

U.S. Geological Survey Activities on the Fox and Illinois Rivers

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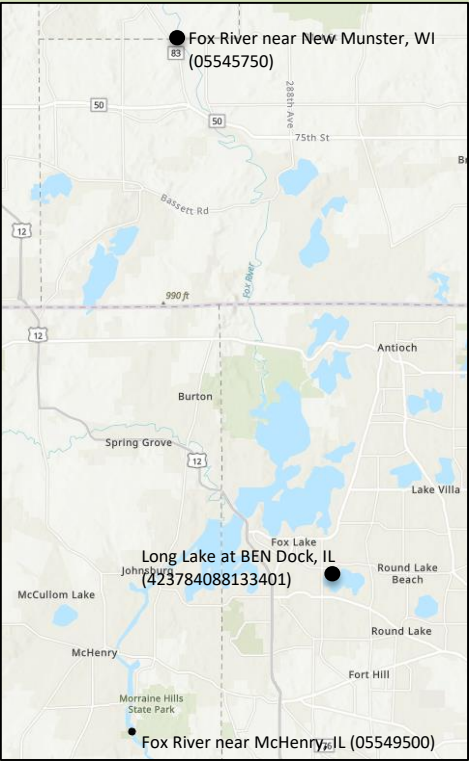
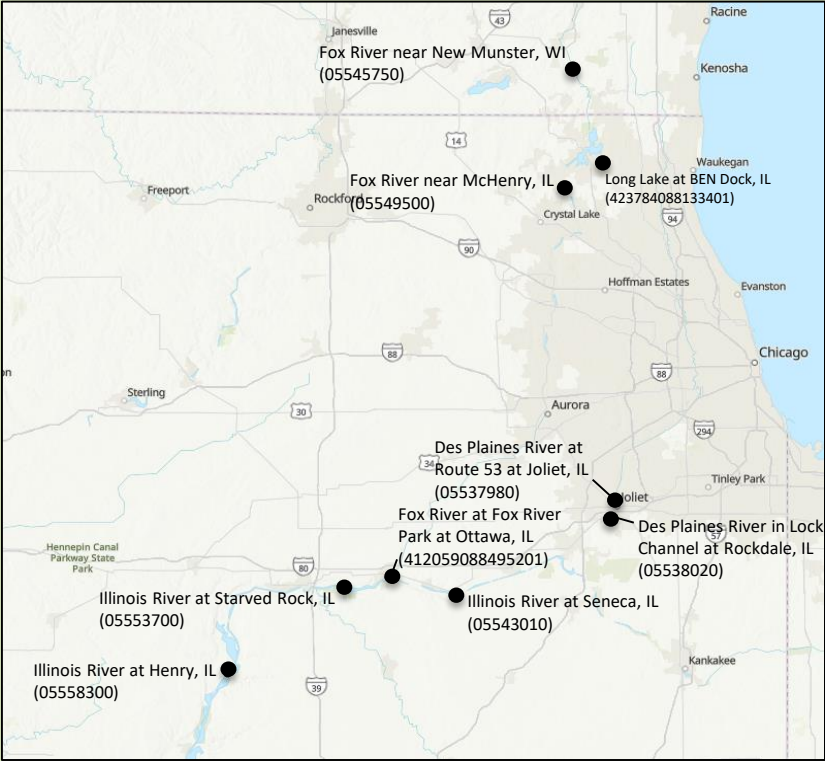
U.S. Geological Survey

Central Midwest Water Science Center

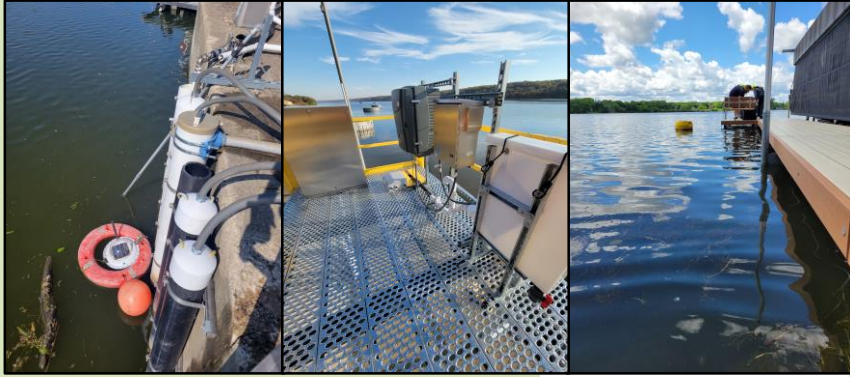
Fox River Study Group Annual Meeting

October 31, 2024

USGS Water Quality Monitoring on the Illinois and Fox Rivers



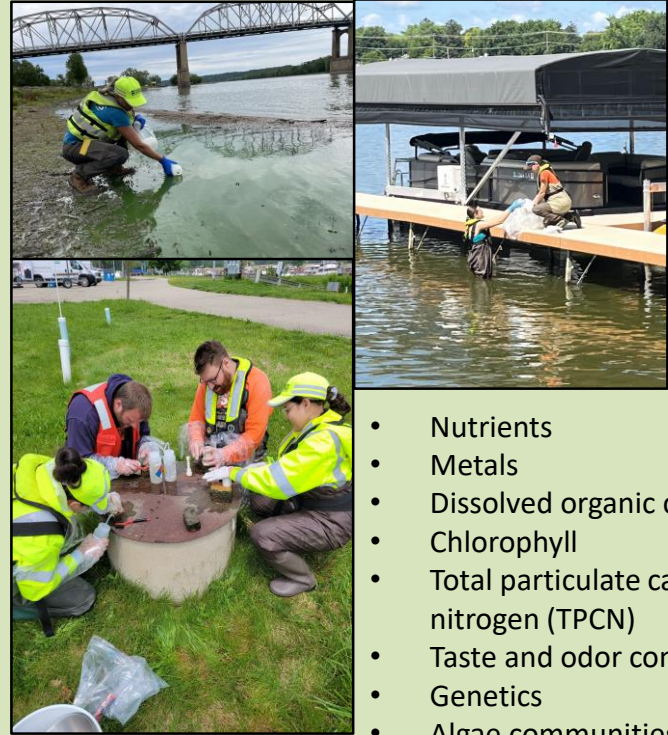
Continuous Water Quality Monitoring



- Water temperature (WT)
- Specific conductance (SPC)
- pH
- Dissolved oxygen (DO)
- Turbidity
- Chlorophyll-*a* (Chl)
- Phycocyanin (BGA)
- Nitrate
- Phosphate
- Dissolved carbon dioxide



Discrete sampling



- Nutrients
- Metals
- Dissolved organic carbon (DOC)
- Chlorophyll
- Total particulate carbon and nitrogen (TPCN)
- Taste and odor compounds
- Genetics
- Algae communities
- Toxins



Fox River McHenry Gage



Study Background - USGS

Goal of Fox River Implementation Plan

- Use models and various other techniques to evaluate potential management strategies to meet water quality (QW) standards on the Fox River
- Original Qual2k model, (Limnotech)
 - Calibrated with intensive sampling event 2012
 - 13 Locations along Fox River
 - Previous model consistently over predicted DO in free-flowing sections of Fox River downstream from several dams

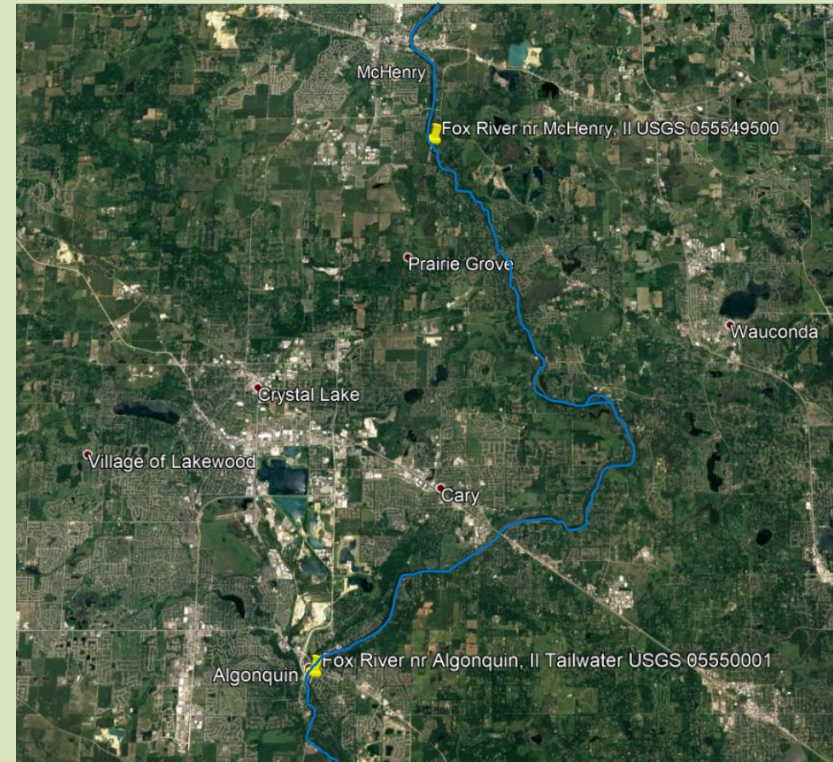
Goal of USGS Water Quality Monitoring

- USGS continuous data was to be added at key locations to help calibrate the QUAL2K model during periods of interest (Summer, Low Flows)
- Initial monitoring began at Fox River near Algonquin Tailwater with continuous QW only
- Monitoring equipment later moved to Fox River near McHenry at Stratton Dam with additional discrete samples upstream and downstream from dam
- Seasonal monitoring March through November each year.



Study Background - Continuous Water Quality Data

- Continuous monitoring of QW data with the goal of identifying diurnal and seasonal trends in DO and nuisance algae during periods of interest
- Algonquin–June 2016 through October 2018
 - Downstream of Algonquin Dam, “trouble area” of initial QWALK2K Model
 - Monitoring Continuous; Water Temp, pH, Specific Conductance, and Dissolved Oxygen
- McHenry- August 2018 through Present (Oct. 2024)
 - Most upstream point of FRSG Study Area, monitoring to quantify QW entering the study area.
 - Monitoring Continuous; Water Temp, pH, Specific Conductance, Dissolved Oxygen, Turbidity, Chlorophyll-*a*, and Blue Green Algae.
 - Discrete Samples; Chlorophyll-*a*, Nutrients, Ortho-Phosphate, and Total Phosphorus



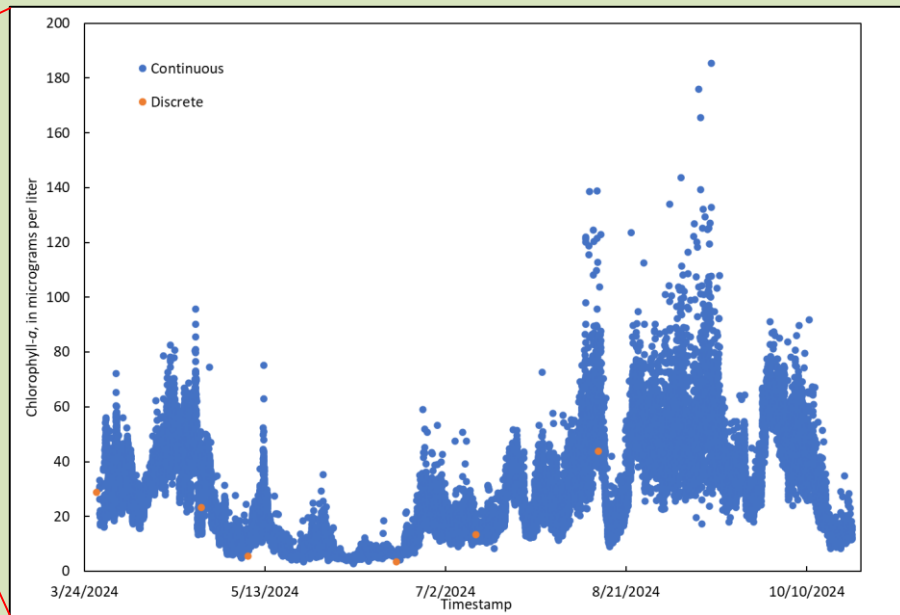
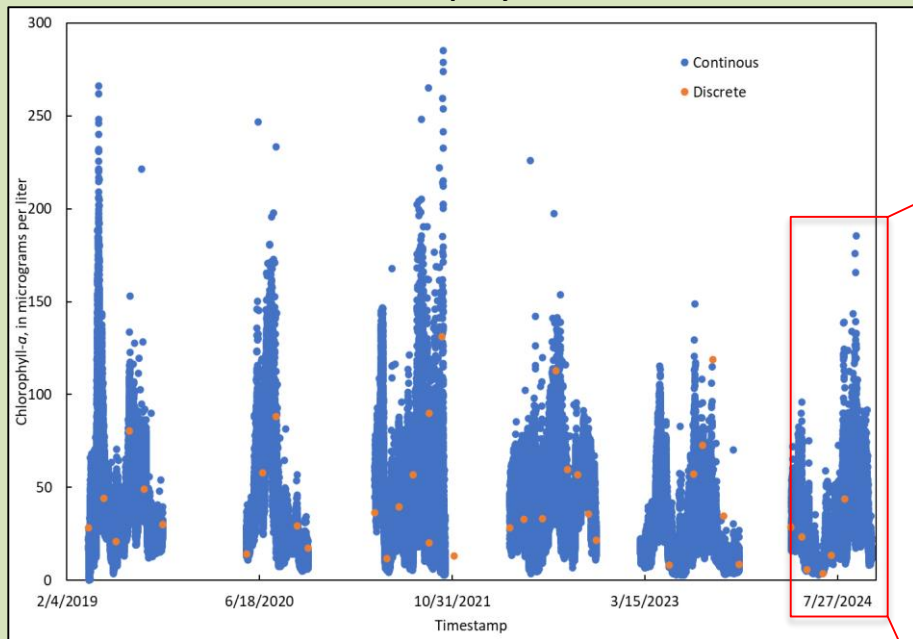


Equipment at the Site

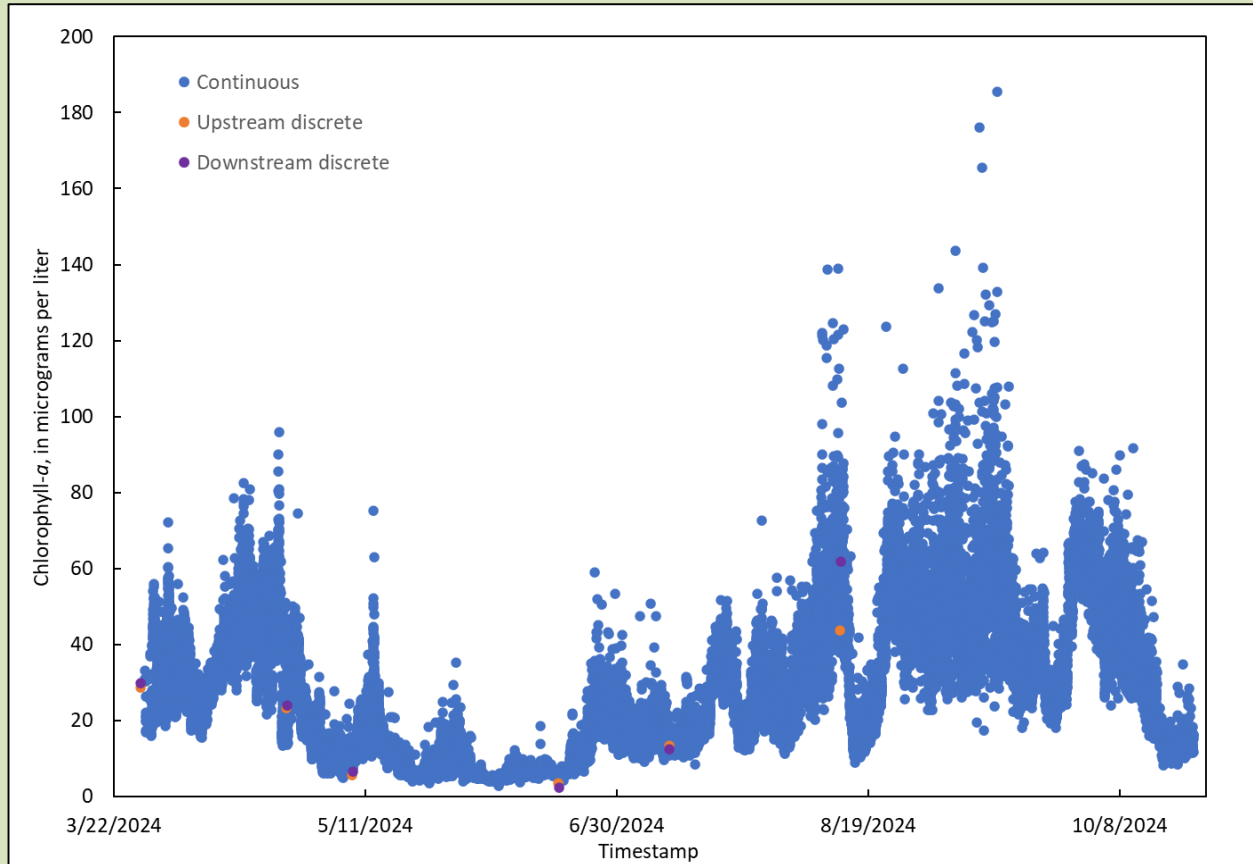
- YSI EXO 2 multi parameter sonde
 - Temperature
 - pH
 - Specific Conductance
 - Dissolved Oxygen
 - Turbidity
 - Total Algae
 - Phycocyanin and Chlorophyll
- Campbell CR850
- Sierra Wireless Modem

Fox River near McHenry, Illinois (05549500)

Entire chlorophyll-*a* record



FY24 Continuous Chlorophyll-*a* Sensor Values vs Discrete Lab Results



Sampling Locations of Algae Blooms at the Fox River in McHenry



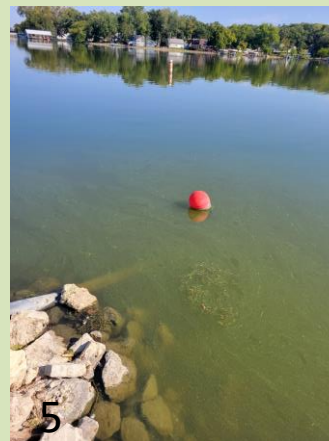
Blooms on the Fox River at the Lock and Dam in McHenry



1: Jul. 20, 2023. Bloom at Water Quality Gage.
2. Oct. 4, 2023, upstream of lock. Bloom sample collected downstream in boat slip.
3. Aug. 13, 2024. Bloom sample location. Upstream of locks.
4. Aug. 13, bloom located in lock channel



5. Sept. 17, 2024. Bloom at Water Quality Gage.
6. Sept. 17, 2024, bloom at downstream boat slip. Bloom sample location.
7. Sept. 17, 2024. Close up of algae bloom.



Bloom samples on Oct. 4, 2023, Aug. 13, 2024, and Sept. 17, 2024, sent in for toxin analysis.

Oct. 4: 12.1 ug/L (MC)
Aug. 13: 11.9 ug/L (MC)
Sept. 17: 7.52 ug/L (MC)

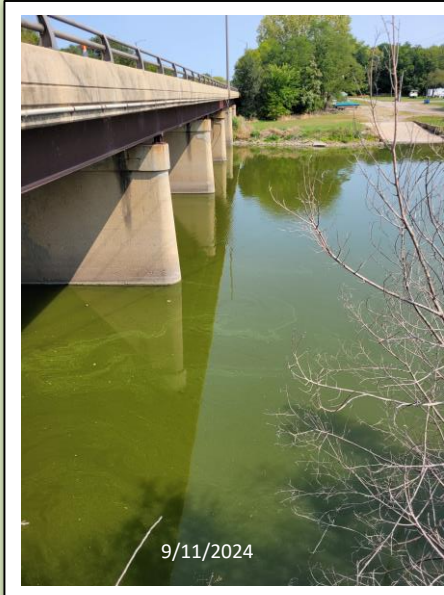
ug/L: micrograms per liter
MC - microcystin

*National Recommended human health recreational criterion: 8.00 ug/L for microcystin

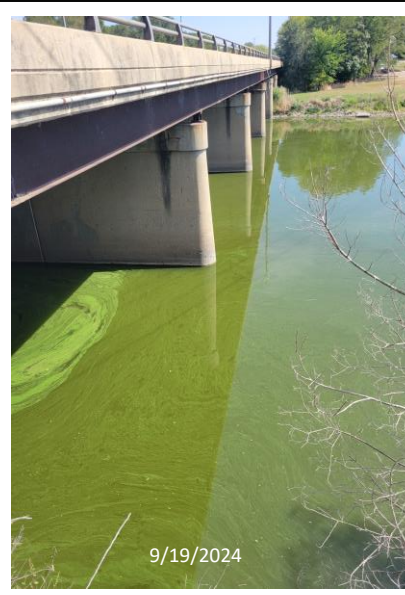


Fox River at Fox River Park at Ottawa, IL (412059088495201)

Harmful algal bloom (HABs) samples



- Depth integrated
 - Microcystins: 3.12 ug/L
 - Nitrate: 0.51 mg/L
 - Phosphorus: 0.014 mg/L
 - Orthophosphate: <0.004 mg/L
- Grab
 - Microcystins: 9.68 ug/L
 - Nitrate: 0.46 mg/L
 - Phosphorus: 0.017 mg/L
 - Orthophosphate: <0.004 mg/L
- Field Readings
 - WT: 21.66°C
 - SPC: 886 μ S/cm
 - pH: 8.80
 - DO: 14.44 mg/L
 - Turb: 14.72 FNU
 - Chl: 66.88 μ g/L
 - Bga: 2.80 μ g/L
 - N: 0.3 mg/L



- Depth integrated
 - Microcystins: 2.68 ug/L
 - Nitrate: 0.47 mg/L
 - Phosphorus: 0.017 mg/L
 - Orthophosphate: <0.004 mg/L
- Field Readings
 - WT: 23.27°C
 - SPC: 929 μ S/cm
 - pH: 8.94
 - DO: 12.51 mg/L
 - Turb: 15.83 FNU
 - Chl: 78.8 μ g/L
 - Bga: 3.00 μ g/L
 - N: 0.3 mg/L

ug/L: micrograms per liter
mg/L: milligrams per liter
FNU: Formazin Nephelometric Units

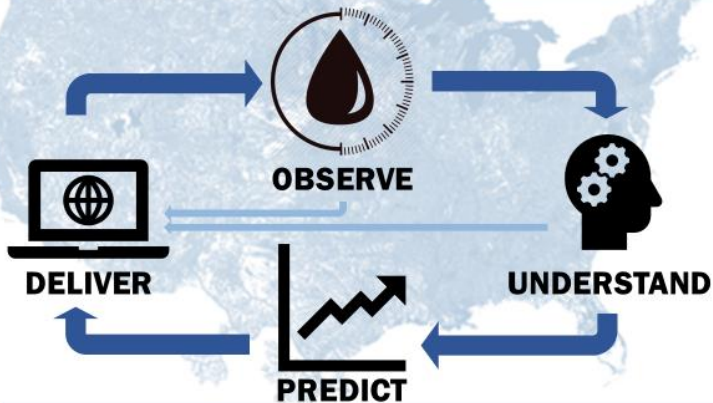
Illinois River Basin Update

An update on comprehensive water monitoring within the Illinois River Basin

Jim Duncker
Hydrologist
U.S. Geological Survey, Central Midwest Water Science Center

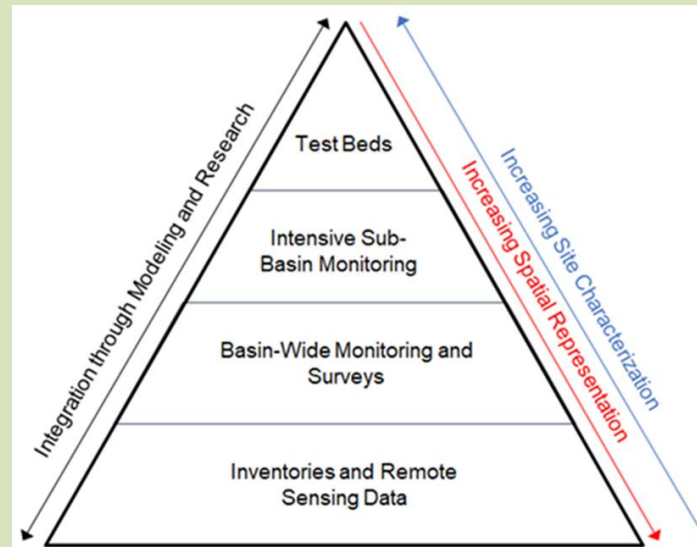


Integrated Water Science Process



USGS

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Next Generation Water Observing System (NGWOS)

NGWOS collects real-time data on water quantity and quality in more affordable, rapid, and intensive ways than has previously been possible. The flexible monitoring approach enables USGS networks to evolve with new technology and emerging threats.



Integrated Water Availability Assessments (IWAA)

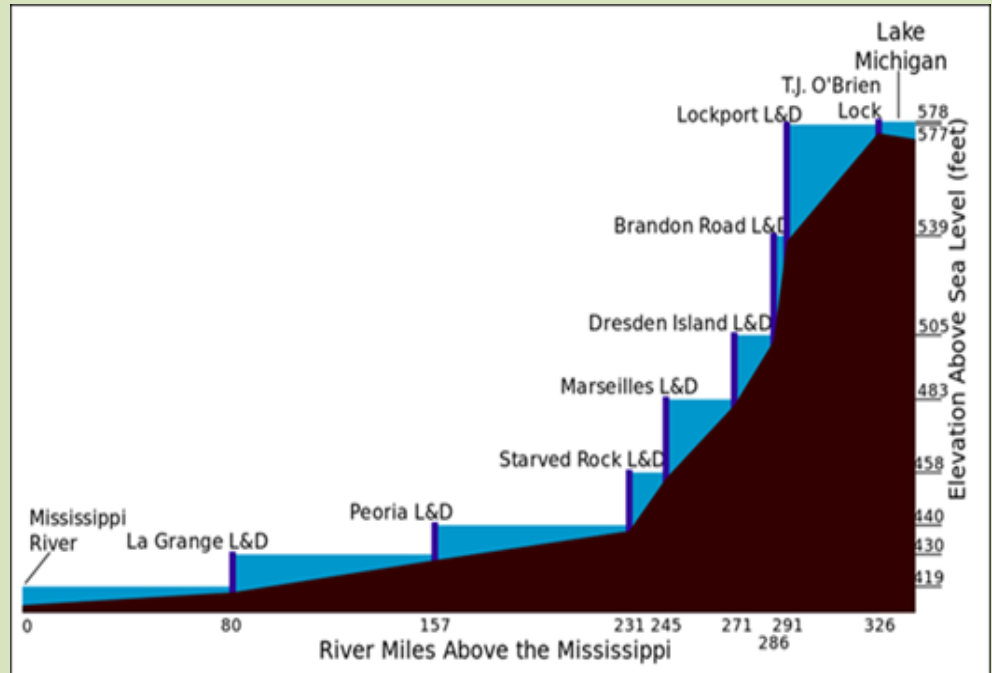
IWAAs examine the supply, use, and availability of the nation's water. These regional and national assessments evaluate water quantity and quality in both surface and groundwater, as related to human and ecosystem needs and as affected by human and natural influences.

USGS

Illinois River Basin and Illinois Waterway



Map view of the Illinois River watershed



Profile view of the Illinois Waterway
(courtesy USACE)

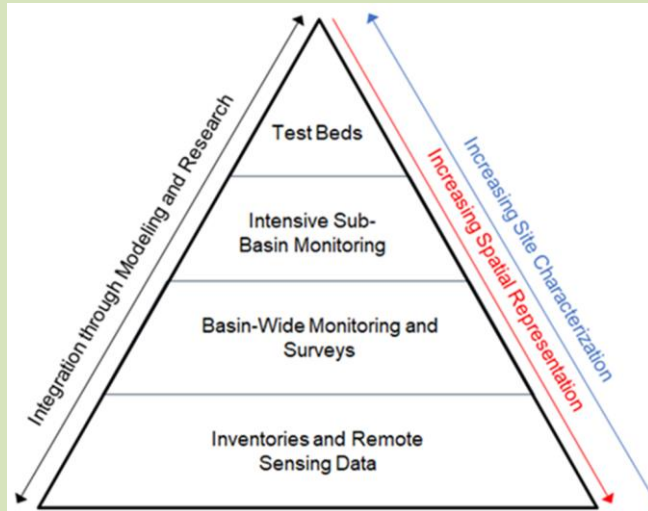
Illinois River Basin focus topics

- Focus Topic 1: **Nutrients**. How are excess nutrients impacting water availability, both groundwater and surface water, in the Illinois River Basin?
- Focus Topic 2: Harmful Algal Blooms(**HABs**). What are drivers of riverine HABs formation, persistence, and transport? How can HAB effects on water availability be forecast and most efficiently managed?



NGWOS Highlights

NGWOS testbeds summary



Expansion of super gage network

Continuous QW surveys-FLAMe

Airborne geophysical survey-AEM

Remote sensing QW-chlor-a

GW borehole velocity meters

Irrigation metering

Nutrient Diffusing Substrates

MicaSense cameras

Remote sensing-flood inundation

Urban flooding instrumentation-IoT sensors, LoRaWAN,

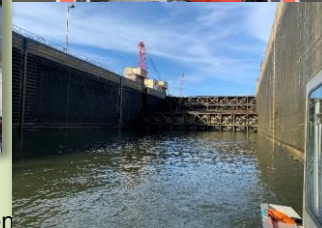
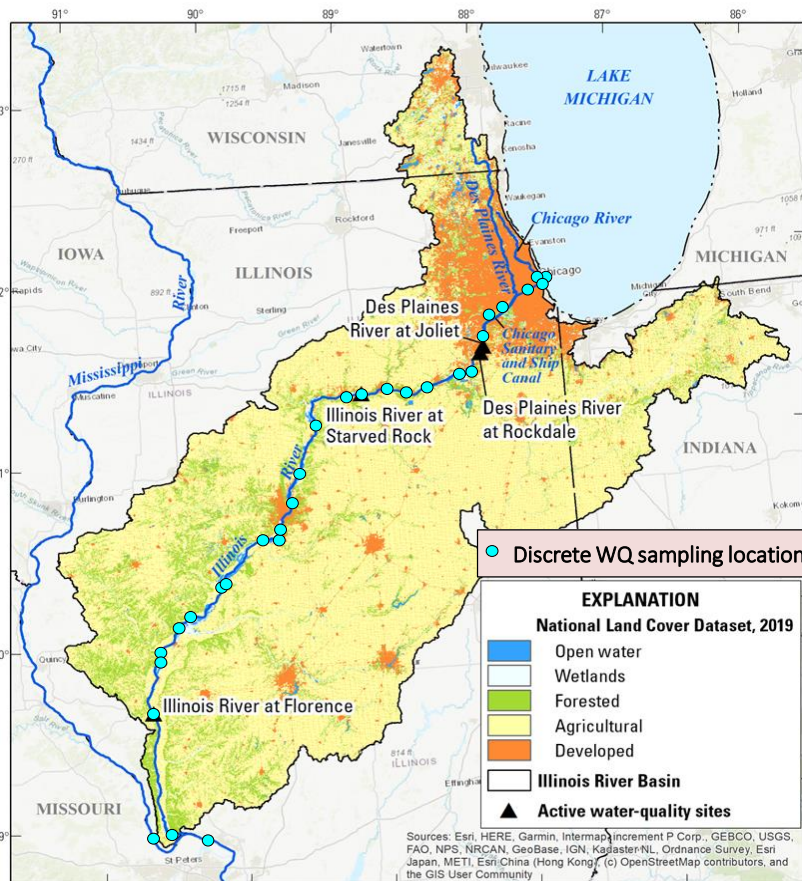
Cosmic Ray soil moisture

fDOM sensor evaluation

eDNA Tracker

FLAMe Water Quality Sampling Campaigns

- Lake Michigan to Mississippi River (~335 miles)
- Seasonal (May, August, November 2022; March 2023)
- 7-8 days per campaign
- 30 discrete sampling locations along mainstem, incoming tributaries, backwaters for nutrients (N, P, C), major ions, dissolved CO₂ & CH₄, C isotopes, dissolved organic matter chemical characterization, PFAS, pharmaceuticals, algal communities (select sites)

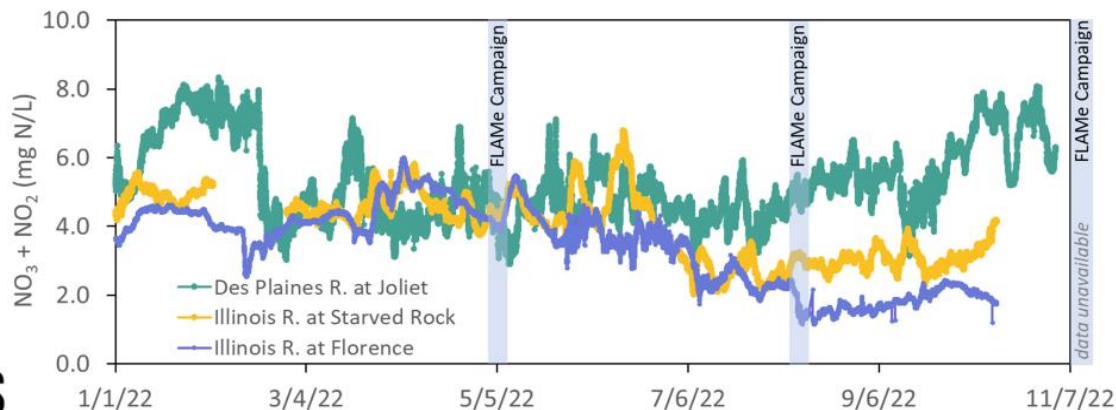


Map courtesy of J. Sharpe

Nitrate Data – FLAMe Campaigns + NGWOS



- Greatest NO₃ concentrations consistently observed in Chicago metropolitan area (often above first super gage).
- Lower NO₃ concentrations downstream, especially in late summer (consistent with N removal through reactive processes).



FLAMe campaigns provide high-resolution “snapshots” of water quality over *large spatial scales*.

NGWOS fixed stations provide high-resolution water quality data over *time*.

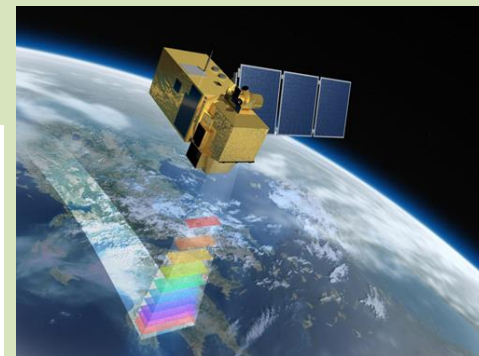




HABs-discrete sampling

- **HABs-discrete sampling Starved Rock pool**-Discrete water quality sampling verifies in situ sonde data. Discrete sampling occurs at select locations throughout the year. Samples processed by NWQL. HABs team successfully sampled a HABs event **in June 2021**; no HABs in 2022 on mainstem ILR; sampled very limited number of reported HABs events in 2023. Bloom event **in September 2024**.

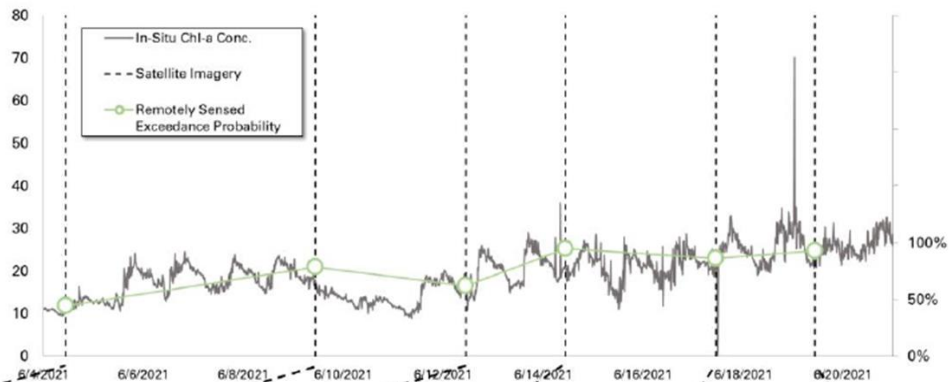
Remote sensing – water quality



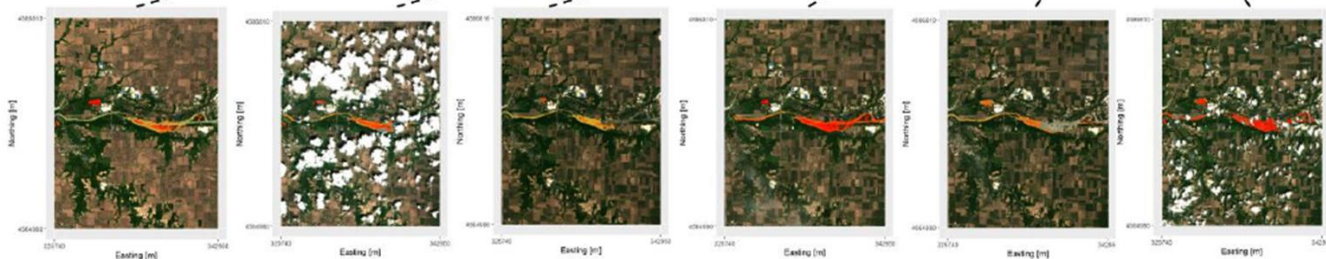
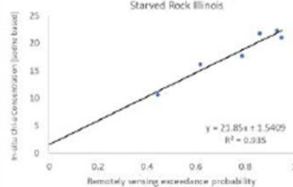
Imagery for Starved Rock, Illinois (USGS 05553700).

Exceedance probability: the estimated probability that a given pixel has a chlorophyll-*a* concentration greater than 10 ug/L.

Chlorophyll-*a* Concentration [mg/L]



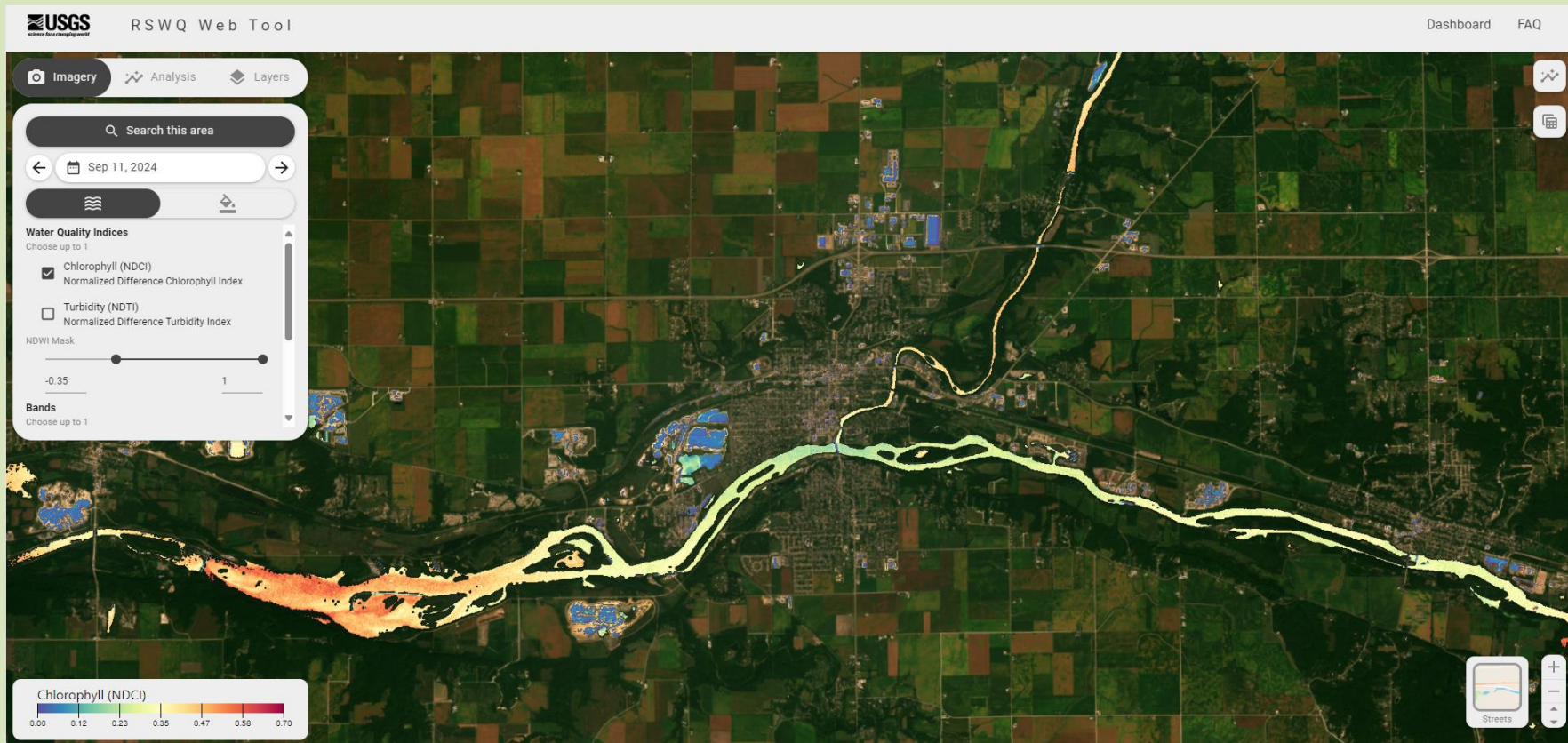
In-situ vs Remotely Sensed Chlorophyll-*a* Metrics: Starved Rock Illinois



June 2021 HABs event on the Illinois River showing good correlation between in situ water quality sonde chlorophyll-*a* readings and Sentinel 2 satellite imagery



Remote Sensing: RSWQ Web Tool





Questions?

Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

All photographs by U.S. Geological Survey.

