

Illinois River Water Quality Improvement Linked to More Efficient Corn Production

by Debra Levey Larson

The quality of water in the Illinois River has improved in one important aspect. A new study published in the *Journal of Environmental Quality* reports that nitrate loads in the Illinois River from 2010 to 2014 were 10% less than average loads in the 1980s and early 1990s.

Reducing the nitrate and phosphorus loads in the Mississippi River by 45% is the USEPA's ultimate recommendation. This will reduce the size of the seasonal hypoxic area, or "dead zone," created in the Gulf of Mexico when nitrate in tributaries like the Illinois River flows into the Mississippi River and down to the Gulf. Illinois has developed strategies to achieve these reductions, which are described in the Illinois Nutrient Loss Reduction Strategy, and other Midwestern states have developed similar strategies.

"The recent reduction in nitrate load in the Illinois River is a promising sign," says Greg McIsaac, University of Illinois researcher and lead author of the study. The study was completed last October, before data for 2015 were available. "Now that these data are available, we know that the Illinois River nitrate load from 2011 to 2015 was 15% lower than the load measured in the baseline period from 1980 to 1996. This 15% reduction

is a milestone that the state hoped to achieve for all its rivers by 2025."

Why the Decline?

In addition to examining trends in nitrate loads and concentrations in the Illinois River from 1976 to 2014, the authors tried to identify reasons for changes in loads and concentrations. One possible source of change considered was nitrate in treated wastewater discharged into the Illinois River by the Water Reclamation District of Greater Chicago from 1983 to 2014. The authors also used annual records of fertilizer sales, livestock numbers, and crop yields to calculate residual agricultural nitrogen for each year—that is, the nitrogen made available to crops in fertilizer, manure, and biological fixation, but not absorbed by the crop or harvested in the grain.

"A significant portion of this residual nitrogen is left in the soil as nitrate and can be washed into the river, primarily through groundwater and subsurface drainage tiles in agricultural fields," McIsaac says.

ASA and SSSA Fellow Mark David, a University of Illinois biogeochemist and study co-author, says the residual agricultural nitrogen was highest

in the late 1980s, following a major drought and low corn yields in 1988.

"Beginning around 1990, the residual agricultural nitrogen began to decline, most likely due to improved fertilizer management and higher corn yields. Since 1980, the amount of nitrogen fertilizer sold in the watershed remained relatively constant, but corn yields increased by about 50%," David says. "This means that more of the nitrogen fertilizer applied was taken up by the corn and harvested in the grain and less was left in the soil or washed down the river."

From their analysis of the data, the team found that annual nitrate loads were significantly correlated with river flow, nitrate discharged in Chicago wastewater, and residual agricultural nitrogen averaged over a six-year window. Nitrate concentrations—the average weight of nitrate in a typical gallon of river water—were also correlated with residual agricultural nitrogen and nitrate discharge from Chicago, but not river flow.

Another one of the study's co-authors, University of Illinois biostatistician George Gertner, is cautious about the findings. "Although the correlations we found are statistically significant, they are not definitive proof that

Farm 1 mile west of the Illinois River. USDA photo by Randy Tankersley.



the reductions in residual agricultural nitrogen or nitrate discharge from Chicago caused changes in nitrate concentrations or loads in the river. The results are, however, strongly suggestive of the connections.”

Precipitation, River Flow Are Important Factors

Nitrate loads are strongly influenced by precipitation and river flow, which can be highly erratic. It is promising that nitrate loads have declined in recent years despite higher-than-average river flows. The five-year average river flow from 2007 to 2011 was the highest recorded since the start of measurement in 1939.

Nitrate concentrations, on the other hand, have declined more consistently since about 1990, which was a period of high concentrations. The reason for the divergence between nitrate concentration and load, explains McIsaac, is that the load is the product of both

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concentration and river flow and the flow is strongly influenced by precipitation while concentrations are not. Higher flows allow the river to carry more pounds of nitrate, but it doesn't necessarily change the concentrations.

Whether nitrate concentrations and loads continue to decline in the future depends on several factors, according to the researchers. “If the annual river flows return to their 1976–2005 average values, and if nitrogen fertilizer efficiency remains high or continues to improve, there likely will be a decline in nitrate loads in the Illinois River,” David explains. “On

the other hand, if river flows remain high, which may be a consequence of climate change, meeting the nitrate reduction goals will likely require more conservation effort than originally proposed.”

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Phosphorus *from page 11*

ent reduction strategies, which have an interim goal of a 12% reduction by 2025. The toolkit is wide open, including cover crops, buffers, reduced tillage, optimization of fertilizer, and converting row crops to perennials. New in-ditch bioreactor technology is being developed to remove nutrients in place (learn more about the latest in bioreactor technology here: <http://bit.ly/1TLFykv>).

And he remains hopeful that we'll find a way to help stabilize collapsing river banks. “If we can find a solution, it would not need to cover a very large area” he says.

Patrick Belmont is more interested in controlling flow. The good news for farmers is that he doesn't think removing tile is the right solution. It's not economically feasible and will ultimately just shift the sediment source back to agricultural lands.

“But we do need to slow the flow,” he cautions. That means installing wetlands and detention basins to temporarily store water locally. Slowing the rush to the river won't be cheap but can be done in ways that not only reduce sediment, but also provide other benefits like nitrogen reduction. Another option would be to increase soil organic matter, which would also provide resilience to drought.

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