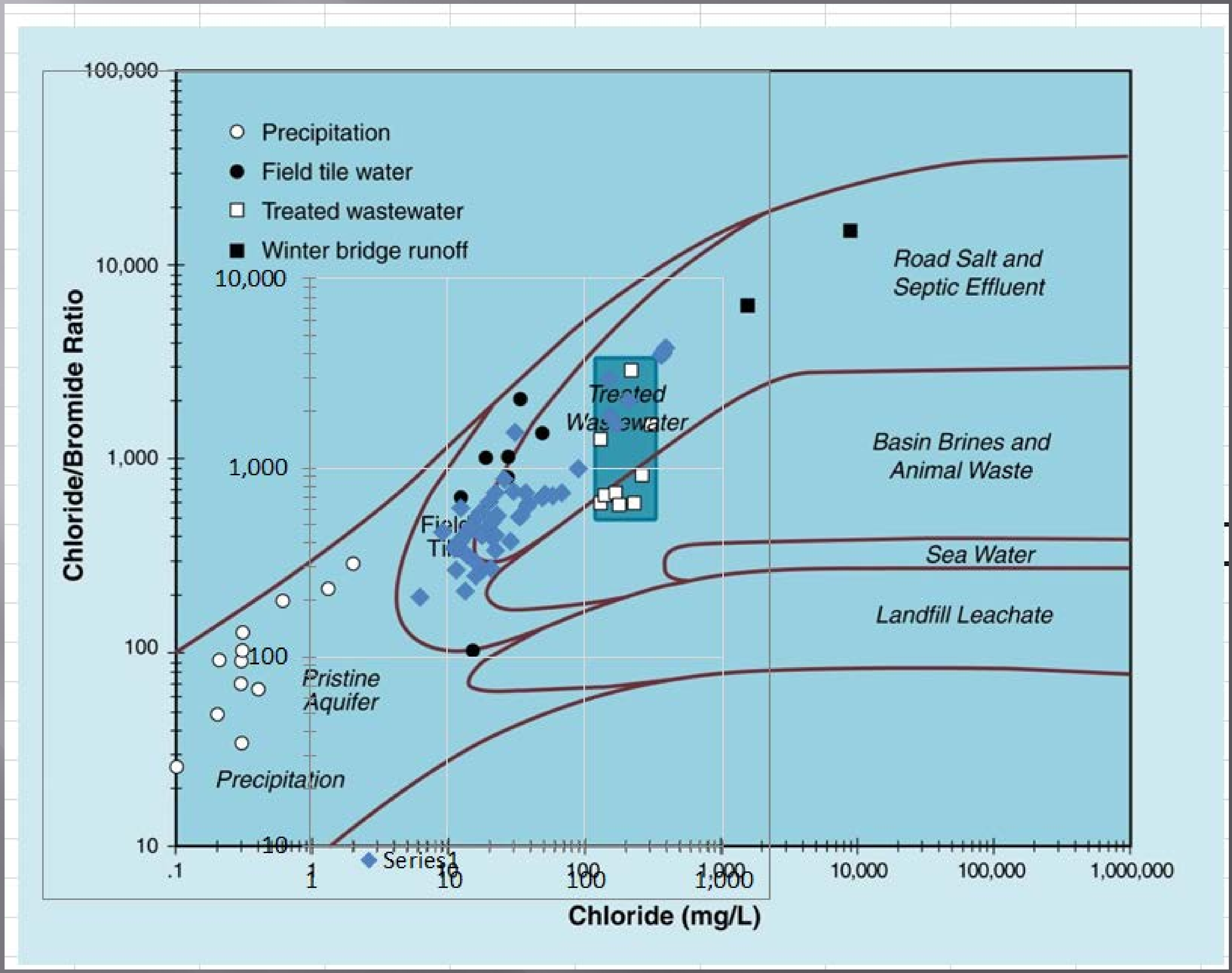
ground water

Estimating Background and Threshold Nitrate Concentrations Using Probability Graphs

by S.V. Panno[1], W.R. Kelly[2], A.T. Martinsek[3], and K.C. Hackley[4]

Abstract

Because of the ubiquitous nature of anthropogenic nitrate (NO_3^-) in many parts of the world, determining background concentrations of NO_3^- in shallow ground water from natural sources is probably impossible in most environments. Present-day background must now include diffuse sources of NO_3^- such as disruption of soils and oxidation of organic matter, and atmospheric inputs from products of combustion and evaporation of ammonia from fertilizer and livestock waste. Anomalies can be defined as NO_3^- derived from nitrogen (N) inputs to the environment from anthropogenic activities, including synthetic fertilizers, livestock waste, and septic effluent. Cumulative probability graphs were used to identify threshold concentrations separating background and anomalous NO_3-N concentrations and to assist in the determination of sources of N contamination for 232 spring water samples and 200 well water samples from karst aquifers. Thresholds were 0.4, 2.5, and 6.7 mg/L for spring water samples, and 0.1, 2.1, and 17 mg/L for well water samples. The 0.4 and 0.1 mg/L values are assumed to represent thresholds for present-day precipitation. Thresholds at 2.5 and 2.1 mg/L are interpreted to represent present-day background concentrations of NO_3-N. The population of spring water samples with concentrations between 2.5 and 6.7 mg/L represents an amalgam of all sources of NO_3^- in the ground water basins that feed each spring; concentrations >6.7 mg/L were typically samples collected soon after springtime application of synthetic fertilizer. The 17 mg/L threshold (adjusted to 15 mg/L) for well water samples is interpreted as the level above which liv-



Precipitation
Field tile water
Treated wastewater
Winter bridge runoff
Chloride/Bromide Ratio
Chloride (mg/L)
Road Salt and Septic Effluent
Basin Brines and Animal Waste
Sea Water
Landfill Leachate
Treated Wastewater
Pristine Aquifer
Precipitation
Series1
100,000
10,000
1,000
100
10
.1
1
10
100
1,000
10,000
100,000
1,000,000

CWS Nitrate Network Results

- 6.8 mg/L of nitrate is the mean concentration;
- 19 mg/L of nitrate is the maximum concentration; and
- 0.16 mg/L of nitrate is the minimum concentration.

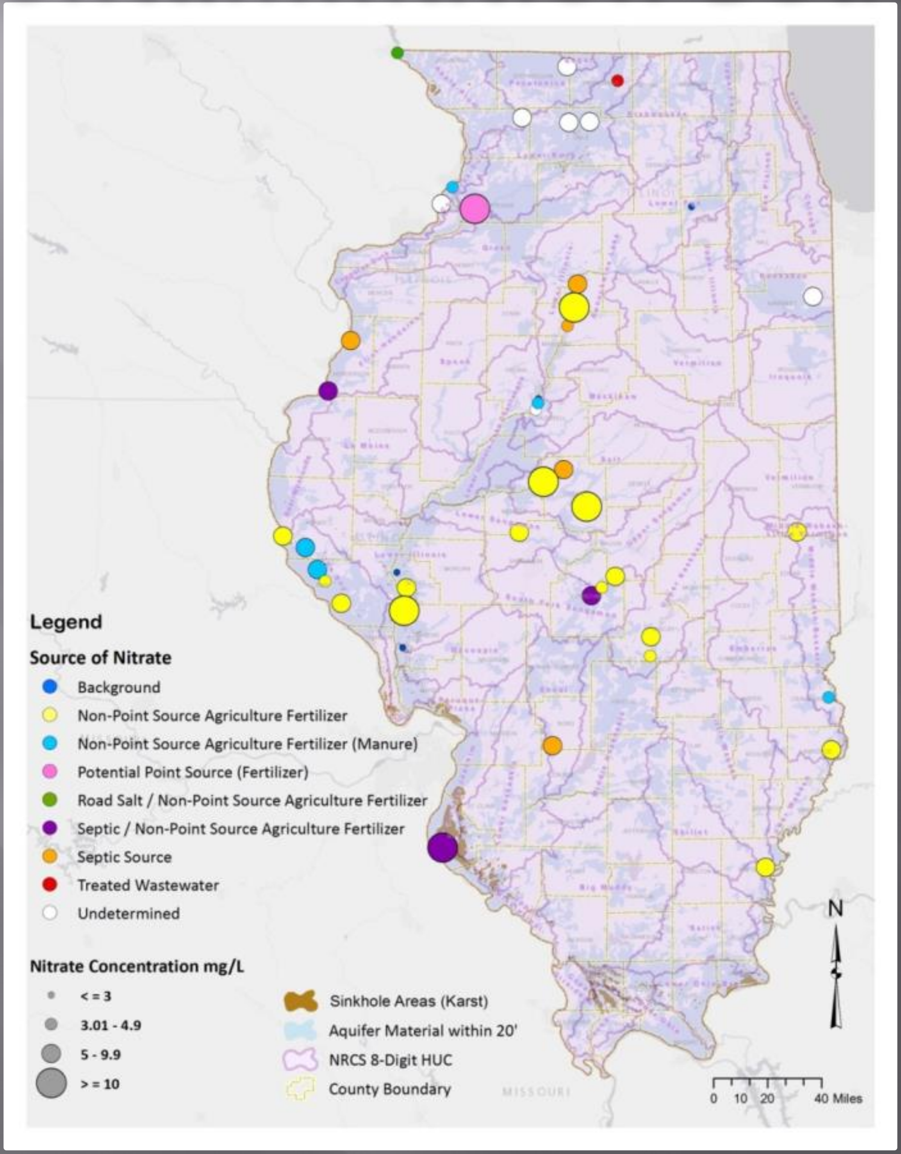
CWS Nitrate Network Sources

- 16 due to non-point source agricultural fertilizer;
- 5 due to non-point source agricultural fertilizer (manure spreading);
- 3 due to a mix of non-point source agricultural and septic sources;
- 1 due to a mix of non-point source agricultural and road salt;
- 5 due to septic system;
- 1 due to a waste water source;
- 1 due to a potential point source of fertilizer

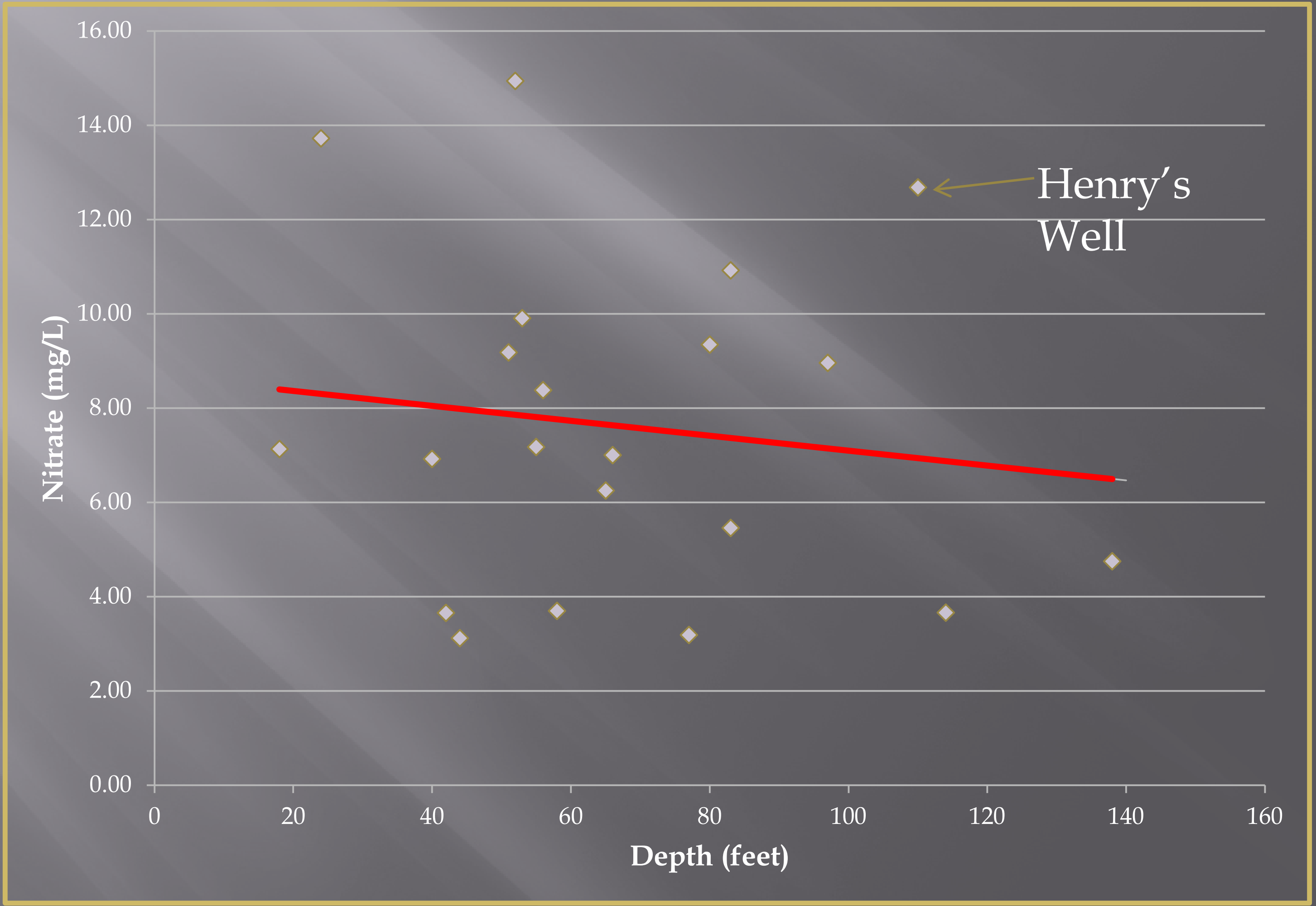
CWS Nitrate Network Sources Cont.

- 4 below background of 3 mg/L; and
- 7 undetermined sources.

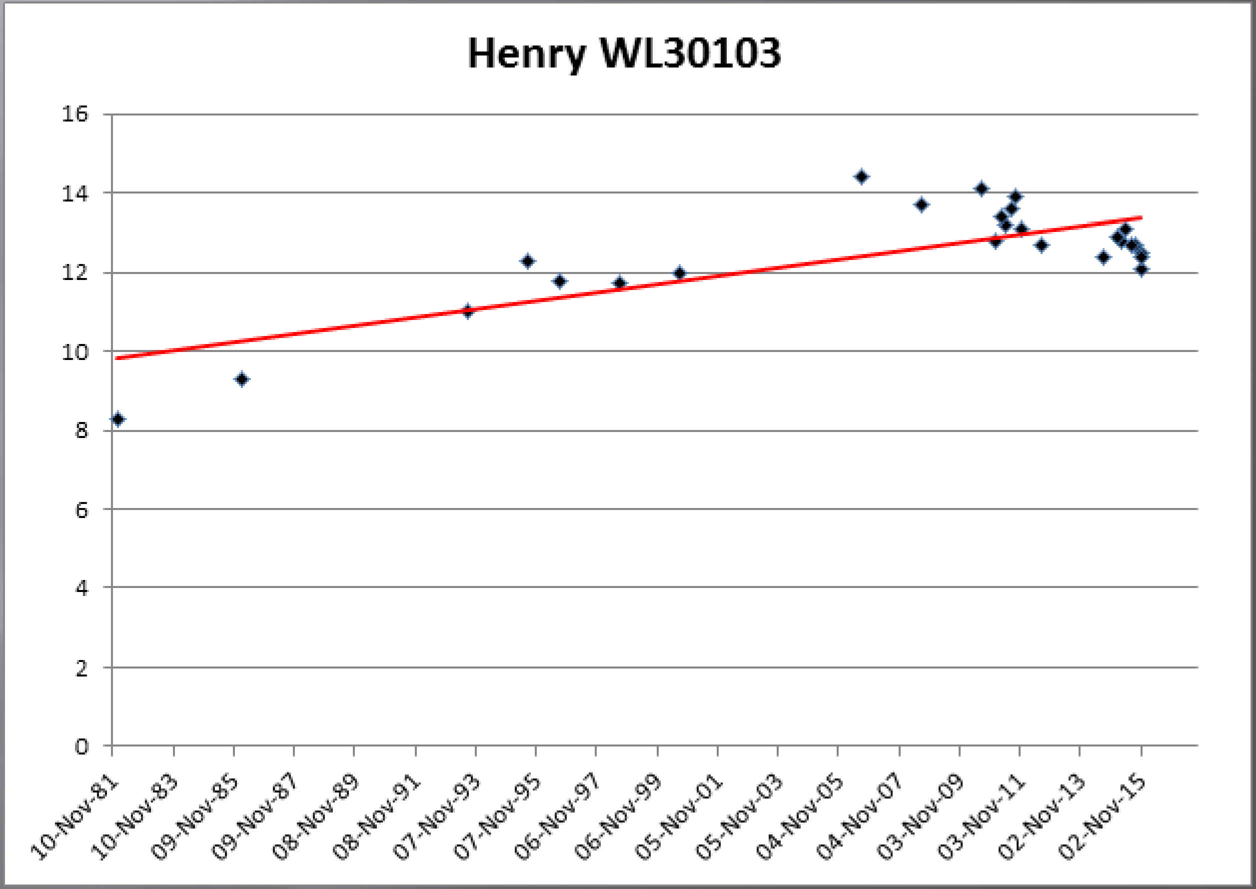
CWS Nitrate Concentration and Contamination Source

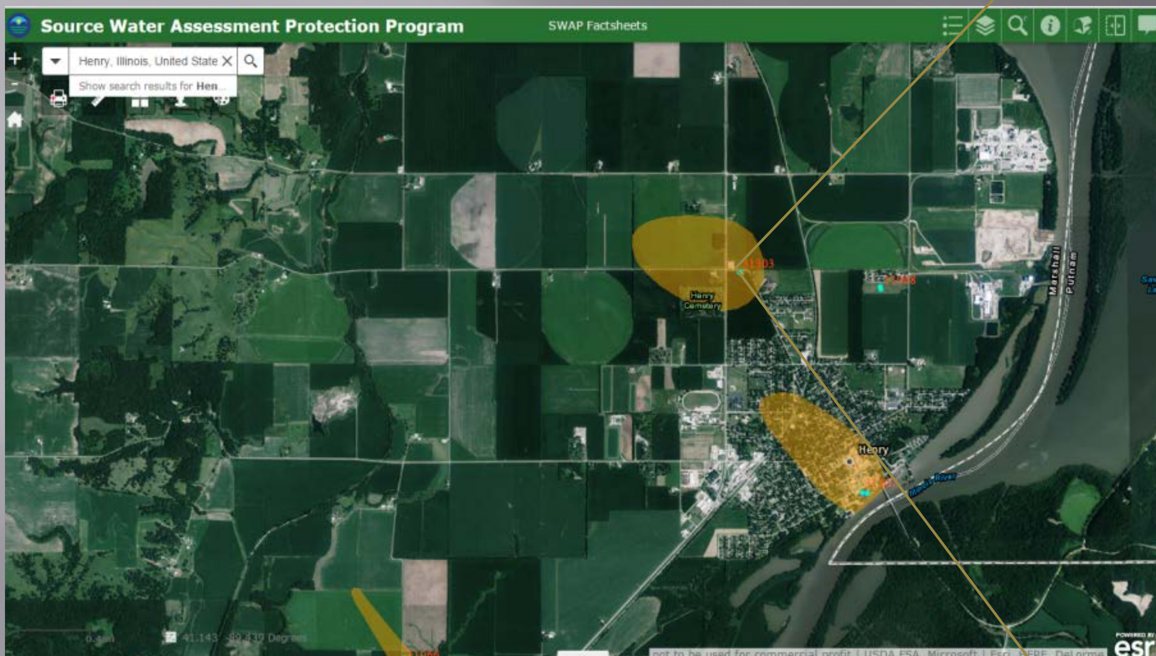


CWS Well Depth to Top of the Screened Interval *vs.* Nitrate Concentration



Nitrate Trend Analysis for Henry's Well





Page 1 **ILLINOIS STATE GEOLOGICAL SURVEY**

	Top	Bottom
sand & gravel	0	147
Total Depth		147

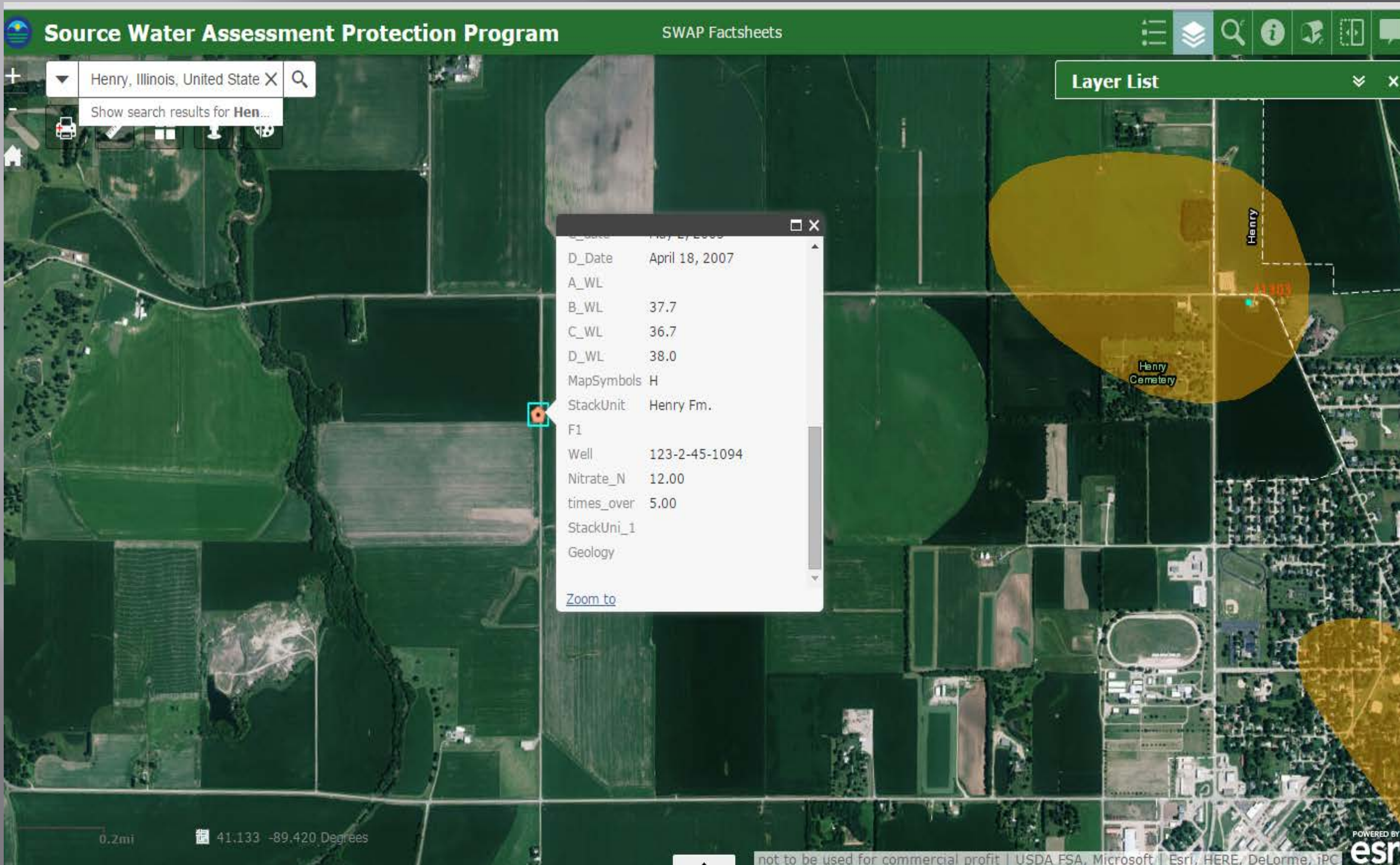
Casing: 16" STEEL 63# from 3' to 110'
Screen: 25' of 16" diameter .06 slot
Water from drift at 110' to 135'.
Static level 73' below casing top which is 3' above GL
Pumping level 87' when pumping at 670 gpm for 8 hours

Driller's Log filed
Company Sample Study filed
Sample set # 56575 (0' - 135') Received: October 9, 1969

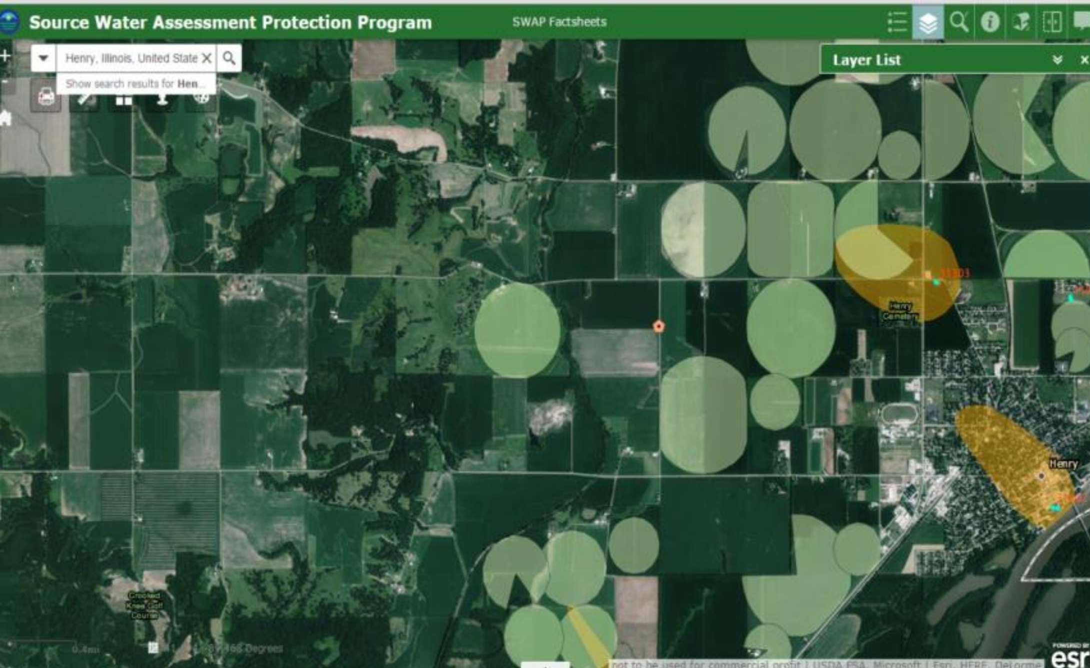
Owner Address: Henry, IL
Location source: Location from permit

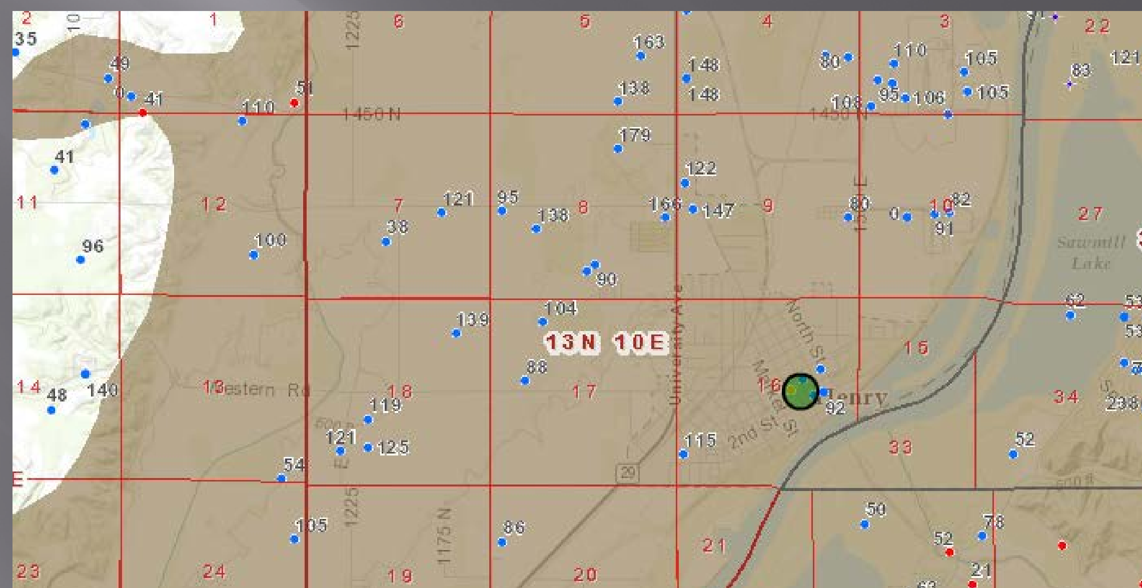
Permit Date: January 1, 1969 **Permit #:** NF 5522

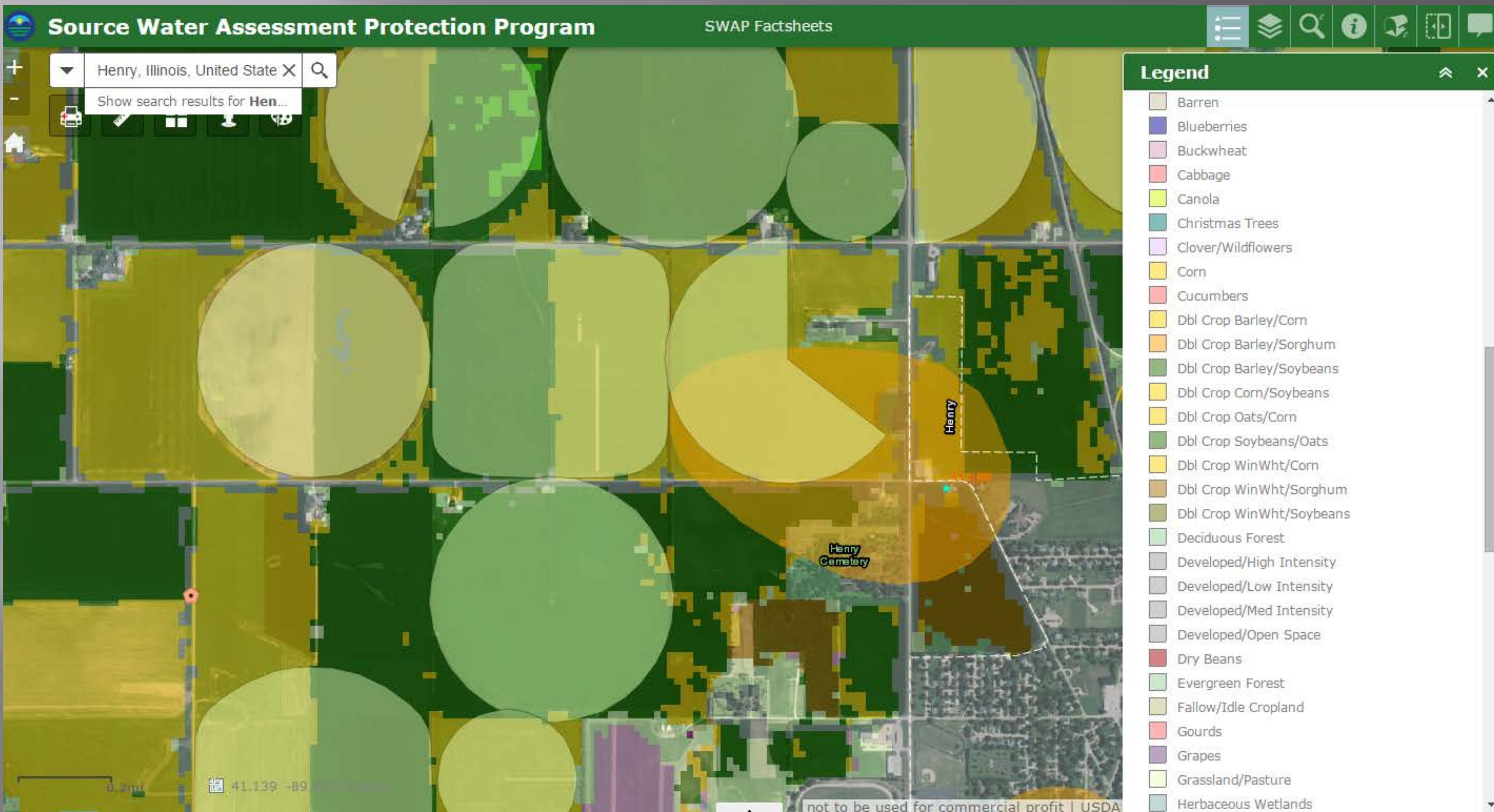
COMPANY Miller, J.P. Artesian Well Co.
FARM Henry, IL.
DATE DRILLED February 13, 1969 **NO.**
ELEVATION 0 **COUNTY NO.** 00145
LOCATION 100'N line, 160'E line of NW NW SW
LATITUDE 41.125792 **LONGITUDE** -89.367719
COUNTY Marshall **API** 121230014500 9 - 13N - 10E



Source Water Assessment Protection Program
SWAP Factsheets
Henry, Illinois, United State
Show search results for Hen...
Layer List
D_Date April 18, 2007
A_WL
B_WL 37.7
C_WL 36.7
D_WL 38.0
MapSymbols H
StackUnit Henry Fm.
F1
Well 123-2-45-1094
Nitrate_N 12.00
times_over 5.00
StackUni_1
Geology
Zoom to
Henry
Henry Cemetery
0.2mi
41.133 -89.420 Degrees
not to be used for commercial profit | USDA FSA, Microsoft | Esri, HERE, DeLorme, iPC
POWERED BY esri


Source Water Assessment Protection Program
SWAP Factsheets
Henry, Illinois, United State
Show search results for Hen...
Layer List
Henry


1450 N
Western Rd
13N 10E
University Ave
North St
Henry
2nd St
Sawmill Lake
1175 N


Source Water Assessment Protection Program
SWAP Factsheets
Henry, Illinois, United State
Show search results for Hen...
Legend
Barren
Blueberries
Buckwheat
Cabbage
Canola
Christmas Trees
Clover/Wildflowers
Corn
Cucumbers
Dbl Crop Barley/Corn
Dbl Crop Barley/Sorghum
Dbl Crop Barley/Soybeans
Dbl Crop Corn/Soybeans
Dbl Crop Oats/Corn
Dbl Crop Soybeans/Oats
Dbl Crop WinWht/Corn
Dbl Crop WinWht/Sorghum
Dbl Crop WinWht/Soybeans
Deciduous Forest
Developed/High Intensity
Developed/Low Intensity
Developed/Med Intensity
Developed/Open Space
Dry Beans
Evergreen Forest
Fallow/Idle Cropland
Gourds
Grapes
Grassland/Pasture
Herbaceous Wetlands
Henry
Henry Cemetery
not to be used for commercial profit | USDA

Section 106 Monitoring Grant

- This will help provide key beneficial NLRS information in assessing and managing nitrate in groundwater by:
  - Determining fluctuations in nitrate concentrations resulting from seasonal climatic changes or groundwater conditions such as dissolved oxygen or pH.
  - Assessing the amount of de-nitrification and source indication by conducting nitrogen gas and nitrogen isotope work.
  - Determining temporal nitrate concentrations resulting from agricultural practices such as irrigation or fertigation and possible best management practices that could mitigate these changes.

4 Primary Tasks Under the Project

1. The USGS will install a 4-inch monitoring well adjacent to an IDA monitoring well previously identified as containing consistently elevated nitrate concentrations ("hot spot well").

   A nitrate monitoring sensor will be installed and collect continuous nitrate data along with standard field parameters. Data collection frequency can range from 15 minute intervals up to 12 hours.

4 Primary Tasks Under the Project cont.

2. Data will be collected at the site for one year. Corroborating irrigation/fertigation records (e.g., Irrigation pumps being turned on and off and approximate pumping rates) in the immediate vicinity will also be obtained through cooperation with the IDA or other agricultural stakeholders.

   Discrete standard water-quality collection of nutrient samples will be collected three times, once at the beginning, during the middle, and at the end of data collection. These discrete data will be used to compare with continuously monitored nitrate concentrations.

4 Primary Tasks Under the Project cont.

3. Nitrate data, field parameters, climate records of temperature and precipitation, and local irrigation pumping records will be analyzed statistically to determine possible causal relations between nitrate concentrations and these possible change-inducing conditions.

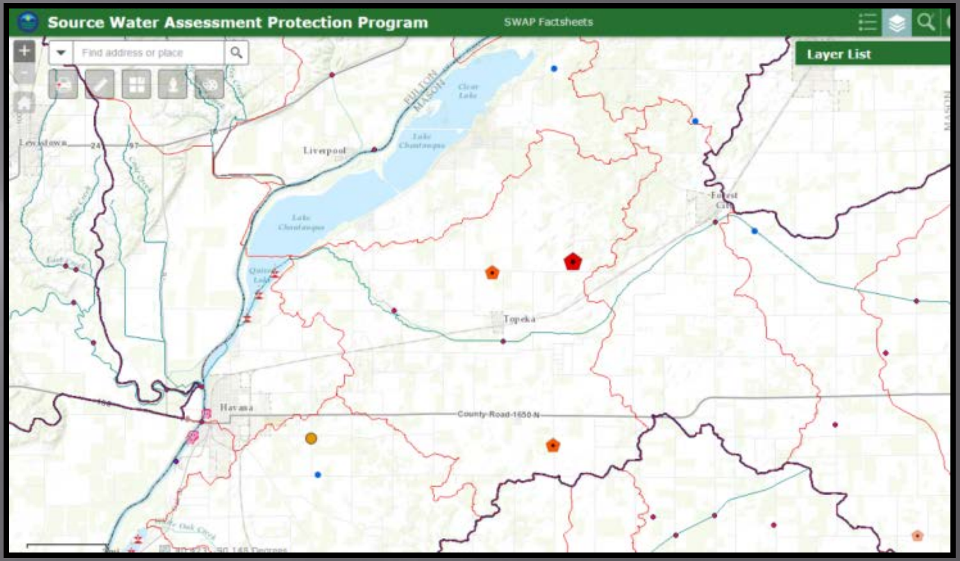
   Fluctuations in nitrate concentrations will be compared with nitrate data collected at the USGS supergage downstream (Illinois River at Florence).

4 Primary Tasks Under the Project cont.

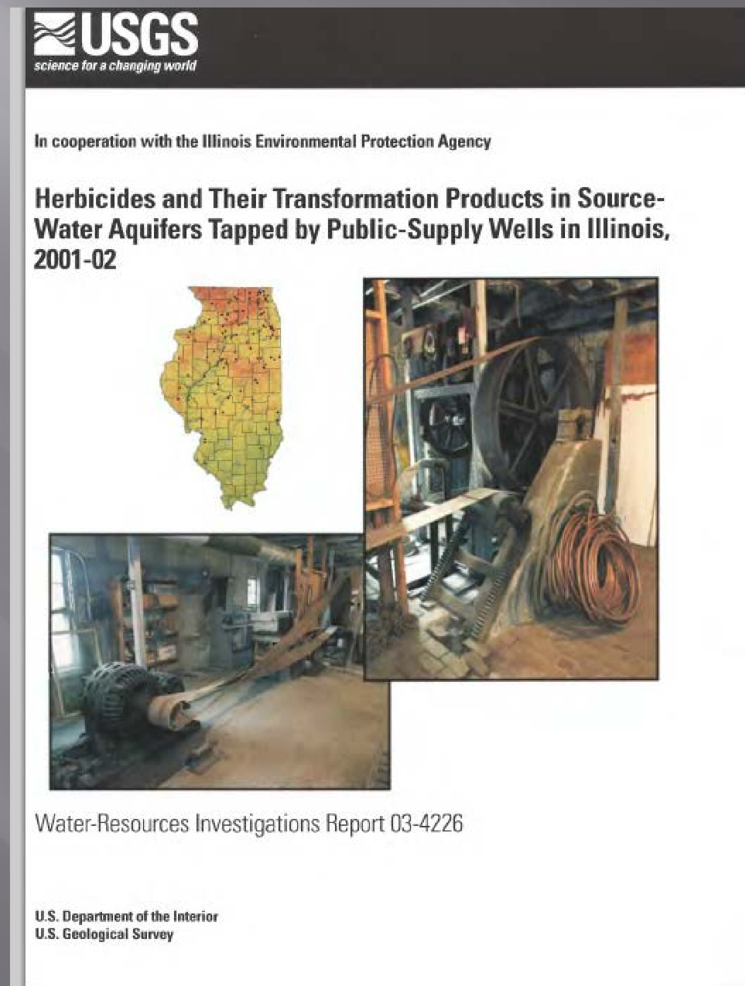
4. Quiver Creek, a surface-water discharge approximately 1.5 miles from a proposed “hot spot” well has a drainage area of 197 square miles and a Q 7/10 of 14 cubic feet per second (cfs) (9,000,000 million gallons per day (mg/d)). The 14 cfs is considered groundwater discharge (baseflow).

   Baseflow groundwater discharge conditions will be determined from climate observation, discharge, and empirical observation.

   Nitrate will be measured in surface and groundwater at baseflow conditions. A survey measuring nitrate and temperature (as well as pH, DO, SC, and surface-water discharge) will be conducted longitudinally at Quiver Creek in the reach of anticipated groundwater discharge to determine where groundwater concentrations are affecting stream quality.



Final Report


USGS
science for a changing world

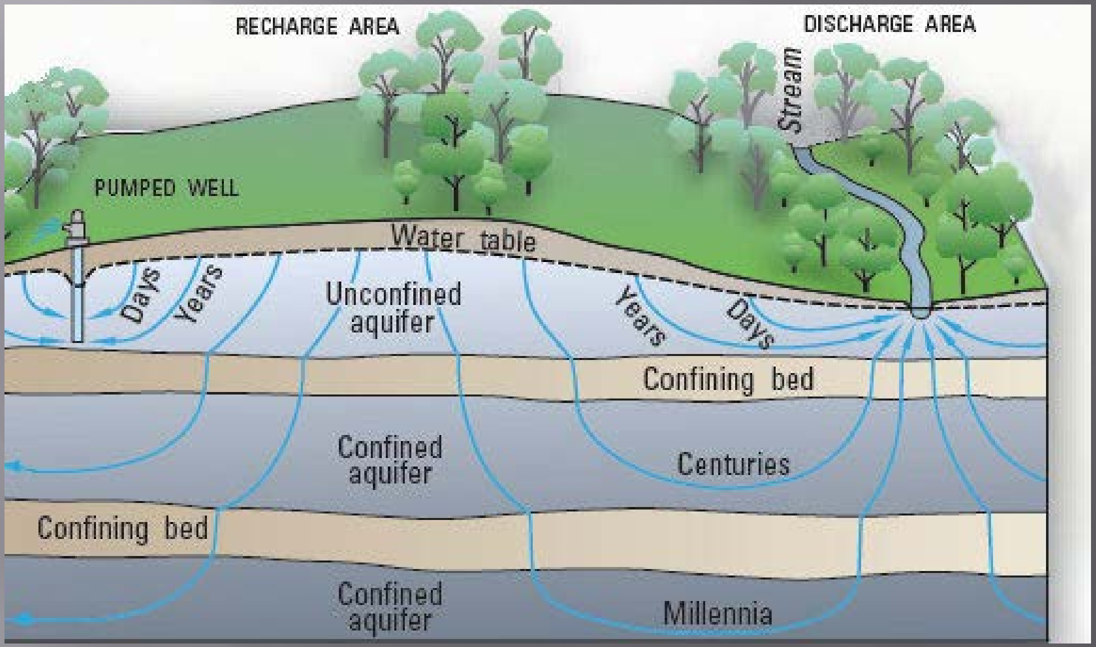
In cooperation with the Illinois Environmental Protection Agency

Herbicides and Their Transformation Products in Source-Water Aquifers Tapped by Public-Supply Wells in Illinois, 2001-02

Water-Resources Investigations Report 03-4226

U.S. Department of the Interior
U.S. Geological Survey

Questions


RECHARGE AREA
DISCHARGE AREA
Stream
PUMPED WELL
Water table
Days
Years
Unconfined aquifer
Years
Days
Confining bed
Confined aquifer
Centuries
Confining bed
Confined aquifer
Millennia

Nutrient Monitoring Council Update of the Metropolitan Water Reclamation District of Greater Chicago's Nutrient Recovery Efforts

Nutrient Monitoring Council Meeting
#5. July 28, 2016

Justin Vick, Aquatic Biologist MWRDGC

SWRP

- Serves 2.38 million people
- Flows:
  - Design Capacity: 1,200 MGD
  - Average 2013: 676 MGD
- 4 aeration batteries
  - 8 tanks/battery
  - 4 passes/tank
  - 96 circular secondary

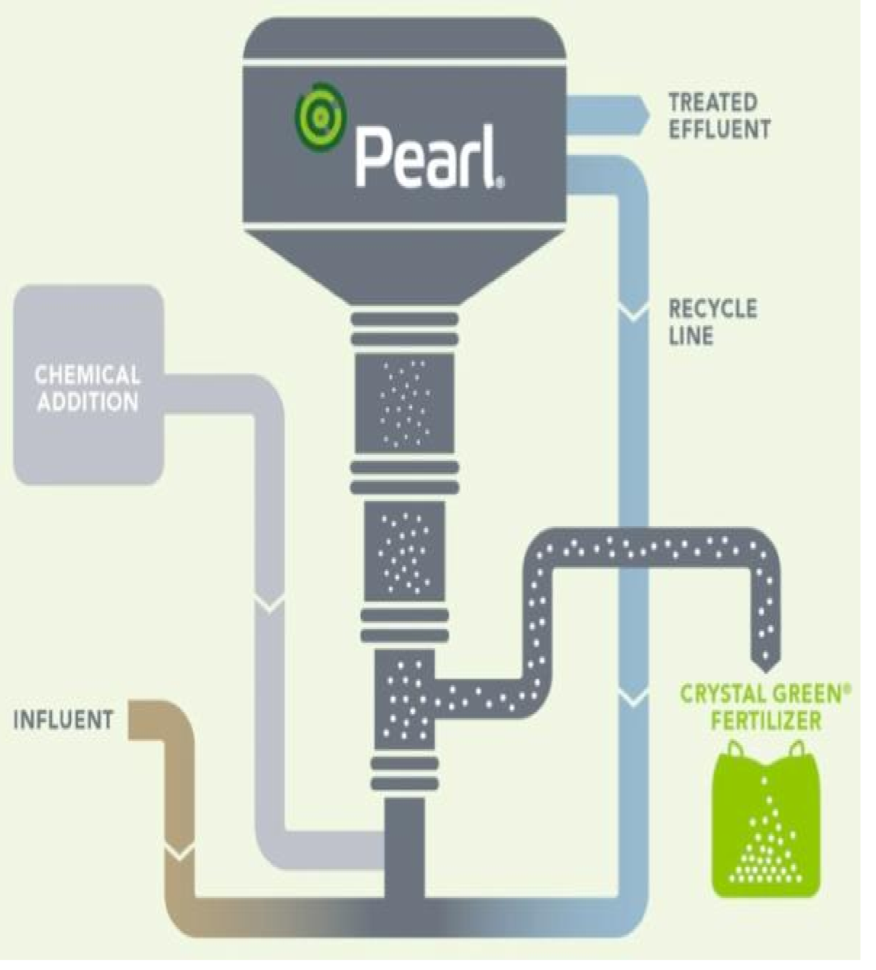
What is Struvite?

$$Mg^{2+} + NH_4^{+} + PO_4^{3-} \rightarrow MgNH_4PO_4\cdot 6H_2O$$

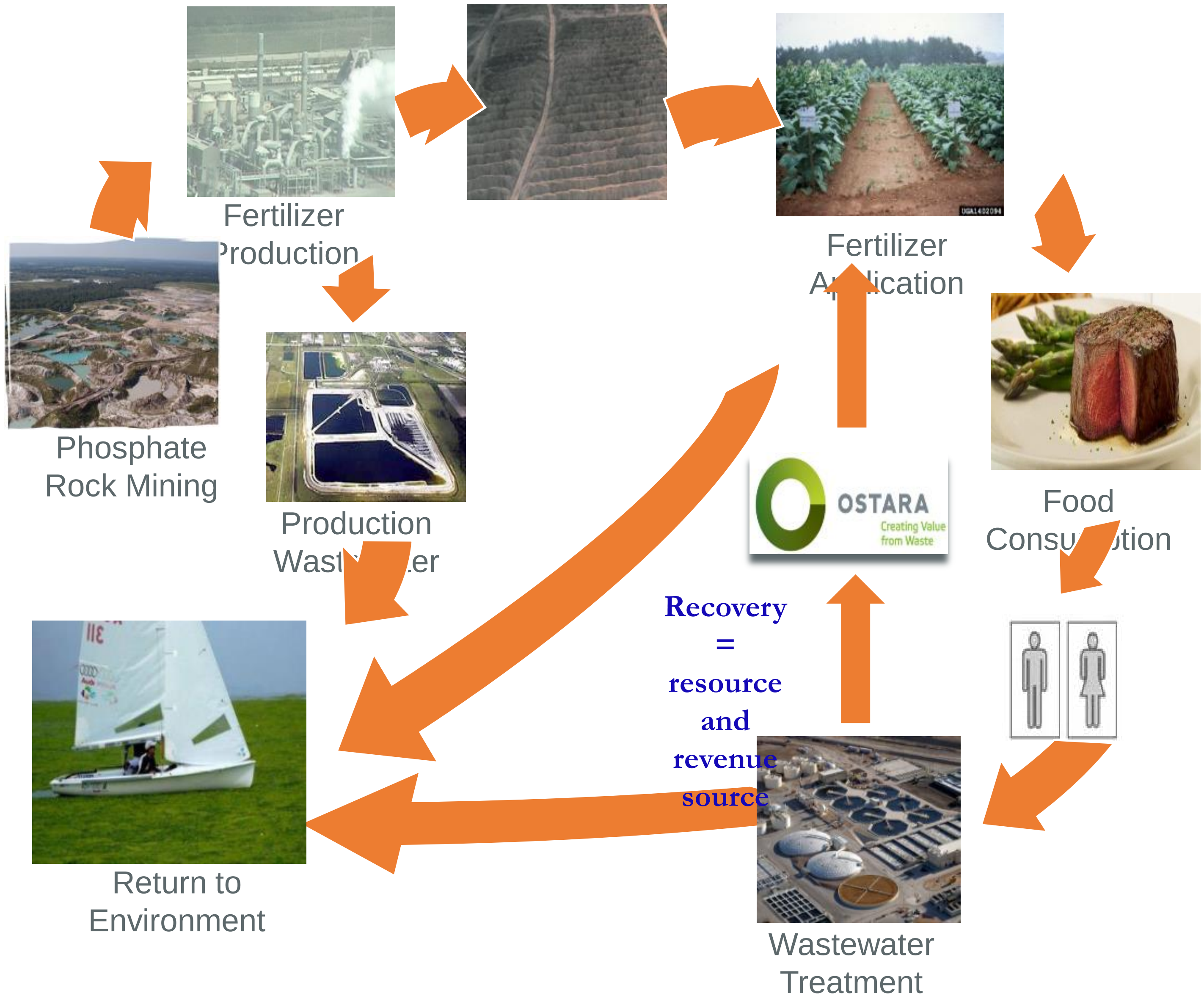
- Naturally occurring
- Exists in most wastewater plants
- Forms mostly in anaerobic digesters and post-digester operations
- Increases O & M co
  - Digester cleaning
  - Chain knocking
  - Flush water
- Impacts plant relia

P Recovery Process – Principle of Operation

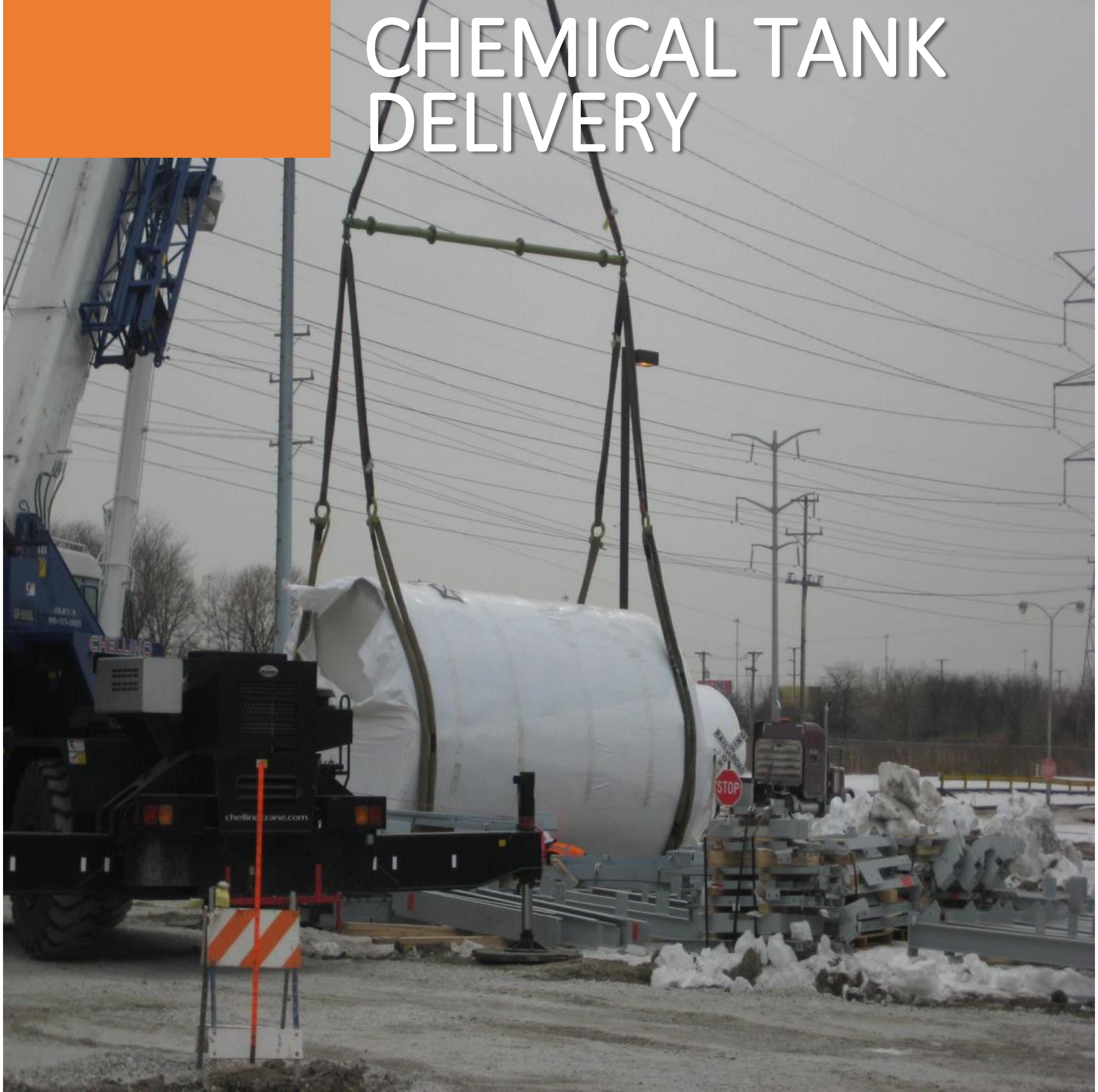
- Use of centrate and P-rich streams in WWTPs as feed
- Streams pumped upward through the bottom of the reactor
- Supersaturation conditions as driving force
  - Inject NaOH to raise pH to 7.7
  - Inject MgCl2 at a molar ratio of 1.1:1 (Mg:P)
  - Spontaneous crystal nucleation occurs
- Deposition on surface of crystals occurs as chemical driving force reduces
- Crystals grow through this precipitation
  - Pellets recycled for further growth



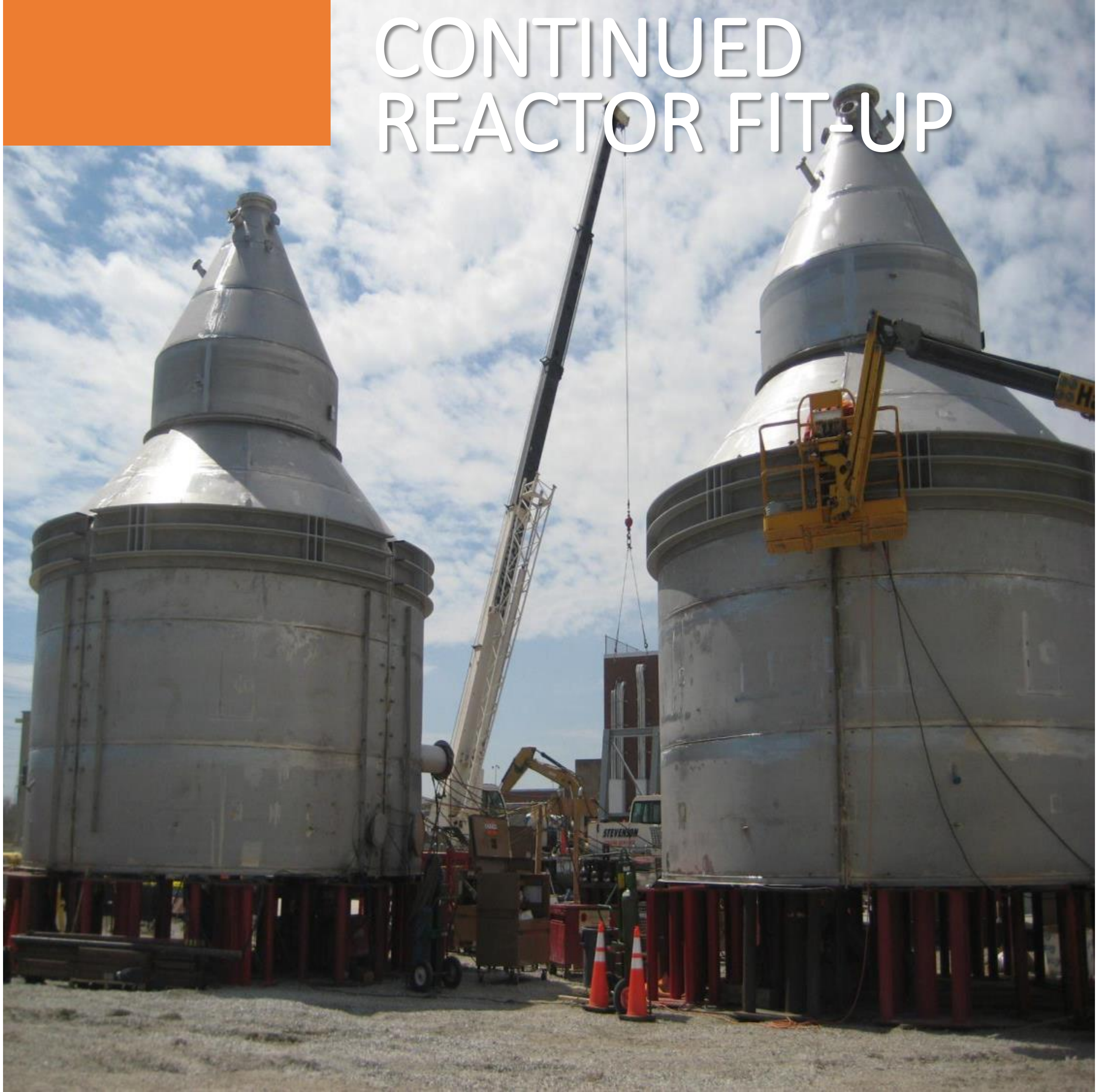
Future Phosphorus "Lifecycle"



CHEMICAL TANK DELIVERY



CONTINUED REACTOR FIT-UP




SWRP Phosphorus Recovery System
Contract 11-195-AP
Black & Veatch Construction, Inc.
11401 Lamar Ave.
Overland Park, KS 66211
View Direction: North
Location: South of SOG
Work: Reactor Reactor C - Critical Lift Installation
Photo No.: IMG_2698.JPG
STEVENSON
STEVENSON
07/22/2015 08:21


SWRP Phosphorus Recovery System
Contract 11-195-AP
Black & Veatch Construction, Inc.
11401 Lamar Ave.
Overland Park, KS 66211
View Direction: Southwest
Location: Central Ave. Bridge
Work: PRB Aerial
Photo No.: IMG_3015.JPG
03/02/2016 12:16

Complete Ostara System

Crystal Green Storage & Bagging

Dewatering Screen & Dryer

Pearl Reactors

Chemical Storage & Feed

Finished Product

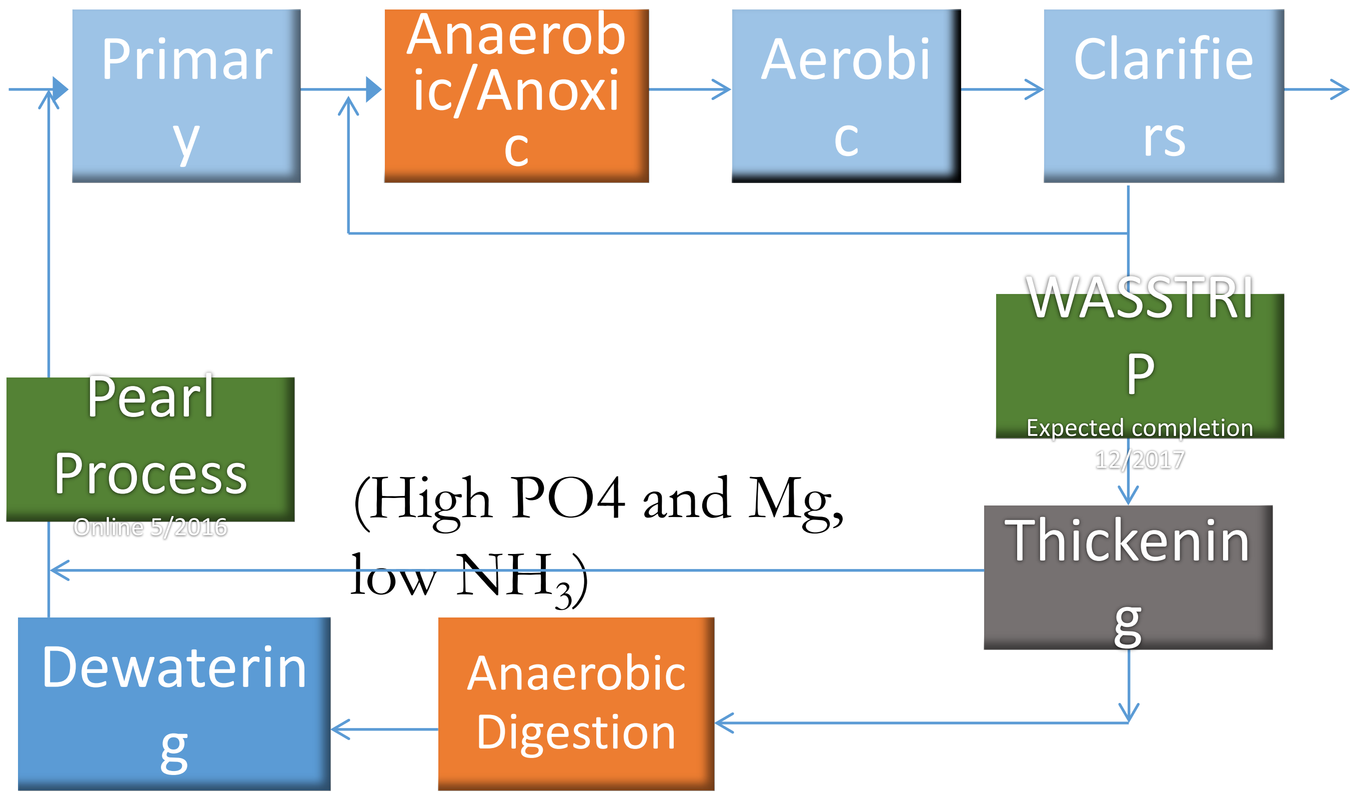
Crystal Green®

High Purity (99.5% Struvite)
5-28-0 +10% - Slow Release Fertilizer

Phosphorus | Nitrogen | Magnesium

- Enhanced Efficiency Fertilizer
- Reduces risk of nutrient run-off
- Sustainably made, with eco-friendly, high-performance benefits

Phosphorus Recovery – Breaks Recycle of P and WASSTRIP Protects Digesters from Struvite Formation

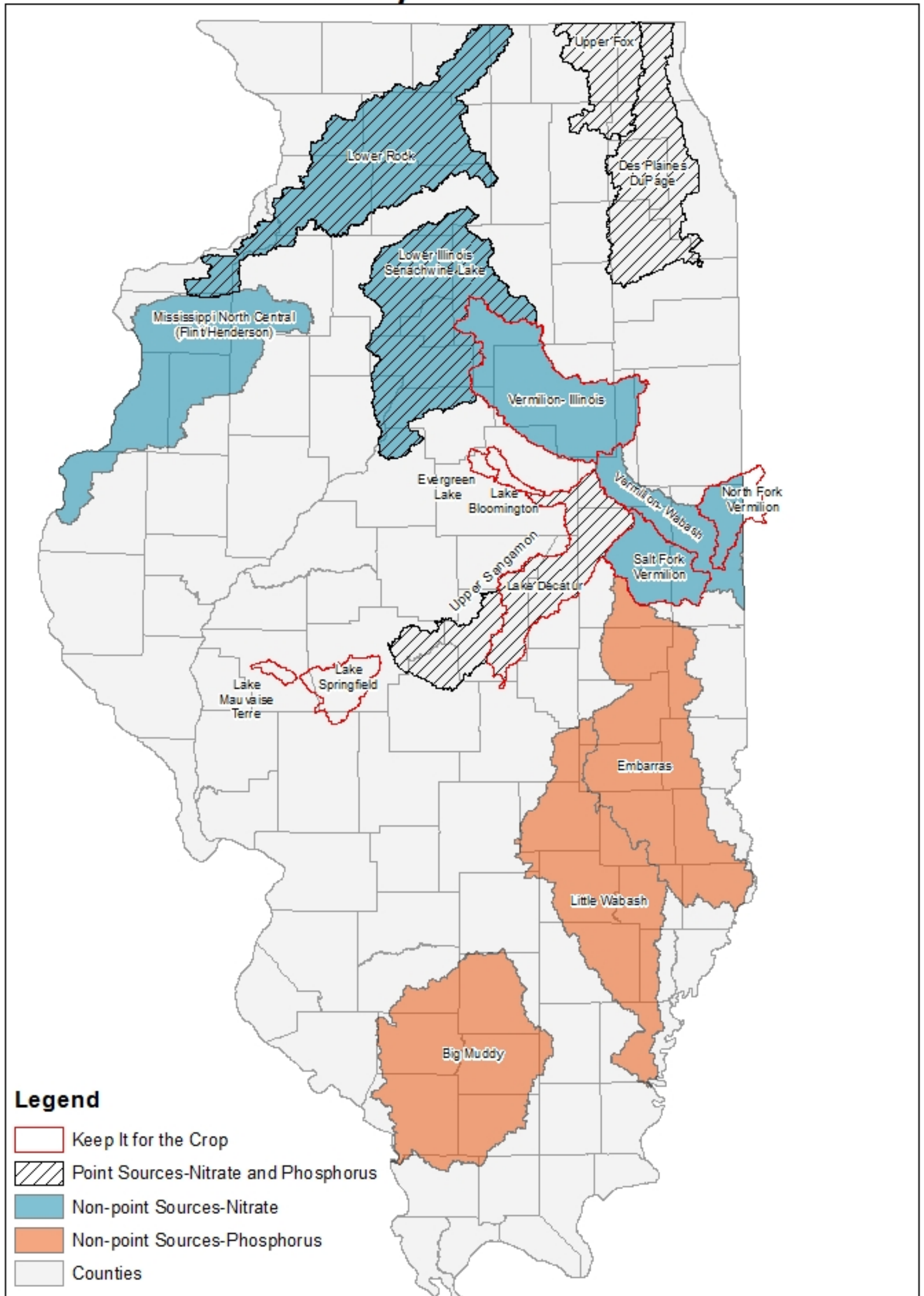


Todays lunch – Woohoo!

Our Collective Goal in *Priority Watersheds*

- *"To hopefully show nutrient reduction and water quality progress through monitoring."*
  - N and P reduction in NLRS Priority Watersheds or Sub-Watersheds (Charge 1b)
  - Trends Over Time (Charge 1c)
  - Local Water Quality Outcomes (Charge 2)
- Want to ultimately develop ***Watershed Nutrient Monitoring Plans*** in all priority watersheds, *but where do we start*?

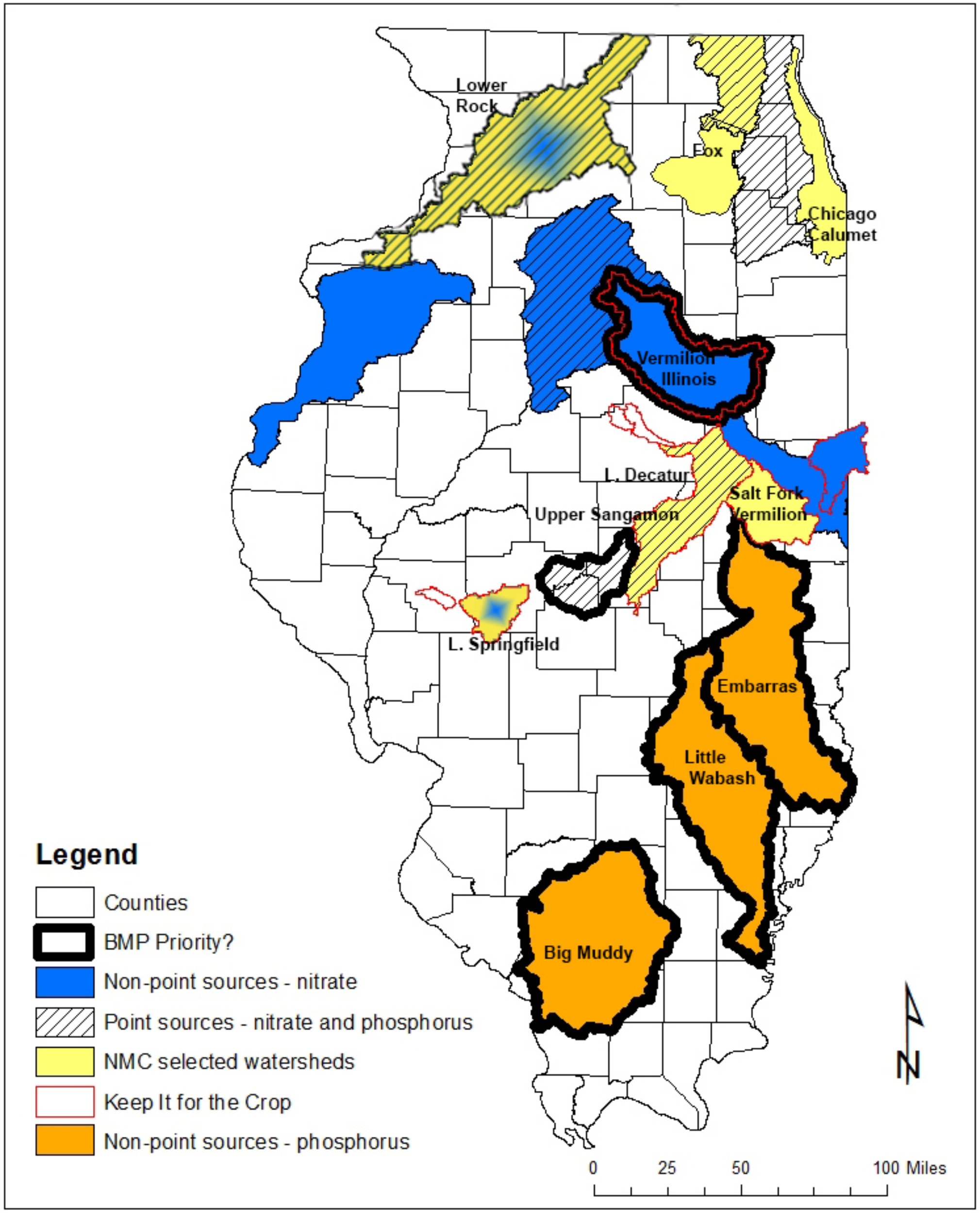
Illinois Nutrient Loss Reduction Strategy
Priority Watersheds



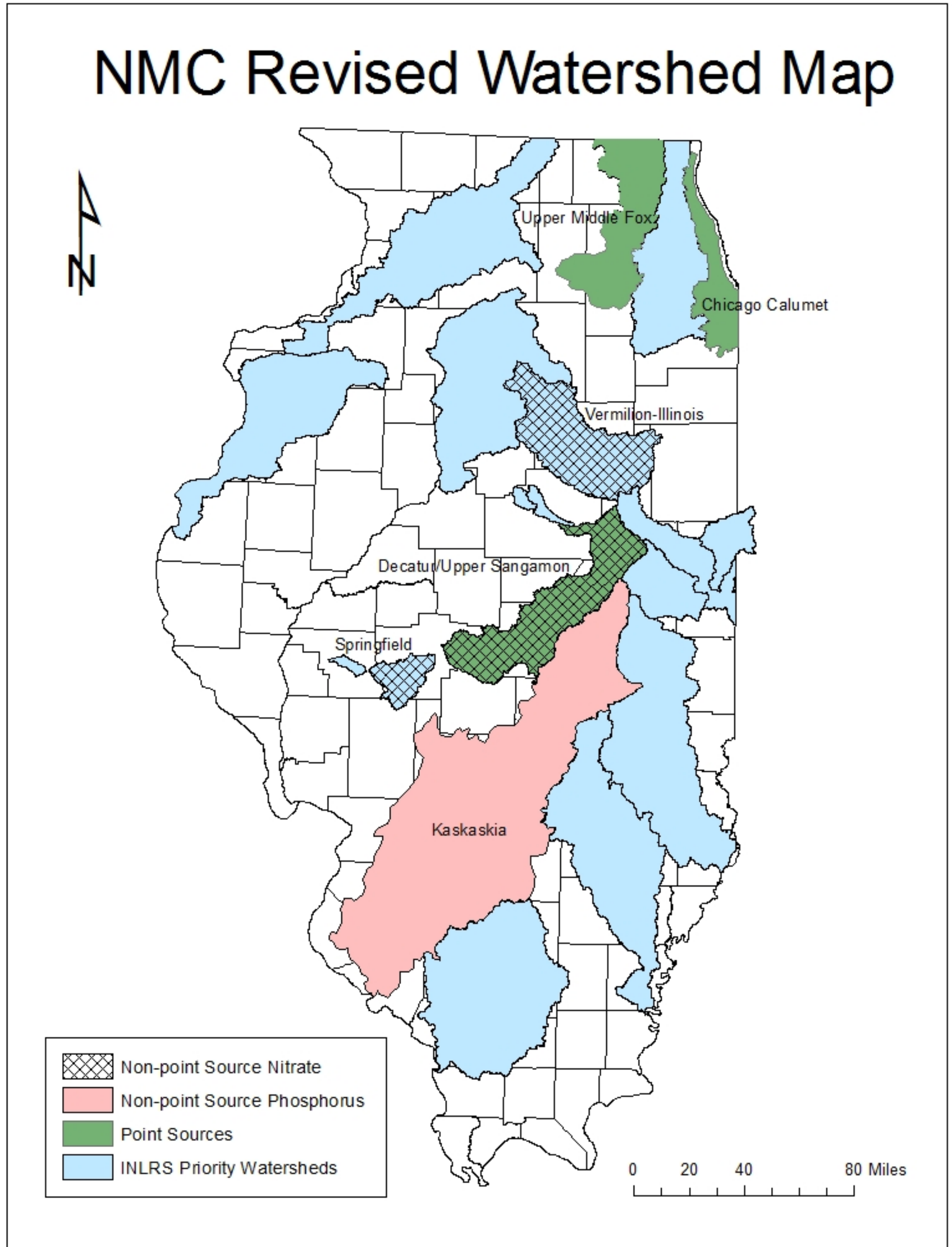
ILLINOIS NUTRIENT LOSS REDUCTION STRATEGY | Improving our w
collaboration ar

Where to start? Past exercises to identify where most of the monitoring and implementation is happening.

Illinois Nutrient Loss Reduction Strategy Priority Watersheds



Watersheds selected at April 5, 2016, Nutrient Monitoring Council meeting as places to start with the development of ***Watershed Nutrient Monitoring Plans.***



What would a *Watershed Nutrient Monitoring Plan* look like?


Upper Mississippi River
Clean Water Act Monitoring Strategy 2013-2022
RECOMMENDED MONITORING PLAN

February 2014

Upper Mississippi River Basin Association

Funding for this project provided by the Illinois Environmental Protection Agency through Section 106 of the Clean Water Act.

- Background
- Overall Scope and Goals
- Monitoring Function (e.g., loads, trends, local WQ improvements)
- Monitoring Design (e.g., targeted, fixed, probabilistic, follow-up, ….chemical, physical, and biological indicators)
- Implementation (e.g., staffing-who?, timeline, costs, funding/in-kind resources, next steps)

Developed *NLRS Priority* *Watershed Nutrient Monitoring Plans* allow us to be ready to rock n’ roll when resources become available!

Watershed Nutrient Monitoring Plans

- Hoo Hoo develops each plan?
  - Are these "other duties as assigned?"
  - Will there be a budget for their development?
- How do we ultimately retrieve, aggregate, and display monitoring data collected by multiple organizations?
- What are our WQ and Biological data needs, and how do we "assess" loadings, trends, and water resource quality improvements?
- Lots of questions to explore! So.....
  - ***Lee – Display of currently available monitoring data***
  - ***Warner/Keefer – Nutrient/Flow data parameters***
  - ***Holtrop/Casper/Vick – Biological data parameters***

NCSA

Exploring IEPA Ambient Water Quality Monitoring Network Data with Great Lakes To Gulf Virtual Observatory

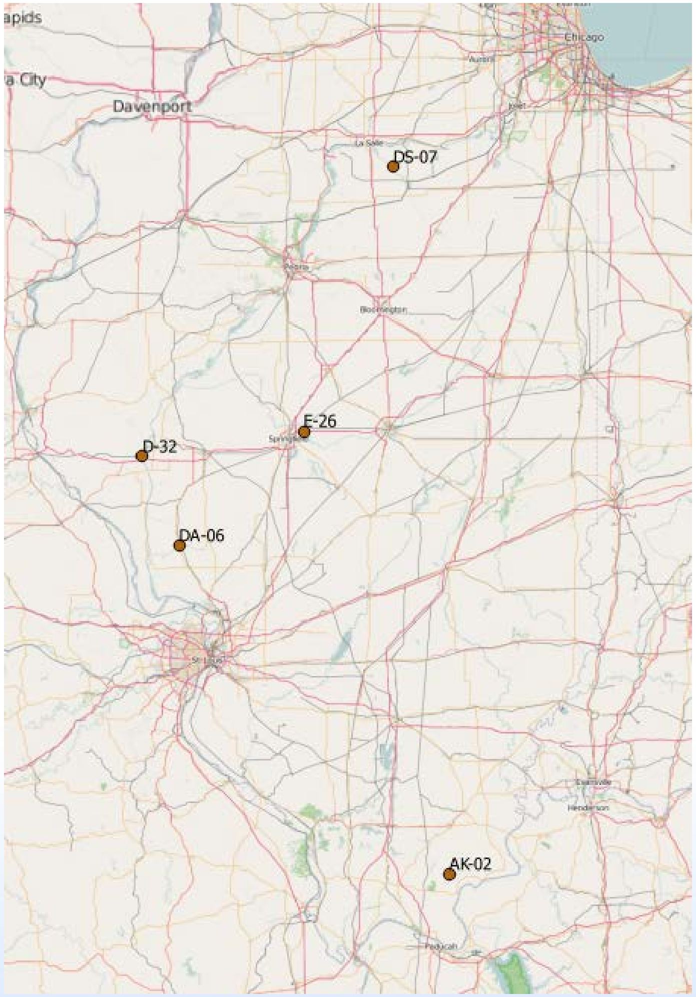
Jong Sung Lee (jonglee1@illinois.edu)
Senior Research Scientist, NCSA

July 28th, 2016 @ 5th Nutrient Monitoring Council Meeting

National Center for Supercomputing Applications
University of Illinois at Urbana-Champaign

Data

- The requested data is acquired via STORET
  - https://ofmpub.epa.gov/storpubl/dw_pages.querycriteria
- Five IEPA AWQMN stations
  - AK-02, D-32, DA-06, DS-07, E-26
  - Requested Parameters:
    - Nitrogen – NO_3+NO_2
    - Nitrogen - Kjeldahl
    - Nitrogen - Ammonia
    - Phosphorus, Total
    - Phosphorus, Dissolved



Purpose

- How feasible is it to load IEPA AWQMN (Ambient Water Quality Monitoring Network) data to GLTG GeoDashboard?
  - Reviewed the methodologies to acquire data
  - Loaded the sample data to GLTG GeoDashboard

STORET Data Warehouse

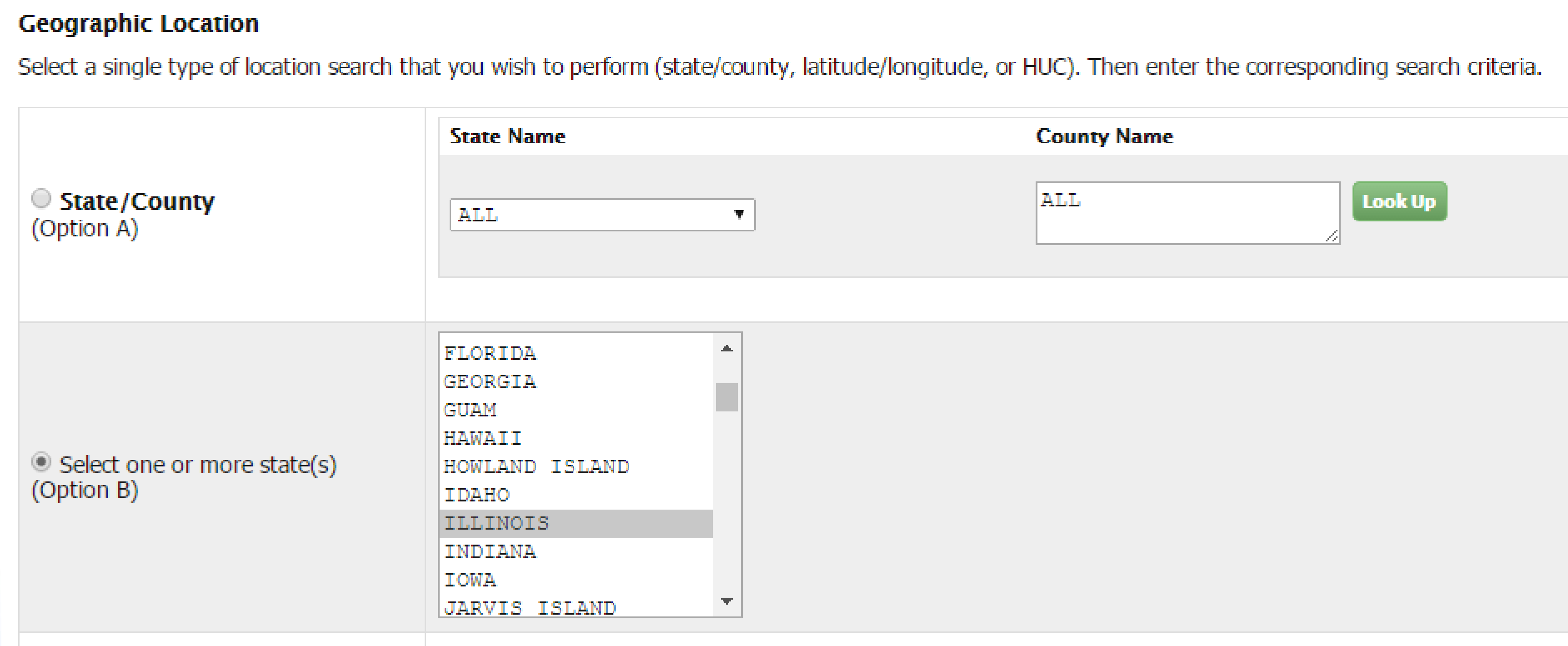
- EPA's repository of the water quality monitoring data collected by water resource management groups
- All data supplied to EPA since January 1, 1999 have been placed in the STORET Data Warehouse.
  - Biological Results
  - Habitat Results
  - Physical/Chemical Results
  - Metrics
  - Indices

Two Ways to Acquire STORET Data

- 1. Creating a query on STORET web interface and downloading the results
- 2. Acquiring data (results) directly via STORET web service
- For this exercise, we used #1 method.

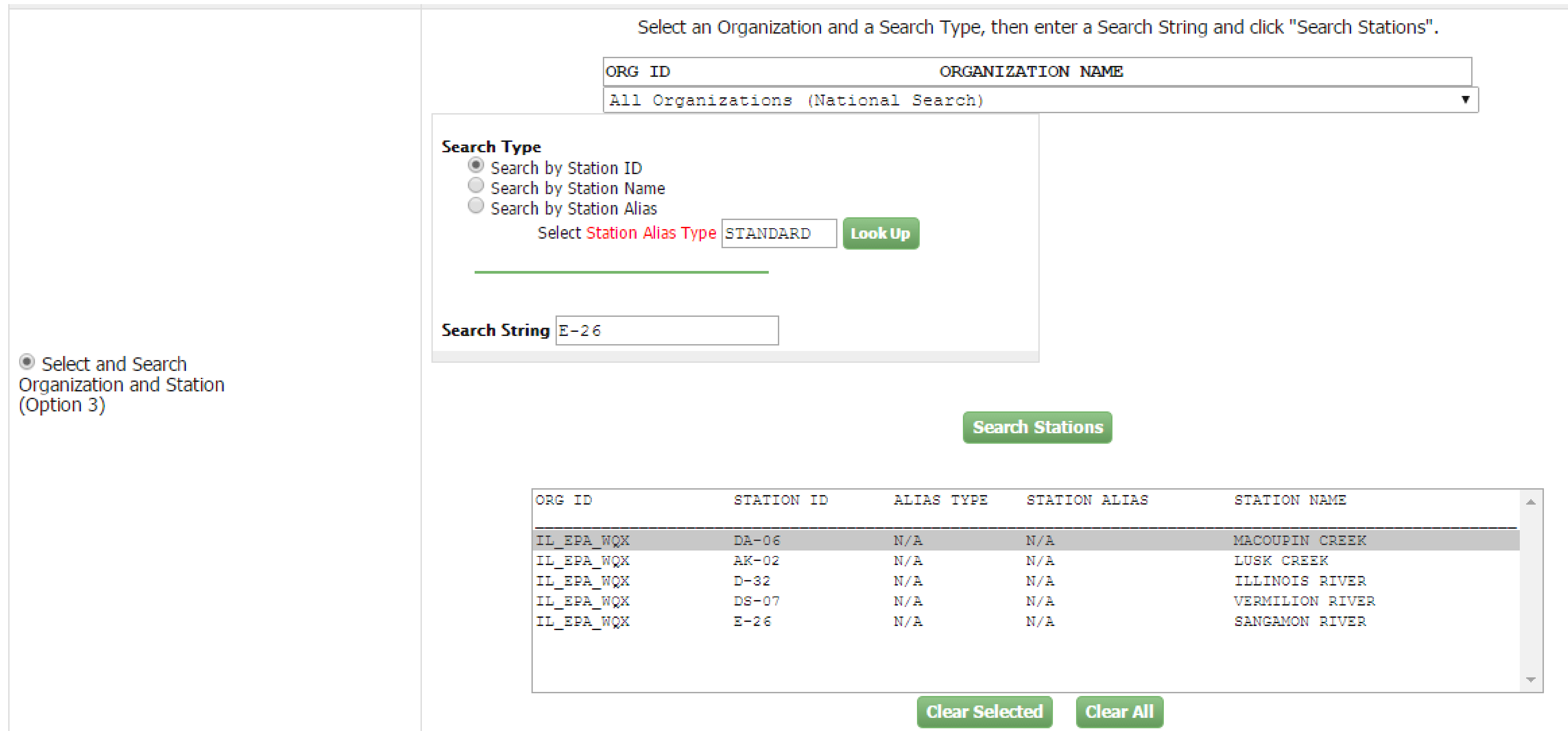
Using STORET Data Warehouse

- Geographic Location: IL



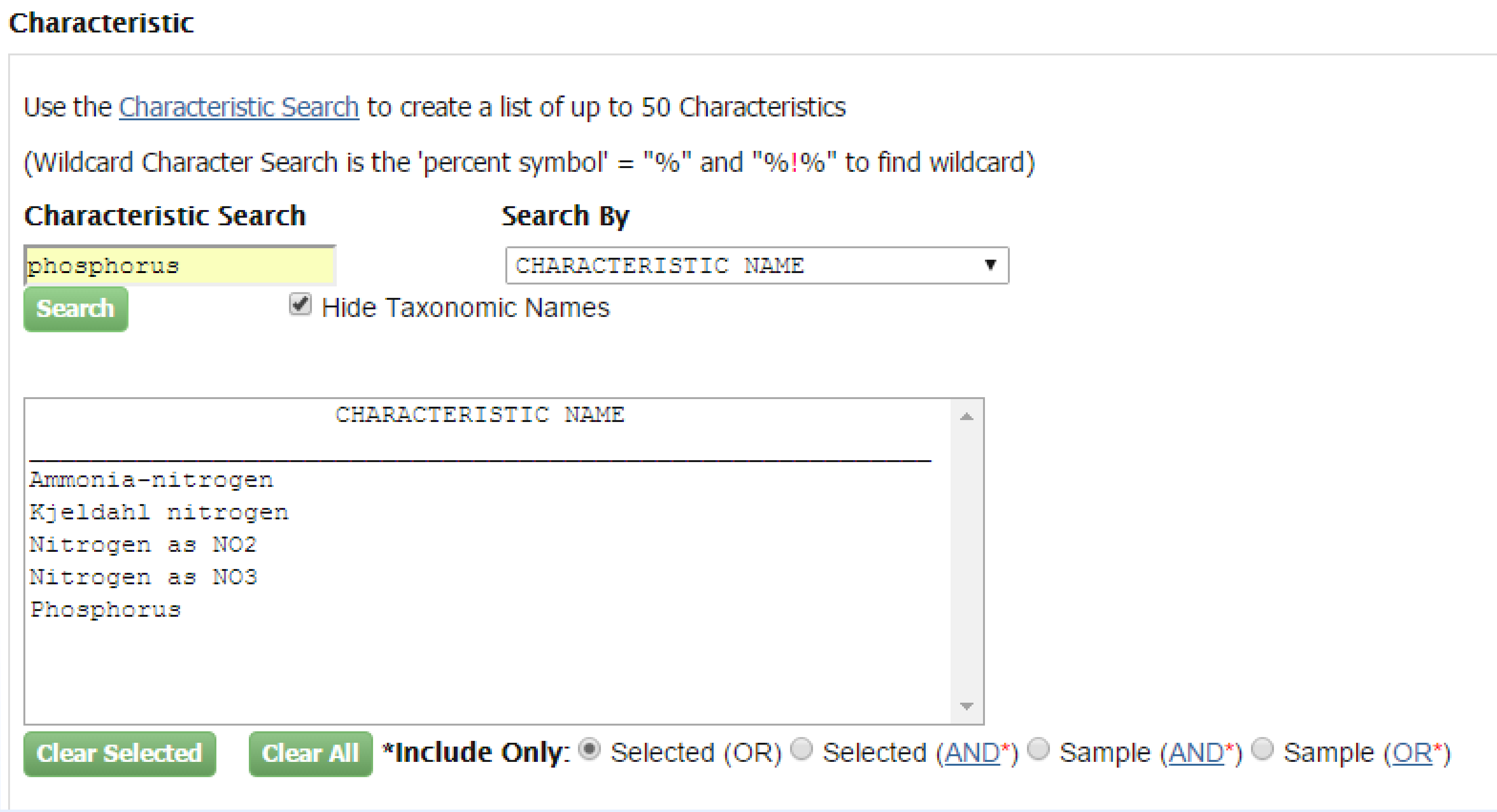
Using STORET Data Warehouse

- Organization, Station & Project: by station ID



Using STORET Data Warehouse

- Characteristic



Using STORET Data Warehouse

- There are 1396 records

Data Download Report

Reset/Clear Criteria

Clear Form

Submit Query

Station Download Result Download

*EXCLUDE **Report Count(s): (Optional)**

REGULAR, BIOLOGICAL, HABITAT METRIC INDEX

Advanced Users Only*

Request Information	
Request ID :	945866
Request Type :	Result Download
Record Count :	1396
Request Mode :	Immediate batch
File Name :	JSL_20160726_114239.zip
URL :	https://www3.epa.gov/storet/modern/downloads/JSL_20160726_114239.zip
Email Address :	jonglee1@illinois.edu

You will be notified when the request is processed.

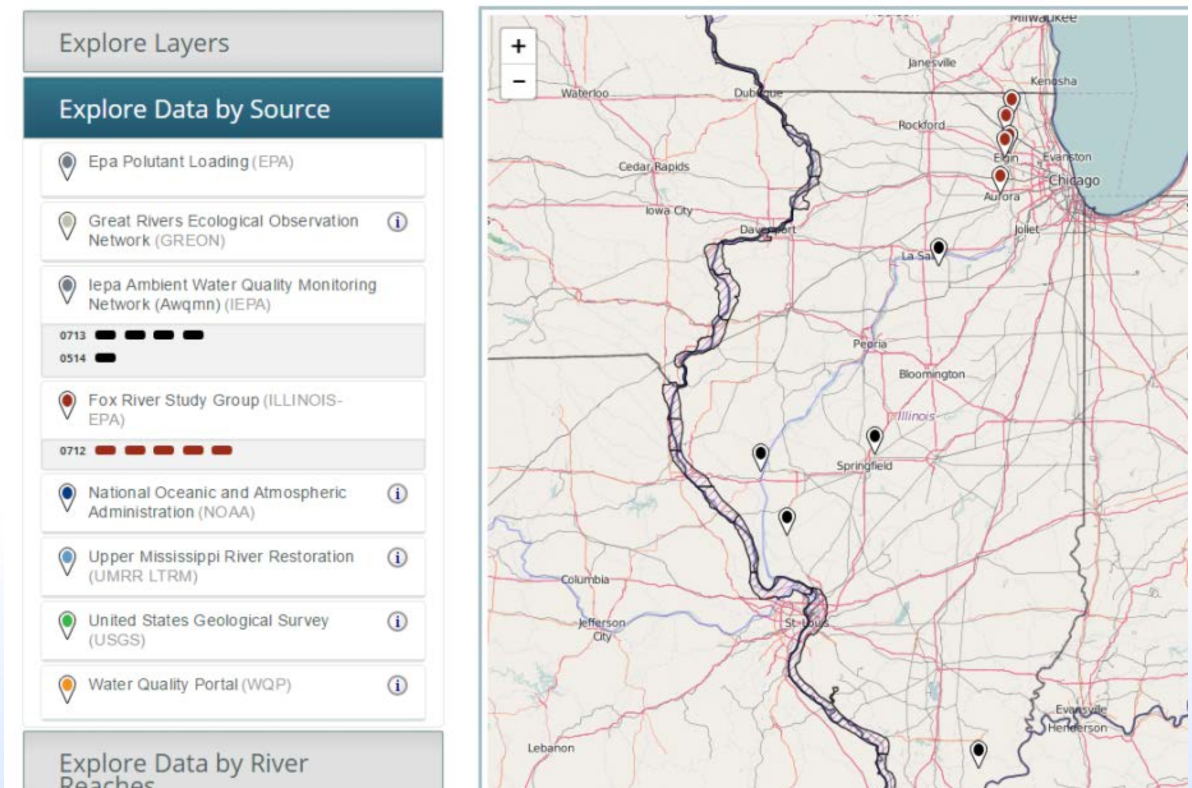
AK-02	312
D-32	280
DA-06	265
DS-07	258
E-26	281
Grand Total	**1396**

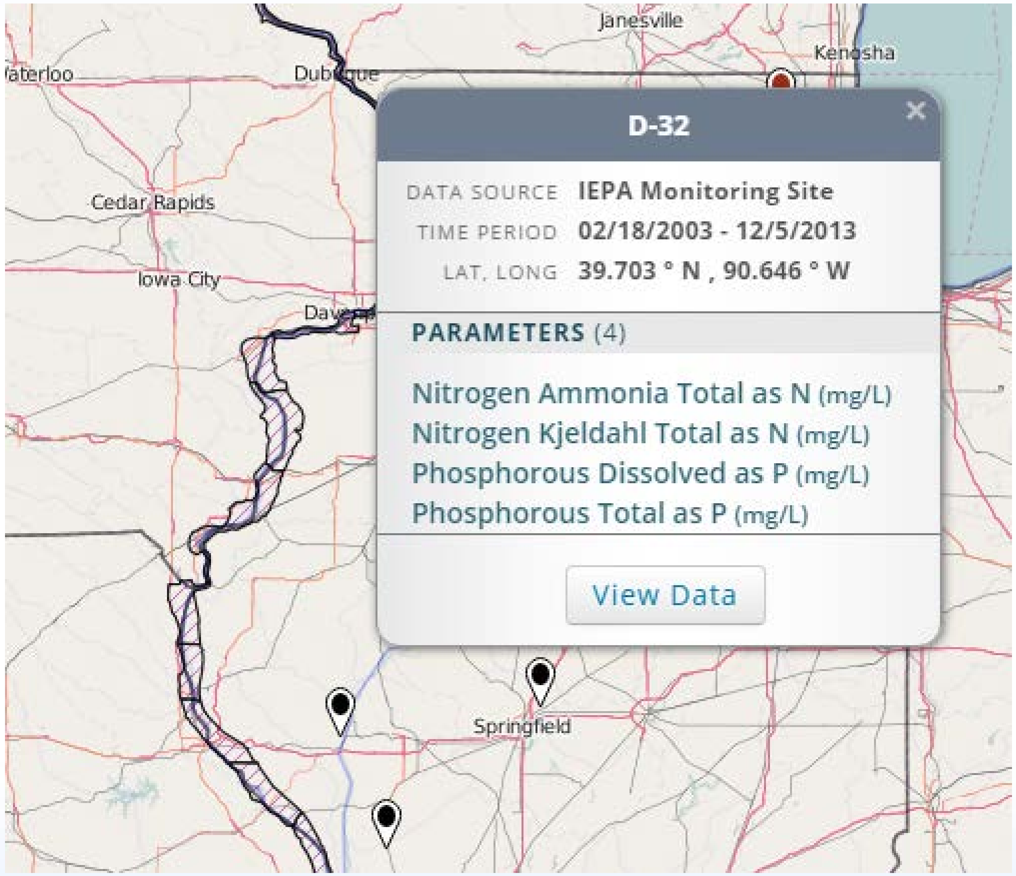
Another Way to Acquire Data

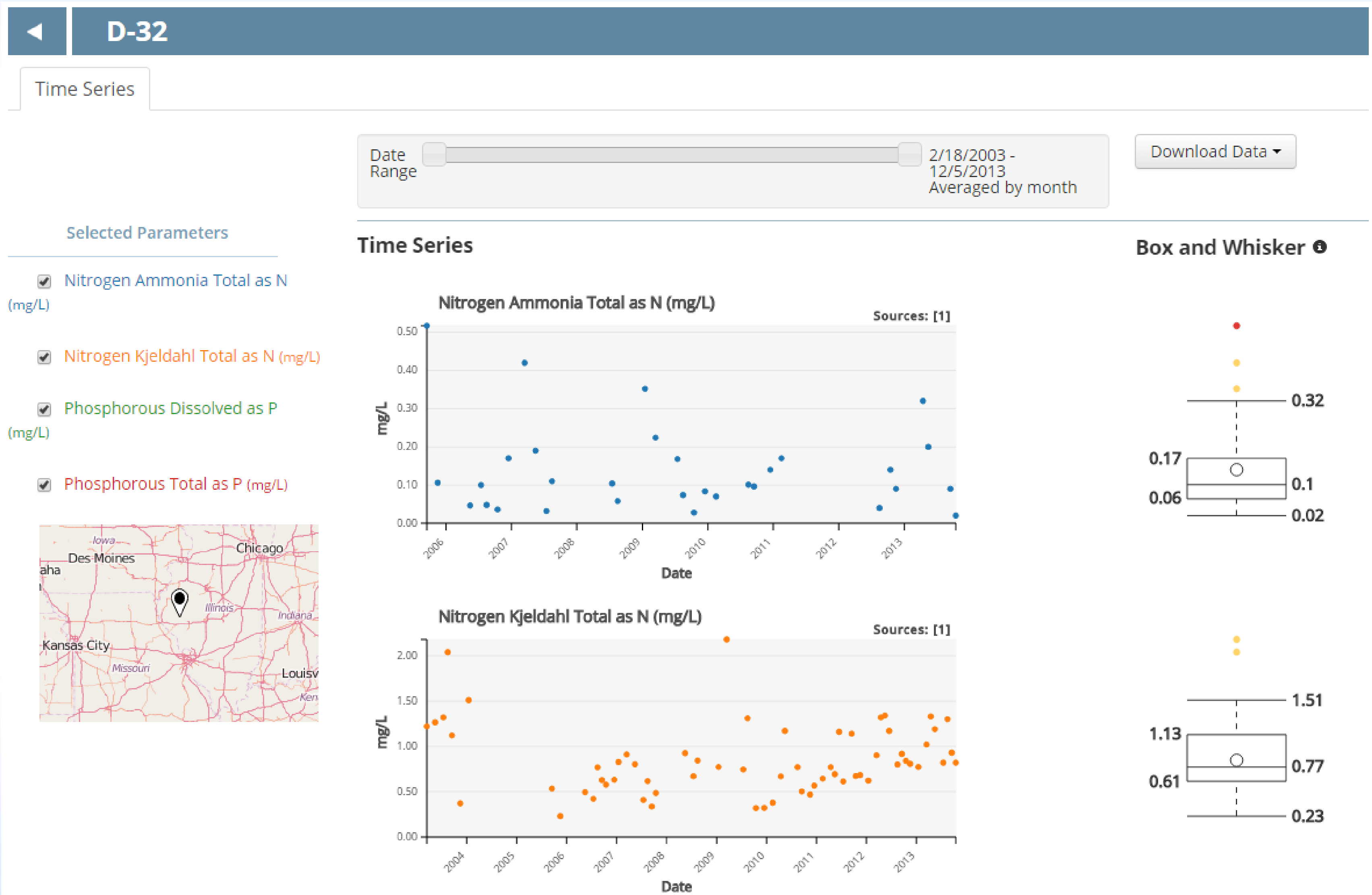
- There is a STORET web service.
- We can develop a data fetcher to acquire data without using web interface.
- However, there are many parameters to use the web service. We need help from IEPA to acquire data correctly.
- Limitation: maximum number of results is 20,000

Loading Data to GLTG

- It’s in Tab-delimitated text format.
- Running a parser to load the data




Janesville
Kenosha
Cedar Rapids
Iowa City
Springfield
D-32
DATA SOURCE IEPA Monitoring Site
TIME PERIOD 02/18/2003 - 12/5/2013
LAT, LONG 39.703 ° N , 90.646 ° W
PARAMETERS (4)
Nitrogen Ammonia Total as N (mg/L)
Nitrogen Kjeldahl Total as N (mg/L)
Phosphorous Dissolved as P (mg/L)
Phosphorous Total as P (mg/L)
View Data


D-32
Time Series
Date Range
2/18/2003 - 12/5/2013
Averaged by month
Download Data
Selected Parameters
Nitrogen Ammonia Total as N (mg/L)
Nitrogen Kjeldahl Total as N (mg/L)
Phosphorous Dissolved as P (mg/L)
Phosphorous Total as P (mg/L)
Iowa
Des Moines
Chicago
Illinois
Indiana
Kansas City
Missouri
Time Series
Box and Whisker
Nitrogen Ammonia Total as N (mg/L)
Sources: [1]
mg/L
0.00
0.10
0.20
0.30
0.40
0.50
2006
2007
2008
2009
2010
2011
2012
2013
Date
0.32
0.17
0.1
0.06
0.02
Nitrogen Kjeldahl Total as N (mg/L)
Sources: [1]
mg/L
0.00
0.50
1.00
1.50
2.00
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Date
1.51
1.13
0.77
0.61
0.23

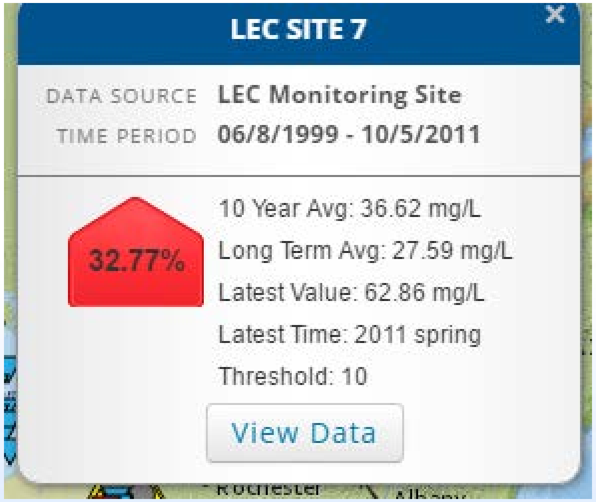
NCSA

Demo

- http://gltg-dev.ncsa.illinois.edu/geodashboard/

Current Activity: Trend Analysis

- GLTG will have Trend analysis with threshold visualization (water quality standard value)
- Display the up/down trend of a selected parameter and whether it is above/below the threshold or not



- Current implementation in Great Lakes Monitoring project
- Trend (%) =

  (Avg of 10 yr – Avg of all) / Avg of all
- Up (+ trend), down (- trend)
- Red color: above threshold value

Trend Analysis

- What do you think about this method to compute trends?
- Does your organization have methodologies to compute trends?
  - What’s your preferred way to compute trends?

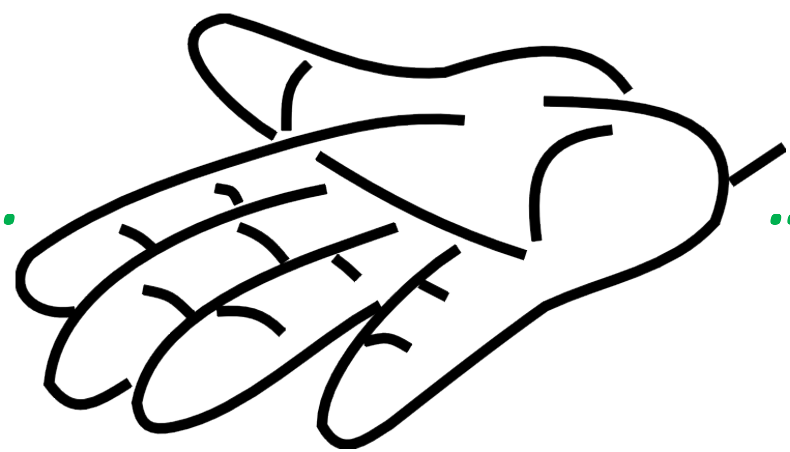
Next Step

- Currently GLTG project is in 3rd phase.
- One of tasks is acquiring watershed level data.
  - Walton Foundation provides opportunity loading of all Fox River data on GLTG Virtual Observatory.
  - We will load all Fox River data in terms of N and P
- Another test case for NMC

Top "Water Quality" (e.g., nutrients and flow) Monitoring Data Parameters and Associated Information

- Laura Keefer (ISWS) and Kelly Warner (USGS)

I have a……

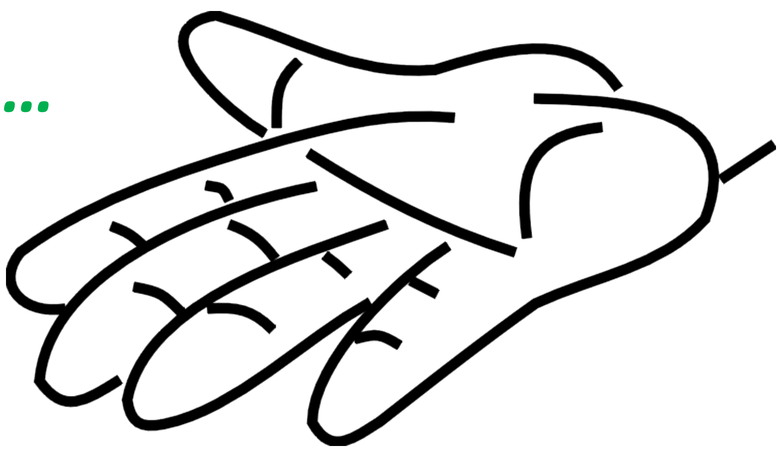


…..for you!

Top "Biological" Monitoring Data Parameters and Associated Information

- Ann Holtrop (IDNR), Andy Casper (INHS), and Justin Vick (MWRDGC)

I have a……



…..for you!

Monitoring Biological Parameters as Part of NLRS Implementation

Justin Vick, Andy Casper, and Ann Holtrop

July 28, 2016

Charge

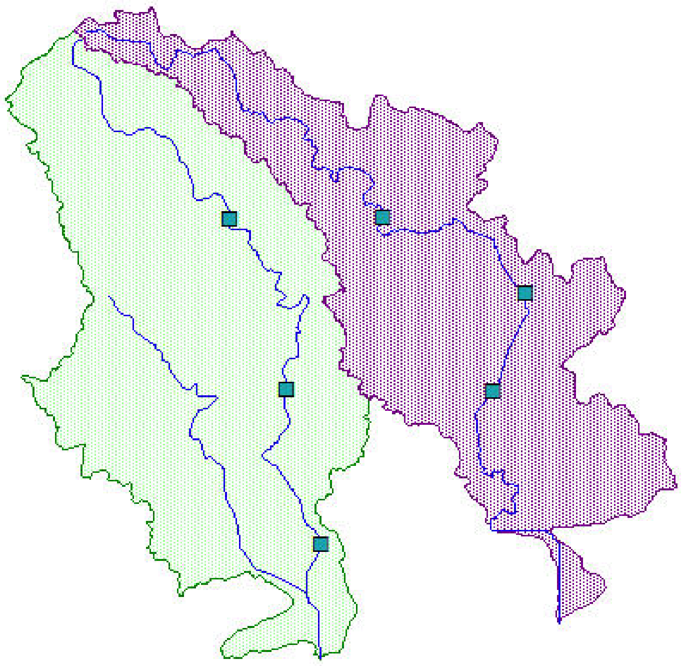
- To identify some key biological data parameters that can be used to communicate the effectiveness of BMPs at reducing nutrients and improving local water quality in selected priority watersheds.
  - Changes in biota will follow improvements in water quality. There might be a multi-year lag in biological response.
  - Focus of biological monitoring will be in selected priority watersheds where stakeholders are interested.

Caveats

- Covariates should be measured to interpret biotic responses.
  - Local flow
  - Local water quality
  - Instream habitat

Caveats Continued

- Sampling design will depend on desire to tie biological response to reduction in nutrients.
  - Fixed vs random sites
  - Seasonal vs annual sampling
  - Treatment vs reference design
  - BMP implementation rates may need to be tracked



Caveats Continued

- Sampling design can vary based across priority watersheds based on goals of "community".
  - Need to use similar methods pre- and post-BMP implementation

Minimum Goals

- Mean native taxa richness within the waterbody (or reach) is maintained or increased (for fish, mussels, or EPT).
- Focal Species abundance (or relative abundance) is maintained or increased in priority watersheds.
- Focal Species distribution is maintained or increased within priority watersheds (e.g., mean number of reaches with recent observations or proportion of reaches evaluated with observations).
- Percentage of evaluated reaches meeting aquatic life designated use are maintained or increased.
- Excessive primary production within the waterbody (or reach) is decreased.

Focal Species

- Selected for different habitat types
- Species that resonate with public and are collected with “standard” sampling
- Expect species to respond to practices implemented
  - Nest builders that may be sensitive to sedimentation
  - Sensitive to variable flow conditions
  - Sensitive to low dissolved oxygen or elevated ammonia

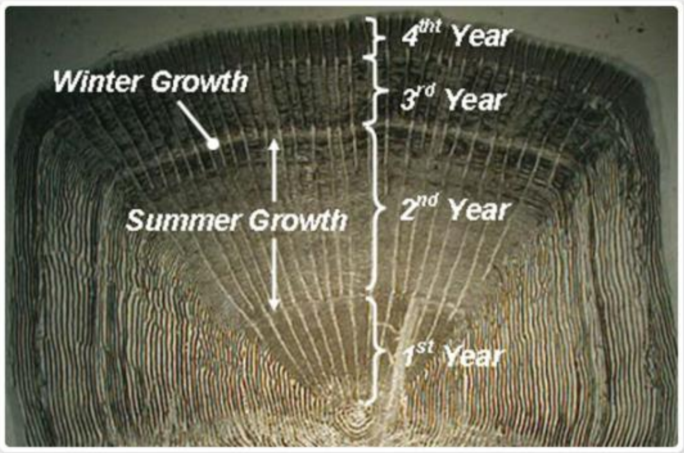

Smallmouth Bass

Specific Responses to NLRS (Moderate)

- Altered flow regimes
  - Focal Species requiring clear gravel substrates are maintained or increased within priority watersheds.
- Nutrient loads
  - Focal Species with sensitivity to low dissolved oxygen are maintained or increased within priority watersheds.

Species Fitness Response to NLRS (Best)

- Fitness of Focal Species (e.g., reproductive success, growth rate [size at age], proportion with DELT, proportion intersex) is maintained or increased within priority watersheds.



Next Steps

- Identify priority watersheds for biological monitoring.
- Meet with partners to identify current monitoring activities (WQ too) and likelihood of continuance.
- Develop template for watershed monitoring plan.
- Develop and implement plans.

Discussion: Where do we go from here?

- If needed, refine the WQ and Biological data parameters documents, then combine into one.
- Pick a pilot watershed, meet with WQ and Biology partners, ID current programs and likely continuance.
- Develop a template for development of a Watershed Nutrient Monitoring Plan.
- Develop the plan.
  - Um, do we, the NMC, develop the plan?
  - Do we contract development of the plan out to someone, and we, the NMC, provide review and approval/blessing?
  - If contracted out, any idea what one might cost?
  - Potential funding sources (e.g., CWA Section 106)?
- Implement the plan.

"Next Steps" Summary
(NMC July 28, 2016)

- Summarize today's action items
  - A.
  - B.
  - C.
- Future topics for the September 13, 2016 meeting?
  - That's only 6 weeks away, and in that time...... ☺
  - I won't be available to give NMC update at Policy Working Group meeting on August 30. Volunteer?
- Other (TBD)

Next NMC Meetings

- September 13, 2016
- December 6, 2016