Session C: Monitoring Nutrient Loads and Water Resource Outcomes – Progress, Opportunities, and Challenges

Moderator: Gregg Good, IEPA

Session C: Summary

- *Introduction to the Nutrient Monitoring Council (NMC)*
  - Who are we and when were we formed?
  - What’s our charge?
  - When and where do we meet?
  - What’s our typical meeting structure?
- *Session Overview*
  - What we’ve been up to over the past 2+ years.

Who are we and when were we formed?

- "We are a group of 13 top notch, highly intelligent, extremely good looking, enthusiastic, and much-loved Illinois monitoring and research professionals." (NMC 2015) ☺
- 1st meeting - May 13, 2015.
- Illinois EPA is "Chair Extraordinaire."

Nutrient Monitoring Council Members (9/6/17)

Illinois EPA
Gregg Good, Rick Cobb

Illinois State Water Survey
Laura Keefer

Aqua Illinois
Kevin Culver

Illinois Natural History Survey
~~Andrew Casper~~ (need to replace)

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
Nicole Manasco

U.S. Geological Survey
Kelly Warner

National Center for Supercomputing Apps
Jong Lee

Several Guests Typically at Each Meeting

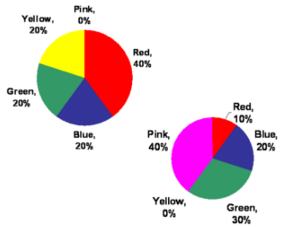
NMC Charges (Revised 10/26/15)

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.



When and where do we meet?

- 3-4 times per year
- Alternate between Springfield and Urbana
- 9 meetings so far
- Today is “meeting 9.5 lite” – many members are here
- 10th – March 28, 2018
- 11th – August 29, 2018

What’s our typical brutal meeting structure?

- 10:00 a.m. – 11:00 a.m.
- A little lite lunch
- Mandatory nap time
- Start up again at 2:00 p.m.
- Adjourn by 2:30 p.m.
- Occasional field trips

(awaiting reimbursement)

The Nutrient Monitoring Council in reality…

- Extremely hard-working and caring group of monitoring and research professionals.
- Always learning more about what each other is doing.
- Oh my, we collect a lot of data in this state!
- Extremely rewarding experience to lead this group.
- We try to have some fun.
- We're doing some good things, so lets talk about them!!

“Illinois Super Gages”

Kelly Warner, USGS

NUTRIENT AND SEDIMENT EXPORT FROM ILLINOIS–QUANTIFICATION THROUGH A CONTINUOUS LOADINGS NETWORK (PROVISIONAL RESULTS)

Results After Approximately One Year of Monitoring

Paul Terrio
U.S. Geological Survey

Assessing Long-term Changes in Riverine Nutrient Loads and Comparison of Different Nitrate-N Load Estimation Methods for the Illinois River at Valley City and Florence

Gregory McIsaac
Associate Professor Emeritus
University of Illinois at Urbana Champaign
&
Agricultural Watershed Institute
Decatur, IL

NCSA

Great Lakes To Gulf Virtual Observatory Update

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

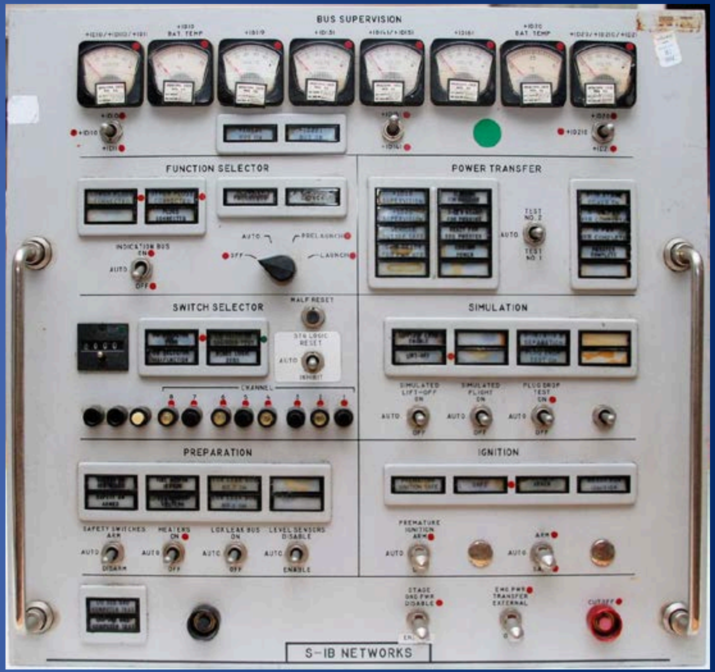
December 6, 2016 @ 7th Nutrient Monitoring Council Meeting

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

Monitoring Challenges for Estimating Nutrient Loads and Developing Water Quality Standards

Gregg Good, IEPA and Paul Terrio, USGS

Panel Discussion



20-Minute Panel Discussion

So let's get started…..

Illinois Supergage Network – Operation and Maintenance Happenings

Illinois NLRS Workshop
November 29, 2017

Kelly Warner
Deputy Director

U.S. Geological Survey
Illinois-Iowa-Missouri Water Science Center

Kelly Warner

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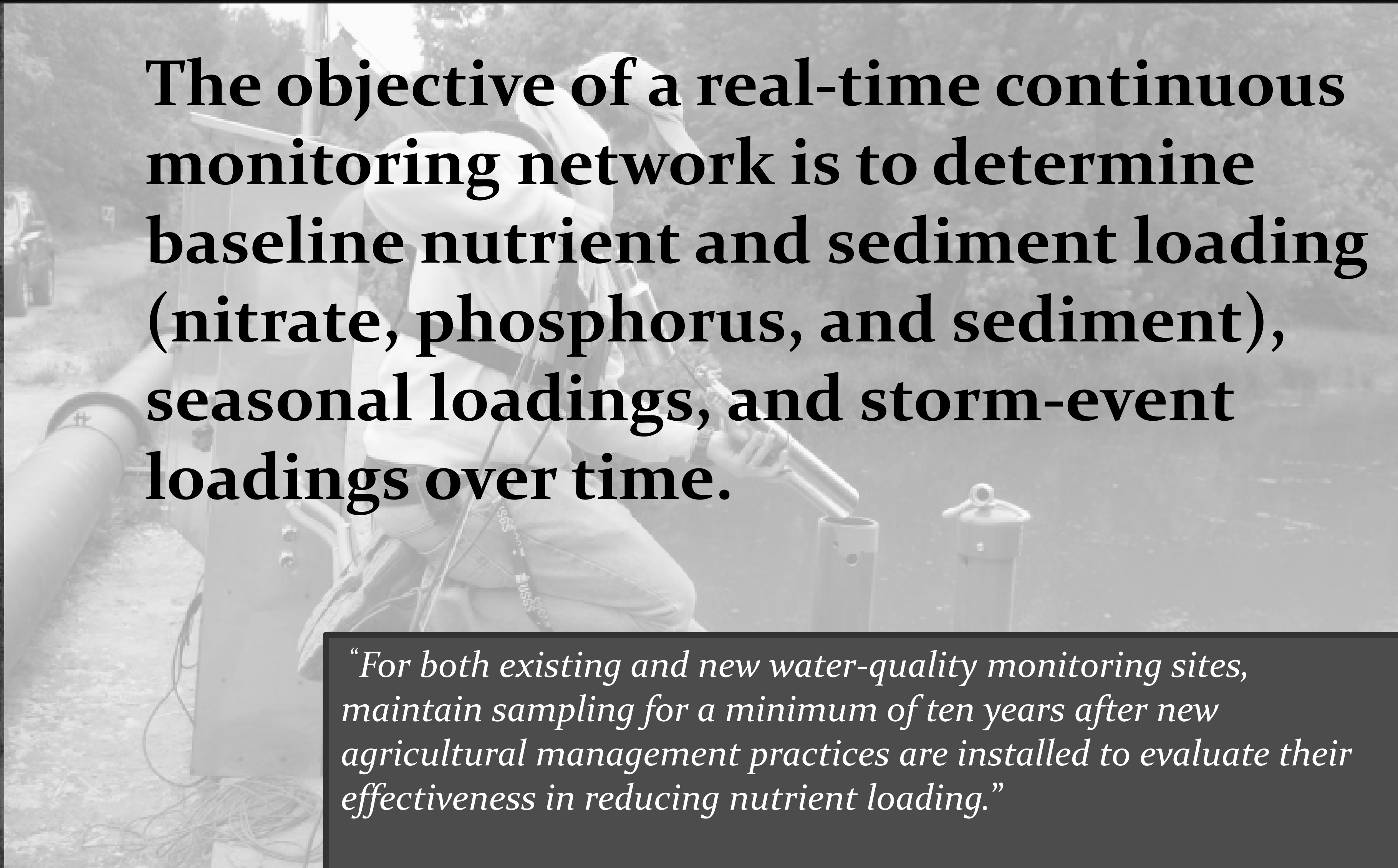
"Without data, you're just another person with an opinion."

~W. Edwards Deming

USGS and IEPA



The objective of a real-time continuous monitoring network is to determine baseline nutrient and sediment loading (nitrate, phosphorus, and sediment), seasonal loadings, and storm-event loadings over time.

"For both existing and new water-quality monitoring sites, maintain sampling for a minimum of ten years after new agricultural management practices are installed to evaluate their effectiveness in reducing nutrient loading."

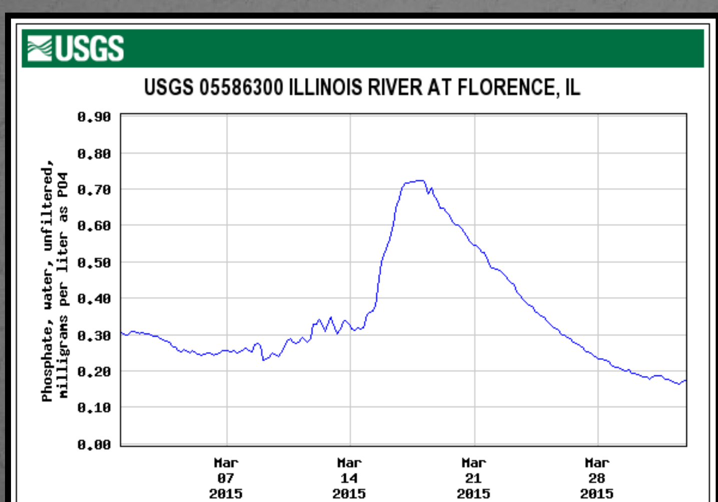
From the Northeast-Midwest Institute Weekly Update (July 20, 2015 on Water Data to Answer Urgent Water Policy Questions

USGS science for a changing world

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

USGS Supergage

- Streamflow
- Turbidity
- SpC, DO, Temp, pH
- Nitrate
- Orthophosphate



http://waterdata.usgs.gov/il/nwis/qw

From SeaBird Coastal

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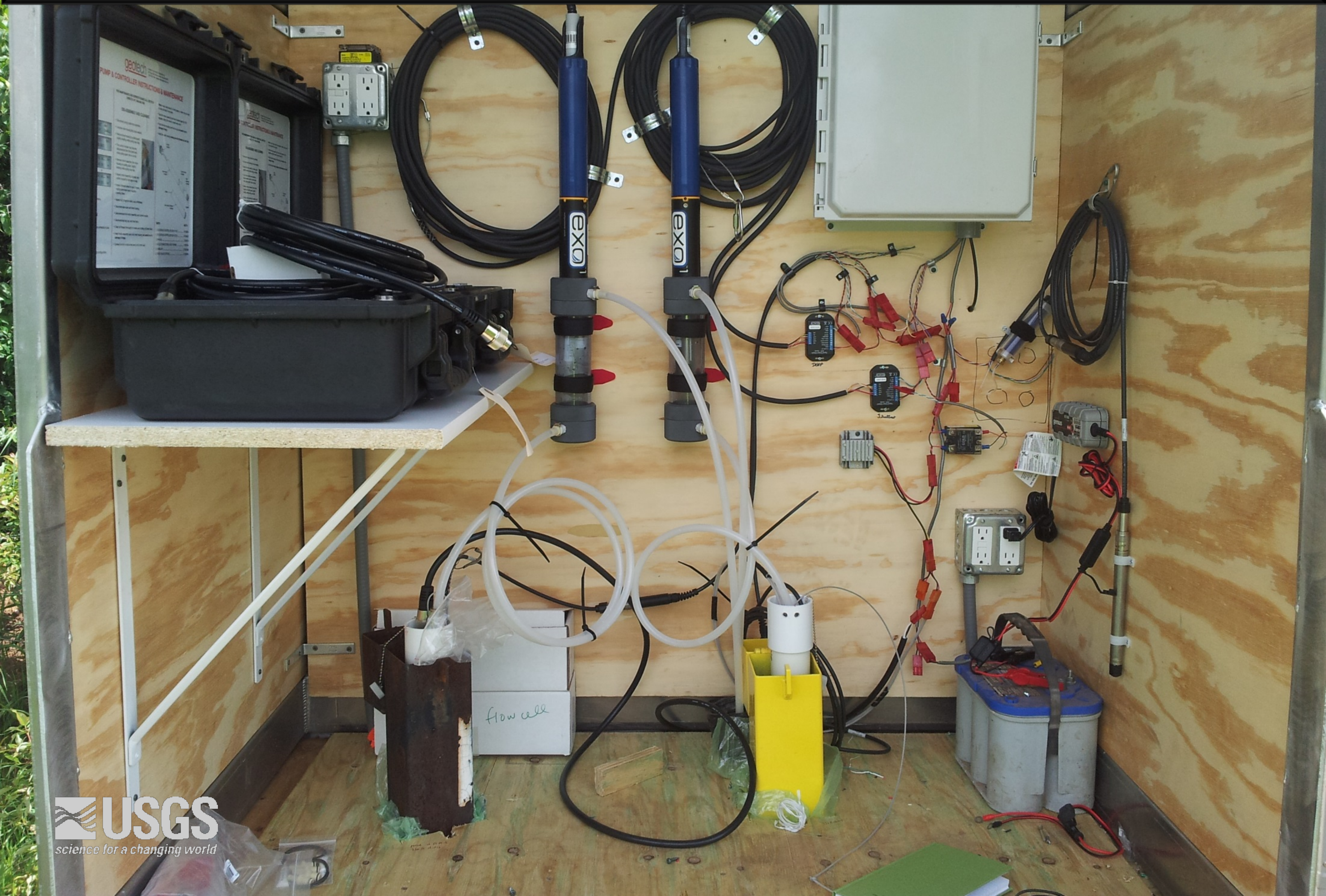
Supergage Insitu Design

Supergage Pumping Design

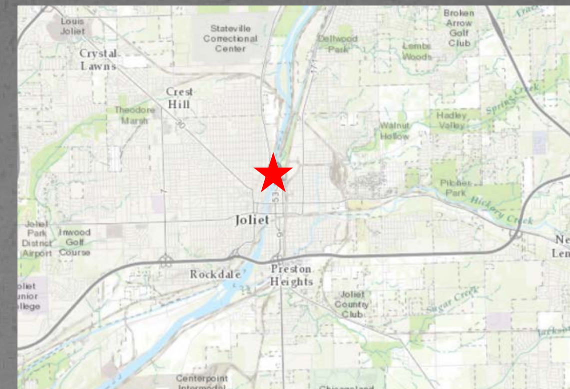


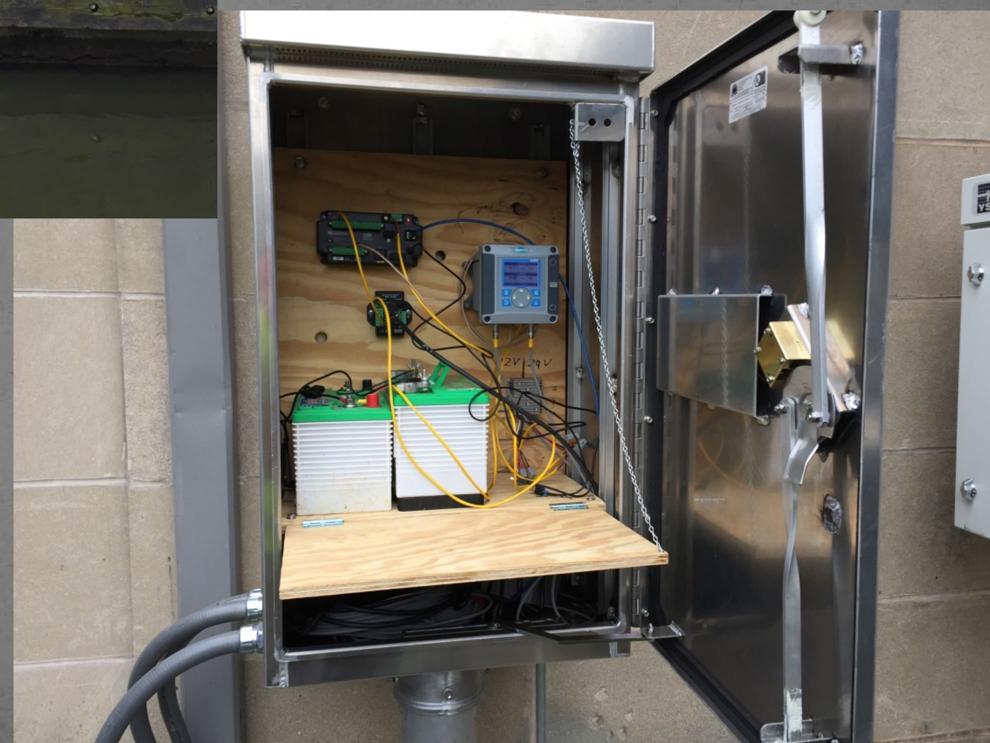
Supergages monitor 75% of Illinois

New Additions

- Kankakee River
- DesPlaines River

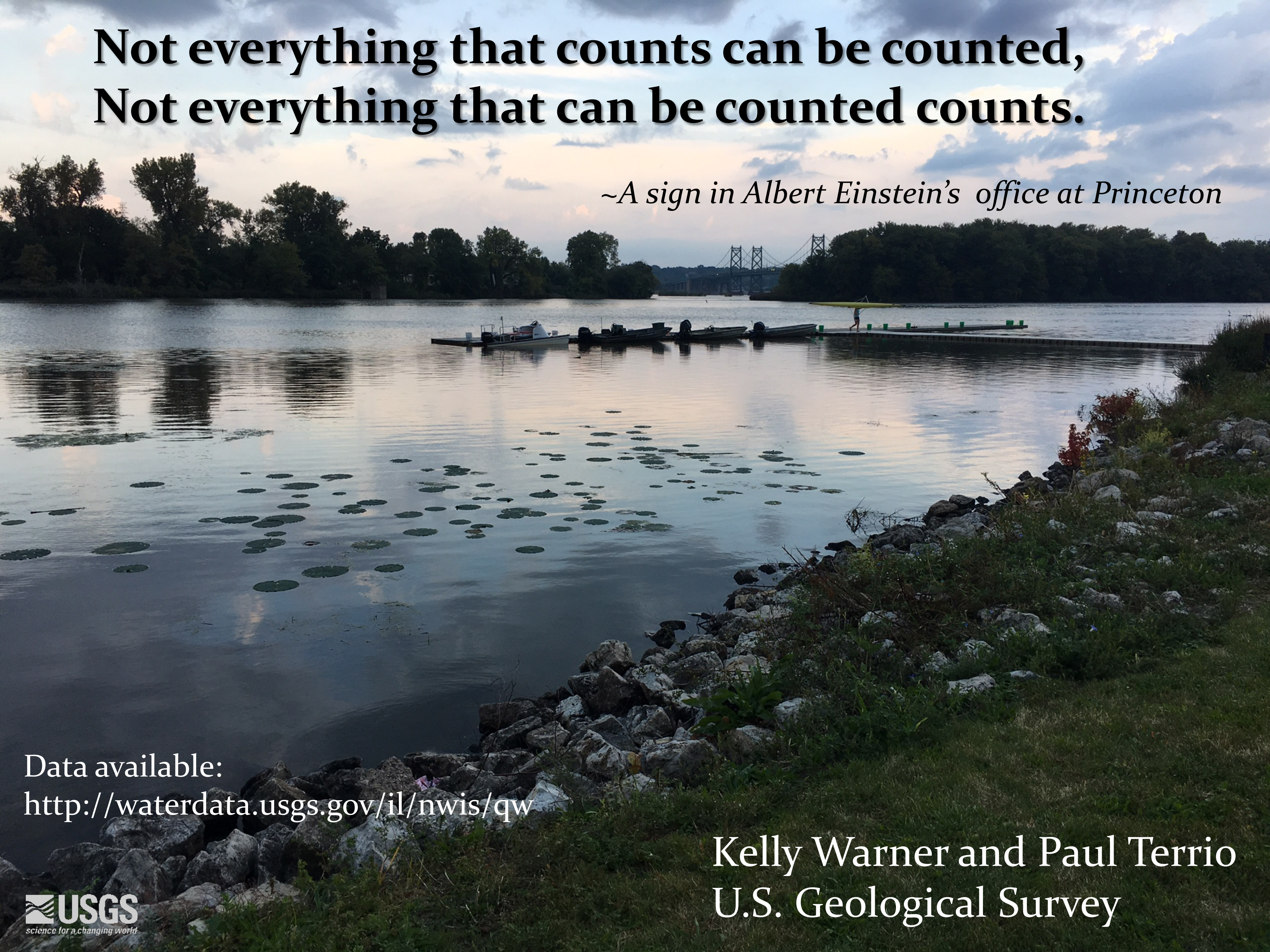
Des Plaines River at Route 53 at Joliet, IL





Maximum concentration and flow

SITENAME	Drainage area	Begin date	Max Nitrate	Date	Max Phosphate	Date	Instantaneous High flow peak	Date
ILLINOIS RIVER	26870	6/2/2012	8.53	4/16/2013	0.724	3/17/15	110000	7/2/15
ROCK RIVER	9549	6/26/2015	14.5	7/22/2017	0.200	6/27/15	43800	7/25/17
KASKASKIA RIVER	5189	9/22/2015	5.3	2/24/2016	0.617	11/6/16	49400	1/1/16
LITTLE WABASH RIVER	3088	9/12/2015	5.7	6/24/2017	0.612	9/6/16	31700	5/8/17
EMBARRAS RIVER	2333	9/11/2015	14.1	6/10/2016	0.777	10/22/16	37600	5/8/17
BIG MUDDY RIVER	2159	10/22/2015	4.79	12/27/2015	0.378	11/18/15	25800	5/4/17
VERMILION RIVER	1290	12/18/2014	25.1	5/29/2017	0.562	4/1/15	37600	12/29/15
GREEN RIVER	1003	6/26/2015	13.7	5/15/2016	0.356*	8/16/16	8030	8/30/16



Not everything that counts can be counted,
Not everything that can be counted counts.

~A sign in Albert Einstein's office at Princeton

Data available:
http://waterdata.usgs.gov/il/nwis/qw

Kelly Warner and Paul Terrio
U.S. Geological Survey

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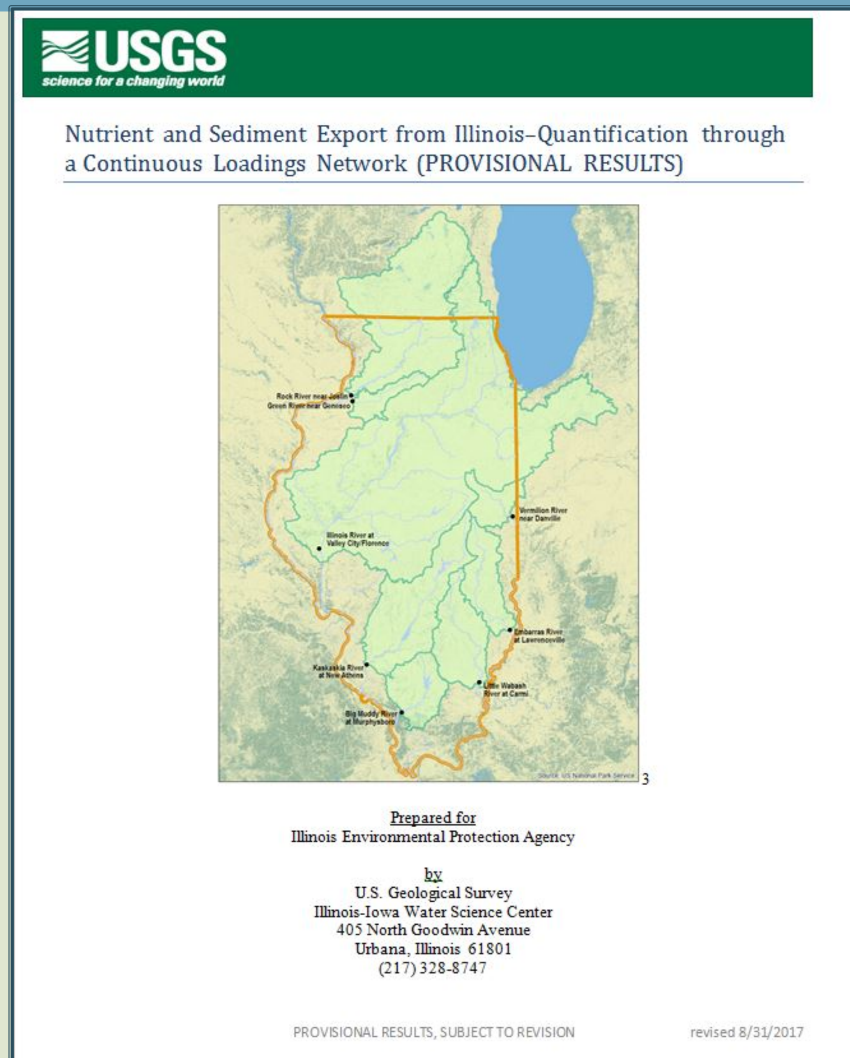
NUTRIENT AND SEDIMENT EXPORT FROM ILLINOIS–QUANTIFICATION THROUGH A CONTINUOUS LOADINGS NETWORK (PROVISIONAL RESULTS)

Results After Approximately One Year of Monitoring

Paul Terrio
U.S. Geological Survey

USGS

SUMMARY REPORT SUBMITTED TO ILLINOIS EPA MARCH 2017



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Nutrient and Sediment Export from Illinois–Quantification through a Continuous Loadings Network (PROVISIONAL RESULTS)

3

Prepared for
Illinois Environmental Protection Agency

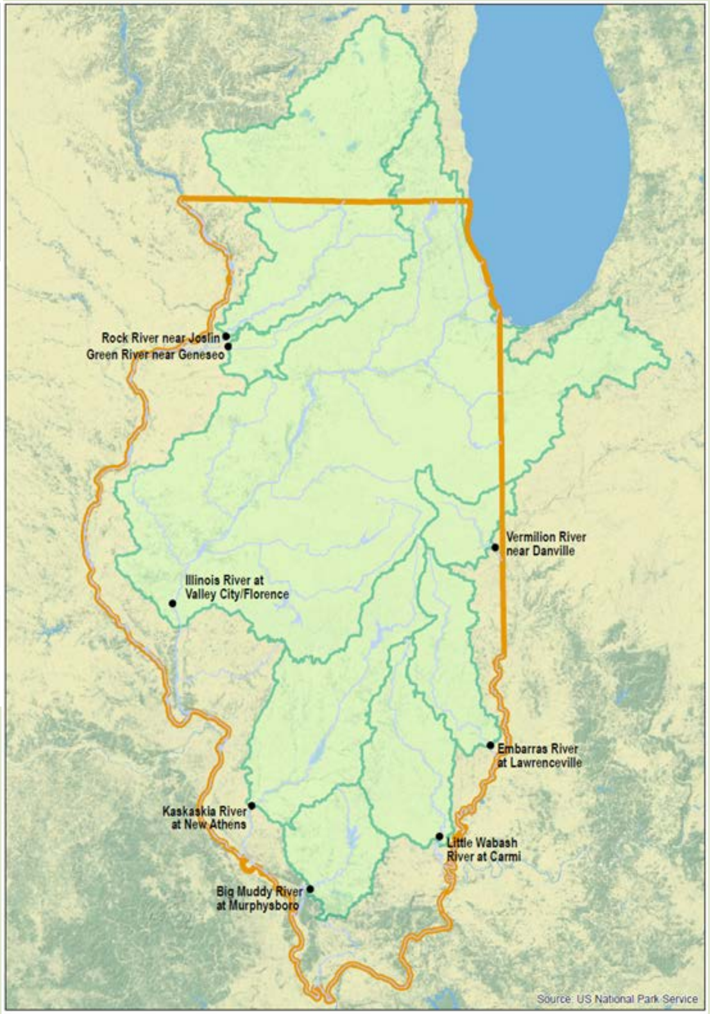
by
U.S. Geological Survey
Illinois-Iowa Water Science Center
405 North Goodwin Avenue
Urbana, Illinois 61801
(217) 328-8747

PROVISIONAL RESULTS, SUBJECT TO REVISION

revised 8/31/2017

ILLINOIS NUTRIENT MONITORING STATIONS (SUPER GAGES)

Stream name	Drainage area in Illinois, in mi^2	Percent of drainage area in Illinois	Percent of Illinois covered by drainage area
Big Muddy River at Murphysboro	2,168	100	3.8
Embarras River at Lawrenceville	2,348	100	4.2
Green River near Geneseo	1,000	100	1.8
Illinois River at Florence/Valley City	22,651	84	40.2
Kaskaskia River at New Athens	5,189	100	9.2
Little Wabash River at Carmi	3,102	100	5.5
Rock River near Joslin	3,973	42	7.1
Vermilion River near Danville	1,199	93	2.1



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METHODOLOGY

- <u>Continuous data collection:</u>
  - Nitrate concentration (NO_3)
  - Orthophosphorus concentration (PO_4)
  - Turbidity concentration
  - Stream discharge
  - Physiochemical parameters

- <u>Regression modeling using above data to determine:</u>
  - Total phosphorus (TP) concentration* = 0.0575 + 0.9668(PO_4 concentration) + 0.0011 (turbidity concentration)
  - Suspended sediment (SS) concentration* = 0.8531 (turbidity concentration)

- <u>Load Calculations:</u>
  - ✓ Nitrate Load = NO_3 concentration x Discharge x Unit conversion
  - ✓ TP Load = Modeled TP concentration x Discharge x Unit conversion
  - ✓ Suspended Sediment Load = Modeled SS concentration x Discharge x Unit conversion

- * *Example equations only*

USGS

NUTRIENT AND SEDIMENT EXPORT FROM ILLINOIS–QUANTIFICATION THROUGH A CONTINUOUS LOADINGS NETWORK (PROVISIONAL RESULTS)

USGS 05599490 Big Muddy River at Route 127 at Murphysboro, IL
(IEPA Site Number N-12)

Location: LOCATION.--Lat 37°45'30", long 89°19'40" referenced to North American Datum of 1983, in NE 1/4 NE 1/4 sec.9, T.9 S., R.2 W., Jackson County, IL, Hydrologic Unit 07140106, on right bank on upstream side of State Highway 127 in Murphysboro, and at mile 37.5.

Equipment: A YSI EXO water-quality monitor equipped with sensors for water temperature, specific conductance (SC), dissolved oxygen, pH, and turbidity collects data at a 15-minute interval. A Hach SOLITAX turbidity sensor collects data at a 15-minute interval. 15-minute interval dissolved nitrite plus nitrate nitrogen (hereafter referred to as nitrate) data are collected using a Hach NITRATAX sensor. Continuous (2- to 6-hour interval) phosphate data are collected using a WET Labs Cycle-PO4 (Cycle) in-situ phosphate analyzer.

Data period: October 1, 2015 to January 5, 2017

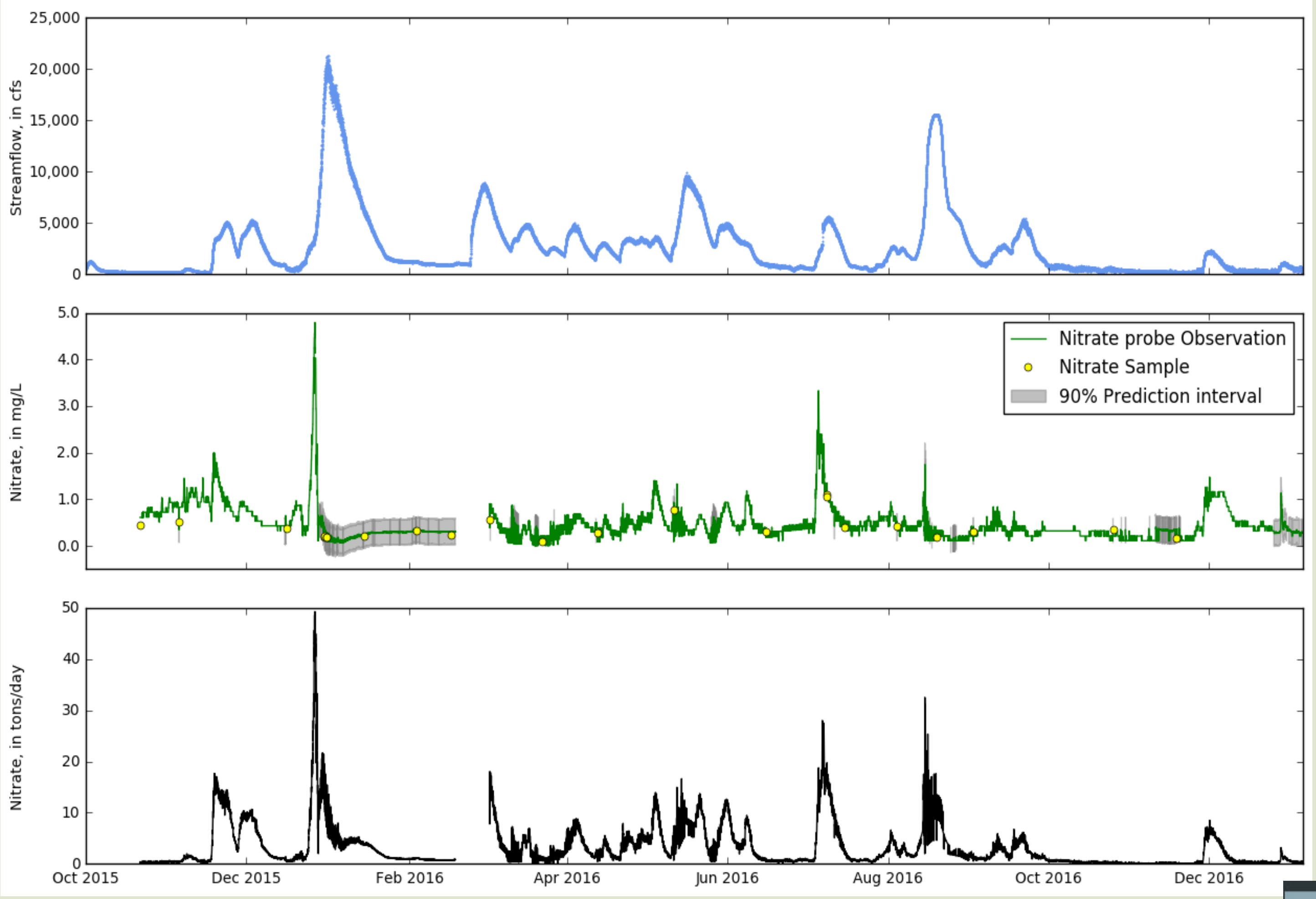
Station Summary: In general, this station has fairly good period of continuous data record for nitrate and phosphate. Phosphate and turbidity concentrations are generally suitable for the Cycle analyzer. Significant periods of missing data include mid-Dec. 2015-Feb 2016 when the instruments were removed for the winter months, and there are gaps in phosphate data from late-Sep. to late-Oct, 2016 and mid-Dec. 2016 to mid-Jan. 2017 when the phosphate analyzer was removed for the winter months. The bridge deck at this station will be rebuilt in the summer of 2017 and the equipment will be temporarily removed during this period (June through August). Manual sample collection will be done during this time to provide some continuity in the data record.

Data Summary: This preliminary summary presents streamflow, continuous nitrate, and predicted total phosphorus and suspended-sediment concentration (SSC) for this station. The continuous nitrate concentration readings are directly measured by the sensor. The graphs below show some periods for which continuous nitrate data was missing for extended periods and nitrate concentrations and loadings were computed by regression modeling (periods for which 90% prediction intervals are shown). Continuous total phosphorus concentration was predicted using regression models developed with turbidity and phosphate analyzer data. Continuous SSC was predicted using regression models developed with turbidity data. The results are provisional at this point until additional samples and data are collected. The streamflow and concentration were multiplied to obtain a provisional load time series.

BIG MUDDY RIVER AT MURPHYSBORO, IL (05599490)

Oct. 2015-Dec. 2016 (data after Nov. 18, 2016 is provisional)

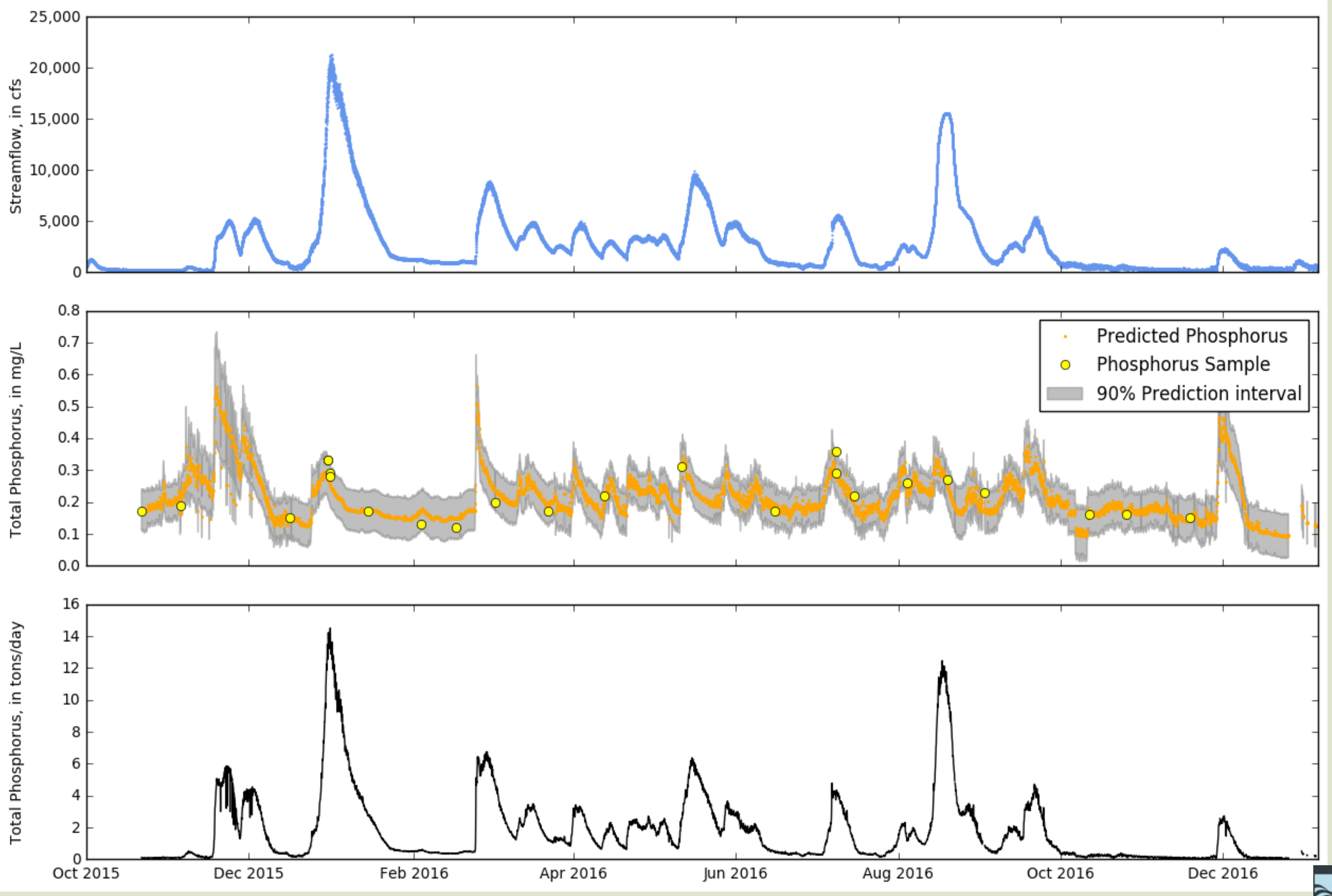
Nitrate



BIG MUDDY RIVER AT MURPHYSBORO, IL (05599490)

Oct. 2015-Dec. 2016 (data after Nov. 18, 2016 is provisional)

Total Phosphorus



Provisional normalized annual load for nitrate, total phosphorus, and suspended sediment for each site that the data and (or) regression equations were provisionally adequate.

Normalized annual loads are computed from the period of data available data for each site. Normalized load values were derived from at least one year's worth of data during the period August 2015 through January 2017.

TBD; Insufficient data to determine the annual load or yield.

Stream name	Nitrate		Total Phosphorus		Suspended Sediment	
	Annual load (lb)	Annual yield (lb/acre)	Annual load (lb)	Annual yield (lb/acre)	Annual load (ton)	Annual yield (ton/acre)
Illinois River at Florence/Valley City	215,220,950	12.5	21,020,287	1.2	4,340,965	0.3
Embarras River at Lawrenceville	17,427,920	11.7	1,961,336	1.3	809,448	0.5
Big Muddy River at Murphysboro	2,339,032	1.7	1,310,602	0.9	279,837	0.2
Green River near Geneseo	11,614,829	18.1	338,962	0.5	162,462	0.3
Rock River near Joslin	83,426,545	13.7	TBD	TBD	TBD	TBD
Little Wabash River at Carmi	TBD	TBD	2,571,015	1.3	730,403	0.4
Kaskaskia River at New Athens	12,957,382	3.9	TBD	TBD	758,746	0.2
Vermilion River near Danville	TBD	TBD	TBD	TBD	TBD	TBD

Indicates highest yield

Indicates lowest yield

ACTIONS AND PLANS

- Additional data will allow refined and more accurate regression models
  - Seasonal and flow-related multiple regressions

- Emphasis put on high-flow / high-turbidity events (to define the upper end of the regression equation for total phosphorus)

- Phosphate analyzers have been problematic.
  - ✓Water body characteristics (turbidity, phosphorus concentrations)
  - ✓Instrument performance (staining, microfluidics, filters, materials)
  - ✓Manufacturer support and servicing - continuing effort
  - ✓USGS remains committed to the effort
    - Working with the manufacturer and examining other options
    - Collecting manual samples in effort to maintain data record
  - ✓Different phosphate analyzers where feasible

NUTRIENT AND SEDIMENT EXPORT FROM ILLINOIS–QUANTIFICATION THROUGH A CONTINUOUS LOADINGS NETWORK (PROVISIONAL RESULTS)

Thank you!

Paul Terrio
U.S. Geological Survey
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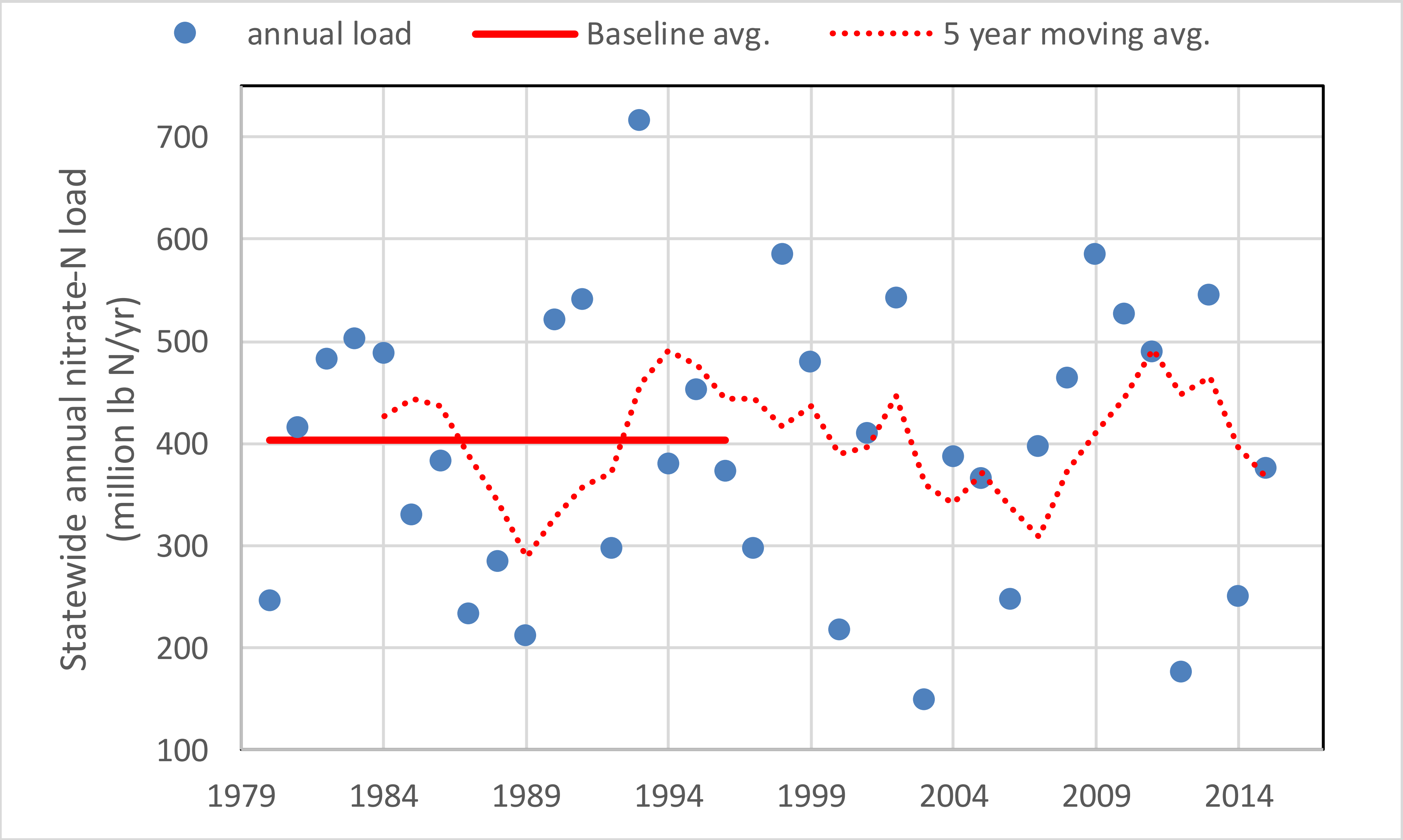
USGS

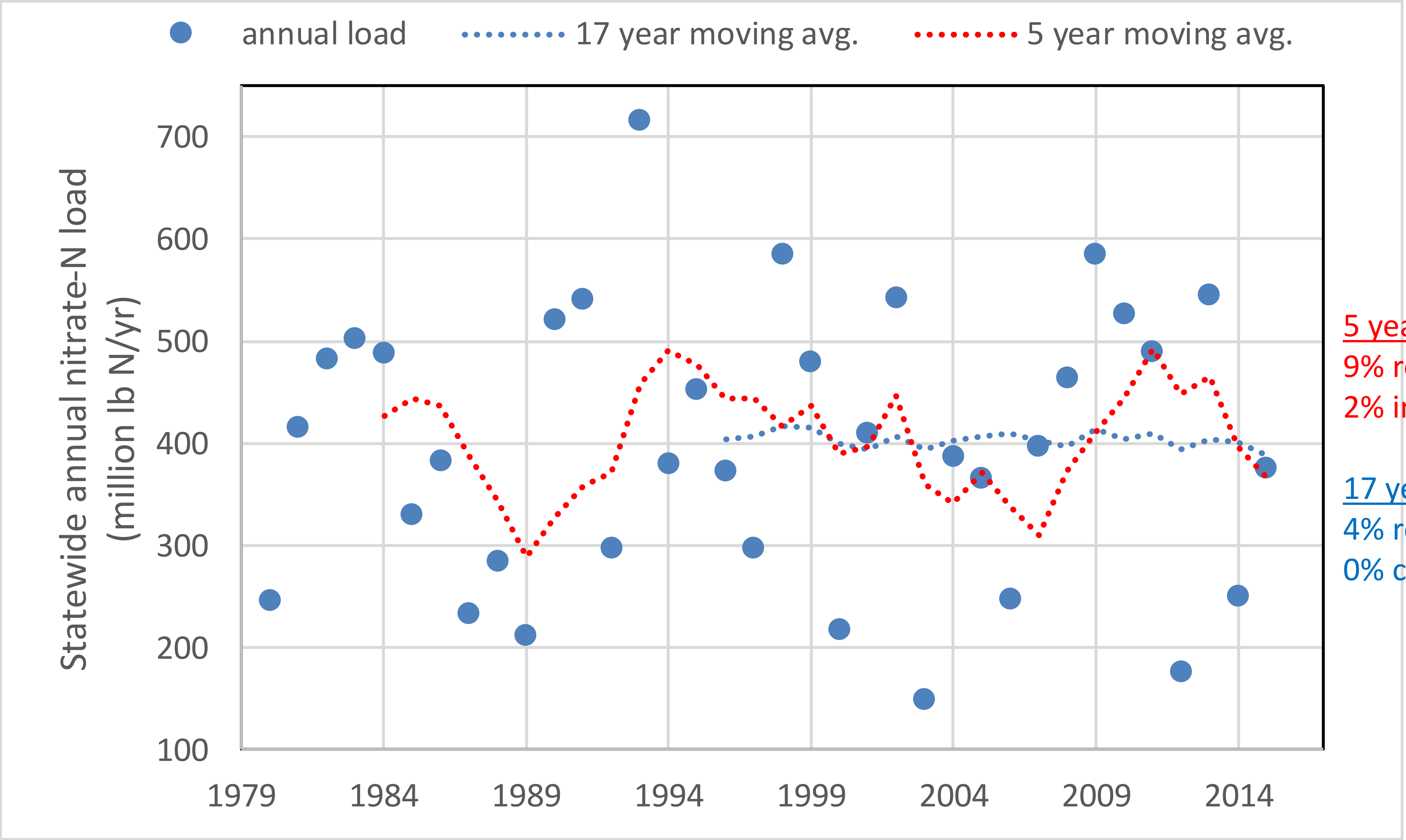
Assessing Long-term Changes in Riverine Nutrient Loads and Comparison of Different Nitrate-N Load Estimation Methods for the Illinois River at Valley City and Florence

Gregory McIsaac
Associate Professor Emeritus
University of Illinois at Urbana Champaign
&
Agricultural Watershed Institute
Decatur, IL

Statewide estimates of annual nitrate loads (blue dots), 1980-96 baseline average (solid red line), and five year moving average value (red dashed line)



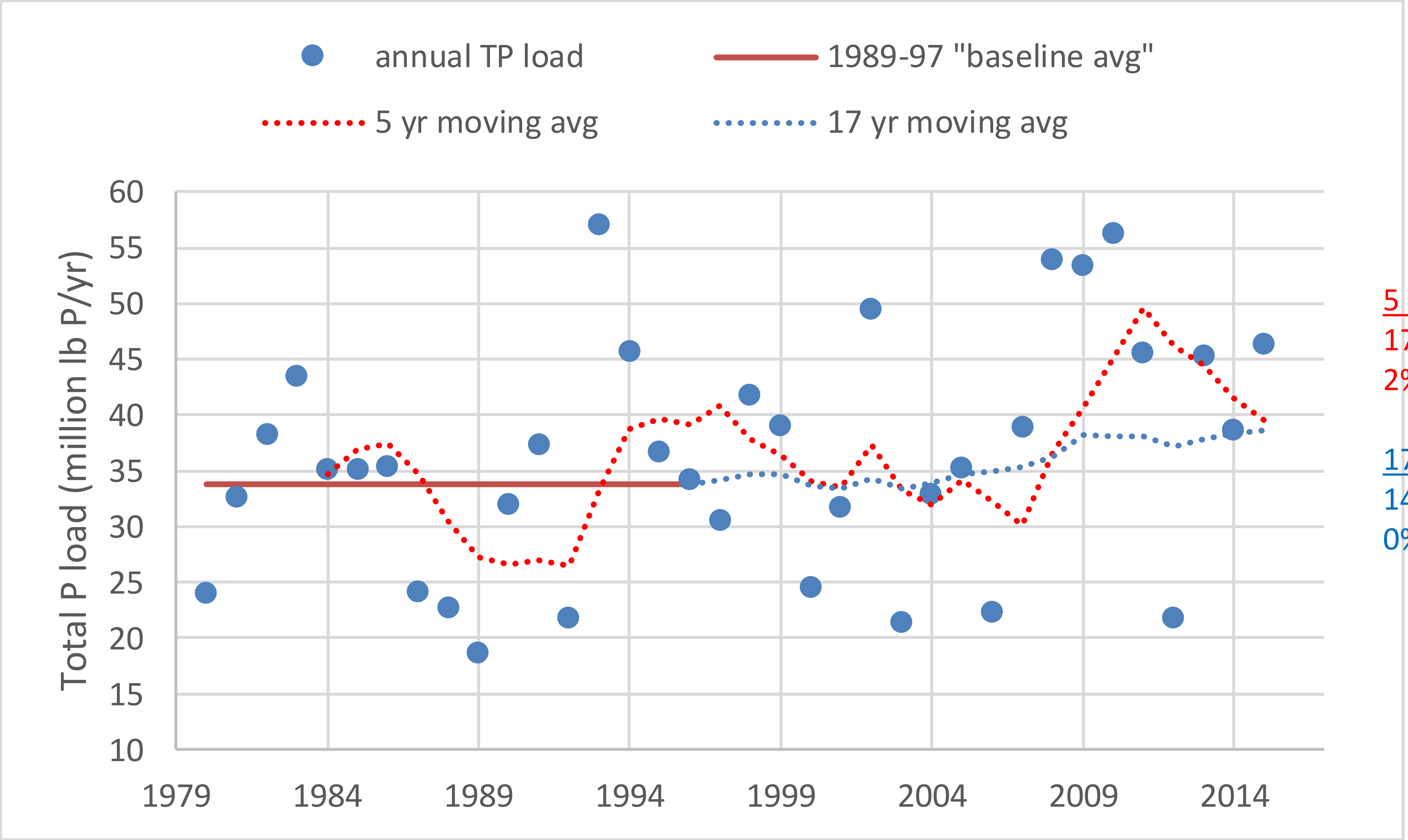
Statewide estimate of annual nitrate loads (blue dots), five year moving average value (red dashed line), and 17 year moving average value(blue dashed line)



5 year average 2011-2015
9% reduction in nitrate load
2% increase in flow

17 year average 1999-2015
4% reduction in nitrate load
0% change in flow

Statewide estimate of annual TP loads (blue dots), 1980-96 baseline average (solid red line), five year moving average value (red dashed line), and 17 year moving average (blue dashed line).



5 year average 2011-15
17% increase in TP load
2% increase in flow

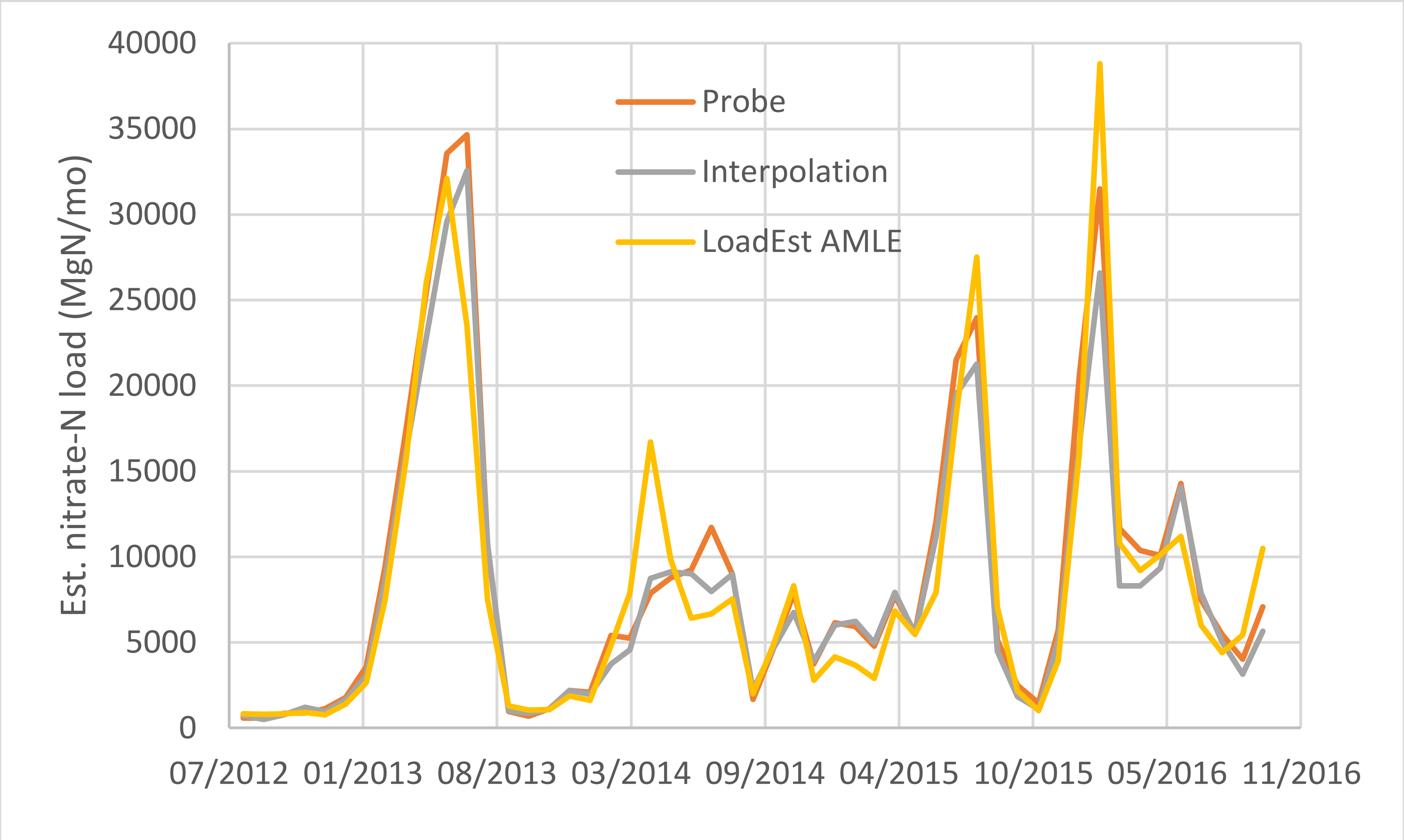
17 year average 1999-2015
14% increase in TP load
0% change in flow

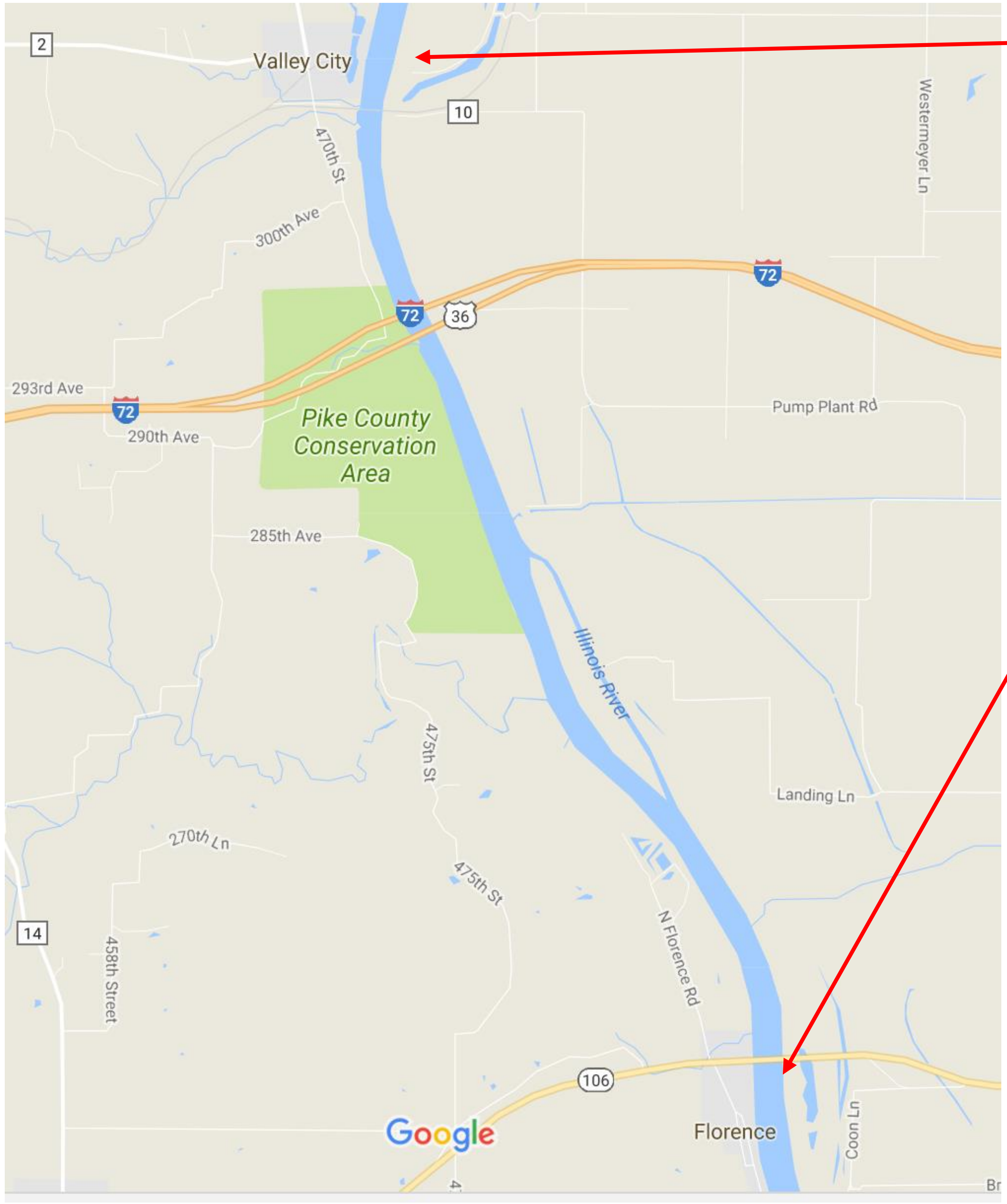
Load estimation methods

- Load = flow x concentration

- Flows are generally calculated every 15 minutes
- But concentration generally measured weekly or monthly
- How do we calculate loads at times when concentration is not measured?
- Several different methods have been developed to estimate concentrations, and different methods lead to different load estimates

Monthly estimated nitrate-N loads for the Illinois River at Valley City and Florence
from instream probe concentrations, linear interpolation of traditional sampling events, and LoadEst AMLE





<u>Valley City (26,473 sq. mi. drainage area)</u>

Discharge measured since 1939

Width and depth integrated water samples collected about 12 times per year 1975-2012

<u>Florence (26,870 sq. mi. drainage area… about 5 miles downstream from Valley City)</u>

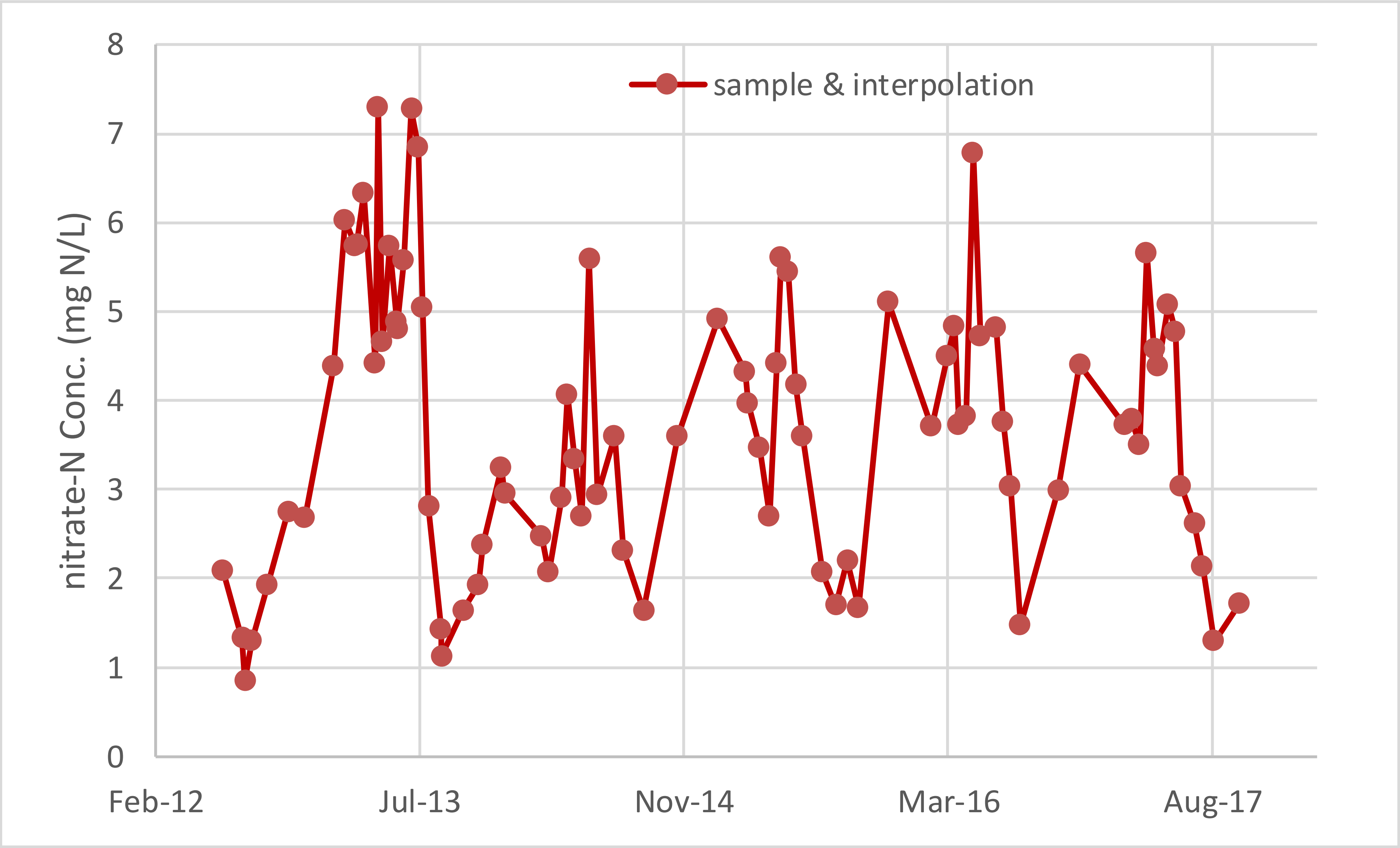
Discharge not measured

Width and depth integrated water samples collected about 17 times per year since summer 2012, but still identified as Valley City

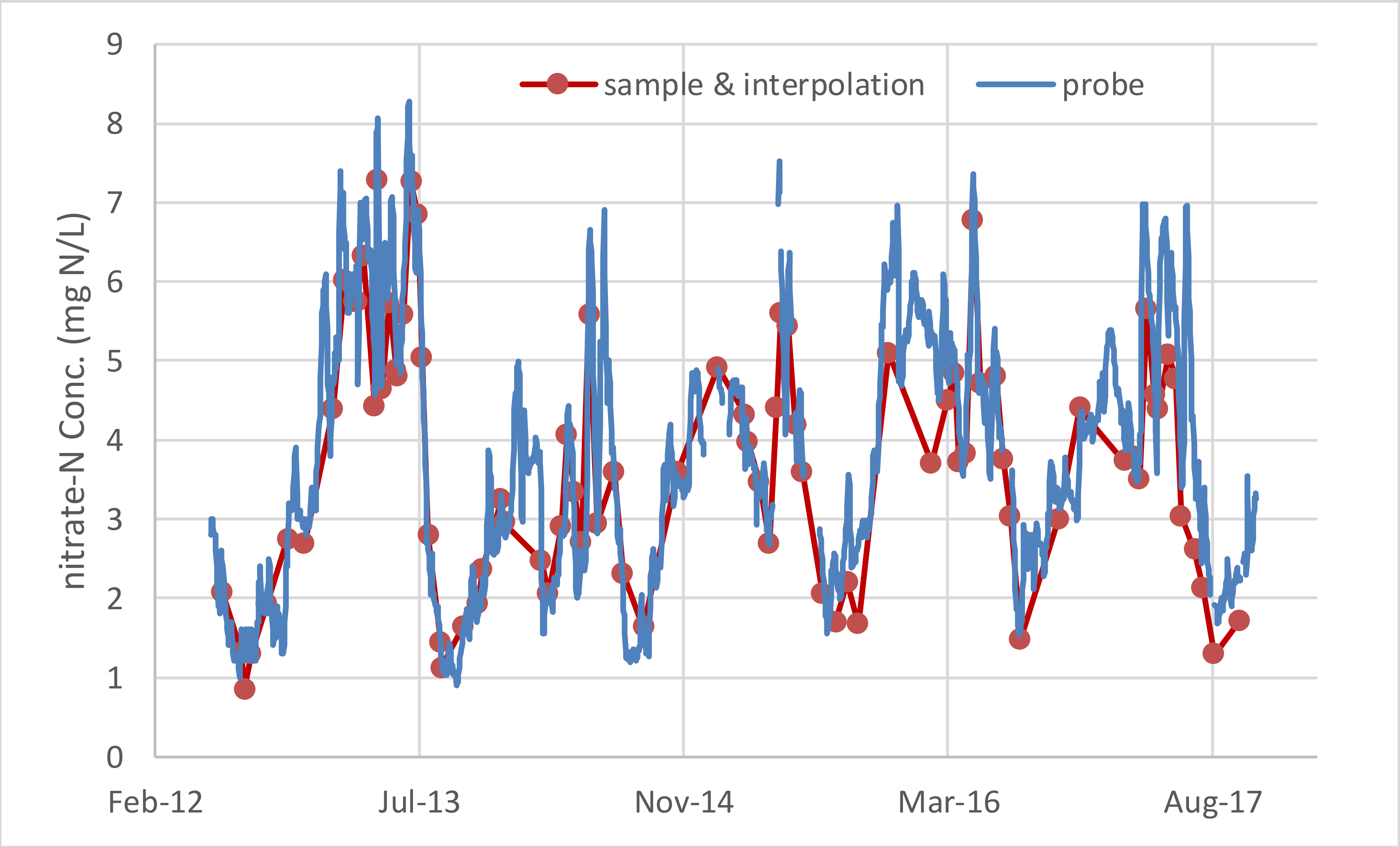
Additional point water samples collected to assess accuracy of the probe

Nitrate concentrations measured in situ every 15 minutes when probe is functional

Measured Nitrate-N concentrations ( )and linearly interpolated values at “Valley City” 2012-17



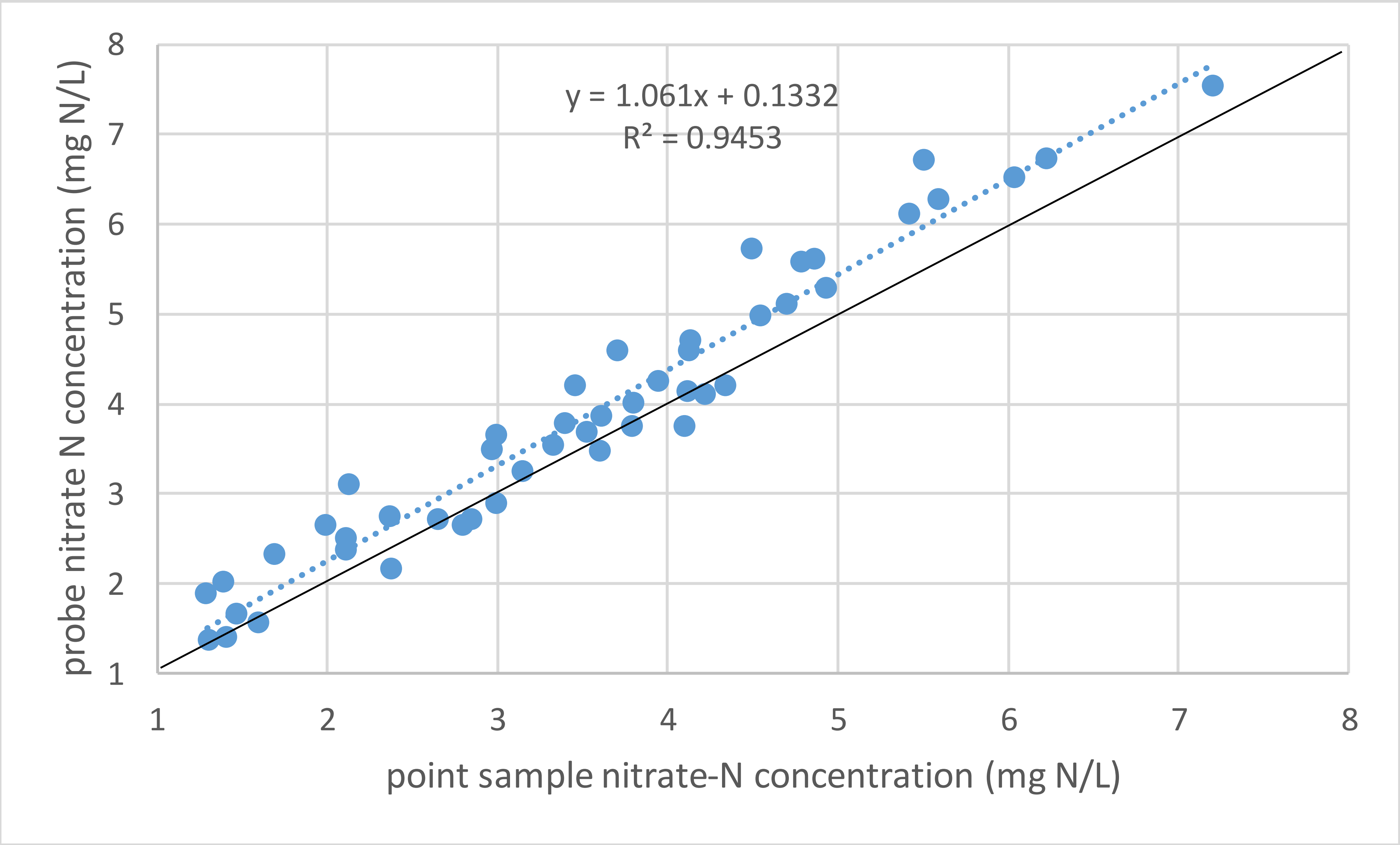
Daily mean Nitrate-N concentrations at Florence (probe) and measured and interpolated values at “Valley City”



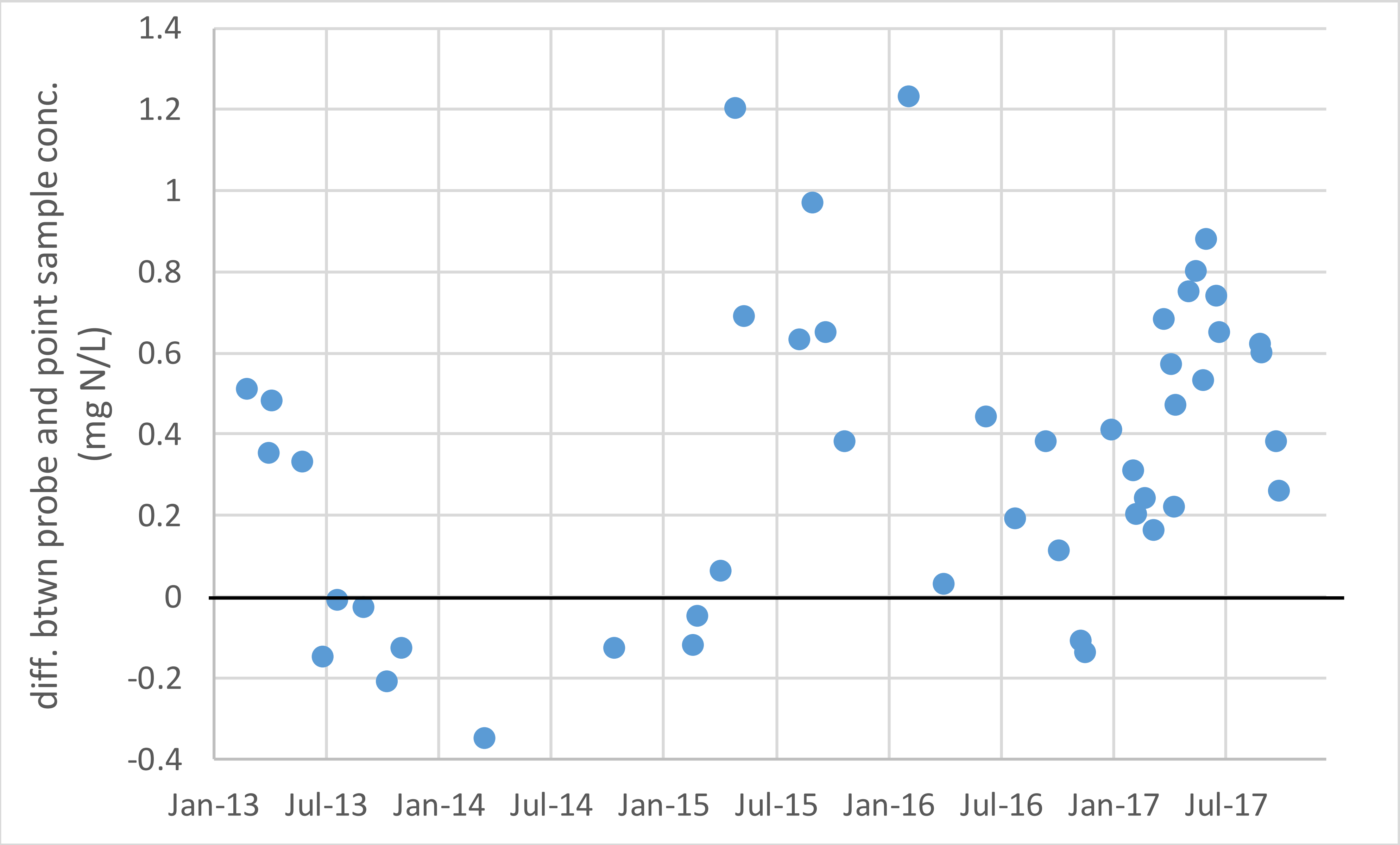
Nitrate-N concentrations at Florence 2012-2017

Probe measured concentrations averaged 9.4% larger than point sample (sample method code 82398=50)

15 minute probe data matched to within 10 minutes of point sampling time

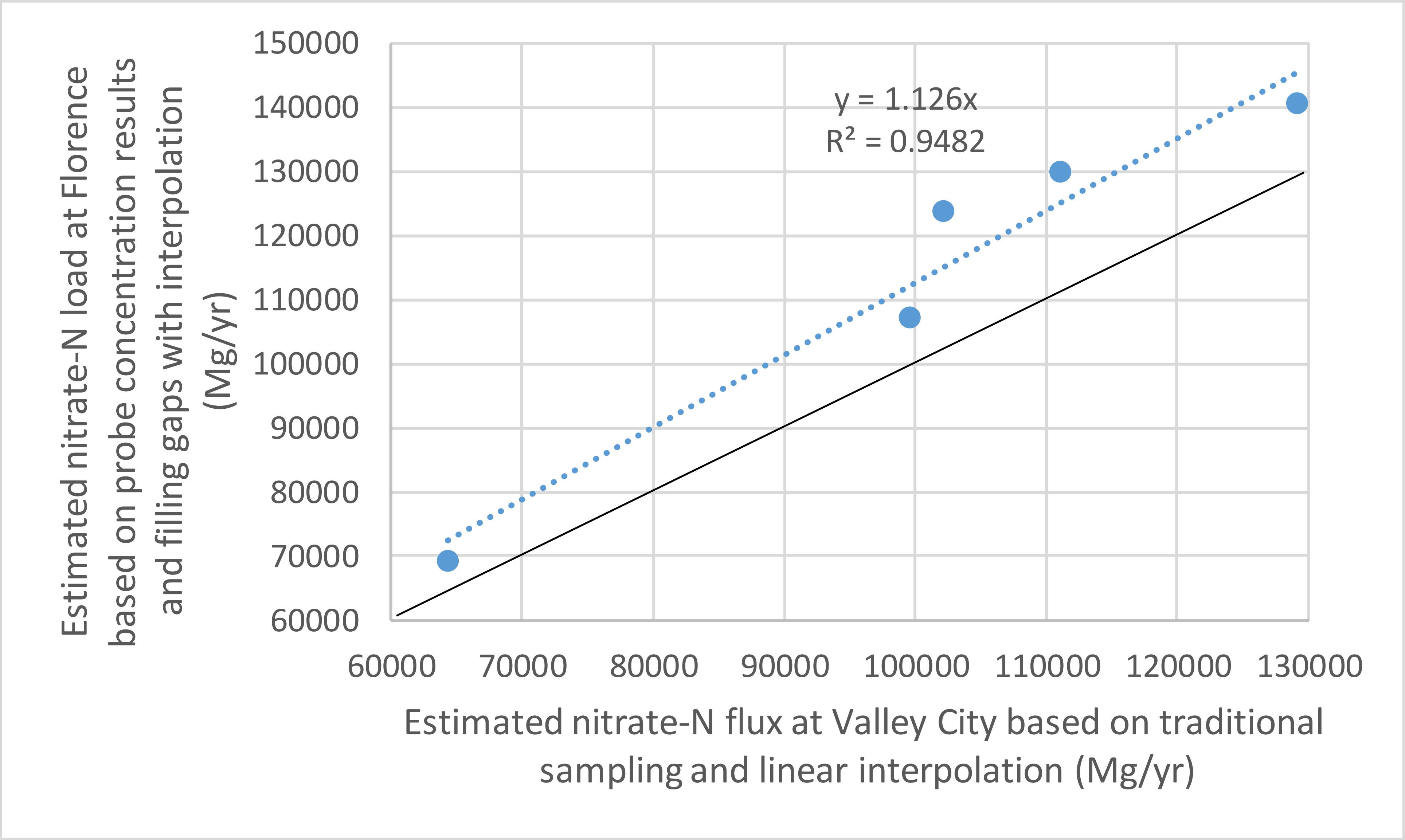


Probe measured concentrations minus point sample concentration at Florence



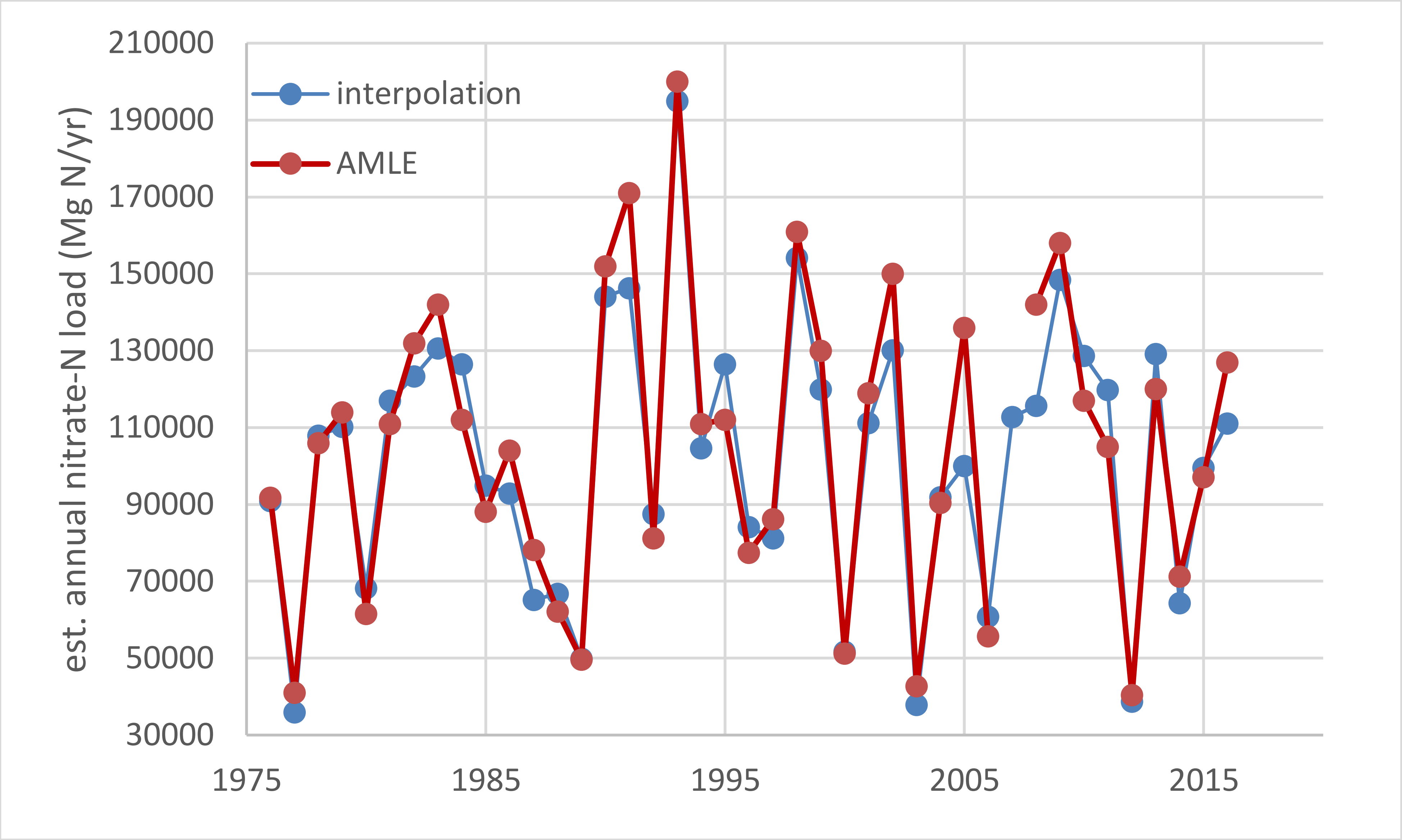
Estimated annual nitrate-N loads at "Valley City" and Florence 2013-2017

From traditional sampling methods and linear interpolation, vs. continuous probe measured concentrations



Estimated annual nitrate-N load at Valley City by linear interpolation of concentrations (blue) and by LoadEst Adjusted Maximum Likelihood Estimator (AMLE) (red)

http://toxics.usgs.gov/hypoxia/mississippi/flux_ests/sub_basins/ILL-VALL.html



Interpolation

2012-16 avg

17% reduction

2000-2016 avg

10% reduction

AMLE

2012-16 avg

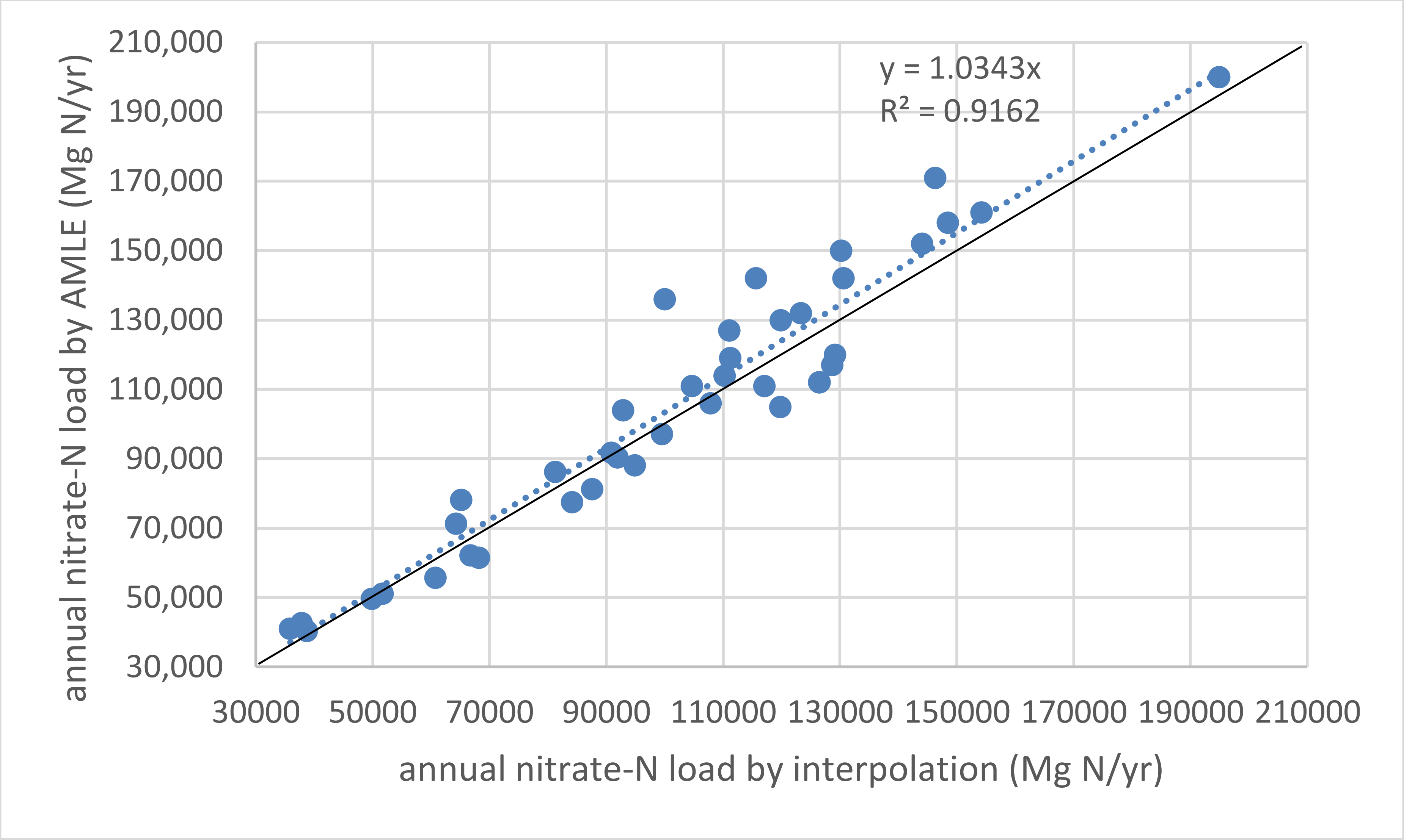
16% reduction

2000-2017 avg

6.6% reduction

Estimated annual Nitrate-N load at Valley City by linear interpolation of concentration (horizontal) vs LoadEst Adjusted Maximum Likelihood Estimation (AMLE, vertical) 1976-2016

http://toxics.usgs.gov/hypoxia/mississippi/flux_ests/sub_basins/ILL-VALL.html



What does it all mean?

- Continuous probe measured Nitrate-N concentrations at Florence 2012-2017 averaged about 9.4% greater than point sampled concentrations at Florence. Is there a need for better calibration?
- Annual Load estimates from probe concentrations averaged 12.6% greater than estimates from linear interpolation between traditional sampling events.
- Differences in load estimates may be due to 1) probe calibration; and 2) the probe detecting high concentration episodes missed by less frequent traditional sampling;
- Accurate assessment of changes over time requires either consistent methods or methods that produce equivalent results.
- There is considerable variability in 5 year average loads, largely due to rainfall and flow variations; 17 year average loads have been more stable.

Great Lakes to Gulf Observatory – A Place to Deposit, Organize, and Integrate NLRS Data and Information

Jong Lee, Ph.D.

National Center for Supercomputing Applications

University of Illinois at Urbana-Champaign

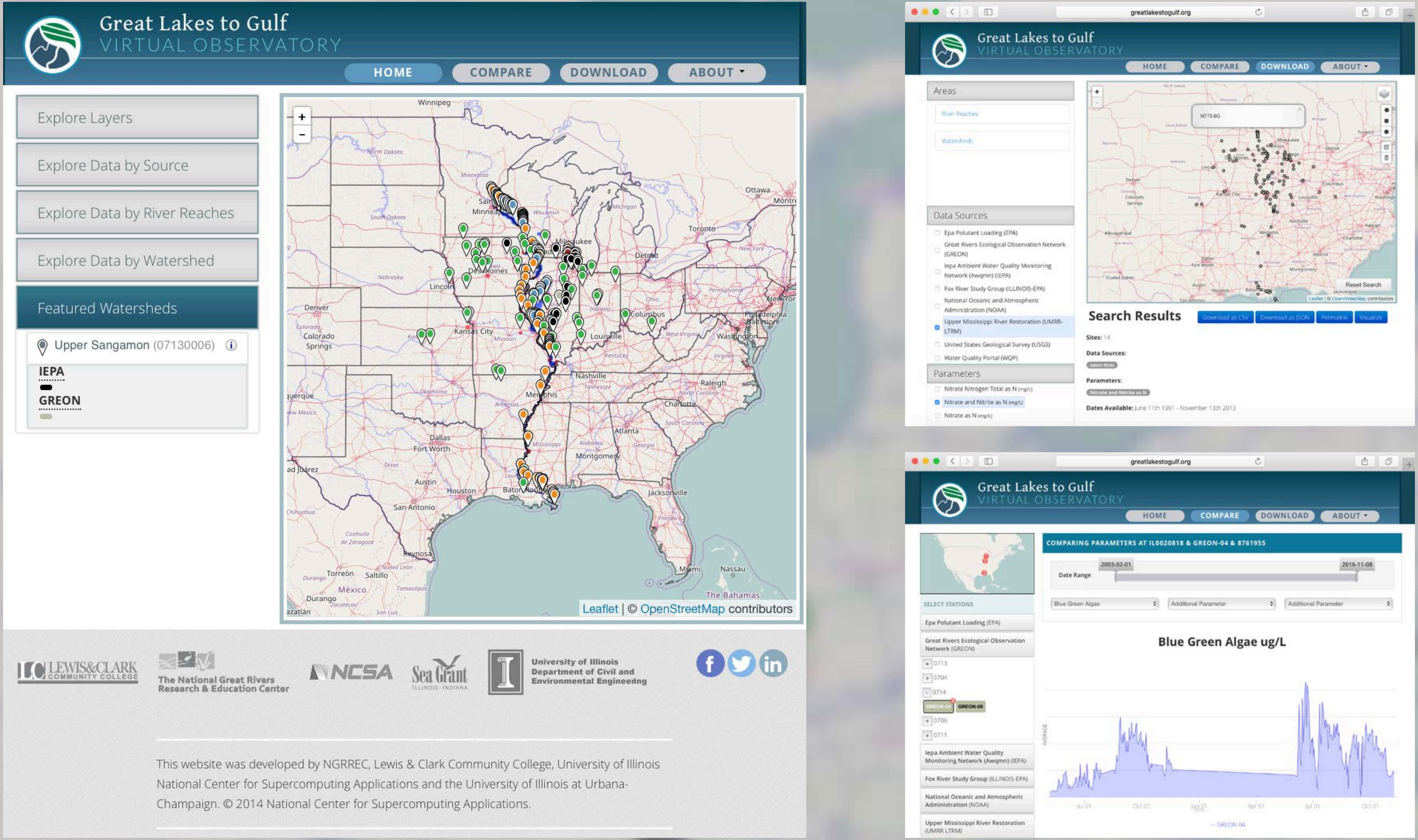
@ 2017 Inaugural Illinois NLRS Workshop, 11/29/2017

GLTG Overview

What is the Great Lakes to Gulf Virtual Observatory?

- The GLTG Observatory is a geospatial application that integrates water quality data from multiple sources to visualize nutrient pollution and water quality conditions in the Mississippi River watershed.

- The online interactive application provides users with tools to explore, analyze and compare water quality data from the Mississippi River and its tributaries.



Great Lakes to Gulf
VIRTUAL OBSERVATORY
HOME
COMPARE
DOWNLOAD
ABOUT
Explore Layers
Explore Data by Source
Explore Data by River Reaches
Explore Data by Watershed
Featured Watersheds
Upper Sangamon (07130006)
IEPA
GREON
Leaflet | © OpenStreetMap contributors
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The National Great Rivers Research & Education Center
NCSA
Sea Grant ILLINOIS-INDIANA
University of Illinois Department of Civil and Environmental Engineering
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Areas
River Reaches
Watersheds
Data Sources
Epa Polutant Loading (EPA)
Great Rivers Ecological Observation Network (GREON)
Iepa Ambient Water Quality Monitoring Network (Awqmn) (IEPA)
Fox River Study Group (ILLINOIS-EPA)
National Oceanic and Atmospheric Administration (NOAA)
Upper Mississippi River Restoration (UMRR-LTRM)
United States Geological Survey (USGS)
Water Quality Portal (WQP)
Parameters
Nitrate Nitrogen Total as N (mg/L)
Nitrate and Nitrite as N (mg/L)
Nitrate as N (mg/L)
Search Results
Download as CSV
Download as JSON
Permalink
Visualize
Reset Search
Sites: 14
Data Sources:
Parameters:
Dates Available: June 11th 1991 - November 13th 2013
COMPARING PARAMETERS AT IL0020818 & GREON-04 & 8761955
Date Range
2003-02-01
2016-11-08
SELECT STATIONS
Blue Green Algae
Additional Parameter
Blue Green Algae ug/L
Upper Mississippi River Restoration (UMRR LTRM)

What Data Sources does the GLTG application utilize?

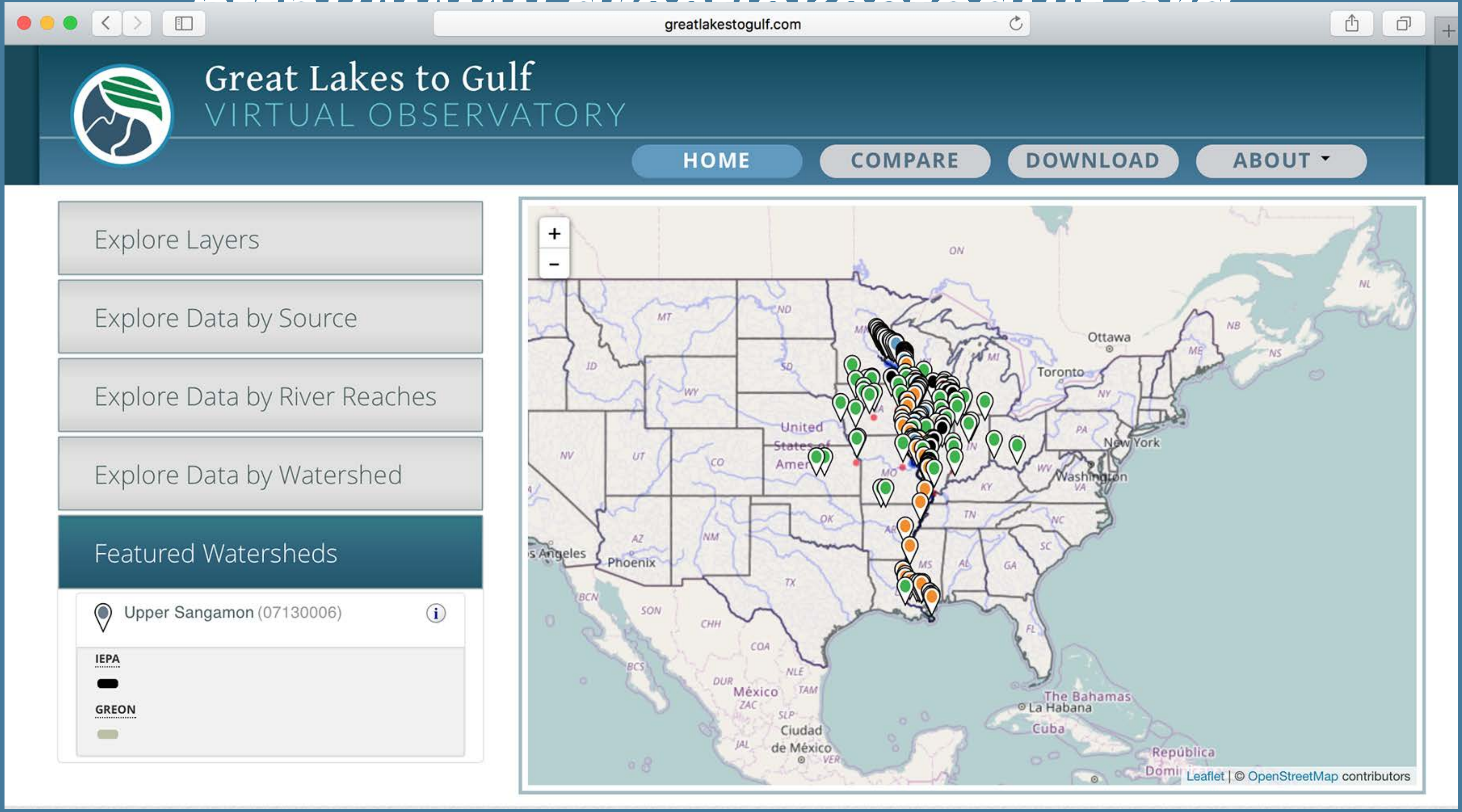
- 1019 sensor sites, 23,369,518 datapoints (and growing)
  - US Geological Survey – NWIS (National Water Information System)
  - UMRR LTRM – Upper Mississippi River Restoration Long Term Resource Monitoring Program
  - US Environmental Protection Agency – STORET/WQX (STOrage and RETrieval and Water Quality eXchange)
  - National Oceanic and Atmospheric Administration (NOAA)
  - WQP (Water Quality Portal)
  - NGRREC – GREON (Great Rivers Ecological Observatory Network)
  - TN Department of Environment and Conservation, Division of Water Resources, Water Quality Branch
  - Fox River Watershed, Fox River Study Group & Illinois State Water Survey

Great Lakes to Gulf Partners

- National Great Rivers Research and Education Center (NGRREC)
- National Center for Supercomputing Applications (NCSA), University of Illinois at Urbana-Champaign
- Illinois-Indiana Sea Grant
- Lewis and Clark Community College

Great Lakes to Gulf
VIRTUAL OBSERVATORY

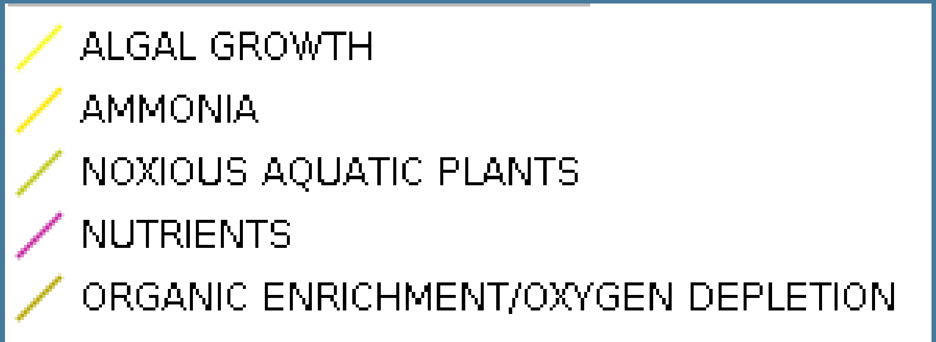
Visit Great Lakes to Gulf at http://www.greatlakestogulf.org

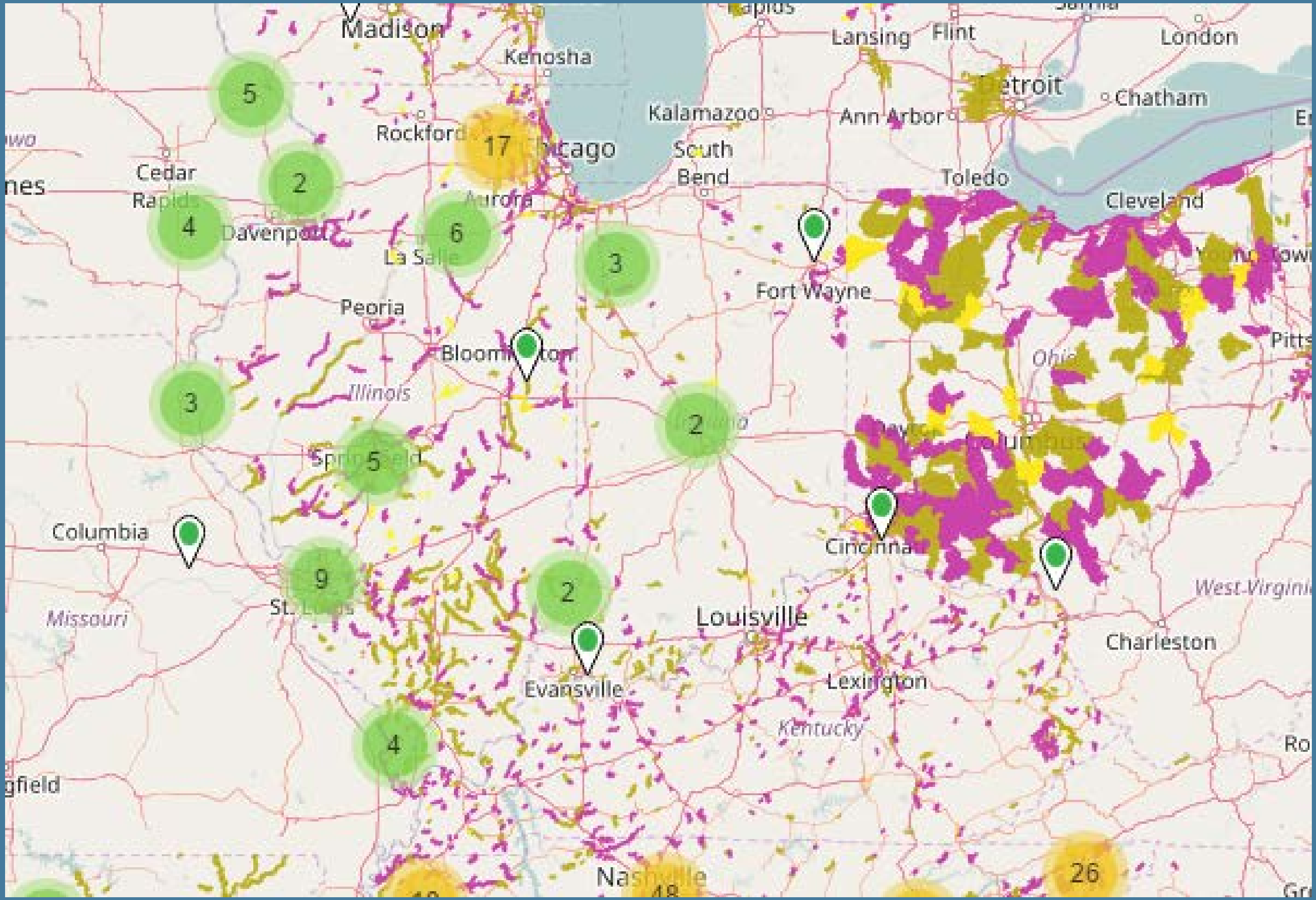


Great Lakes to Gulf
VIRTUAL OBSERVATORY

GIS Layers

- EPA Impaired Streams
- https://www.epa.gov/tmdl

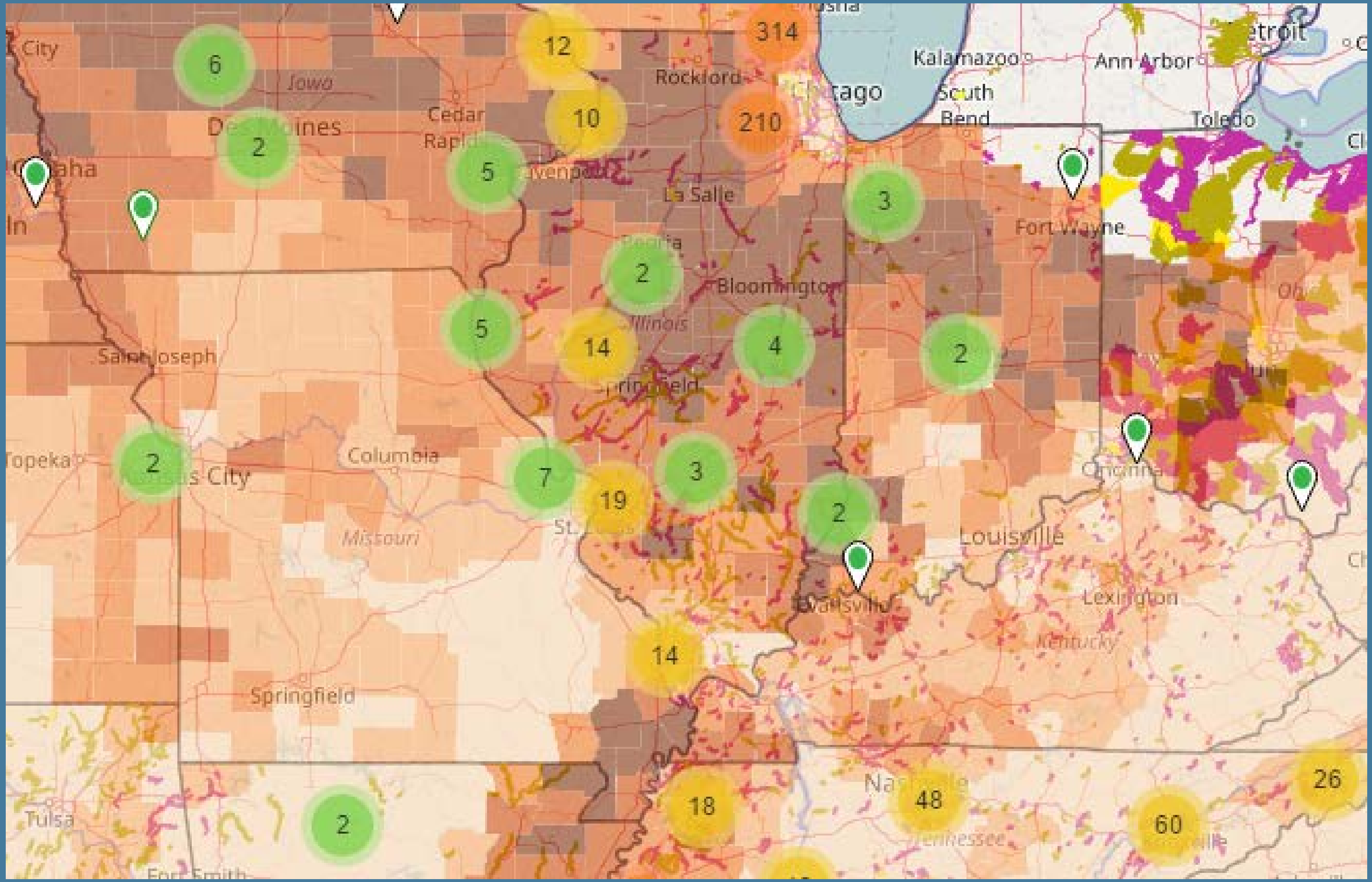




Great Lakes to Gulf
VIRTUAL OBSERVATORY

GIS Layers

- Average Annual Nitrogen Fertilizer Inputs for 1997 to 2006



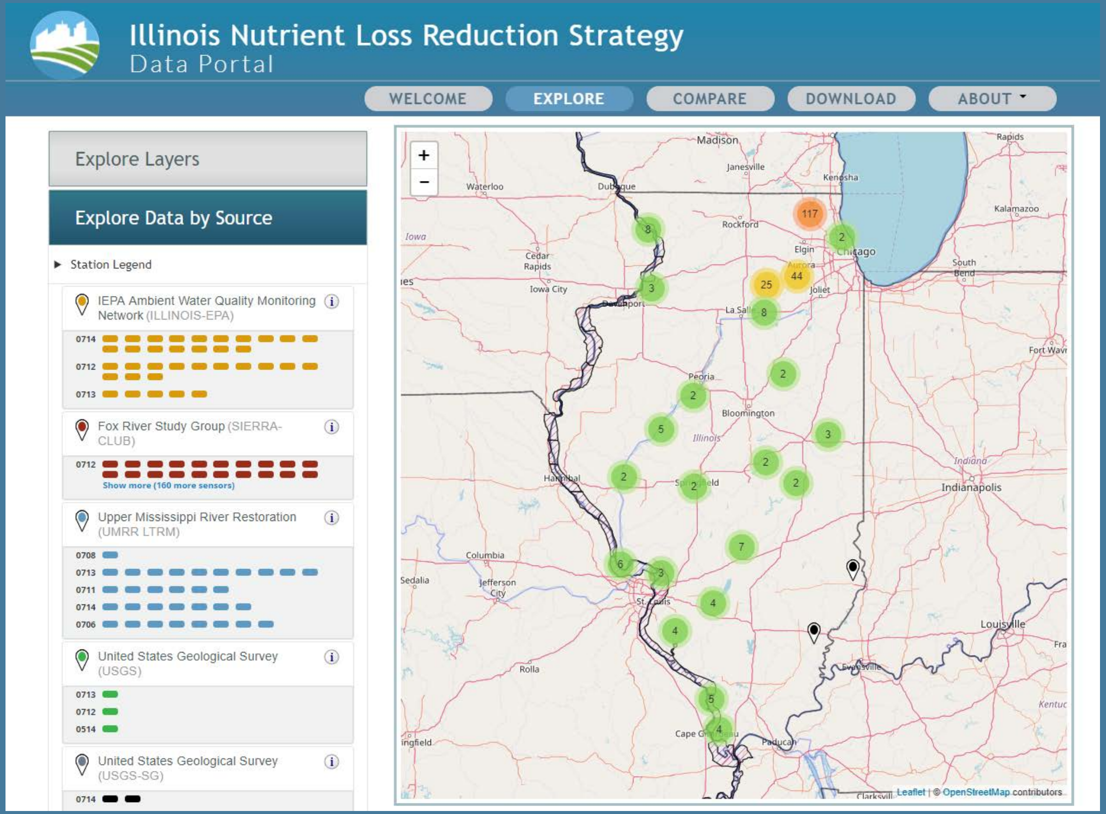
	0 - 11.2 kg/ha
	11.3 - 27.2 kg/ha
	27.3 - 45.4 kg/ha
	45.5 - 65.9 kg/ha
	66.0 - 107.1 kg/ha

Mark David, Laurie Drinkwater, and Gregory McIsaac (2010) “Sources of Nitrate Yields in the Mississippi River Basin,” J. Environ. Qual. 39:1657–1667

Illinois NLRS Data Portal

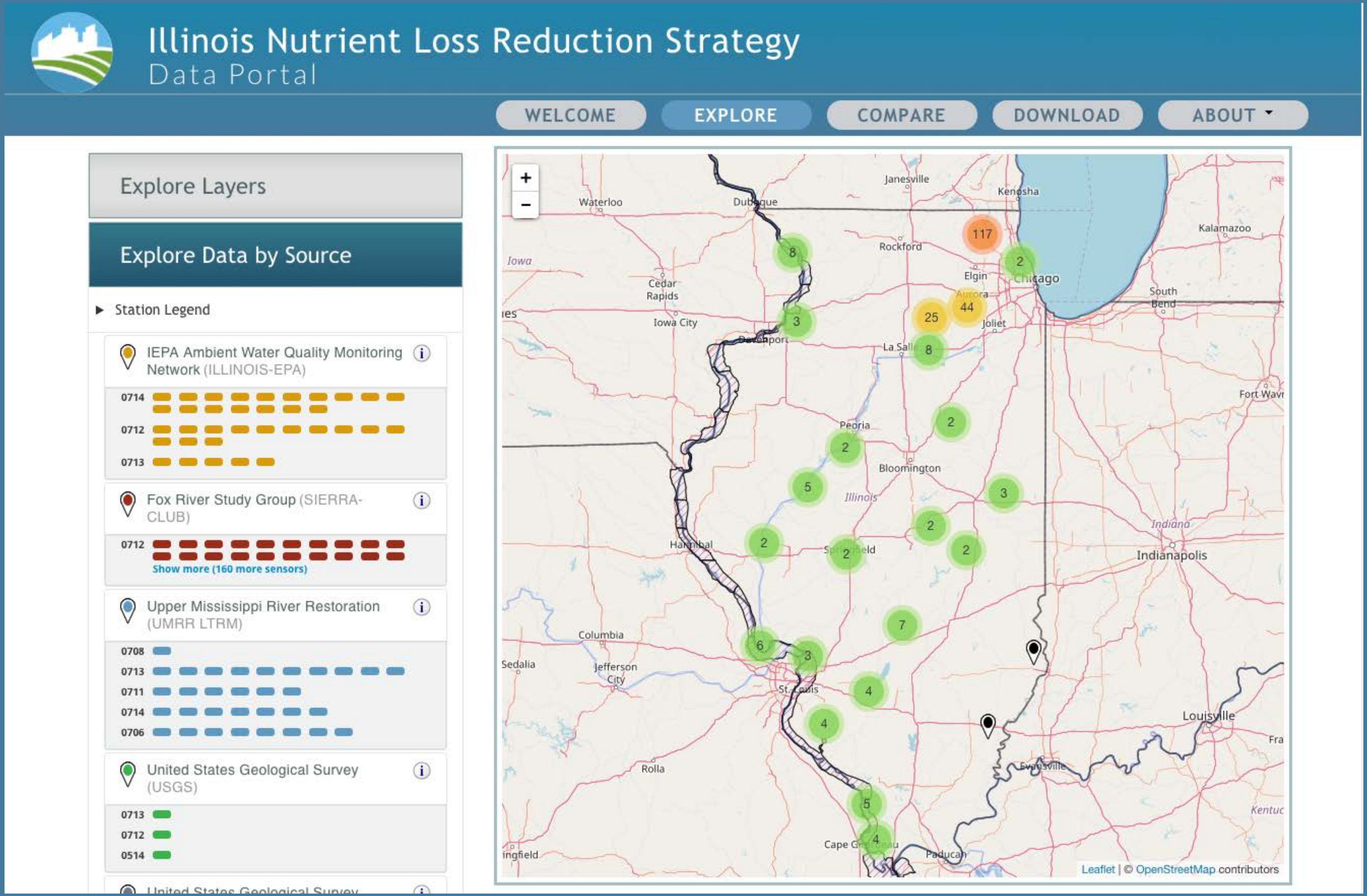
Development of IL NLRS Data Portal

- Base on GLTG application and data, IL NLRS data portal is under development working with IL EPA
- IL NLRS data portal will host the data for IL NLRS
- Initial data is from GLTG
- It will launch Dec, 2017 or Jan, 2018



Great Lakes to Gulf
VIRTUAL OBSERVATORY

Explore Data

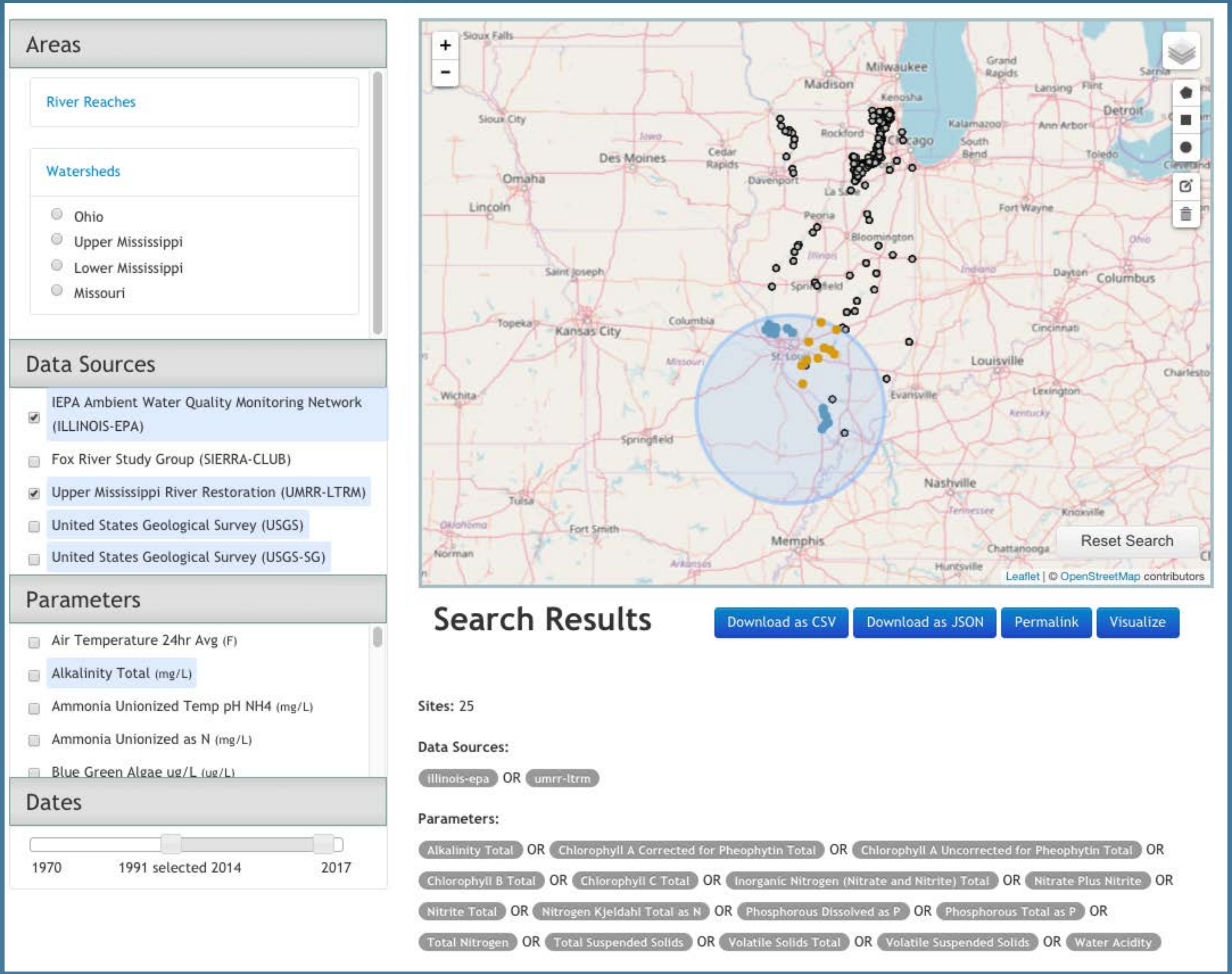


Great Lakes to Gulf
VIRTUAL OBSERVATORY

Compare Data

Great Lakes to Gulf
VIRTUAL OBSERVATORY

Download Data



Great Lakes to Gulf Virtual Observatory

https://greatlakestogulf.org

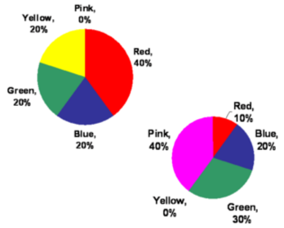
Monitoring Challenges for Estimating Nutrient Loads and Developing Water Quality Standards

Gregg Good, IEPA and Paul Terrio, USGS

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.



Challenges When it Comes to Monitoring Nutrient Loads, Trends, and Water Quality Outcomes

1. Monitoring is a challenging endeavor, period (Note my hair color!).

- Goals/objectives, collection, chain of custody, laboratory analysis, standard operating procedures, QA/QC, QMPs, QAPPs, data storage, data retrieval, data analysis, data reporting, FOIA requests, …..whew!

2. Monitoring takes time (Illinois River Waterway – Gibson-Reinemer, et al).

- Years or even decades of monitoring are needed to document a true change or trend (e.g., annual rainfall/intensity variations, time lags from implementation to response, cause/effect relationship development).

3. Monitoring is like a drug.

- The more you have, the more you want. The more you want, the more expensive it gets. Once you have it, it's hard to give up. And monitoring ain't sexy, so it's hard to compete for limited funding.

Challenges When it Comes to Monitoring Nutrient Loads, Trends, and Water Quality Outcomes

4. Monitoring is expensive in a time of diminishing resources – Where's the money?

- Staff, equipment, supplies, vehicles, lab, data management, financial assistance agreements….
- Will funding be available for the Super Gage network continuation after March 2020?
- Will funding be available for continuous monitoring at wadable streams?
- Will enough IEPA and IDNR field biologists be employed to continue on with water chemistry, habitat, and fish/macroinvertebrate collections to assess water quality outcomes?

5. Monitoring - Whose responsibility is it anyway?

- Who has the overall responsibility for monitoring loads and water quality outcomes? Is it just state government? What about local groups or the feds?
- The Nutrient Loss Reduction Strategy was established without a dime for implementation or monitoring. There's that "doing more with less" thing again!

Challenges When it Comes to Monitoring Nutrient Loads, Trends, and Water Quality Outcomes

6. Monitoring methods and load estimation methods are ever-changing.

- Technology is forever changing and improving. Who would have thought a decade or two ago that we'd have nitrate probes, chlorophyll probes, phosphate sensors…..and someday soon, total phosphorus probes!
- With those changes and improvements will come the challenge of comparing "apples to apples" when estimating loads or trends over time (as Dr. McIsaac has pointed out).

7. Measuring water quality trends and outcomes – Ah, the many variables!

- Flow, habitat, nutrient concentration, temperature, extreme events, etc., all add to the difficulty of teasing out whether or not point or NPS nutrient reduction, due to implementation of the Nutrient Loss Reduction Strategy, is working. This will be a never-ending challenge!

8. Keeping track of all this stuff over time, and keeping the ball rolling.

- The first two years have been great, but will NLRS implementation and monitoring enthusiasm still be there 10, 20, or 30 years from now?

Water Quality Standards Development Challenges

Data Needs Identified by NSAC

1. Benthic chlorophyll-a data for wadable streams.

Benthic algae (periphyton) are the main group of primary producers in wadable streams and the group most likely to respond to nutrient enrichment in shallow streams.

2. User perception information for water column and benthic algae.

This could take the form of a user perception survey in order to derive a numeric standard for sestonic and benthic chl-a based on aesthetics (a management goal). Increased surveillance and monitoring to identify nuisance algal bloom conditions and associated nutrient concentrations would be beneficial.

Water Quality Standards Development Challenges

Data Needs Identified by NSAC

3. Additional continuous dissolved oxygen (DO) monitoring.

Some data analyses were restricted to only those sites with continuous DO data, which limited the spatial coverage or statistical strength of the analyses. At a minimum, the State should maintain its current level of continuous DO monitoring. It would be advantageous to extend the monitoring at each site for longer than the current two 1-week periods (early and late summer).

4. A revised mIBI (or some form of macroinvertebrate analysis) that isolates the effect of nutrients on macroinvertebrate communities.

The current mIBI appears strongly related to physical habitat, and thus provides limited insight into the effects of nutrient enrichment. Some metrics, such as % EPT and % air breathers, are likely to better identify the effects of nutrient enrichment and corresponding low DO level.

Water Quality Standards Development Challenges

Data Needs Identified by NSAC

5. Sediment respiration / sediment oxygen demand.

When DO concentrations fall below the standard, it would be useful to know what fraction of the O_2 demand was due to respiration by algae versus respiration by bacteria and other microbes in the sediment. Particularly important for rivers with soft sediments.

6. Response of Illinois streams to habitat improvement.

Habitat quality, as assessed by QHEI, has emerged as a key driver of biotic condition. It is important to determine the extent to which biotic integrity would improve as physical habitat improved versus changes related to nutrients, algae, and DO conditions.