Influence of Waterfowl on Water Quality at Marion County Lake

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Hypothesis

Canada geese (*Branta canadensis)* migrate in large flocks that are often several thousand in size. These flocks can have an often-underestimated impact on nutrient dynamics in freshwater systems (see Fig. 3).. Marion County Lake near Marion, Kansas is a eutrophic lake with frequent harmful algae blooms that detract from its leisure value. We hypothesize that the geese are a major contributor of phosphorus to Marion County Lake.

Fig 1: Water and fecal sampling locations around the perimeter of the lake.

Background Information

Marion County Lake is heavily populated by Canada geese every winter. While the geese inhabit the lake, they become major nutrient contributors to the lake through their fecal droppings. The feces falls to the lake bottom and joins the sediment, where it becomes both a nutrient source and sink.

As the water warms during the summer, nutrients bound to lake sediment tend to be released due to a combination of biological and chemical processes. The combination of warm temperatures, inorganic phosphorus release, and chlorophyll-A from diatoms in the sediment results in an extremely conducive environment for cyanobacteria harmful algal bloom development and growth.

Once the blooms start to grow, they can then act as their own nutrient source. The blooms constantly recirculate phosphorus into the water system; so much that even as concentrations of other nutrients and diatoms decrease (up to 60%), phosphorus levels continue to rise (Bartoli et al. 2018). Eventually, the blooms can take over the surface of the water, growing in thick mats. At this stage, the blooms release cyanotoxins that vary in detrimental, even fatal, effects on humans and organisms in contact with the water.

Due to the continuous recirculation of phosphorus, the annual return of migratory waterfowl, and the guaranteed nutrient loading from the waterfowl, the harmful algal blooms will continue to grow season after season unless action is taken. Any actions should be made as soon as possible since internal storage of phosphorus in bottom sediment can persist for many years. In a study that examined long-term data from six eutrophic Danish lakes, it was found that internal phosphorus loading from sediments can delay lake recovery by up to 10 years (Søndergaard et al., 2013).

Experiments

Two different experiments were performed using samples acquired from Marion County Lake. Water samples taken from four locations around the lake's perimeter were used to run water quality tests, while goose excrement gathered at one of the sites was used to test the nutrient leaching. The procedures of both experiments are detailed below.

Water Quality: (Testing for both Nitrogen and Phosphorous concentrations)

1. Diluted sample according to testing concentration
2. Added reagent to sample and mixed
3. Observe the change in color correlating to nutrient concentration

Fecal Leaching: (Testing how much Nitrogen and Phosphorous are released into the environment from the fecal matter)

1. Autoclave 40-gram sample of goose feces for two days
2. Grind whole sample to fine powder
3. Add 10-grams of dried sample to 100 milliliters of water from Campus Creek (4x)
4. Cover two of the four mixtures and set aside; filter the other two to find immediate leaching results, keep filtered solution
5. Let covered samples sit for one week, filter, keep solution
6. Send solutions to lab to test

Results

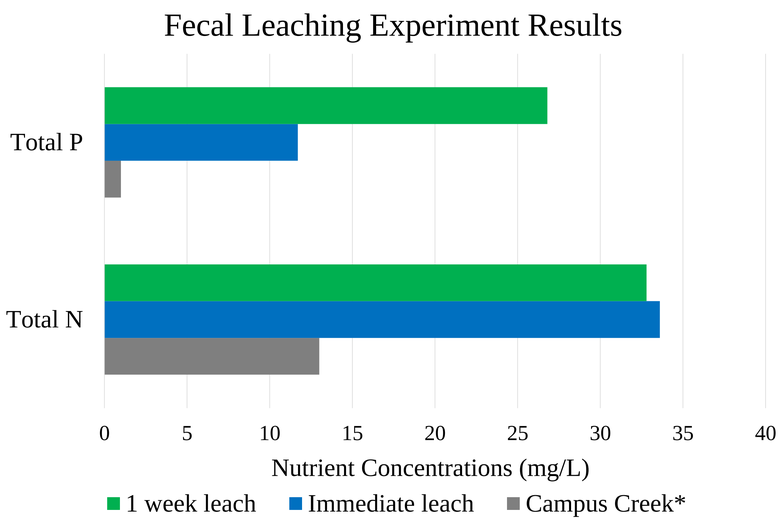

Figure 2: Leaching experiment nutrient results.

After one week of leaching, a substantial biofilm was observed on the surface of the flasks. We believe the cause for the total nitrogen decrease from the immediate leach to the 1-week leach is due to microbial biomass accumulation since the biofilms did not pass through the filter.

*We used Campus Creek as our natural water source for the experiments due to the age of our Marion Co. Lake samples.

Acknowledgments

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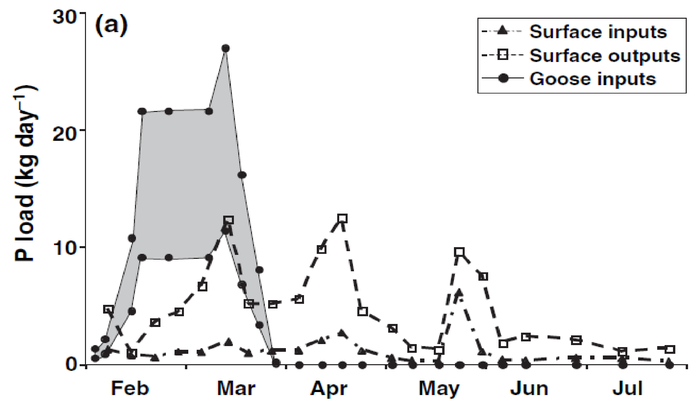

Fig. 3: Phosphorus contribution of Canada geese relative to watershed inputs at Middle Creek Reservoir, PA. (Olsen, et al., 2005).

Potential Solutions

To reduce the high concentrations of nutrients in the lake water, Marion County Lake officials seek natural solutions that won't disrupt lake recreation. Three options were considered: floating waterbeds, constructed wetlands, and various vegetative uses.

Floating waterbed treatment would be the most viable solution to implement on the lake. Floating waterbeds are foam matts constructed to hold submerged vegetation. They have been proven to have high nutrient removal efficiencies using native vegetation. The "Beemat" floating waterbed shown in Figure 4 has a nitrogen removal rate of 0.01 g/m^2 of matt/day (McAndrew et al., 2016). Floating waterbeds are also cost effective and can be easily self-assembled. Floating waterbeds are meant to be in waters equal to or less than five feet deep.

For Marion County Lake, these waterbeds can be tethered in place at shallow coves away from boating, fishing, and swimming areas. Based on the research conducted, approximately 1 acre of the 300 acres of the lake water surface area would need to be covered by floating waterbeds. However, a smaller initial amount of floating waterbed matts can be implemented, and the matts can be added or removed as needed. To keep any waterfowl from walking on the waterbed or consuming the vegetation, small wire or net fencing can be placed around the perimeter of the floating waterbed. The only maintenance required for the floating waterbeds is cleaning debris that accumulates on the matts and harvesting the biomass.

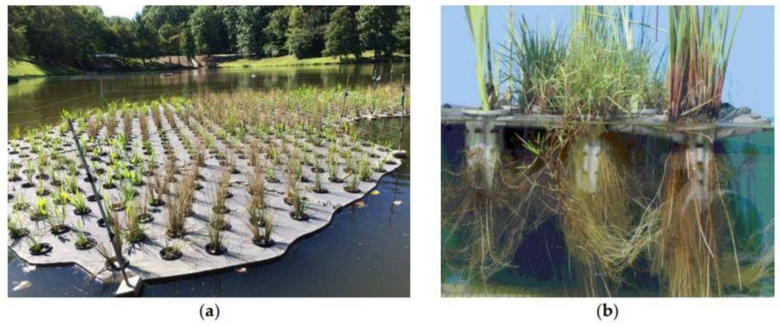

Figure 4: A surface view (a) and a cross-sectional view (b) of the "Beemat," a floating waterbed treatment system (McAndrew et al., 2016).