

# **Algae Blooms and Fish Kills:**

Case Studies in East-Central Illinois

**Illinois Lake Management Association**

**Annual Conference**

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# Algae Blooms in the News

- **Harmful Algal Blooms (HABs)**

- Blue-Green Algae (Cyanobacteria)
- Produce toxins harmful to people and animals
  - Skin rashes, blisters, eyes and nose irritation, respiratory problems, diarrhea, vomiting, and liver, kidney, and nervous system damage
- Illinois EPA developed a HAB program in 2013
- EPA FY2021 budget calls for an additional \$22.4 million to address and reduce HABs

**WHEN IN DOUBT, STAY OUT!**

STAY AWAY FROM THE WATER WHEN YOU SUSPECT  
A HARMFUL ALGAL BLOOM IS PRESENT.



**DON'T**  
Play with scum  
or mats on  
the shore



**DON'T**  
Let animals  
drink water, eat  
algae, or swim



**DON'T**  
Swim



**DON'T**  
Fish or wade

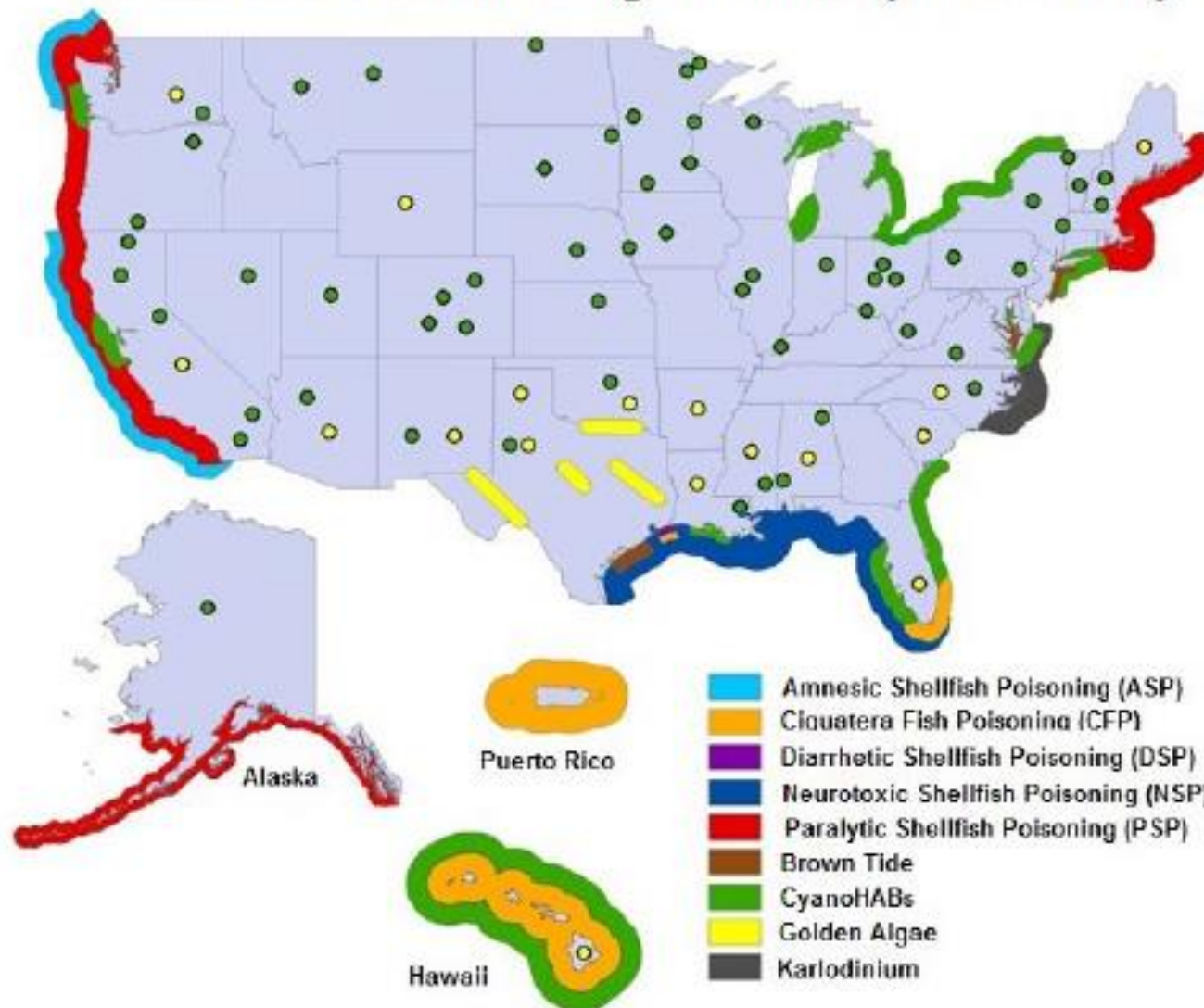


**DON'T**  
Boat or kayak

# Blue-Green Algae Blooms are a frequent occurrence in Lake Erie



## Locations of Harmful Algal Blooms (2008–2017)



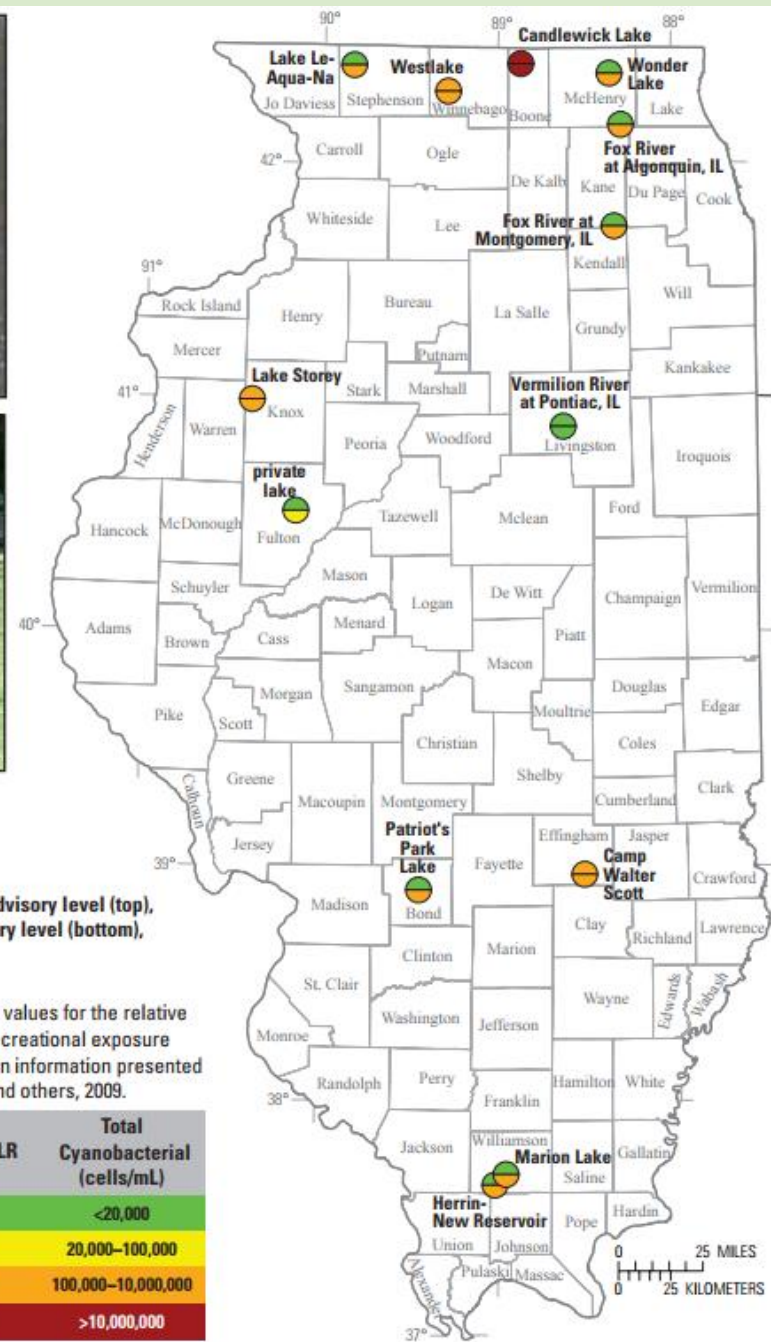
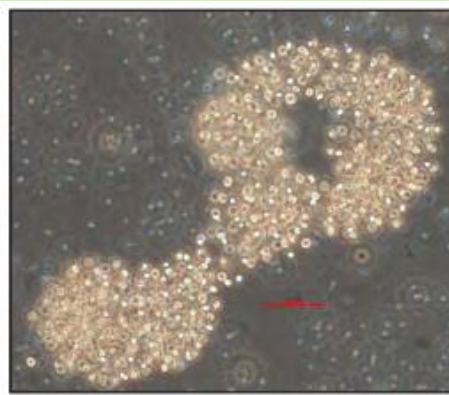
Source: Marc Suddleson, Manager, MERHAB-Sponsored Research Program, NOAA

Figure 2. Types of harmful algal bloom events that have occurred across the country since 2008.


# 2012 USGS and IEPA study

Cyanobacteria has always been present, but these harmful algal blooms are a relatively recent development.

To this point, the problem areas appear to be lakes and impounded reaches of rivers.



## EXPLANATION

 Marion Lake Site with Microcystin-LR advisory level (top), Total Cyanobacteria advisory level (bottom), and name

World Health Organization (WHO) guidance values for the relative probability of acute health effects during recreational exposure to microcystins and cyanobacteria, based on information presented in Chorus and Bartram, 1999, and Graham and others, 2009.

Relative Probability of Acute Health Effects (Advisory Level)	Microcystin-LR (ug/L)	Total Cyanobacterial (cells/mL)
Low	<10	<20,000
Moderate	10–20	20,000–100,000
High	20–2,000	100,000–10,000,000
Very High	>2,000	>10,000,000

Figure 1. Cyanobacteria sampling sites in Illinois showing relative probability of acute health effects from microcystins and cyanobacterial cells based on maximum levels found in samples collected in 2012.

# Algae Blooms in Rivers

- **Fox River**
  - 16 mainstem dams
  - high nutrients
  - algae blooms in most years
  - 303D list for low dissolved oxygen
- **Upper Mississippi River**
  - 27 dams
  - high nutrients
  - excessive growth of planktonic, benthic, and filamentous algae
  - frequent occurrence of low dissolved oxygen events
- **Illinois River and Des Plaines River**
  - 8 mainstem dams
  - June 2018 blue-green algae bloom from Morris to Lacon
- **Ohio River**
  - 20 locks & dams
  - 2015 massive 630-mile blue-green algae bloom
  - originated near Wheeling, WV in mid-August
  - 6-week duration
  - reached Evansville, IN about 50 miles from Illinois border

# Vermilion River (Illinois River drainage)



Figures 16-17. Photos of an algae bloom on the Vermilion River (Illinois River drainage) southeast of Pontiac on August 22, 2019.

Mid-day Dissolved Oxygen = 5.3 mg/L at 66% saturation

# Vermilion River (Wabash River drainage)

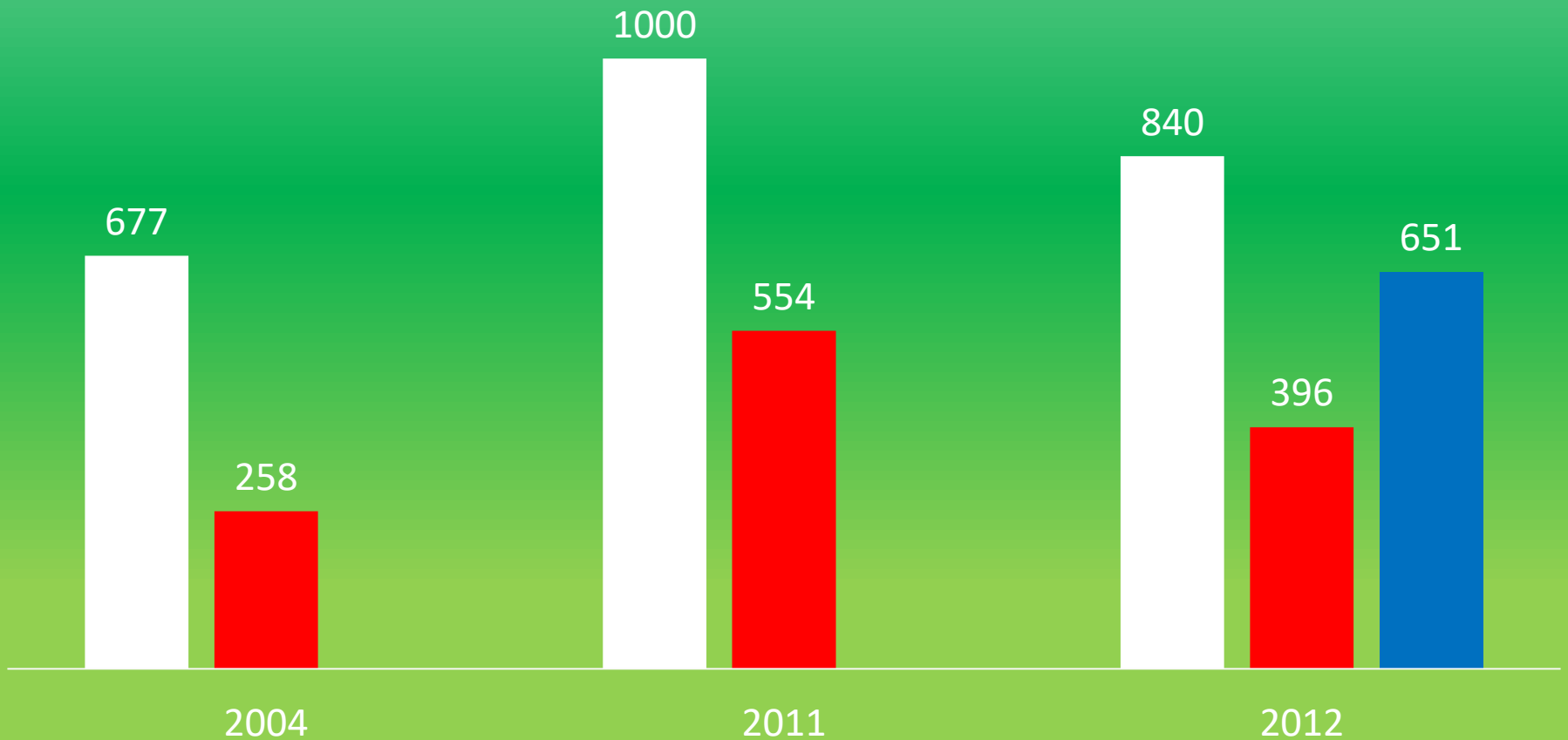
annual diatom algae blooms in Danville Dam impoundment





# Fish Abundance at Danville Dam

■ DOWNSTREAM ■ POOL ■ RIVER



# Iroquois River diatom algae blooms of 2010 and 2011

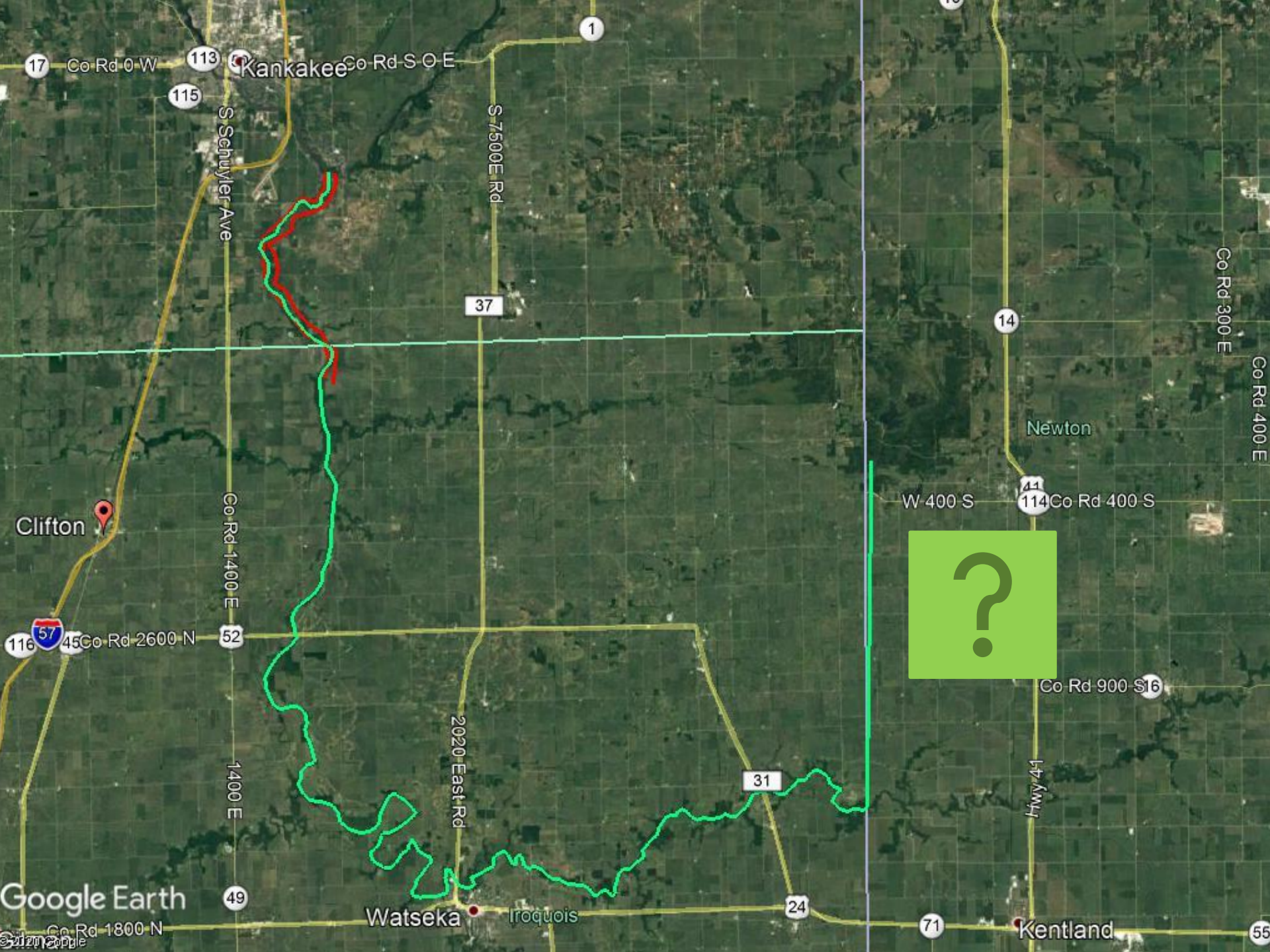


# Iroquois River diatom algae blooms of 2010 and 2011



Iroquois River  
diatom algae  
blooms of 2010  
and 2011





Kankakee

Clifton

Newton

Watseska

Iroquois

Kentland



Google Earth

© 2010 Google

# July 20, 2010 Iroquois River Fish Kill

- Algae Bloom tracked 49.86 miles from Indiana state line to the Kankakee River, likely much further upstream into Indiana.
- Fish kill impacted 6.94 miles
- Estimated 8,213 fish killed
- Channel Catfish, Bullheads, Madtoms, Yellow Bass, Smallmouth Bass, Sunfish, Walleye, Minnows, Darters, and Suckers
- Catfish species comprised 88% of kill

Phylum	Genus	Specific Epithet	Variety	Labeled Bottle	Unlabeled Bottle
BACILLARIOPHYTA	Cyclotella	meneghiniana		Plus	Plus
BACILLARIOPHYTA	Melosira	oistans		Plus	Plus
BACILLARIOPHYTA	Melosira	italica	tenuissima	Plus	
BACILLARIOPHYTA	Nitzschia	acicularis		Plus	Plus
BACILLARIOPHYTA	Nitzschia	linearis		Plus	Plus
BACILLARIOPHYTA	Nitzschia	palea		Plus	Plus
BACILLARIOPHYTA	Surirella	elegans		Plus	
BACILLARIOPHYTA	Synedra	delicatissima	delicatissima		Plus
CHLOROPHYTA	Acinastrum	hantzschii	fluvialite		Plus
CHLOROPHYTA	Ankistrodesmus	convolutus			Plus
CHLOROPHYTA	Ankistrodesmus	falcatus	acicularis	Plus	Plus
CHLOROPHYTA	Ankistrodesmus	falcatus	mirabilis	Plus	
CHLOROPHYTA	Coelastrum	microporum		Plus	Plus
CHLOROPHYTA	Cosmarium	sp.			Plus
CHLOROPHYTA	Cosmarium	sp.			Plus
CHLOROPHYTA	Crucigenia	quadrata			Plus
CHLOROPHYTA	Crucigenia	rectangularis		Plus	Plus
CHLOROPHYTA	Crucigenia	tetrapedia		Plus	Plus
CHLOROPHYTA	Dictyosphaerium	pulchellum		Plus	Plus
CHLOROPHYTA	Kirchneriella	lunaris	lunaris	Plus	Plus
CHLOROPHYTA	Micractinium	pusillum			Plus
CHLOROPHYTA	Oocystis	borgesi		Plus	
CHLOROPHYTA	Pediastrum	duplex	gracilimum		Plus
CHLOROPHYTA	Pediastrum	simplex	duodenarium		Plus
CHLOROPHYTA	Scenedesmus	abundans		Plus	Plus
CHLOROPHYTA	Scenedesmus	arcuatus	platydisca		Plus
CHLOROPHYTA	Scenedesmus	bijuga	alternans	Plus	Plus
CHLOROPHYTA	Scenedesmus	dimorphus		Plus	
CHLOROPHYTA	Scenedesmus	opoliensis		Plus	Plus
CHLOROPHYTA	Scenedesmus	quadricauda		Plus	
CHLOROPHYTA	Tetraedron	regulare	incus		Plus
CHLOROPHYTA	Tetraedron	trigonum	trigonum		Plus
CHLOROPHYTA	Tetrastrum	heterocanthum		Plus	Plus
CHLOROPHYTA	Tetrastrum	staurigeniaeforme			Plus

Dr. O'Flaherty (WIU) confirmed  
the diatom algae bloom of  
*Cyclotella meneghiniana*

Phylum	Genus	Specific Epithet	Variety	Labeled Bottle	Unlabeled Bottle
CRYPTOPHYTA	Cryptomonas	erosa		Plus	
CRYPTOPHYTA	Cryptomonas	sp.		Plus	Plus
CYANOPHYTA	Dactylococcopsis	rhapsodioides			Plus
CYANOPHYTA	Gomphosphaeria	lacustris		Plus	Plus
CYANOPHYTA	Schizothrix	caldicola			Plus
EUGLENOPHYTA	Euglena	tripteris			Plus
EUGLENOPHYTA	Euglena	sp.			Plus
XANTHOPHYTA	Pseudotetraedron	neglectum			Plus
PROTOZOA	Unknown Flagellates			Plus	Plus
BACTERIA	Bacillus			Plus	Plus

# White River fish kill in Indiana caused by same diatom algae in 2009.



## Yellow-Brown Algal Bloom Makes White River Water Brown and Foamy and May Be Responsible for Fish Kill July 2009

**M**any people have noticed a dark brown color on the White River in Hamilton and Marion Counties in the past week (July 18 -28, 2009). There are also

patches of foam and areas where a brownish scum is collecting. The algal bloom is known to extend from north of 116th street in Hamilton County down to at least 16th street in Indianapolis.

These conditions are being caused by a bloom of single-celled algae in the group of algae known commonly as yellow-brown algae or diatoms.

Scientists from the Center for Earth and Environmental Science (CEES) at IUPUI, observed the bloom on the White River on Friday, July 24, 2009 in an area just south of Conner Prairie, extending downstream for a significant distance. Conditions on the river varied from areas of very dark brown water color, to areas with patchy foam and bubbles, to areas with a brownish scum that in places looked like a film, froth, or scum surface.

Nicolas Clercin, a research scientist at CEES who is an expert on algae analyzed the sample and determined that it was dominated (>99%) by a diatom called *Cyclotella meneghiniana*. Diatoms are microscopic single-celled algae that photosynthesize like all plants. They are tiny (20-25 microns in size) – so that more than 80-100



Greenish-brown algal scum collecting along White River shoreline near 116th Street



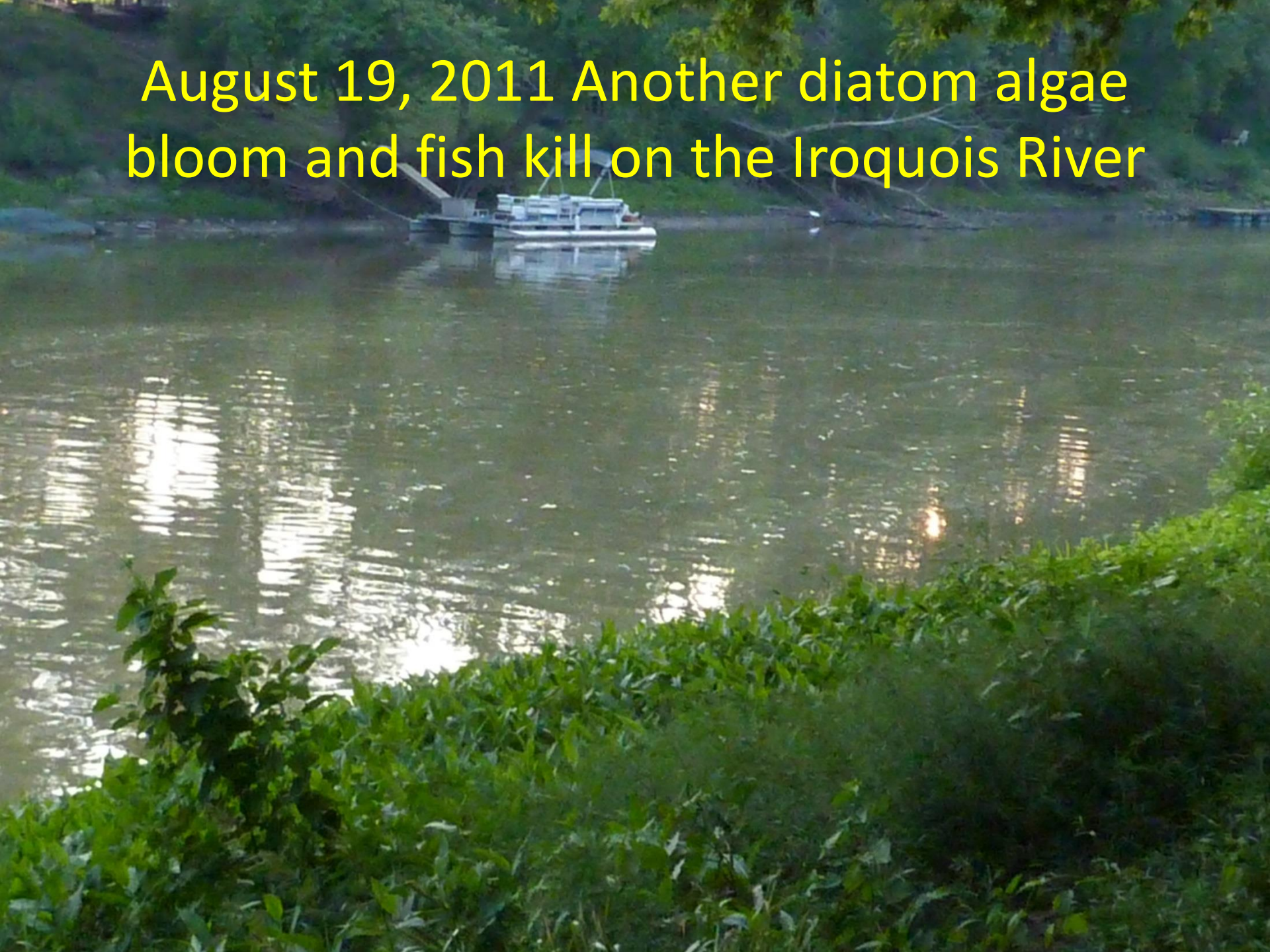
Large areas of the diatom bloom had patches of floating bubbles and foam



Patches of yellowish-brown foam in areas of concentrated algal bloom

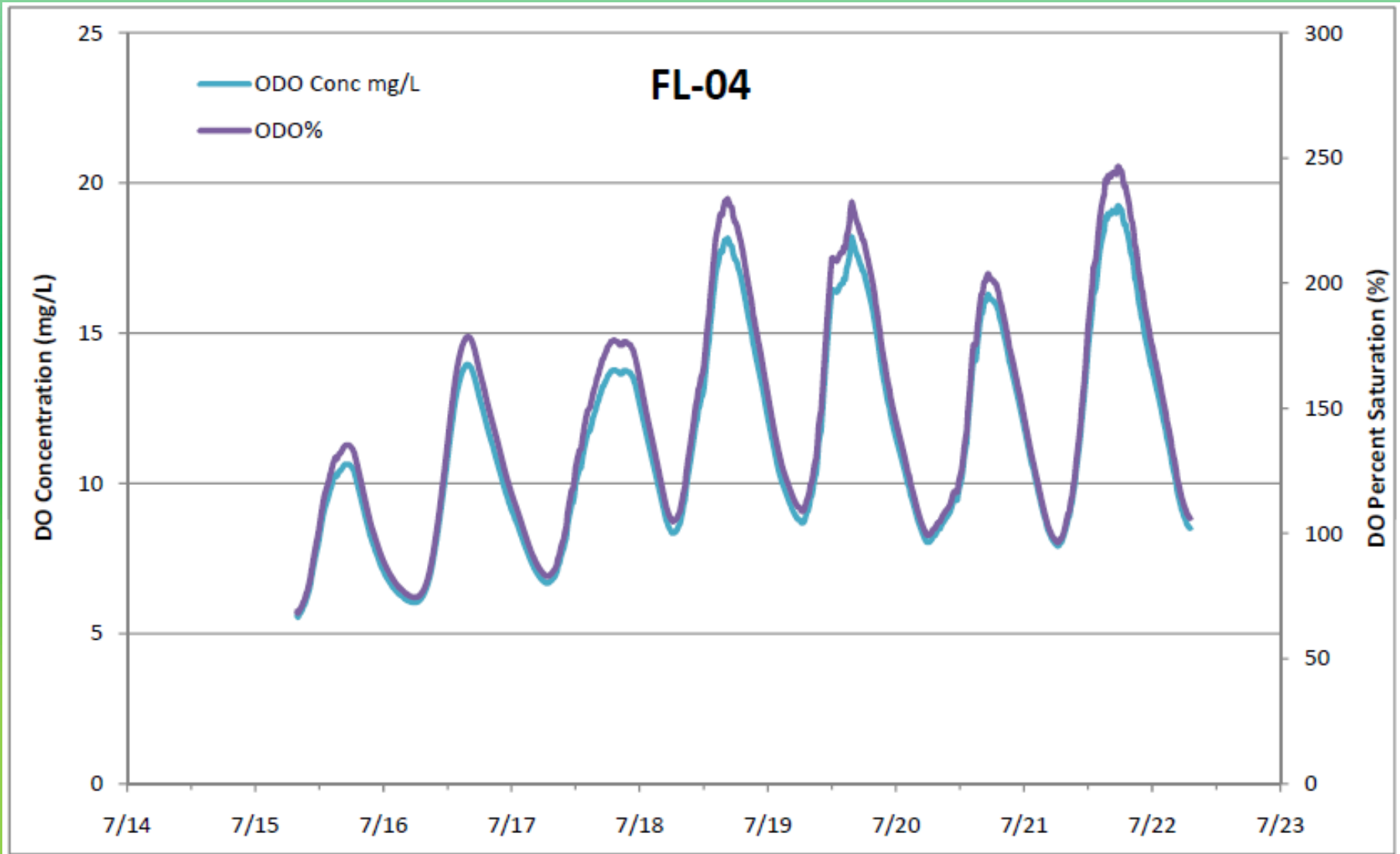


August 19, 2011 Another diatom algae bloom and fish kill on the Iroquois River



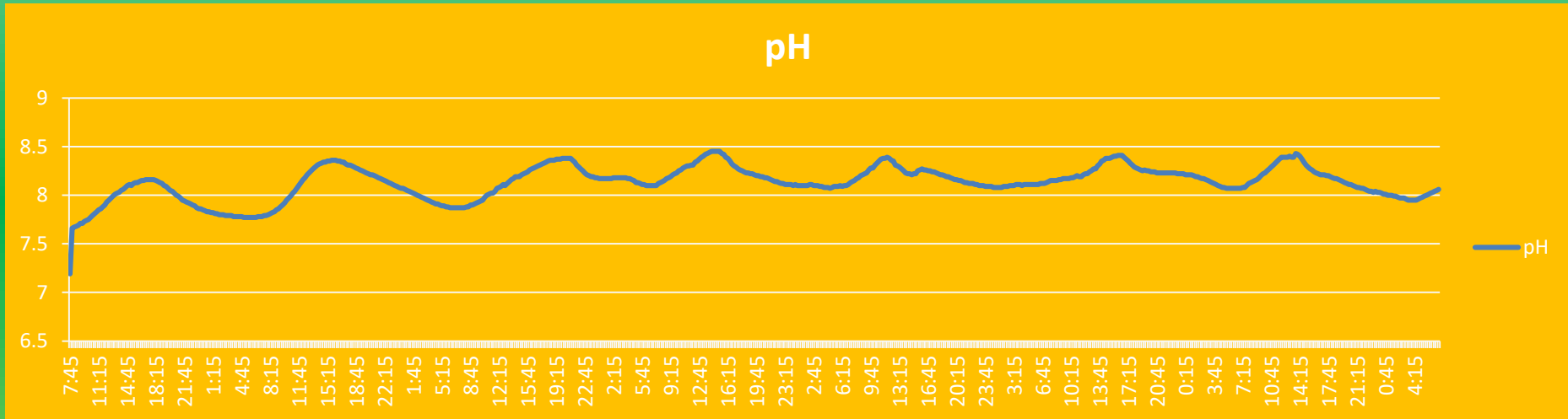
# 2010 Iroquois River Fish Kill

## Huge Swings in Dissolved Oxygen

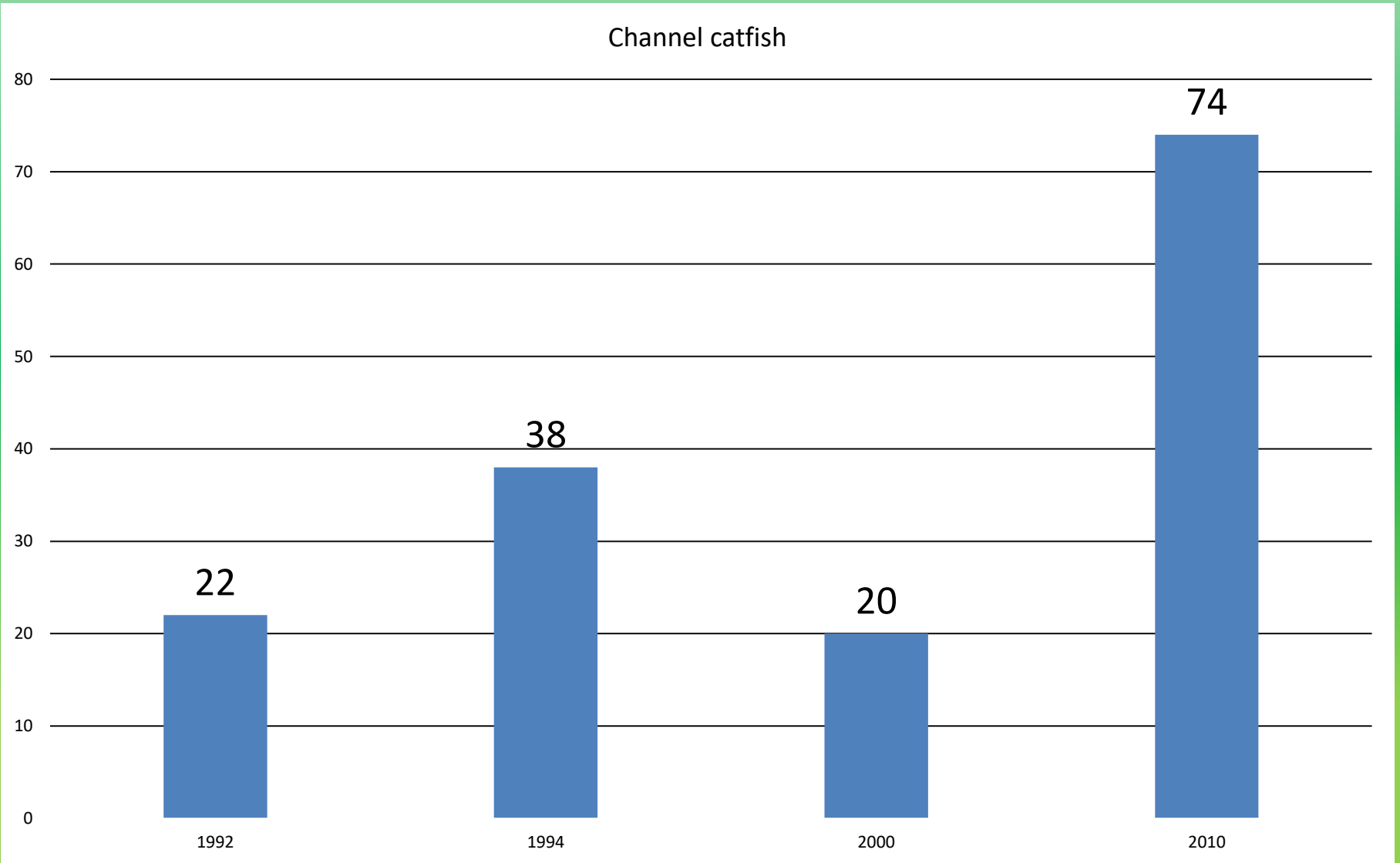



# 2010 Iroquois River Fish Kill

## elevated pH readings with diurnal swings



# Channel Catfish Catch Rates at Sugar Island





2019 Salt Fork Vermilion River  
Algae Bloom and Fish Kill  
August 10-12

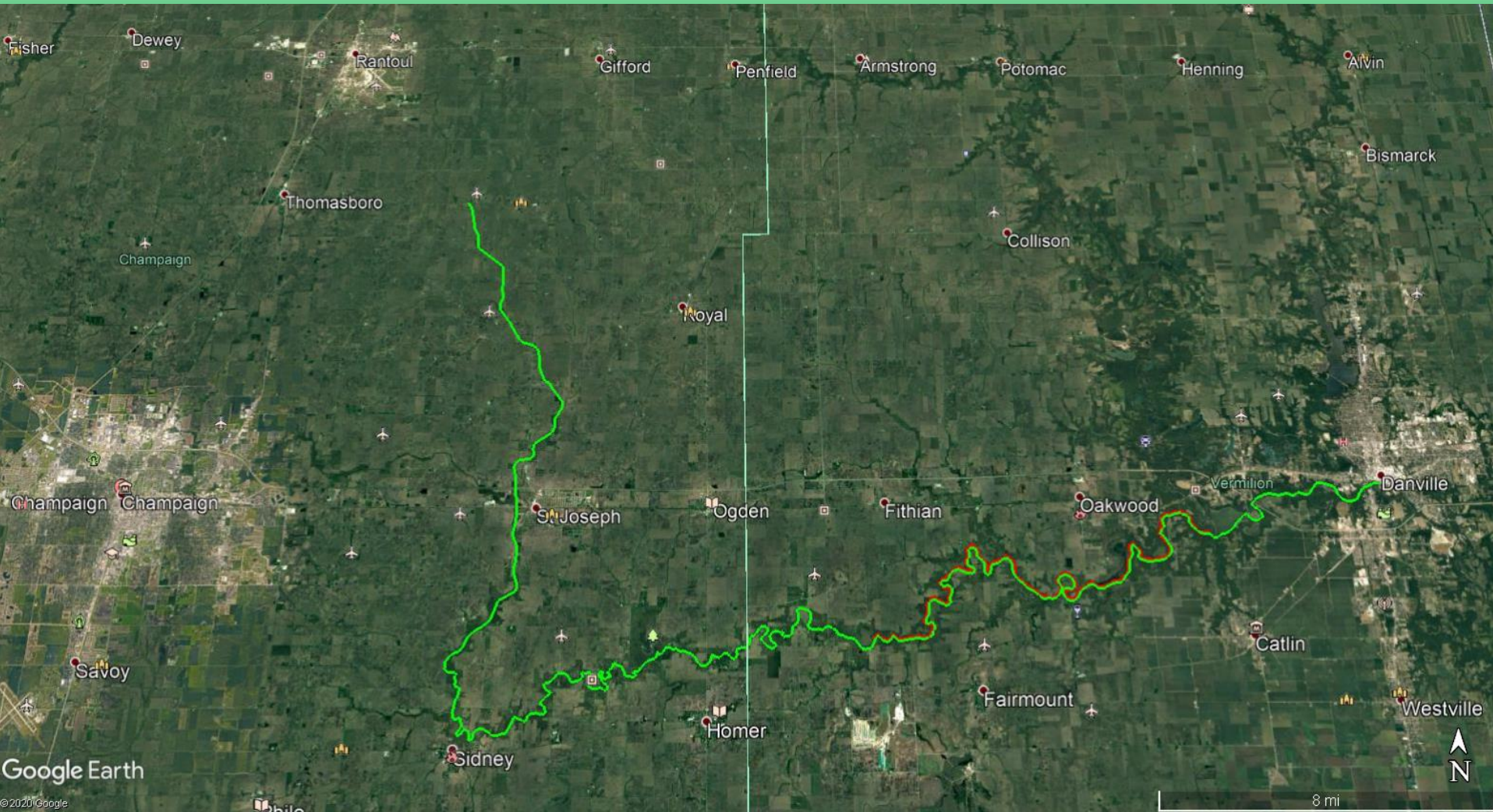
# 2019 Salt Fork Vermilion River Algae Bloom and Fish Kill



# 2019 Salt Fork Vermilion River Algae Bloom and Fish Kill



# 2019 Salt Fork Vermilion River Algae Bloom and Fish Kill





# 2019 Salt Fork Vermilion River Algae Bloom and Fish Kill

- Algae Bloom tracked at least 61 miles
- Fish Kill 17.59 miles
- 8,734 estimated fish killed
- Bullheads, Madtoms, Smallmouth Bass, Sunfish, Minnows, Suckers, and Darters
- 45% Sucker species
- Large die-off of Corbicula clams
- No evidence of a native mussel kill



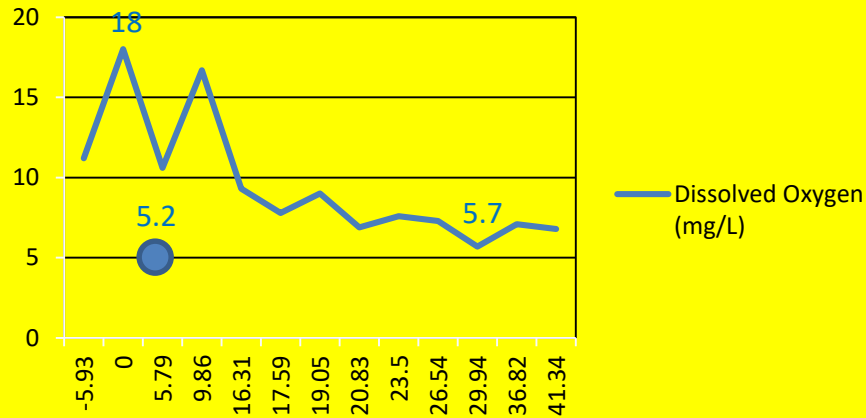
Field test was  
negative for blue-  
green algae  
(Cyanobacteria)  
and  
IEPA lab tests were  
negative for  
cyanotoxins:  
microcystin and  
cylindrospermopsin



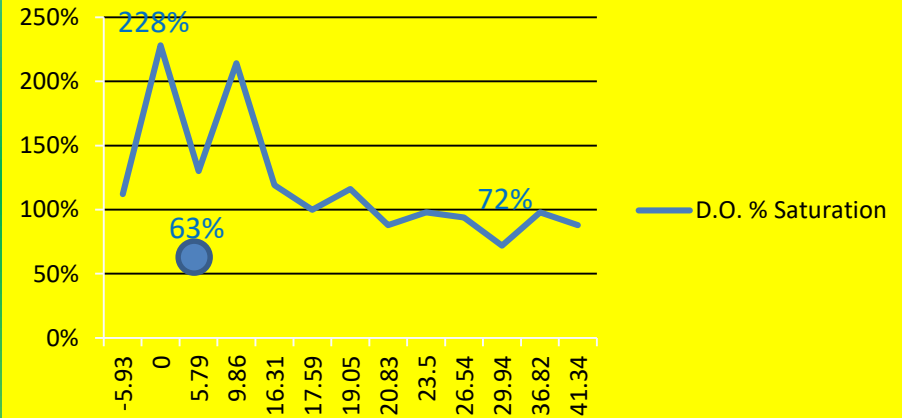
# Dissolved Oxygen was elevated and supersaturated

August 13 readings

### Dissolved Oxygen (mg/L)



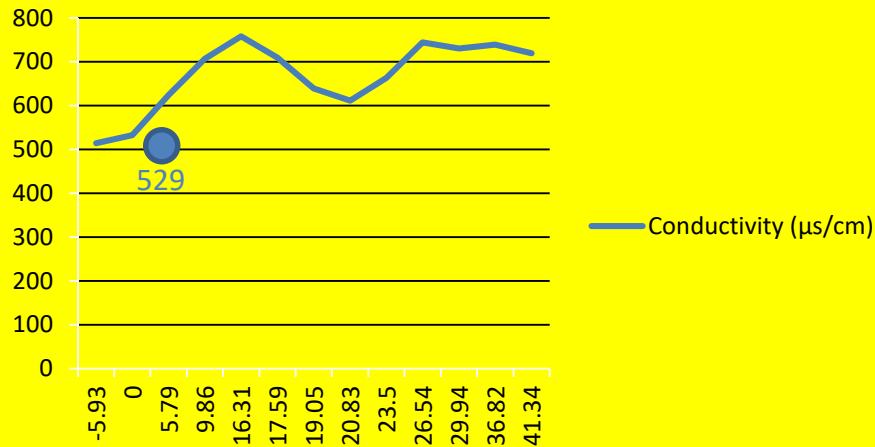
### D.O. % Saturation



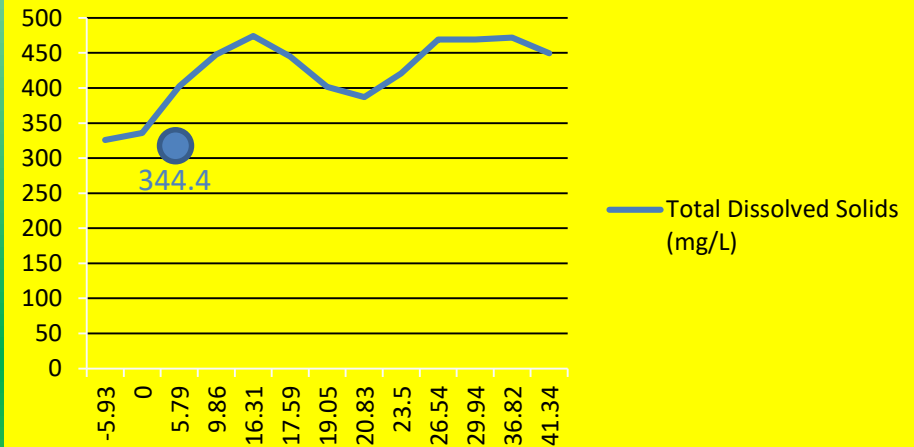
At the time of the fish kill, Jim Garavaglia reported dissolved oxygen readings over 20 mg/L.

# Conductivity and Total Dissolved Solids were also elevated.

### Conductivity ( $\mu\text{s}/\text{cm}$ )



### Total Dissolved Solids (mg/L)



Haihan Zhang et al. (2018) Dynamics of Bacterial and Fungal Communities during the Outbreak and Decline of an Algal Bloom in a Drinking Water Reservoir observed elevated conductivity during the decline phase of the algae bloom.

Krista Noel Prosser from Baylor University (2012) Influence of pH and Total Dissolved Solids on Harmful Algal Blooms of *Prymnesium parvum* found that increased levels of total dissolved solids stimulated algal growth and increased acute toxicity to fish.

# What causes these Algae Blooms?

You can't have algae blooms without nutrients.

Total Nitrate-N  
(lb/acre/yr)

-  <5
-  5–9.99
-  10–14.99
-  15–19.99
-  20–24.99
-  >25
-  HUC8 Boundary
-  Illinois State Boundary
-  Illinois Rivers

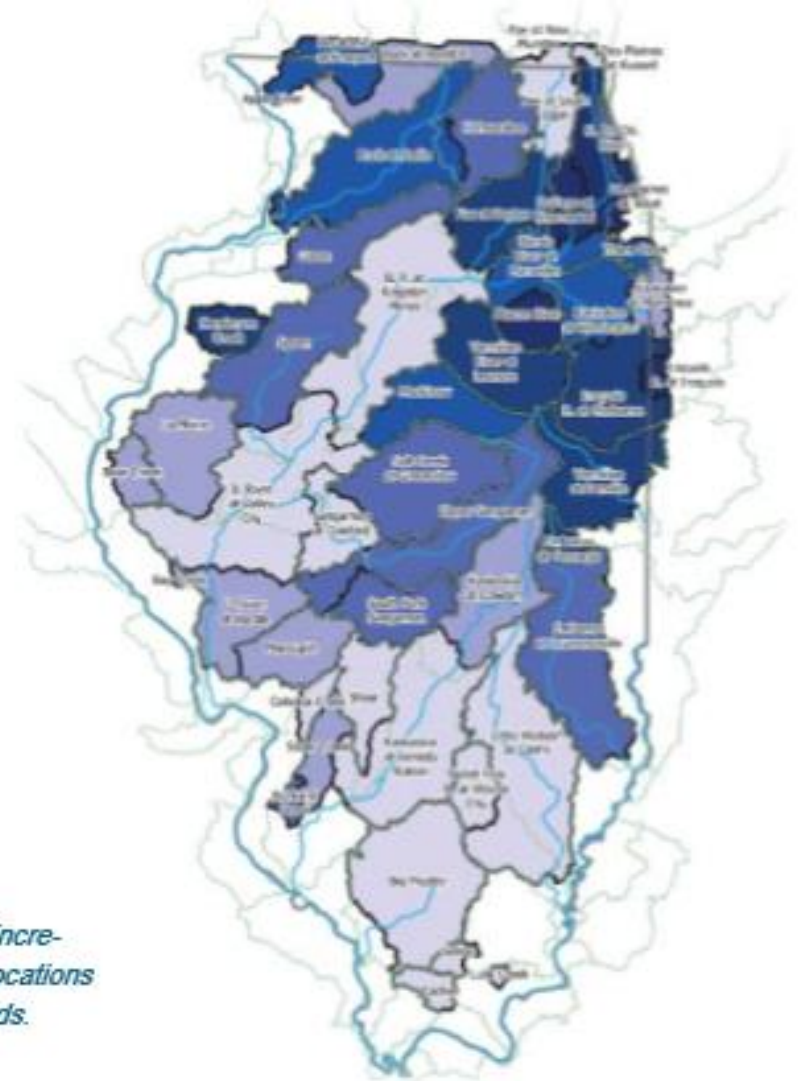


Figure 3.3. Average annual 2012–17 incremental nitrate-N yields at monitoring locations used to estimate HUC8 yields and loads.



ILLINOIS  
NUTRIENT LOSS  
REDUCTION STRATEGY

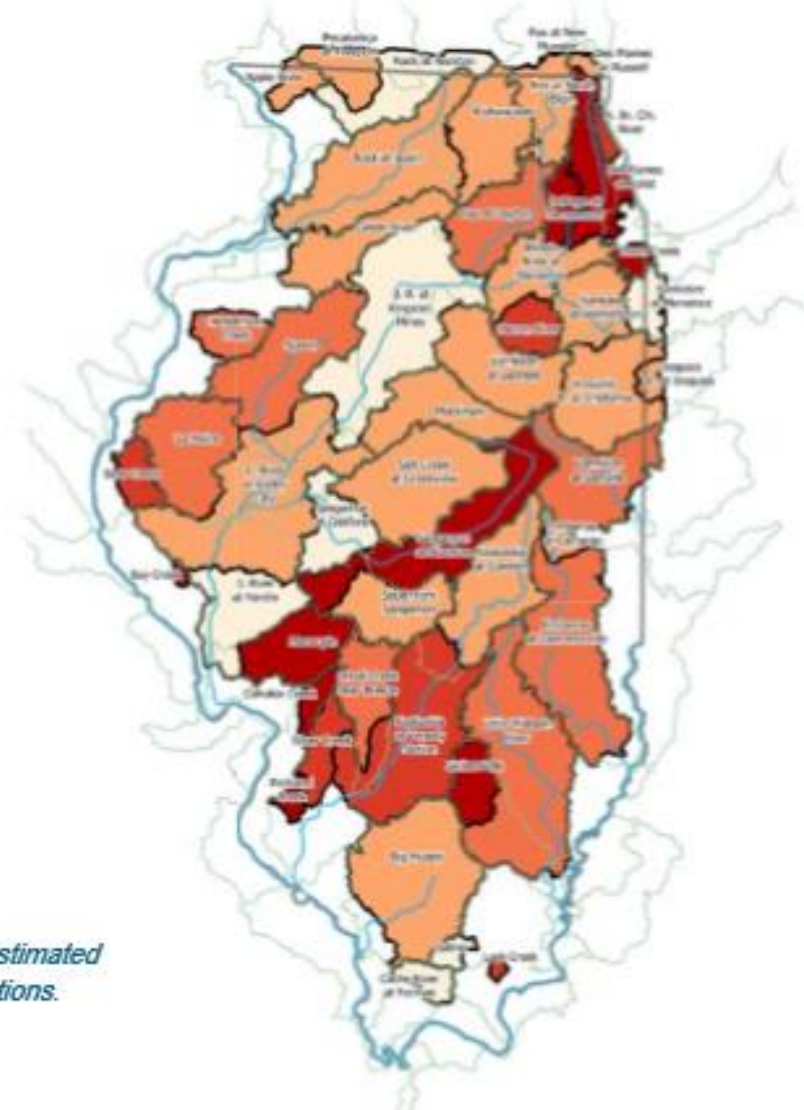
Biennial Report  
2019

# What causes these Algae Blooms?

You can't have algae blooms without nutrients.

## Total P (lb/acre/yr)

- <0.5
- 0.5–0.99
- 1.0–4.49
- 1.5–1.99
- >2.0
- HUC8 Boundary
- Illinois State Boundary
- Illinois Rivers



*Figure 3.5. Annual average 2012–17 estimated incremental TP yield at monitoring locations.*



**ILLINOIS**  
NUTRIENT LOSS  
REDUCTION STRATEGY

**Biennial Report**  
2019

# What causes these Algae Blooms?

You can't have algae blooms without nutrients.

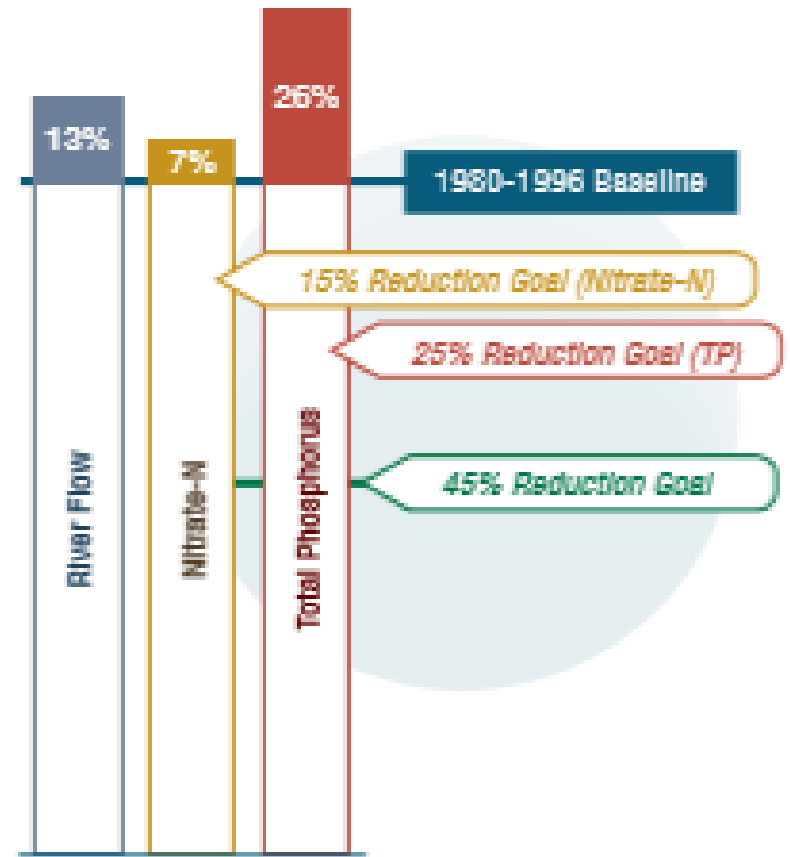


Figure 1.3. Percent increase from baseline to average 2013–2017



ILLINOIS  
NUTRIENT LOSS  
REDUCTION STRATEGY

Biennial Report  
2019



Water quality readings during algae blooms will actually show very low nutrient levels, as they are consumed by the abundant algae.

Intensive monitoring of nutrients in the Salt Fork by the University of Illinois reported results leading up to the algae bloom in early August:

Nitrate concentrations less than 1 mg/L

Dissolved Reactive Phosphorus (DRP) less than 0.015 mg/L

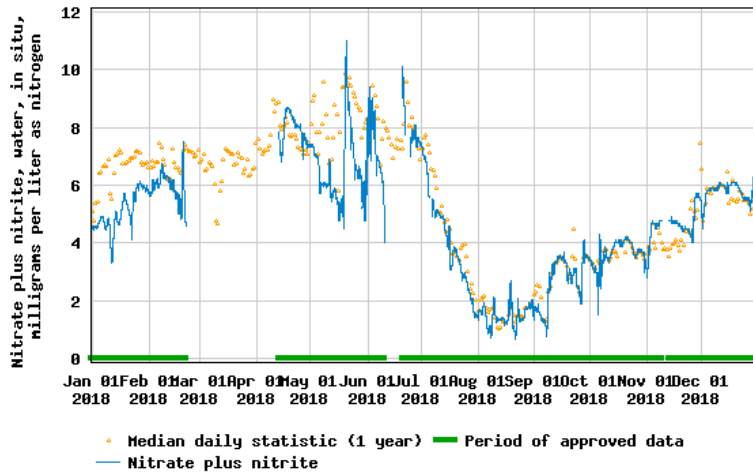
Compare this to 2008-2014 low flow, late summer/early fall concentrations:

Nitrates were typically 5-10 mg/L

DRP were 1-3 mg/L

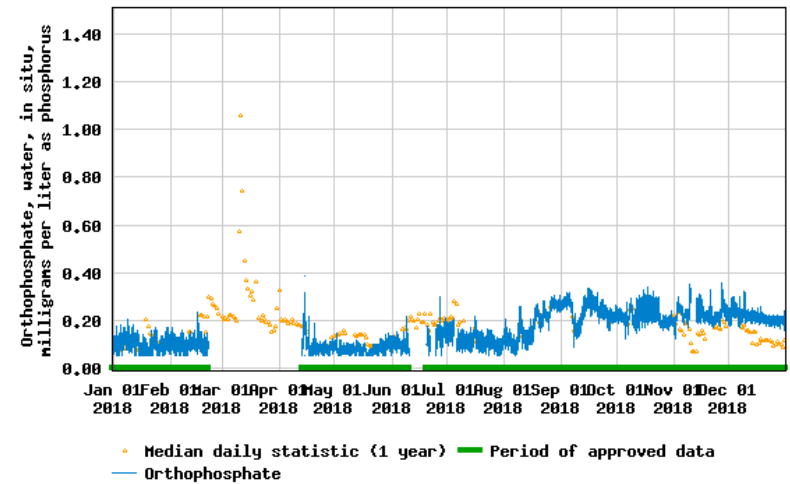
# Algae blooms are occurring when nutrients are typically at their lowest of the annual cycle.

USGS 03339000 VERMILION RIVER NEAR DANVILLE, IL

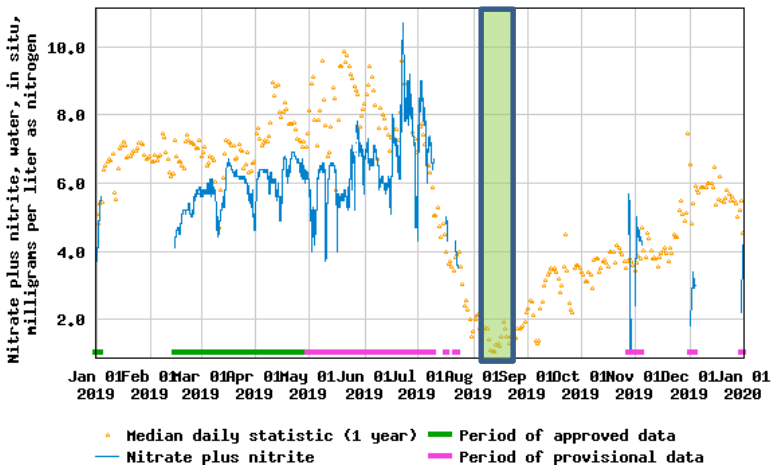


2018

USGS 03339000 VERMILION RIVER NEAR DANVILLE, IL

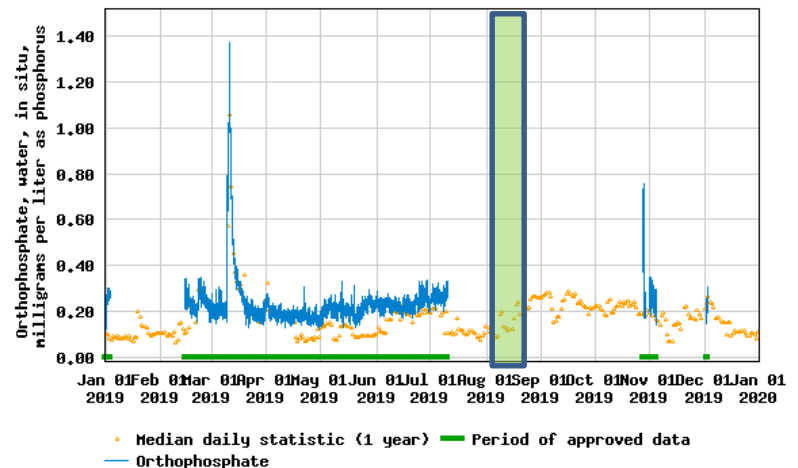


USGS 03339000 VERMILION RIVER NEAR DANVILLE, IL

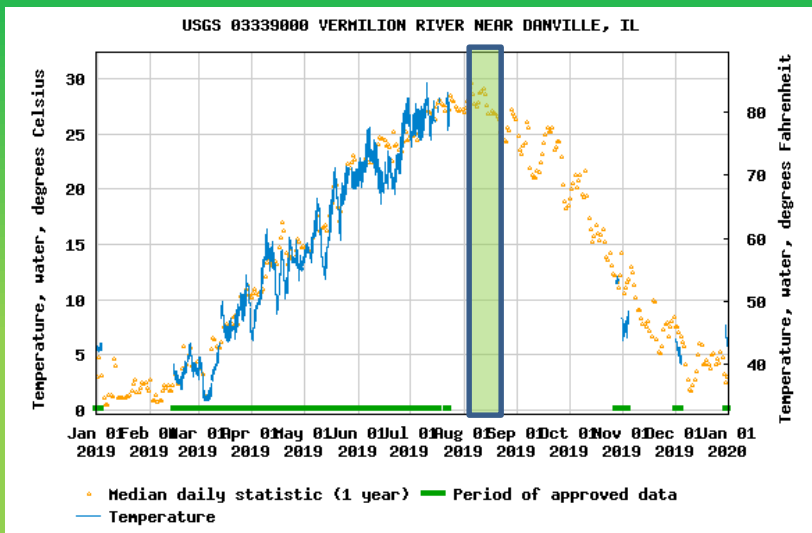
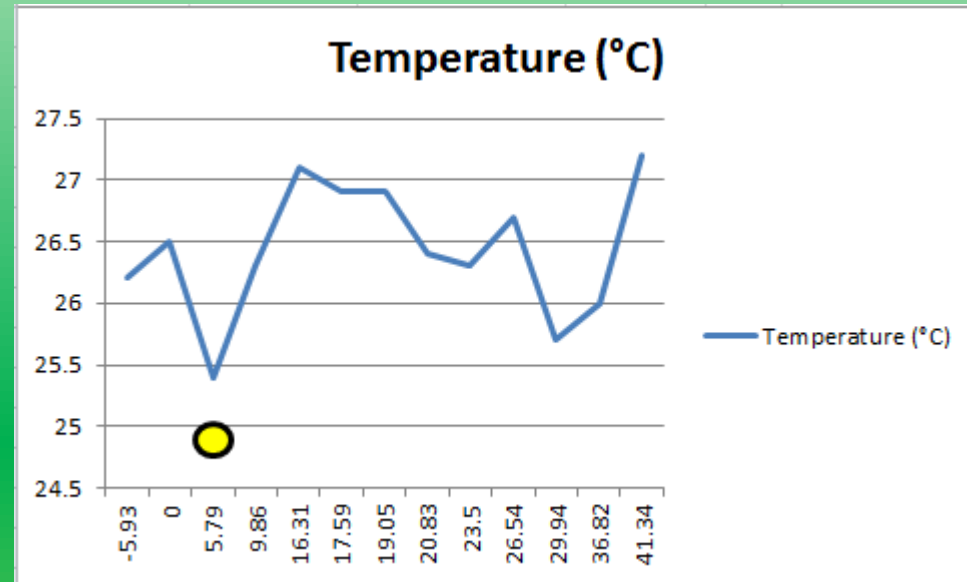
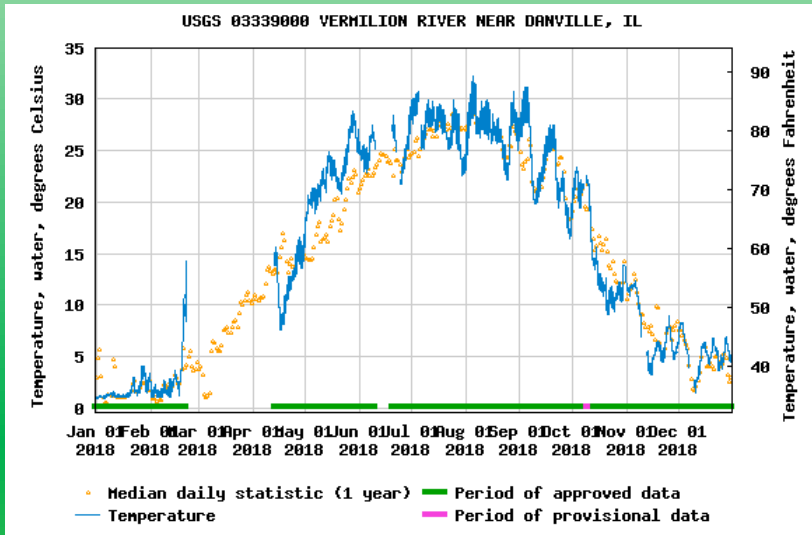


2019

USGS 03339000 VERMILION RIVER NEAR DANVILLE, IL

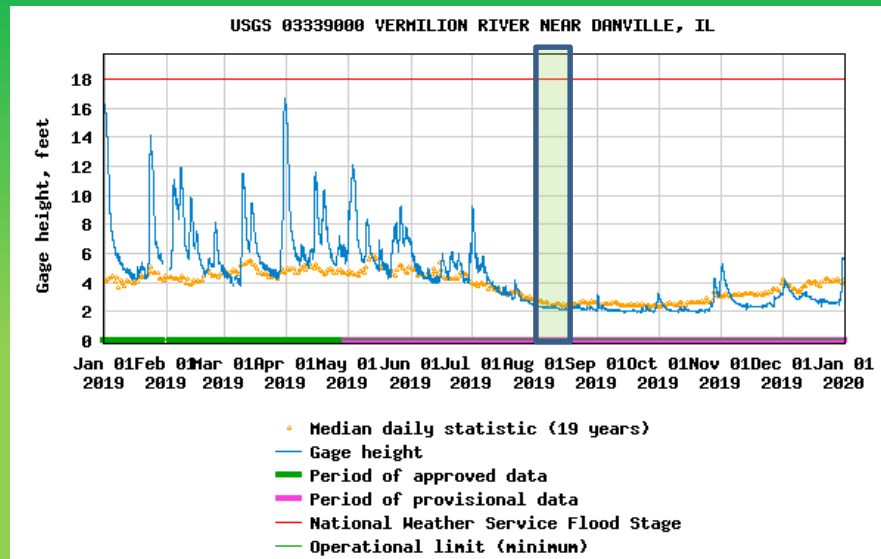
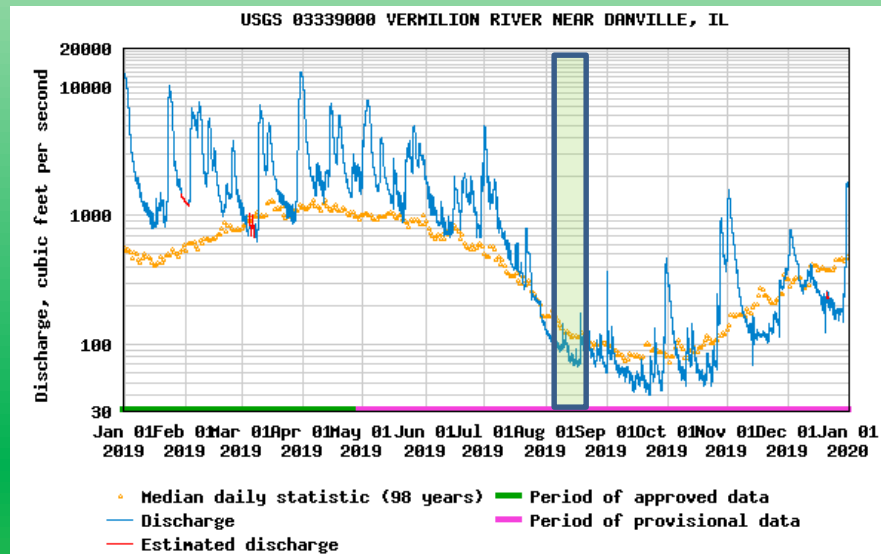


# Algae blooms are occurring when water temperatures are at their highest.



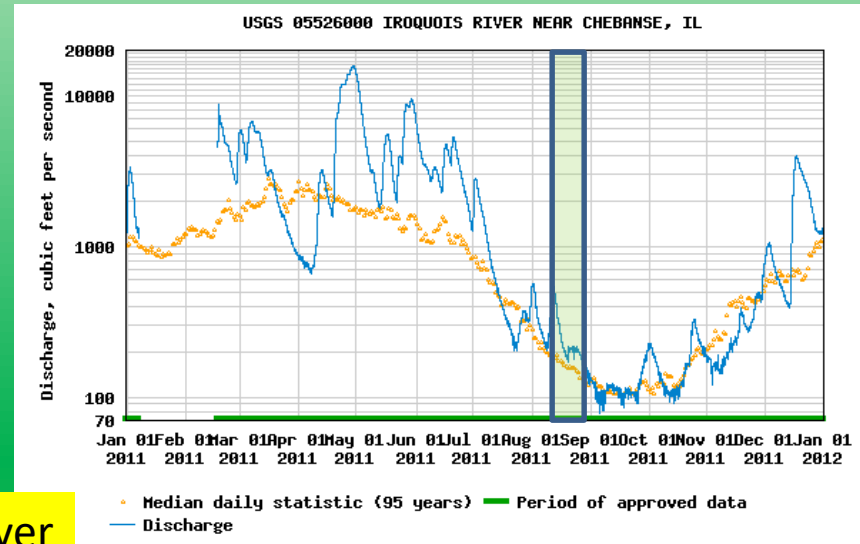
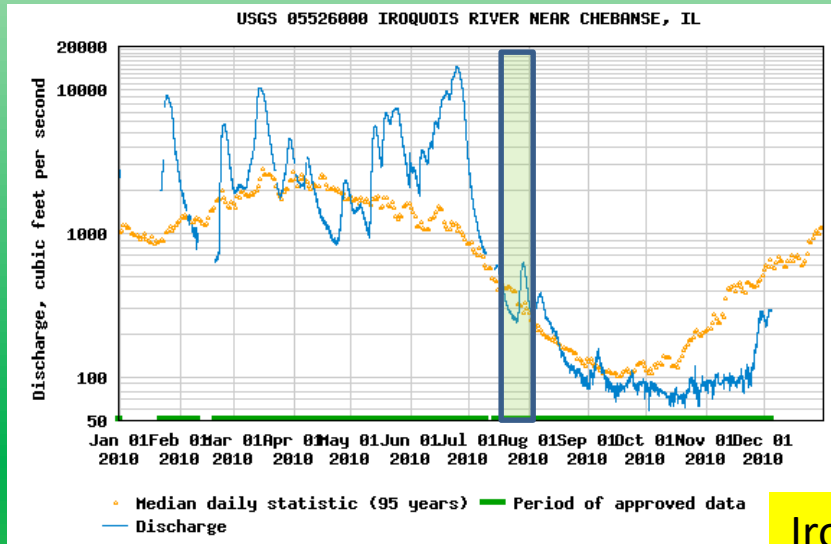
During the algae bloom of 2019, Salt Fork water temperatures were higher than the reference tributary. But, they were not elevated above normal.

Algae blooms are occurring during periods of low flow (with a possible trend following periods of high flows).

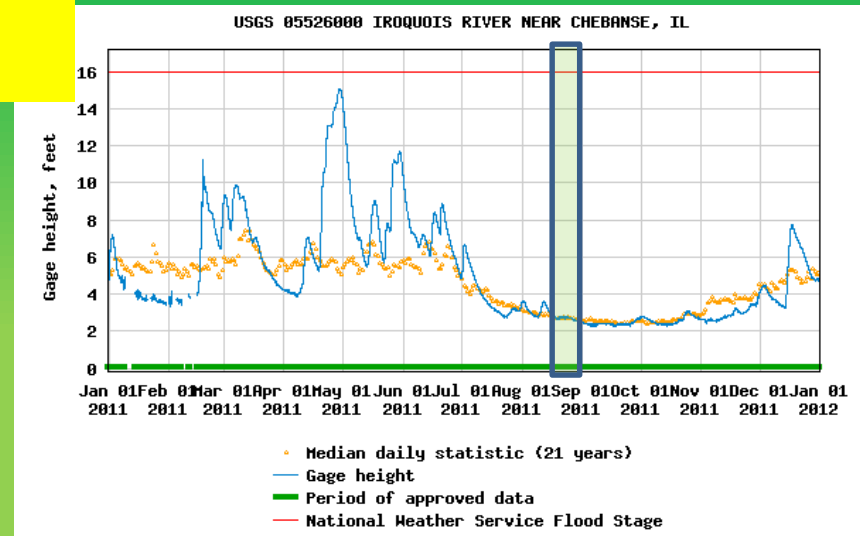
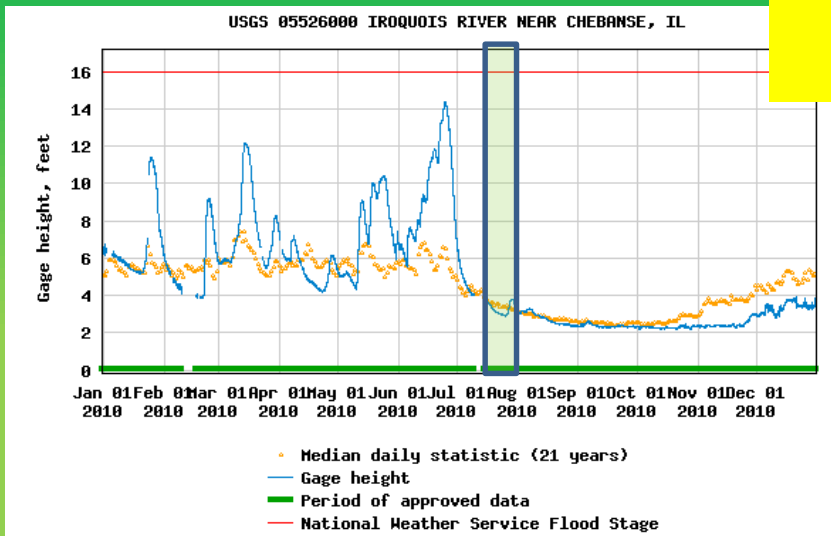


2019 Salt Fork  
Vermilion River  
algae bloom

# Algae blooms are occurring during periods of low flow (with a possible trend following periods of high flows).



Iroquois River  
← 2010  
2011 →



# Conditions Leading to Algae Blooms

- Nutrients likely play a role, but not predictable.
- Warm water temperatures play a role, but not predictable.
- Impoundments
- Low flow (possibly following a period of high flow), but not predictable.
  - Higher spring flows with more frequent high water events
  - Longer periods of low flow in summer/fall

# Causes of Fish Mortality

- Large diurnal swings in Dissolved Oxygen
- Supersaturation of Dissolved Oxygen (Gas Bubble Disease)
- Low overnight Dissolved Oxygen levels
- Abrupt changes in pH
- Algal toxins