PGOLID PHOSPHORUS LOADING MODEL

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Executive Summary

Introduction

PGOLID has an extensive data set from its monitoring programs. The lake monitoring program was started in 1996, and has resulted in consistent data from 1996 to 2014. The stream monitoring program was started in 2001 and has resulted in consistent data from 2001 to 2014. This data was inputted to a BATHTUB computer model (US Army Corps of Engineers) to determine the proportion of phosphorus loading from different sources to the lake. These results can be used to implement programs to improve or maintain the water quality by addressing the phosphorus sources. Potential phosphorus sources include septic systems, shoreline runoff, precipitation, internal loading and inlet loading.

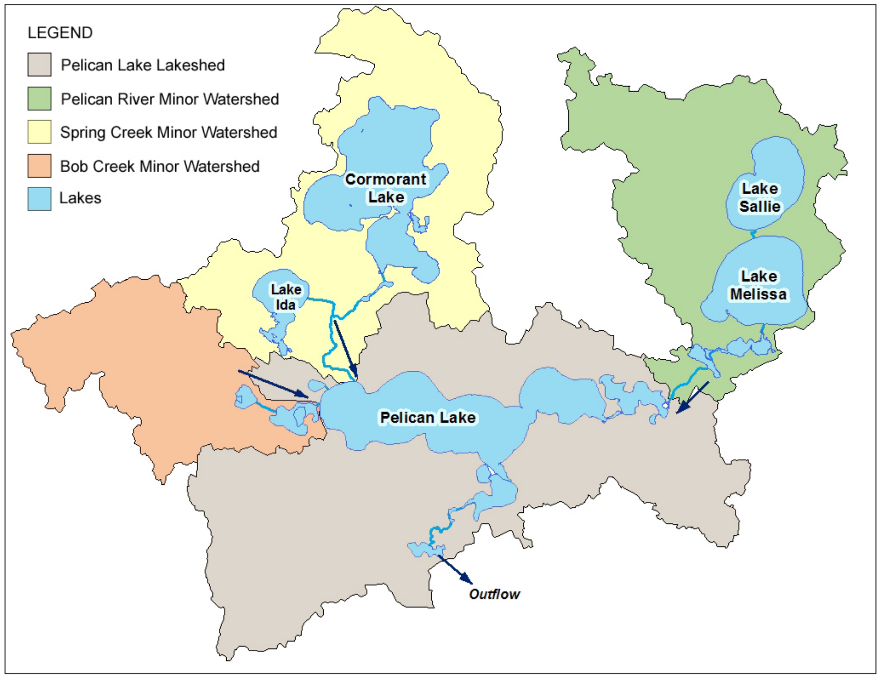

Figure 1. Watersheds contributing water and phosphorus to PGOLID.

Results

The model output for each lake shows the percentage of phosphorus loading from each of the different sources (Figure 2). Little Pelican, Pelican, and Fish Lakes look somewhat similar because they have major inflows from the Pelican River. Overall, the largest source of phosphorus loading to the lakes is the inlets, especially the Pelican River. Septic systems and shoreline runoff are minimal in comparison to the inlets.

Bass Lake looks different from the other lakes because it is fairly isolated, with no major inlets. The connection between Bass and Fish Lakes does not appear to move much water back and forth, but there is undoubtedly some exchange (~11%). Therefore, the septic systems and shoreline runoff have a larger proportional impact in Bass Lake than the other PGOLID lakes (Table 1, Figure 2).

Septic systems and shoreline runoff have a larger proportional impact in Bass Lake than the other PGOLID lakes

Table 1. Model output of phosphorus loading proportions from 2009.

	Little Pelican Lake	Pelican Fairhills Bay	Pelican Main Bay	Fish Lake	Bass Lake
Inlet Loading	94.1%	73.8%	77.0%	96.2%	10.5%
Internal Loading	2.4%	16.6%	7.0%	1.0%	11.1%
Precipitation	1.9%	4.5%	11.5%	1.6%	30.4%
Shoreline Runoff	1.1%	0.9%	2.2%	0.7%	31.0%
Septic Systems	0.6%	1.1%	2.3%	0.5%	17.0%

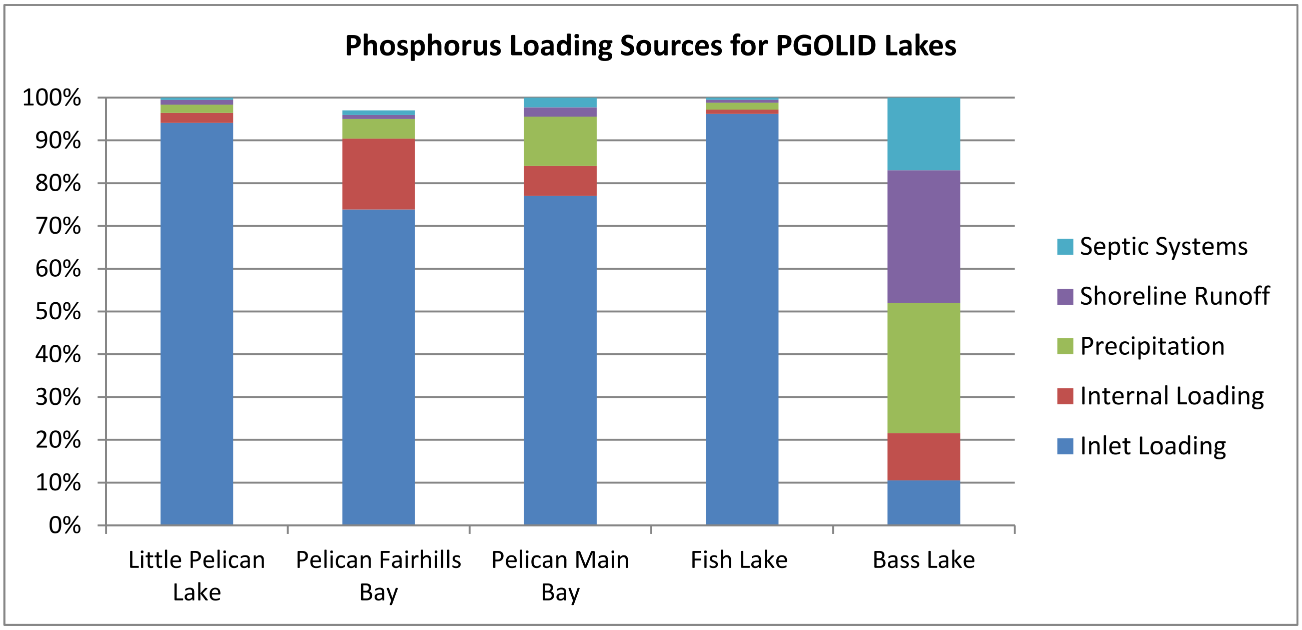

Figure 2. Phosphorus loading sources for PGOLID Lakes.

Implications

Because the Pelican Group of Lakes has so much water flowing through them, they are continually flushed out. This is good, because much of the nutrients coming into the lake go back out of the lake. The nutrients that stay in the lake are taken up by plants and algae and settle down into the sediments.

Septic Systems

Septic systems are a phosphorus source to the lake that can be controlled. Because of the Pelican River flow through the lakes, septic systems do not have much impact on the lake. Bass Lake, however, is different. Because there is not the water exchange occurring in Bass Lake, the septic system nutrients stay in the lake. It is still important to make sure the septic systems in the lake remain in good working order.

Shoreline Runoff

Shoreline runoff is a phosphorus source to the lake that can be controlled. Because of the Pelican River flow through the lakes, shoreline runoff is not a major source of phosphorus to the lake, but it does still affect it, especially in localized areas. When looking at the shoreline area from the water's edge to 250 feet back from the lake, 58-85% of the phosphorus loading from that land area comes from developed lots (impervious surface and turf grass). Shoreline runoff can fuel plant growth in swimming areas near shore. PGOLID has been implementing a Shoreline Restoration Program with a DNR Shoreline Habitat Restoration Grant since 2009. Restoring turf lawns to native grasses, wildflowers, trees and shrubs, and limiting the impervious surface in new development will limit future shoreline runoff. Having a natural shoreline is especially important in Bass Lake because it does not have a major inlet flushing it out.

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Precipitation

Precipitation is a phosphorus source to the lake that cannot be controlled. The amount of phosphorus loading from precipitation is determined by the surface area of the lake. The more surface area the lake has, the more rain it receives directly from rainfall. Bass Lake had the highest loading from precipitation, but this is because it has very little inlet loading. Of the other segments, the Main Bay of Pelican Lake had the most phosphorus loading from precipitation because it has the largest surface area. There is nothing that can be done to limit phosphorus loading from precipitation.

Internal Loading

Internal loading is a phosphorus source to the lake that can be somewhat controlled. It is based on the morphometry (size and depth), and biology of the lake, but it is also based on the amount of phosphorus in the lake. Limiting external phosphorus inputs to the lake can help reduce the amount of internal loading in a lake. Internal loading is most prevalent in Fairhills Bay of Pelican Lake. This is because this bay is deep enough to stratify (separate into a warm top layer and cold bottom layer) and it receives nutrients and sediment from the Pelican River. Little Pelican Lake has the highest in-lake phosphorus of all the PGOLID lakes, but because it is shallow it does not fully stratify in the summer. The water column remains fairly mixed, and so the bottom of the lake has oxygen present, which keeps the phosphorus in the sediments from releasing in to the water.

Inlet Loading

Inlet loading is a phosphorus source to the lake that can be somewhat controlled. The best way to manage inlet loading is to maintain good relationships with upstream neighbors, and to monitor for any problems that could arise. If problems are detected they can hopefully be fixed before the impact to the lake is large. PGOLID has been implementing a stream monitoring program since 2001.

The largest source of phosphorus to the PGOLID Lakes is the Pelican River (Figure 2). This means much of the phosphorus comes from upstream in the watershed such as Detroit Lakes (Figure 3).

The largest source of phosphorus to the PGOLID Lakes is the Pelican River. This is mainly due to the large amount of water entering Pelican Lake from upstream.

Figure 3. The entire watershed for PGOLID Lakes.

It is difficult to control phosphorous inputs upstream in the watershed. PGOLID maintains good working relationships with upstream entities such as the Pelican River Watershed District and the City of Detroit Lakes.

Spring Creek also contributes phosphorus loading to Pelican Lake (20%). PGOLID maintains a good working relationship with the Cormorant Lakes Watershed District, and have a signed agreement for how much water can be discharged from Big Cormorant Lake into Spring Creek. Bob Creek is a minor phosphorus source to Pelican Lake (5%). PGOLID has worked with a farmer along the creek to increase stream buffers to better protect the stream's water quality.

Future Scenarios

Once the model was set up and fit the monitoring data set (predicted water quality from the model = observed water quality from monitoring), future scenarios could be run to see what would affect the water quality of PGOLID lakes.

Zebra mussels

Data from 2013 was put into the model to see what effect Zebra mussels have had on the lakes. The phosphorus values were similar to pre-zebra mussel years, but the clarity values were much different. Zebra mussels affect the clarity of the lake, but not the phosphorus loading. This means that in future years when we run this model, we'll have to make a correction for Zebra mussels for the model to fit.

Inlet loading

The model was run and the phosphorus loading from each inlet was increased by 50% to see what effect that would have on the lakes. There was not much change if the Bob Creek inlet phosphorus loading increased by 50%. If the phosphorus loading was increased by 50% from Spring Creek it would add about 2% more phosphorus to Pelican Lake than current rates. If the phosphorus loading was increased by 50% from the Pelican River, Pelican Lake received 6% more phosphorus and Little Pelican Lake received 2% more phosphorus.

Shoreline Runoff

The model was run and the phosphorus loading from shoreline runoff was increased by 50% to see what effect that would have on the lakes. Bass Lake showed the greatest effect with 9% more phosphorus entering the lake. This would contribute to greener water. The other lakes had about 1% increase in phosphorus.

Septic Systems

The model was run and the phosphorus loading from septic systems was increased by 50% to see what effect that would have on the lakes. Bass Lake showed the greatest effect with 6% more phosphorus entering the lake. This would contribute to greener water. The other lakes had about 1% increase in phosphorus.

Next Steps

The overall conclusions from this study result in the following priorities for future projects:

1. Because the Pelican River is the largest source of phosphorus to the PGOLID lakes, better understand the loading coming from upstream by installing a stream flow monitoring gauge in the river before it gets to Little Pelican Lake to get daily flow estimates. Then re-run the model to compare the more specific flow measurements to the monthly measurements in the historical data set.
2. Educate Bass Lake residents about the large proportional effect that shoreline runoff and septic systems have on the lake because there are no inlets flushing it out. Look into volunteers for shoreline restoration projects and make sure septic systems are compliant.