Group 3. Fertilizer use and the phosphorus cycle

Part 1. Regarding the phosphorus cycle

On average, for each acre of corn grown, 52 lbs of P_2O_5 is removed from the soil and stored in the corn ears, and 37 lbs of P_2O_5 is removed from the soil and stored in the stover (the stalks and leaves) (Mullins, 2009).

Questions

1. We harvest the ears and eat them, or feed them to cattle, or use them to make ethanol. What does this do to the concentration of phosphorus in the soil?

2. Right now the corn stover is usually left on the fields, but some people hope to use corn stover to make ethanol in the future. What will this do to the amount of phosphorus in the soil?

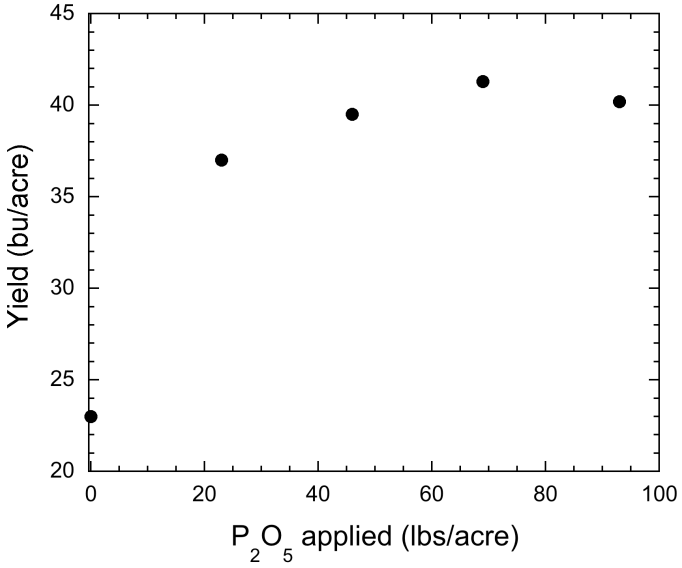
Reference: Gregory Mullins (2009) *Phosphorus, Agriculture and the Environment*, Virginia Cooperative Extension, Virginia Tech.

Part 2. Phosphate as a plant nutrient

Experiment

Scientists in Minnesota applied different amounts of phosphate fertilizer to soybean crops grown in soil with low or very low phosphorus content and measured the yield (amount of beans harvested) in bushels per acre (bu/acre).

Results



The scientists suggest that phosphate fertilizer be applied to soil only with very low or low phosphorus contents (<10 ppm using the Bray soil test, or <7 ppm using the Olsen soil test).

Questions

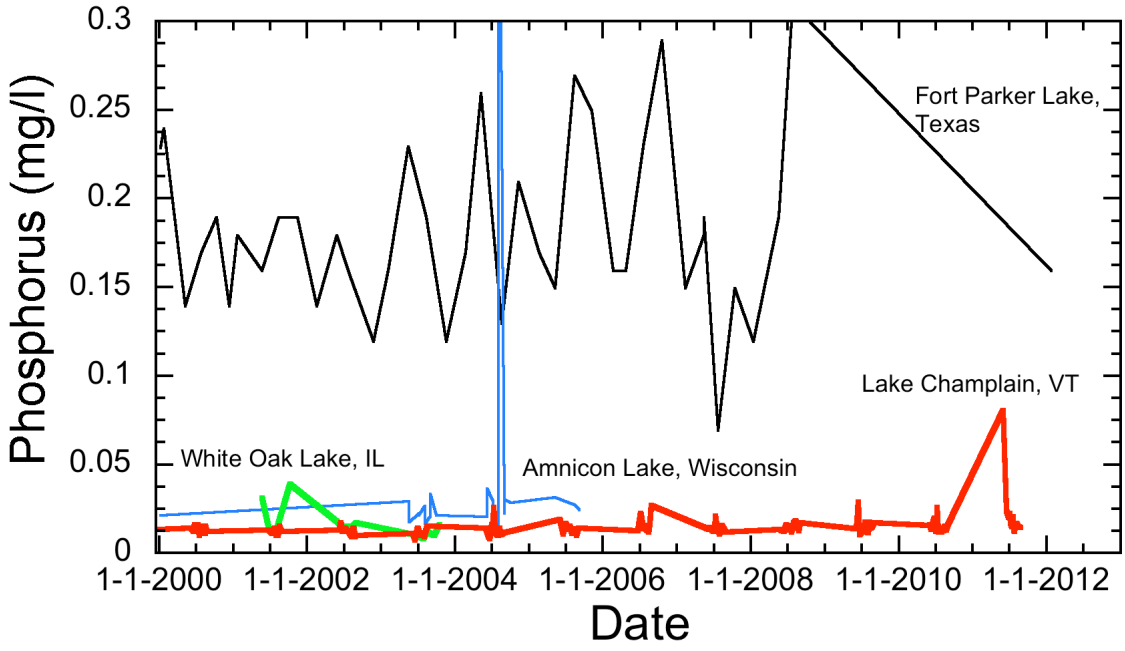
3. Based on the graph, does phosphorus fertilizer help with plant growth?

4. Does more fertilizer equate with more plant growth? Explain your answer.

Reference: Rehm, George W., Schmitt, Michael A., Lamb, John, and Roger Eliason (2012) *Fertilizing Soybeans in Minnesota*.

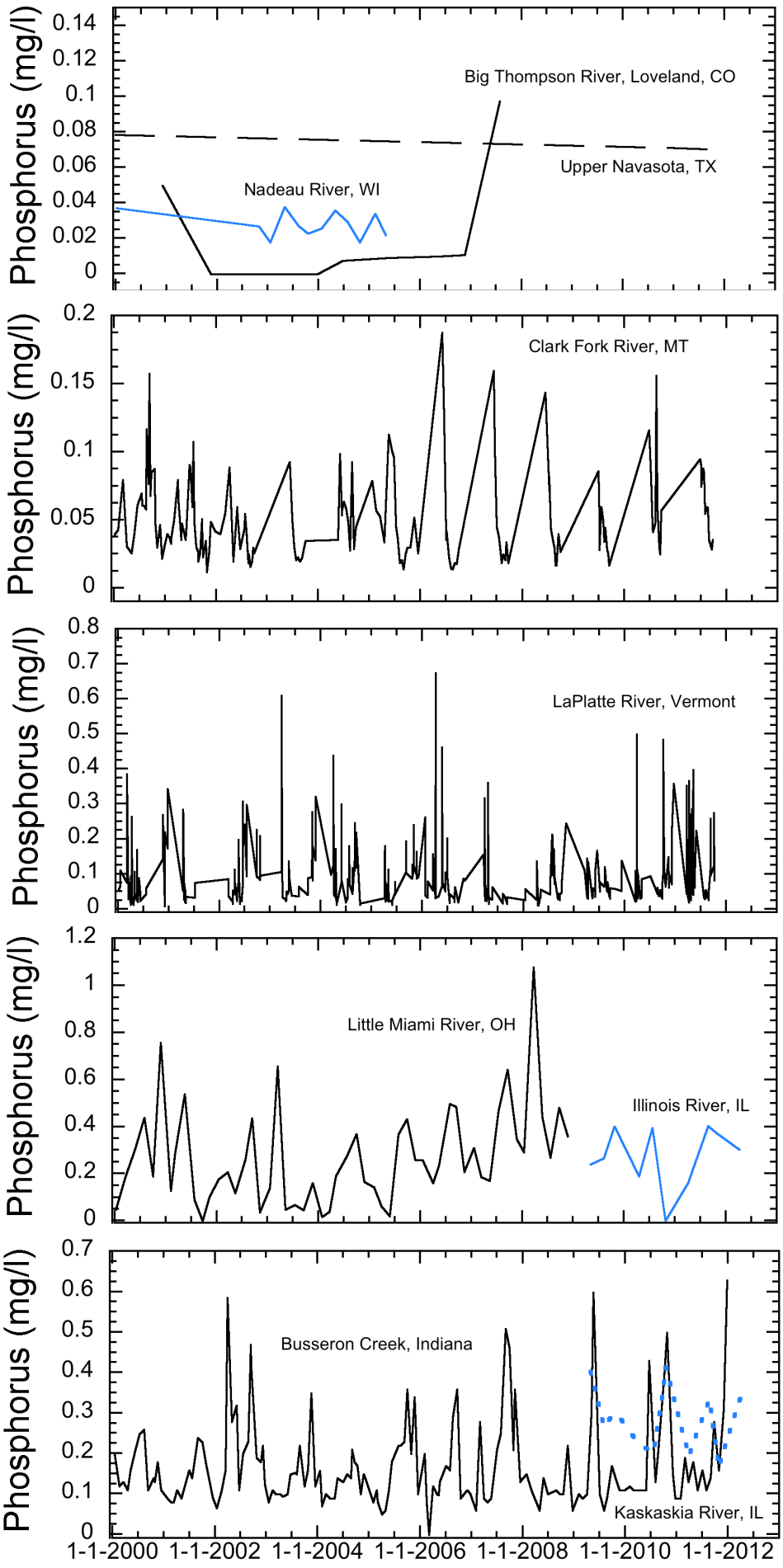
Part 3. Nutrient pollution (eutrophication)

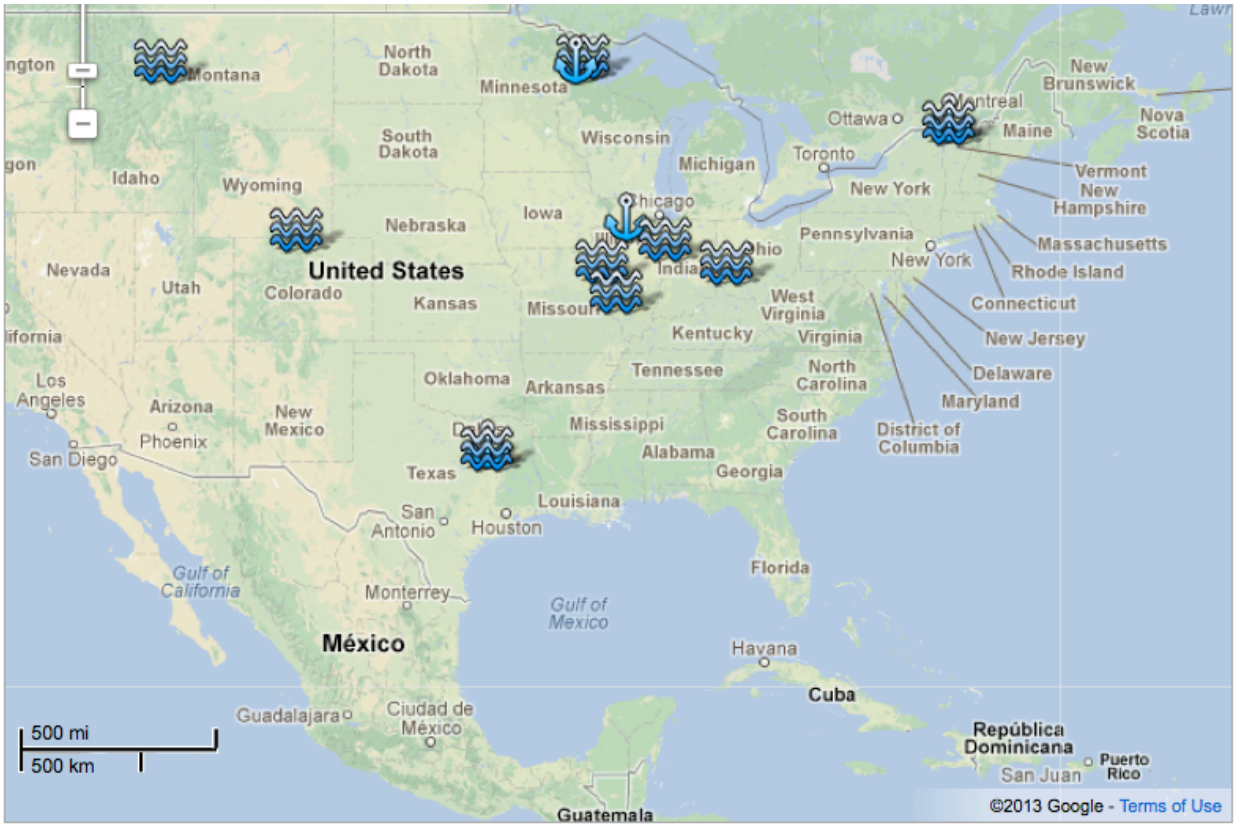
The EPA has set a limit for phosphorus in lakes, flowing streams, and streams entering lakes at 0.025 mg/l, 0.1 mg/l and .05 mg/l, respectively. If actual phosphorus exceeds these limits, then organisms (mostly single-celled organisms) will flourish, so much so that they'll consume all the available oxygen. The water will become anoxic, and organisms will then cease to live there. This nutrient-fueled damage to streams, lakes and oceans is called eutrophication. Graph data were downloaded from the EPA Storet website.



5. The graph above shows measurements of phosphorus in four different lakes. Which of these might have problems with eutrophication? Explain your answer.

6. Graphs on the next page show phosphorus levels in rivers (flowing streams). (In the bottom graph, the dotted line shows measurements for the Kaskaskia River.) Which of the rivers might be susceptible to eutrophism?


Phosphorus (mg/l)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Big Thompson River, Loveland, CO
Upper Navasota, TX
Nadeau River, WI
Phosphorus (mg/l)
0.2
0.15
0.1
0.05
0
Clark Fork River, MT
Phosphorus (mg/l)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
LaPlatte River, Vermont
Phosphorus (mg/l)
1.2
1
0.8
0.6
0.4
0.2
0
Little Miami River, OH
Illinois River, IL
Phosphorus (mg/l)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Busseron Creek, Indiana
Kaskaskia River, IL
1-1-2000
1-1-2002
1-1-2004
1-1-2006
1-1-2008
1-1-2010
1-1-2012



Map showing the locations of lakes (anchors) and streams (water waves) shown in the previous graphs. Symbols of lakes in Texas and Vermont are underneath the stream symbols.

7. Come up with a hypothesis to explain why some lakes and rivers have higher levels of phosphorus than others – think about how (and from where) the phosphorus is entering streams and lakes. What is that hypothesis? How does the data (on the graphs) as well as the map showing the locations of these lakes and rivers support your hypothesis?

8. Why should people care about nutrient pollution (eutrophication)? Give a couple of reasons.

Reference: Data for Lake and River Phosphorus Levels from EPA STORET (http://www.epa.gov/storet/).

Part 4

This is an excerpt from *Natural Capitalism: Creating the Next Industrial Revolution,* written in 1999 by Hawken, Lovins and Lovins:

> An ecological success story rapidly influencing the course of much of the American rice industry is the California Rice Association's creative response to the air pollution caused by the widespread practice of burning rice straw each winter. Silica in the straw was suspected of causing lung disease downwind. Some growers stopped burning and instead flooded their fields after harvest, turning them into habitat for millions of migrating ducks and other wild birds. The decomposing rice stubble rebuilt the soil. The ducks aerated and fertilized the fields. The duck's favorite food animals- worms, little arthropoda, minnows- came to live in the seasonal wetlands. Hunters paid to visit. Farm inputs could be reduced thanks to the natural fertilizers. Crop yields and net incomes rose. Now those farmers, with 30 percent of California's rice acreage, consider rice a coproduct of new businesses- providing water management, wildlife habitat, straw production and other services.

Question:

9. What does the actions of California rice farmers have to do with phosphorus, and the phosphorus cycle?

Reference: Hawken, Paul, Lovins, Amory and Lovins, L. Hunter (2008) Natural Capitalism: Creating the Next Industrial Revolution. Back Bay Books.