# Phosphate Pollution in Two Urban Storm-water Run-off Ponds


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## Introduction

Storm-water run-off ponds are a common feature of urban landscapes that are often reclaimed to become city parks. Because they are subject to run-off from city streets they often receive large amounts of plant nutrients making them extremely eutrophic with large algal and macrophyte blooms and anaerobic sediments. A key nutrient in eutrophication is phosphorus. Schindler et al. (1974) found phosphorus to be a limiting nutrient in most freshwater systems and that phosphorus inputs are often responsible for eutrophication. One property of phosphorus that is important to its role in eutrophication is its tendency to get trapped in the sediment by being bound to redox-sensitive iron compounds and then eventually getting released back into the water column. This property of phosphorus makes it difficult to reverse eutrophication even if phosphorus inputs are stopped (Kalff, 2001).

Inputs of phosphorus can come from many different places. One main input is from sewage or storm run-off which contains phosphorus from detergent, fertilizer, and pet waste. The goal of this study was to test whether run-off from the city of Edwardsville, IL raised the total phosphorus level in two local storm-water run-off lakes causing them to be eutrophic. Our hypothesis was that the total phosphorus levels in the lakes would be high indicating eutrophic status.


Figure 1: Map of the Watershed Nature Center. The Front Lake is to the East. The Back Lake is to the West. White numbers indicate depth. Sampling sites are indicated by yellow stars.

## Study Site

Our study site was two ponds located at the Watershed Nature Center (WNC Fig 1) located on a reclaimed "brownfields" site in the City of Edwardsville. The maximum depth of both ponds is 3 m. The ponds receive run-off from large areas of the city of Edwardsville. They are located in a 400 acre (160 ha.) natural area that was developed in 1991 from the City of Edwardsville sewage lagoons (Gricevich, 1994). The site has been extensively reclaimed by dredging the former lagoons and by establishment of wetland plants. The ponds are currently surrounded by large areas of marshlands with shallow water and many emergent wetland plants including *Typha*, *Phragmites* and *Hibiscus*. The ponds also contain extensive growths of aquatic macrophytes.

## Methods

Water samples collected bimonthly from the two ponds were analyzed for two different phosphorus fractions: total phosphorus (TP, the sum of all phosphorus fractions), and ortho-phosphorus (PO4---), concentrations. We collected the samples in 1-liter polyethylene bottles. In the laboratory, we filtered 200 mL of each sample. We put 50 mL of unfiltered water in Erlenmeyer flasks (for TP) and the rest of the filtered water into 100 mL plastic bottles which were frozen until analysis (for ortho-P). Analytical techniques followed *Standard Methods for the Analysis of Water and Wastewater* (APHA 1985). Before we began, we created multiple standards (0, 100, 200, 300, 400, 1000 µg/L in order to create a standard curve. After the standards were made, we acidified the TP samples by adding 1 mL of 11 N $H_2SO_4$ and then 1 g of potassium persulfate oxidant to digest the organic matter in the sample. Next, we covered the top of the flasks with beakers and put them in the autoclave for 15 minutes. Autoclaving with persulfate oxidizes organic matter in the samples releasing $PO_4^{---}$ for analysis. Once removed from the autoclave, we neutralized the samples by first adding DI water to bring all samples up to 50 mL of liquid and then adding 1 or 2 drops of phenolphthalein to act as a pH indicator. Next, we added 11 N KOH drop-wise until the samples turned pink in color followed by a few drops of 11 N $H_2SO_4$ to remove the pink color. Then, we added 8 mL of color reagent which contains ammonium molybdate, ascorbic acid, and antimony potassium tartarate dissolved in sulfuric acid. After waiting 10 minutes for the blue color to form, the optical density (OD) was measured with a spectrophotometer set at a wavelength of 880 µm. The ODs of the unknown samples were plotted against the standard curve in order to get the phosphorus concentrations. Samples for ortho-P analysis were thawed and analyzed with molybdate color reagent without persulfate treatment. The standard error of estimate for our analysis was 50 µg/L.

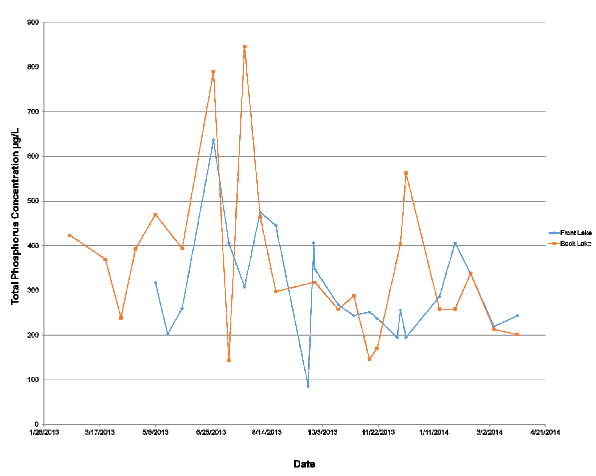


Figure 2. Shows the Total Phosphorus concentrations for each date sampled.

## Results

Figure 2 indicates the total phosphorus concentrations for each date sampled. The TP concentrations show a general trend of being higher in the summer months with a peak of 636 µg/L for the Front Lake and 846 µg/L for the Back Lake. The standard error is approximately 50 µg/L.

Figure 3 indicates the ortho-P levels for each sampling date. The ortho-P levels are high with a peak of 322 µg/L for the Front Lake and 265 µg/L for the Back Lake.


Figure 3. Shows the ortho-phosphorus concentrations for each date sampled.

## Discussion

Figure 2 indicates that total phosphorus levels are high suggesting that run-off from the city is causing eutrophication. The OECD (Kalff, 2001) sets the TP level for a eutrophic lake at 50 µg/L. Figure 1 shows TP levels much higher than this cut-off value indicating that the WNC lakes are extremely eutrophic and possibly receiving very high inputs of phosphorus from run-off. Figure 2 also shows that the TP levels changed very rapidly between sampling dates. A possible explanation of this is that there was contamination during intermittent storm events. In addition, Figure 2 indicates that TP levels are on average higher in the summer months that in the winter months. Figure 3 shows the ortho-phosphorus levels which are higher than expected. In many samples, approximately 50% of the total phosphorus is ortho-P. This result contrasts with most lakes where the ortho-P levels are low because phosphorus is a limiting nutrient. Any free phosphorus in the water is quickly taken up by phytoplankton (Kalff, 2001). One explanation for the high ortho-P levels is that during the summer the sediment in the shallow waters become anaerobic releasing large amounts of phosphorus. It is also possible, according to a study by Lee et al. (1977), that phosphorus could also be released from the sediment under aerobic conditions. Lee et al. suggested that mineralization processes that occur under aerobic conditions could be responsible for the release of phosphorus from the sediments (Lee et al., 1977). In addition, storm events can cause the sediment in shallow waters to be suspended in the water column which provides an opportunity for phosphorus release from particulates under aerobic conditions (Lee et al., 1977). The suggestions from the Lee et al., paper can possibly be applied to the shallow lakes at WNC where the samples were collected.

## Conclusion

Our results show that the Watershed Ponds are extremely eutrophic with high levels of both total and ortho-phosphorus. The likely source of this nutrient is urban run-off.

Internal recycling may also play a role in the high phosphorus concentrations.

## Literature Cited


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