Analysis of Chlorophyll-a and other data collected in the Illinois River Watershed from 1996-2003

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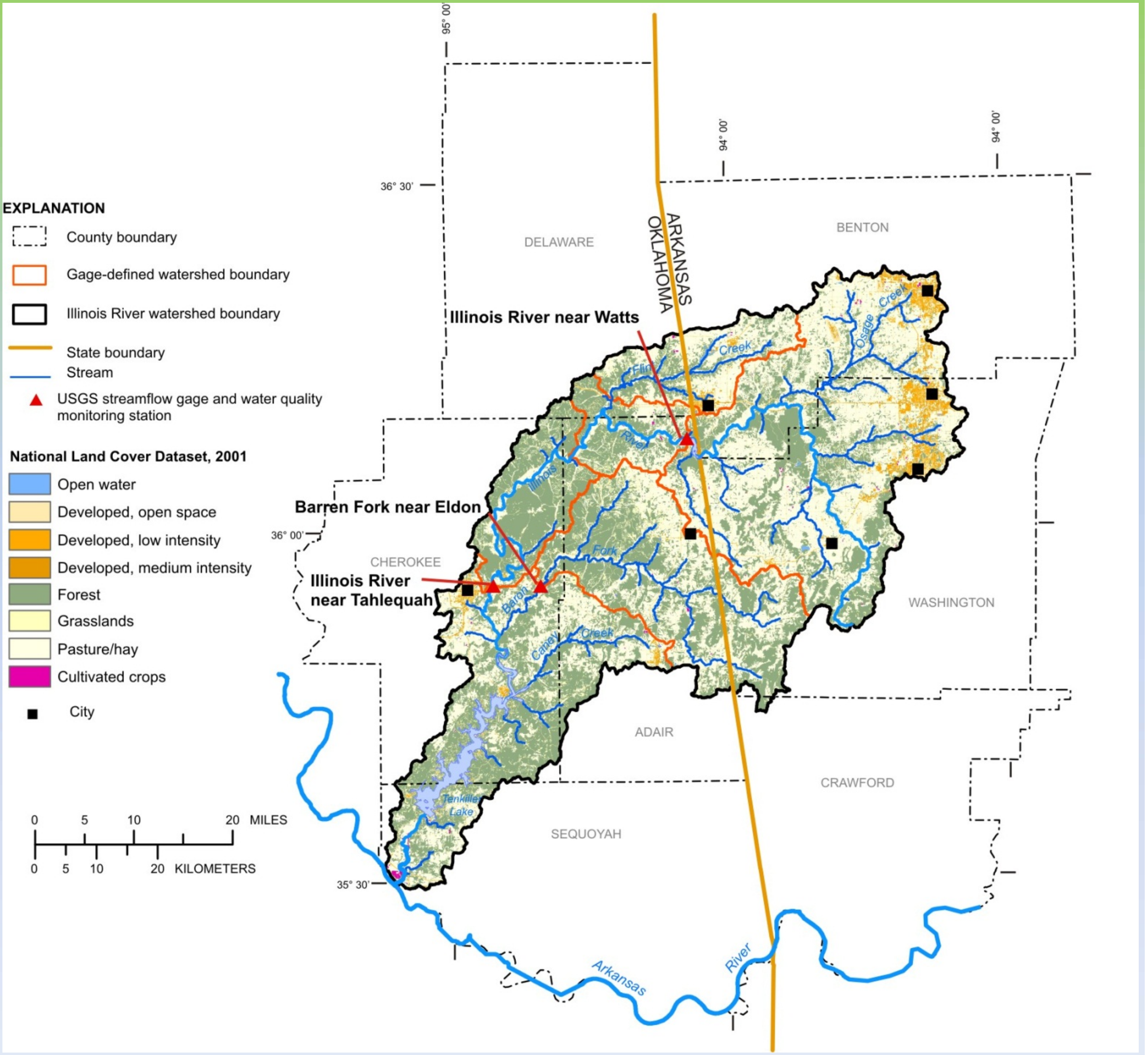
Observations from floaters or fisherman might be:
• Algae are more noticeable in summer during low-flows and warm water
• Algae growth is greater in “developed” watersheds
• Phytoplankton (suspended micro-algae) are the most noticeable form of algae
• Phytoplankton can be scoured away by floods
? – can we verify these observations in the data - ?

Introduction

- The Illinois River and other streams in the watershed are listed on the 303d list for high phosphorus, low dissolved oxygen, and high turbidity…all indicators of eutrophication, the increased growth of algae and other aquatic plants.
- Eutrophication in the Illinois River and downstream Lake Tenkiller impairs environmental quality, the recreational experience, and the economy of northeastern Oklahoma.
- The USGS, in cooperation with the Oklahoma Scenic Rivers Commission, analyzed water samples from three sites for concentrations of the photosynthetic plant pigment chlorophyll-a (a measure of phytoplankton), nutrients, and physical parameters in the water column from 1996-2003.
- This presentation summarizes relations of chlorophyll-a data to values of selected physical parameters, seasonality, and nutrient concentrations to investigate factors contributing to or impeding algal growth.

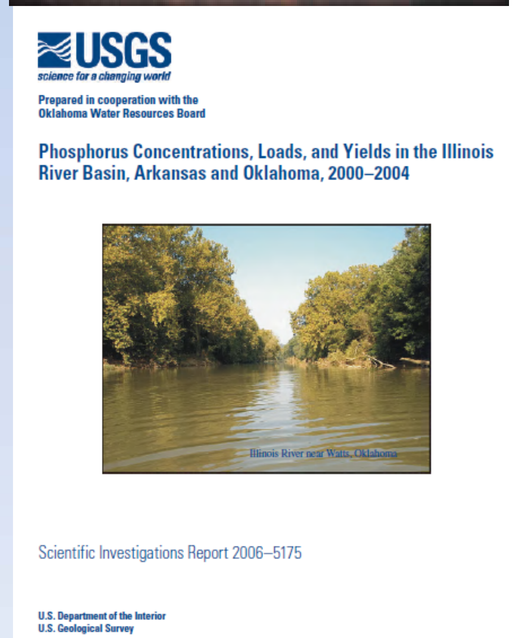
Sites sampled

- Data were collected at the Illinois River near Watts, Okla., and near Tahlequah, Okla., and the Barren Fork at Eldon, Okla. from 1996-2003.
- The USGS has collected water-quality data at those sites since 1955, 1955, and 1958, respectively.



Nutrient loading in the Illinois River

- Phosphorus generally is the limiting nutrient for algal growth in the Illinois River basin as it is for many freshwater ecosystems (Andrews and others, 2009).
- Phosphorus concentrations exceeded the standard of 0.037 mg/L set for Scenic Rivers in Oklahoma in more than 90% of samples collected from the Illinois River and Flint Creek, and about 40% of water samples collected from the Barren Fork.
- USGS Sci. Invest. Rpt. 2006-5175 (Tortorelli et al., 2006) estimated that runoff events carried from 68 to 96 percent of mean annual total phosphorus loads from 2000-2004 in this basin, depending on station and year.
- Phosphorus yields ranged from 576 to 811 pounds per year per square mile, with the greatest yield being estimated for the Illinois River near Watts station and the smallest yield being reported for the Baron Fork at Eldon station.



Illinois River near Watts

- This site is near the state border, downstream of Siloam Springs, the rapidly growing Rogers-Springdale-Fayetteville Metropolitan Statistical Area, and several hundred poultry CAFOs.
- The upstream basin area is 635 square miles.
- This basin, and those of the other sites, are underlain primarily by cherty karstic limestones of the Keokuk and Reeds Springs Formation and the St. Joe Group Mississippian age that overlie the Chattanooga Shale.


Illinois River near Watts, Oklahoma

Illinois River near Tahlequah

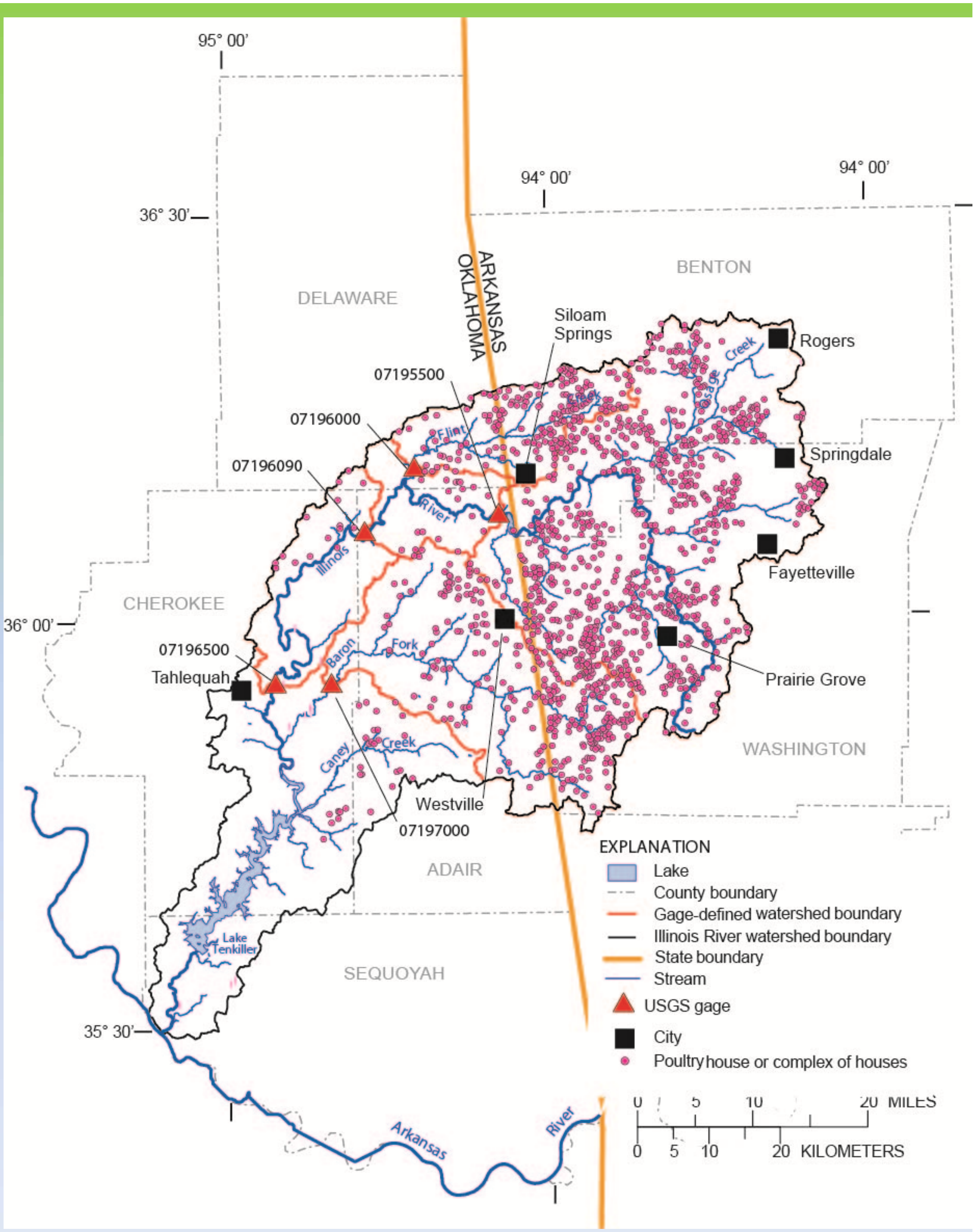
- This site is about 30 miles downstream of the Watts site, with Flint Creek being the major inflowing tributary between these stations.
- The upstream drainage area of this station is 959 square miles.

Barren Fork at Eldon

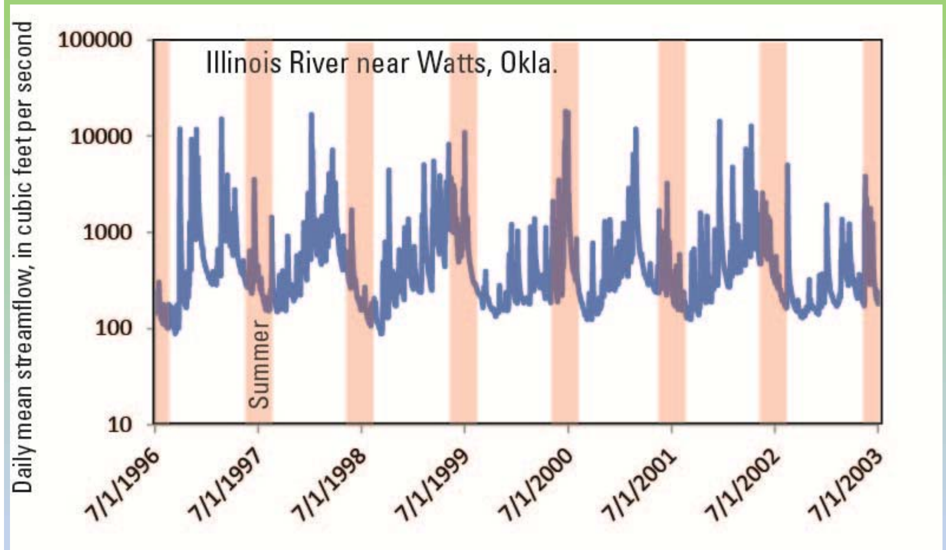
- This site is on a tributary of the Illinois River that generally drains a less-populated part of the watershed. About 100 poultry CAFOs are upstream of this station.
- The upstream drainage area is 307 square miles.

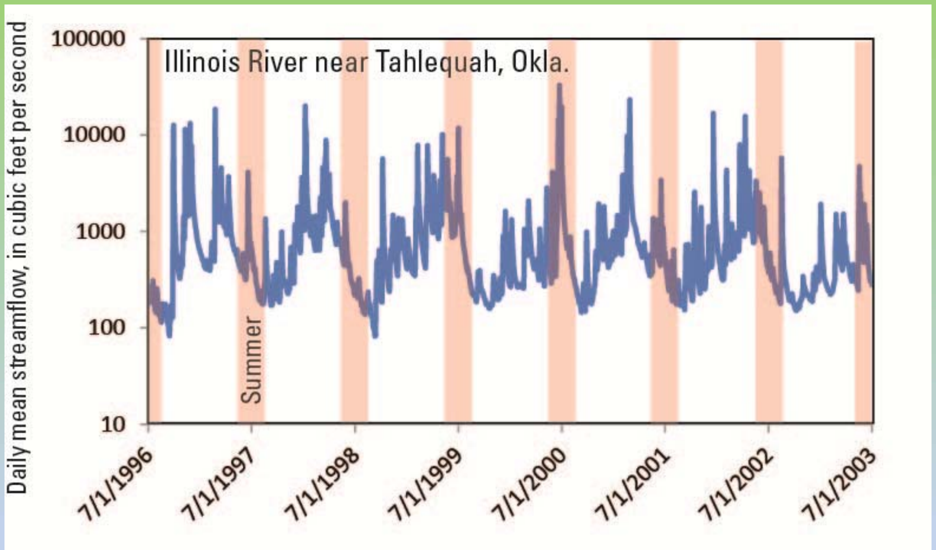
Poultry houses/complexes in the Illinois River basin, as of 2006

Note the difference in poultry-house density between the states and that the Barren Fork drains mostly from OK.

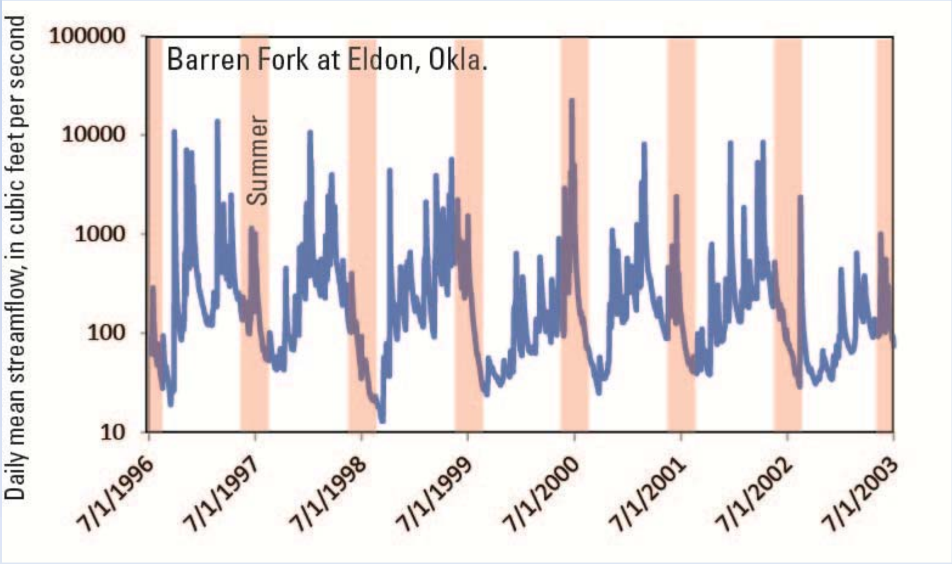


Streamflow during chlorophyll-a collection period

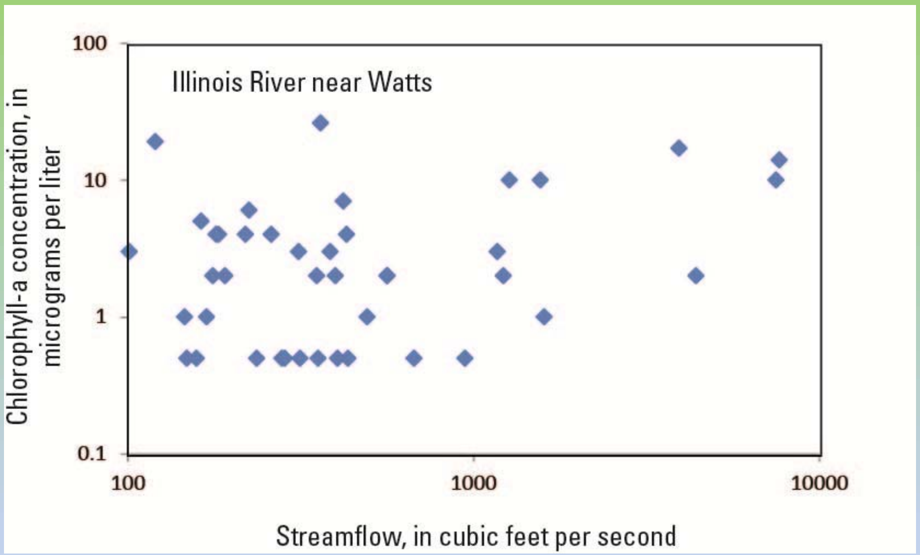


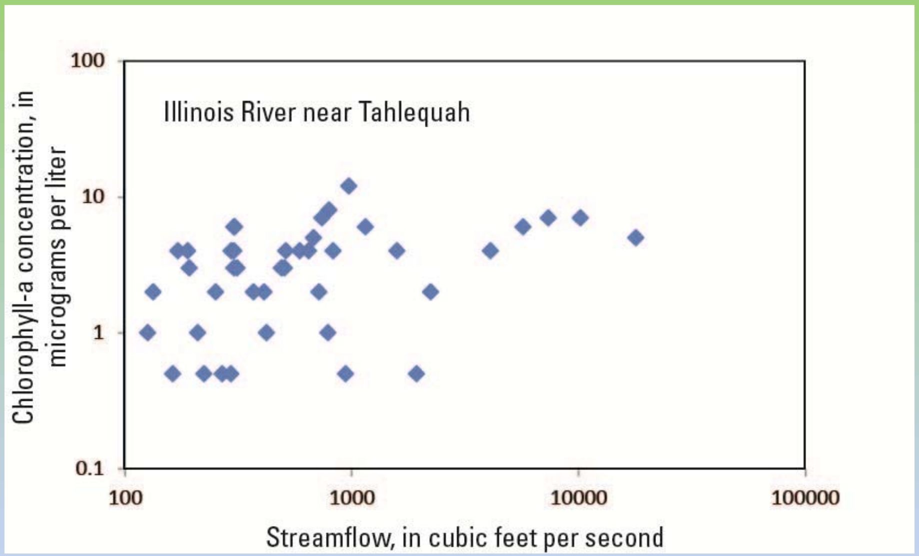


Streamflows at these sites can range from the smallest of the year to the largest of the year during summer, when algal blooms are believed by most observers to be greatest.



Chlorophyll-a with streamflow



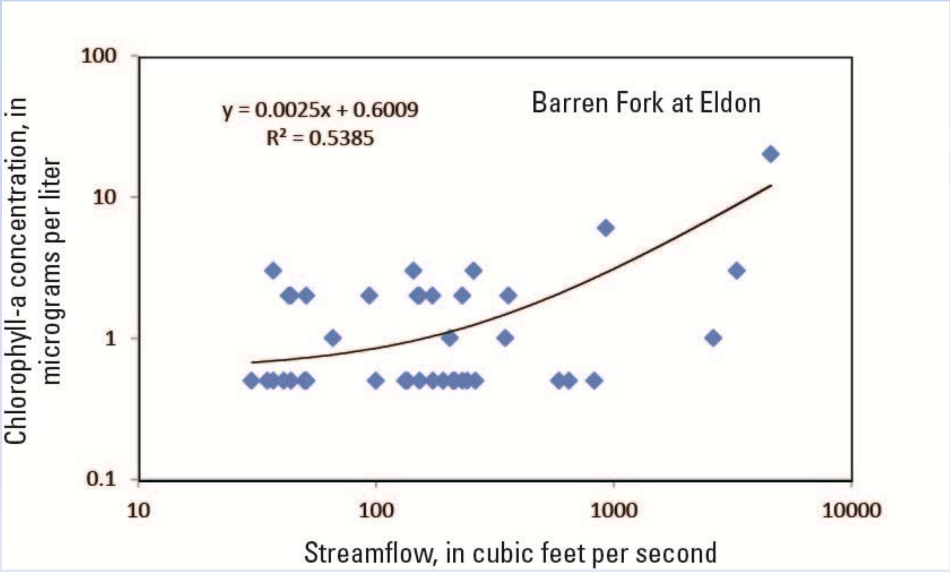


Greater streamflows may:

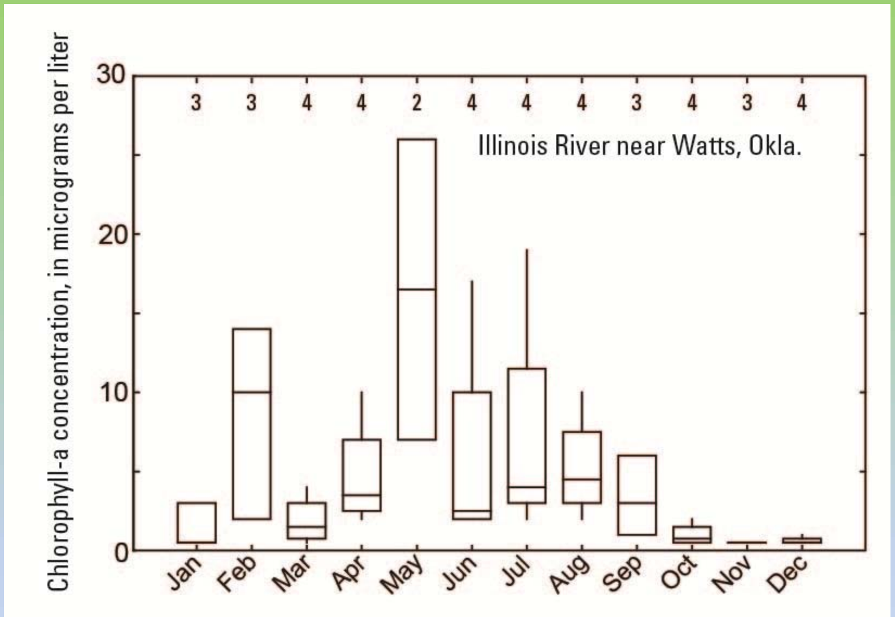
a) increase phosphorus concentrations in streams, thus increasing phytoplankton growth, and scour periphyton and other plant materials into the water column, or

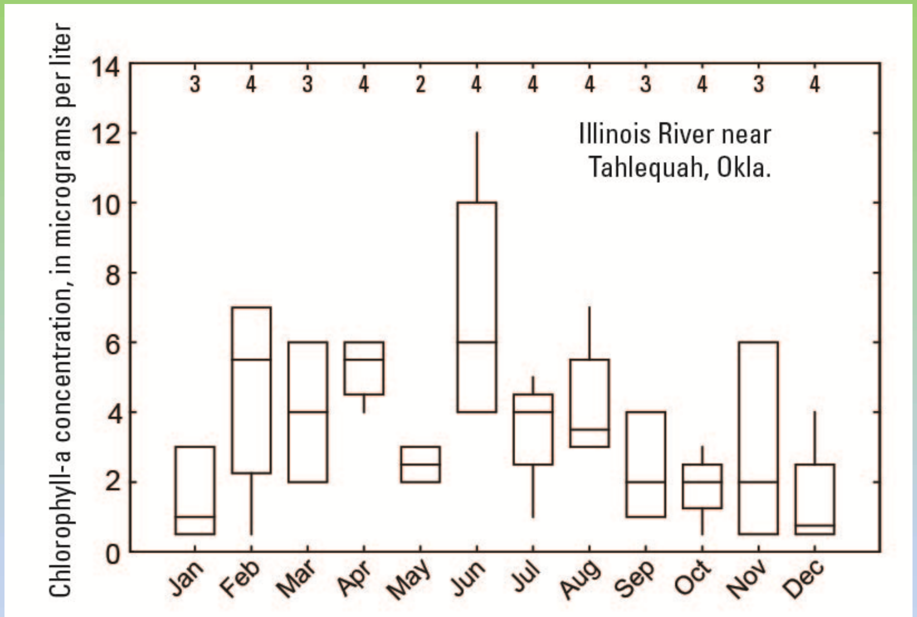
b) flush phytoplankton downstream.

Chlorophyll-a concentration had no clear correlation with streamflow at the Illinois River sites but small correlation at the Barren Fork site.

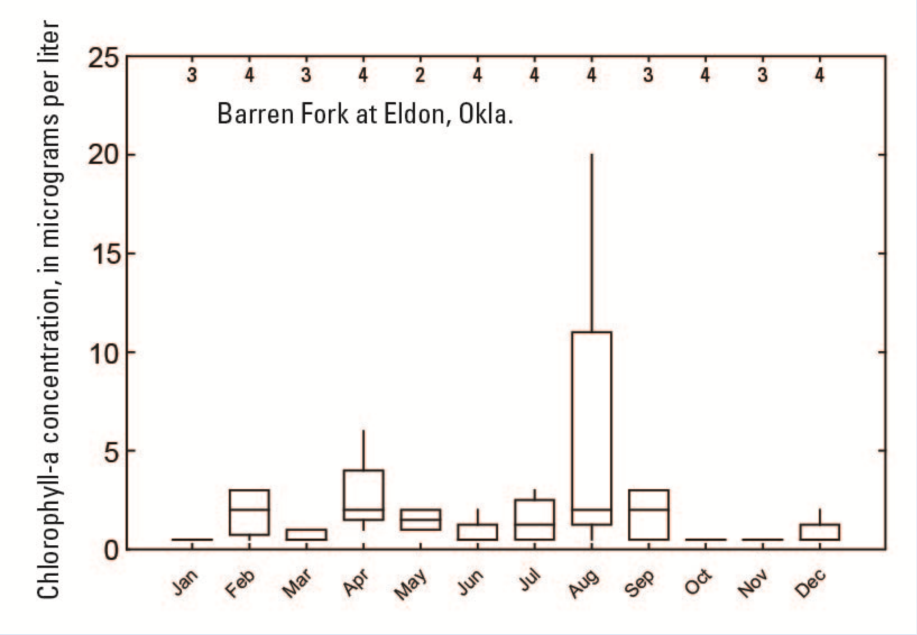


Chlorophyll-a by month

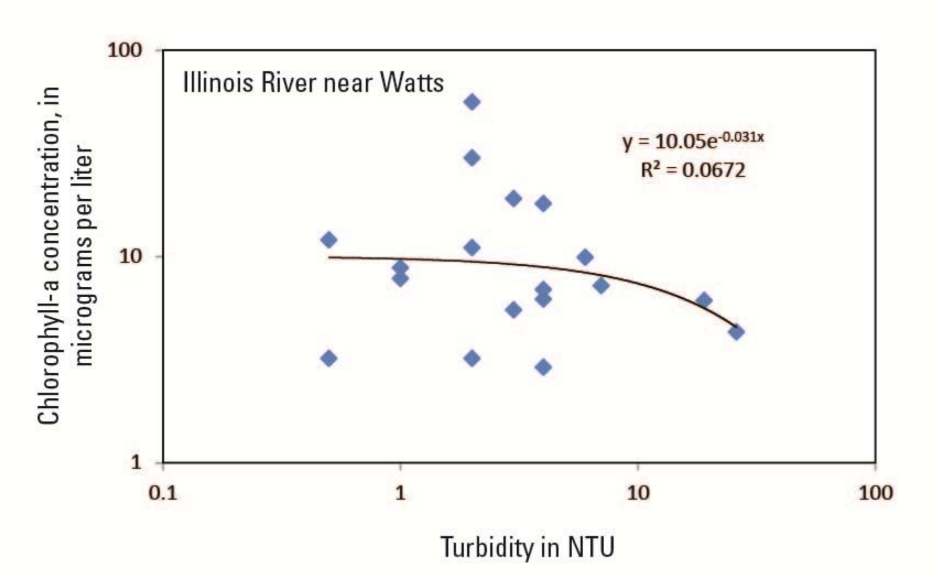


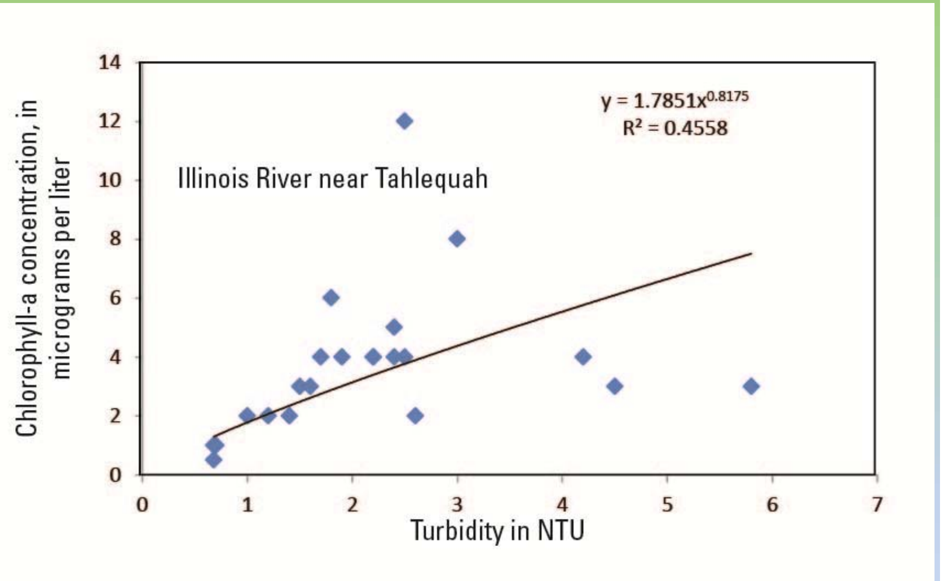


Chlorophyll-a concentrations generally were greatest from February to August. Note the limited number of samples per month.



Chlorophyll-a with turbidity (Apr-Oct, low-flow)

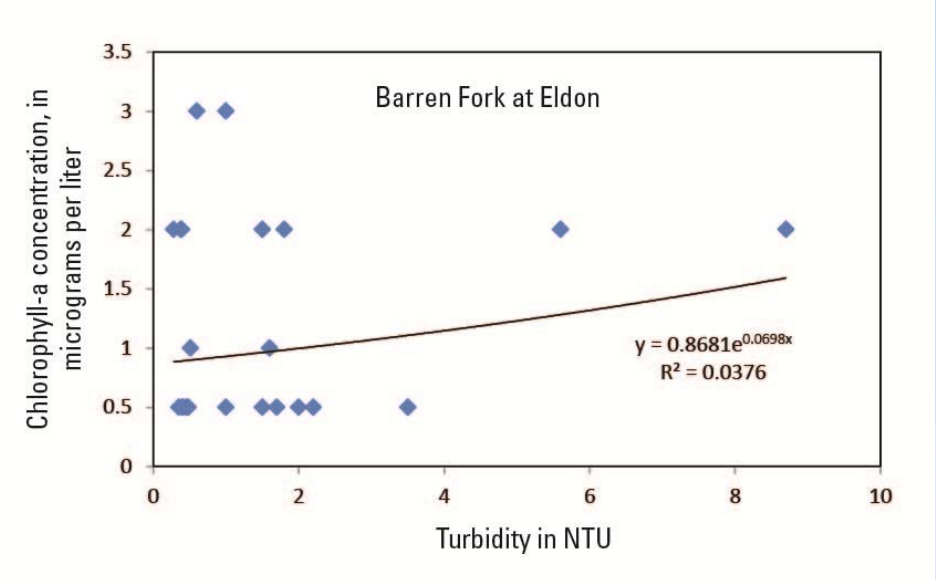




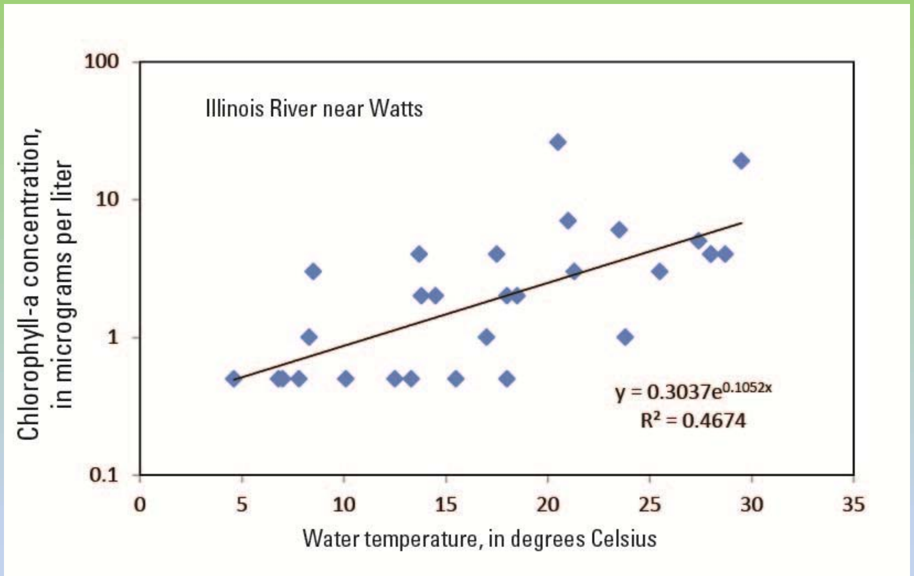
Turbidity can be comprised of inorganic + organic sediments and phytoplankton.

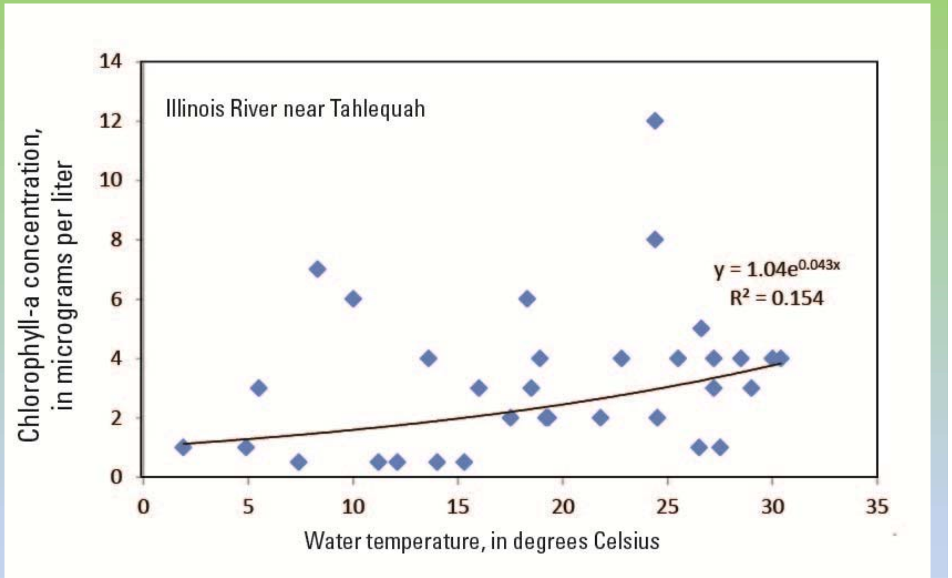
Greater inorganic turbidity would reduce insolation and impede algal growth.

Chlorophyll-a concentration was weakly correlated with turbidity, indicating a variable role of phytoplankton in causing water turbidity in these streams.



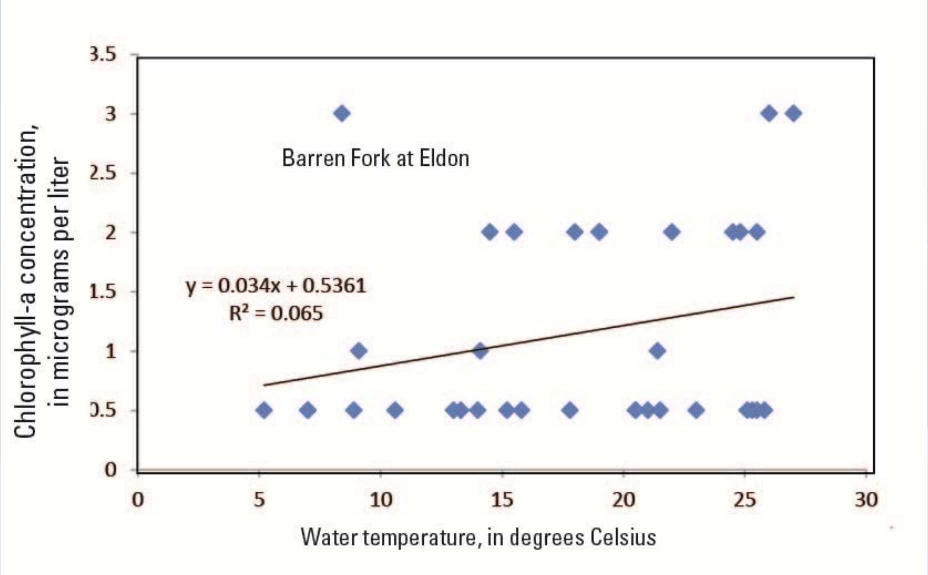
Chlorophyll-a with water temperature at low flow



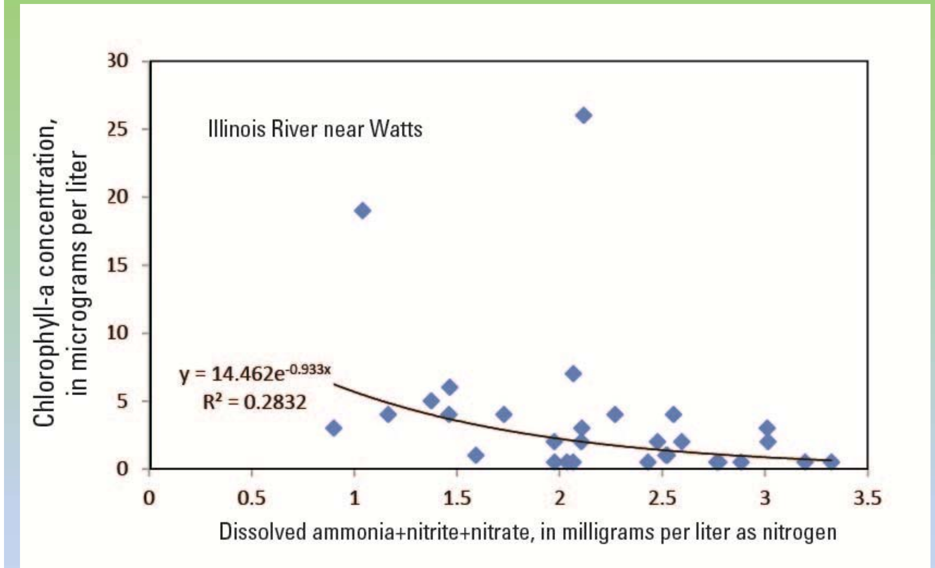


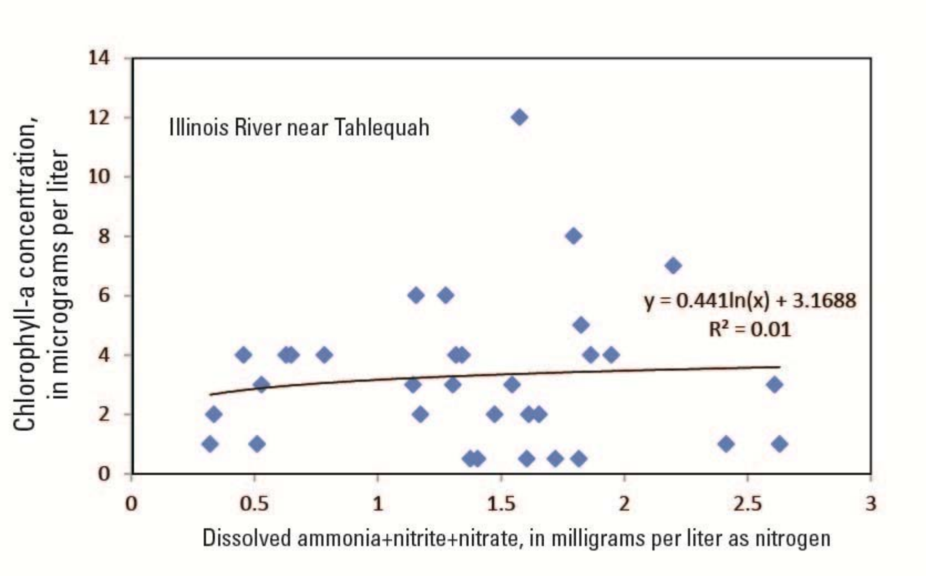
Chlorophyll-a concentration was slightly correlated to water temperature.

Note that chlorophyll-a concentrations at low flow generally were smallest at the Barren Fork at Eldon site.

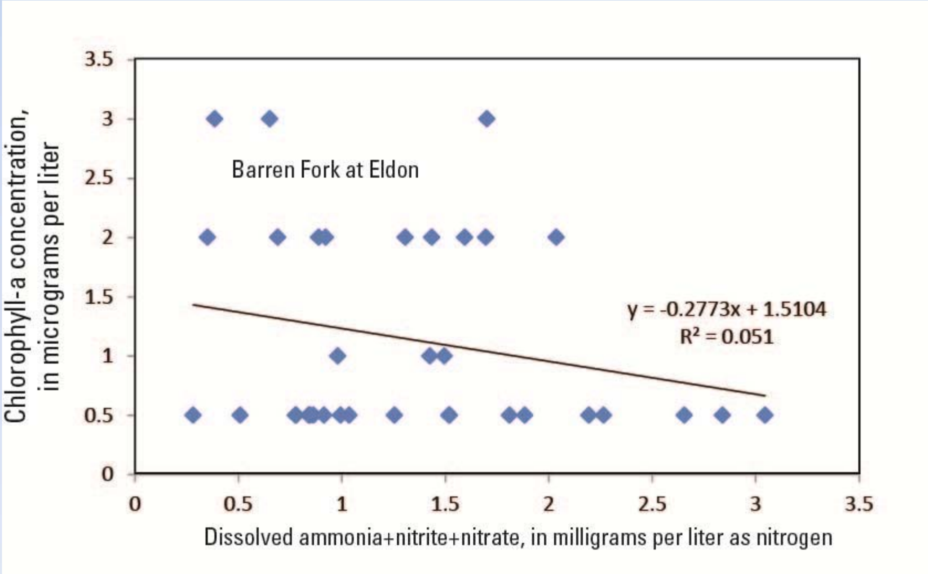


Chlorophyll-a with dissolved nitrogen compounds at low flow

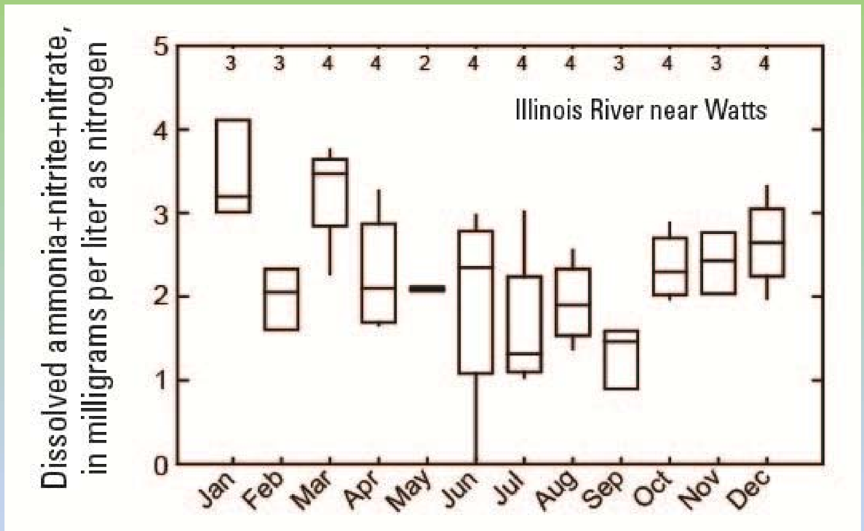


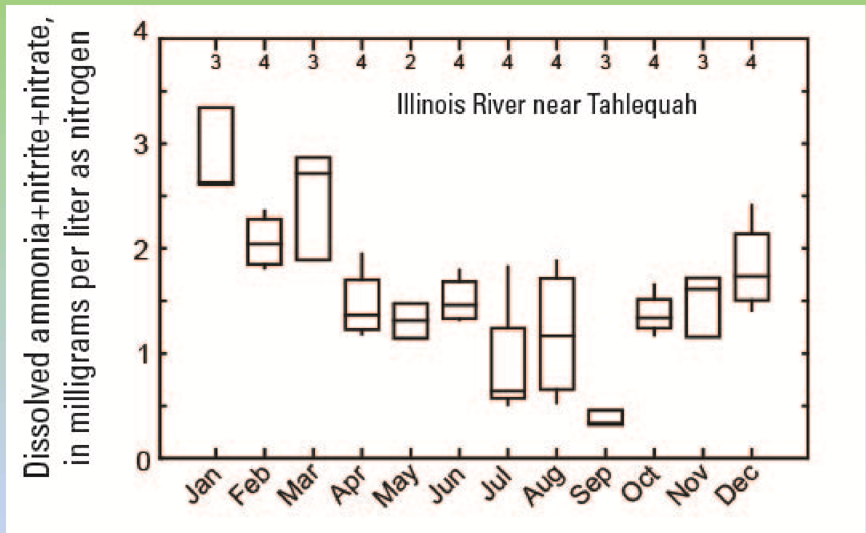


Some of the larger chlorophyll-a concentrations were measured at lesser concentrations of dissolved N compounds, perhaps due to N uptake by phytoplankton and periphyton or phosphorus limitation at larger N concentrations.

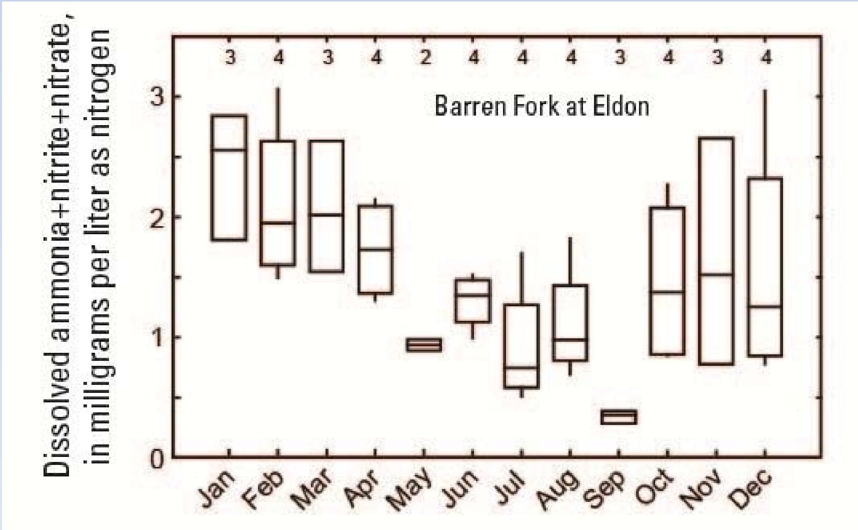


Dissolved nitrogen compound concentration, by month

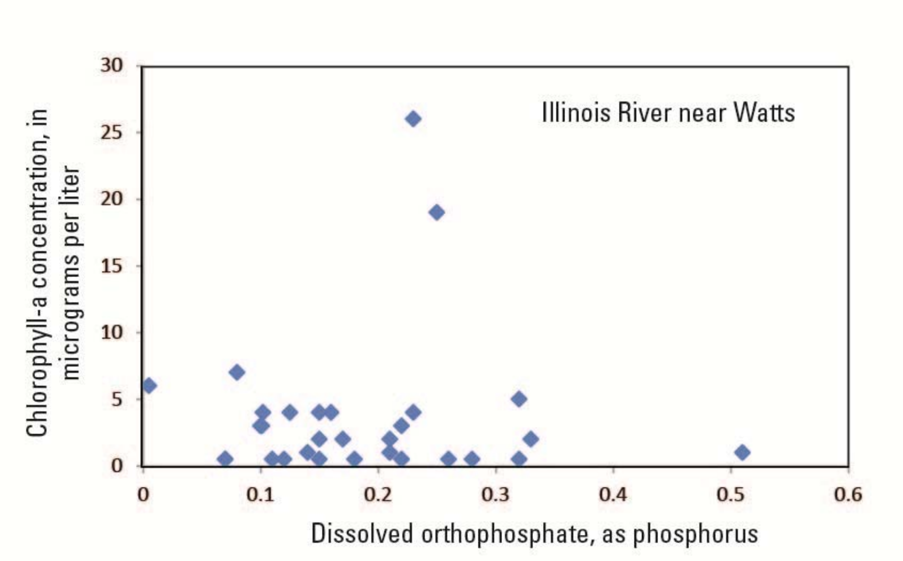


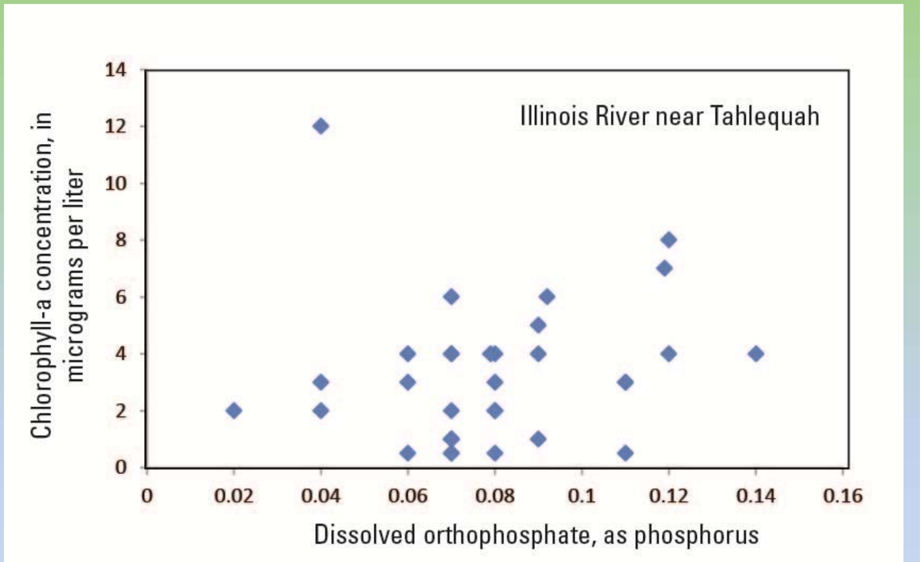


- Note generally greater N concentrations in the late fall through early spring, the inverse of chlorophyll-a concentrations, probably due to lesser N-uptake during colder periods.

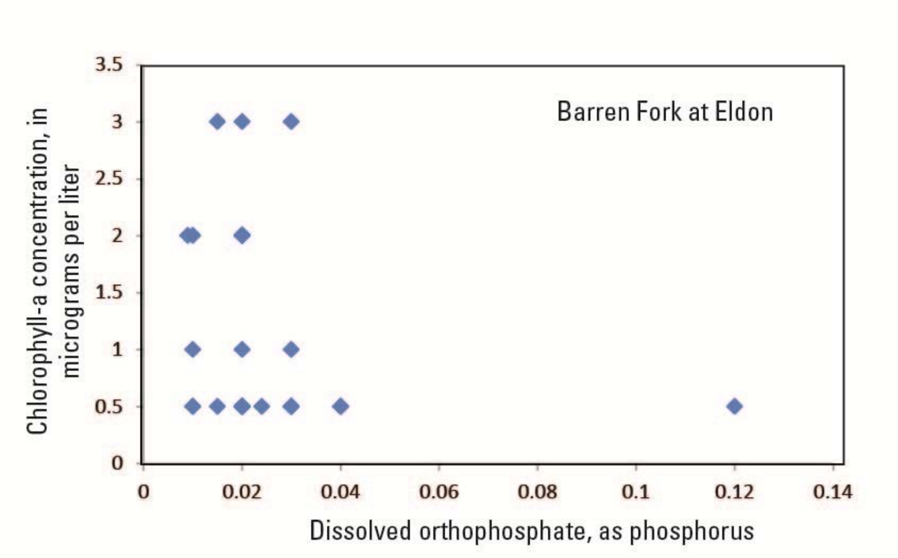


Chlorophyll-a with dissolved orthophosphate-phosphorus at low-flow





There were poor correlations between chlorophyll-a and dissolved orthophosphate-P concentrations, perhaps due to seasonal effects and changes with flow that affect nutrient limitation, or to lack of uptake of 0.45 micron or smaller phosphate particles.



Data needs

- Relatively few chlorophyll-a samples were collected. More frequent sampling over a longer period would provide better information about relations of chlorophyll-a concentrations with factors such as nutrient concentrations, water temperature, turbidity, seasonality, and abundance of herbivorous fish.
- Investigation of nutrient flux in hyporheic zones along streams would better characterize variability of nutrient seepage to local streams.
- Investigation of whether aquatic recreation and cattle access are complicating relations of chlorophyll-a to turbidity would be useful
- In flowing water, periphyton can be a substantial component of algae and related biota. Sampling is needed to quantify periphyton coverage of local streambeds.

Summary

- Chlorophyll-a concentrations generally were greatest in the spring and summer in this basin.
- Chlorophyll-a concentrations and dissolved inorganic nitrogen concentrations tended to have inverse relations, probably due to seasonal changes in N uptake.
- Algal growth is affected by a variety of factors, making blooms difficult to predict in time and place in this watershed.
- Eutrophication can affect the aesthetic quality of water in these streams and the economy of this area.
- More information is needed to better understand the relations between algal growth and factors such as nutrient concentrations and loading, water temperature, and seasonality.

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Questions?
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