# Our Inland Lakes and Septic Tanks:

## Understanding the Contributions to Aquatic Vegetation and Algae Growth

By: Jennifer L. Jermalowicz-Jones, PhD Candidate
Restorative Lake Sciences

*Figure 1: Toxic Microcystis blue-green algae in an inland Michigan lake. Photo: Restorative Lake Sciences, 2009.*

### Introduction:

Inland waters such as lakes provide multiple benefits to riparian communities and local municipalities through a variety of ecosystem services. Stynes (2002) estimated that Michigan's 11,000 inland lakes support a recreational industry that is valued at approximately 15 billion dollars per year. Inland lakes also provide economic and aesthetic values to riparian waterfront property owners with increased residential lot property values and scenic views. A survey of approximately 485 riparians that represented five lakes in Kalamazoo County, Michigan, USA, was conducted in 2002 by Lemberg et *al.* (2002) and revealed that the most important benefit of lakefront ownership was the vista. Thus, lakes clearly provide aesthetic as well as recreational benefits to riparians and those that use them.

For some time, lakes have been under continuous stress from surrounding development and land use activities. A major source of this stress includes the anthropogenic contributions of nutrients, sediments, and pathogens to the lake water from the surrounding landscape (Carpenter et *al.*, 1998). Nutrients have caused critical water quality issues such as the inundation of lakes with dense, filamentous green algae, or worse, toxic blue-green algae (Figure 1). Submersed aquatic vegetation also increases with high levels of phosphorus and leads to impedance of navigation and recreational activities, as well as decreases in water clarity and dissolved oxygen that lead to widespread fish kills (Figure 2). The existence of excess phosphorus in inland waterways has been well established by many scholars (Carpenter et *al.*, 1998; Millennium Ecosystem Assessment, 2005, among numerous others). Major sources of phosphorus for inland waterways include fertilizers from riparian lawns, septic drain fields, and non-point source transport from agricultural activities in the vicinity of a waterbody or upstream from the waterbody. Non-point source effluents such as phosphorus are difficult to intercept due to the diffuse geographical dispersion across a large area of land. Additionally, watersheds generally export more non-point source loads relative to point source loads as a result of the reductions of point source pollution required by the Clean Water Act of 1972 (Nizeyimana et *al.*, 1997; Morgan and Owens, 2001).

*Figure 2: Nuisance aquatic plant growth in an inland Michigan lake. Photo: Roger Schweitzer, 2013*

## Regulation of Nutrient Pollution in Inland Lakes:

The Michigan Department of Environmental Quality (MDEQ) regulates some activities through the Inland Lakes and Streams Program, pursuant to Part 301 of the Natural Resources Environmental Protection Act, P.A. 451 of 1994, as amended. Currently regulated activities include permits for shoreline improvements and beach alterations, wetland mitigation, and dredging. Non-point source pollutants from adjacent lands are loosely regulated, generally through the derivation of Total Maximum Daily Loads (TMDL's) pursuant to the federal Clean Water Act of 1972 (CWA) for water bodies that do not meet state Water Quality Standards (WQS). An initial goal of the CWA was to reduce the discharge of all pollutants into navigable waters by 1985. This goal was clearly not achieved and thus the policy was not as effective as previously assumed. A TMDL is the maximum amount of a specific pollutant a water body can absorb and still maintain good water quality. In Michigan, waters that do not meet WQS must be studied to determine the TMDL's for specific pollutants which also includes nutrients and solids. Once the TMDL's are established for the water body by the MDEQ, they are submitted to the United States Environmental Protection Agency (EPA) for approval. Once approved, the TMDL's are implemented through the regulation of National Pollutant Discharge Elimination System (NPDES) permits for point source pollutants or through improvement programs for non-point source pollution. The WQS strive to maintain waters with acceptable dissolved oxygen concentrations for the fishery,

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suitable conditions for recreation, and the protection of high quality waters. A primary problem with the current TMDL system is that sites need to be monitored frequently to determine what the TMDL should be and once determined, if the system is showing signs of improvement. Although the MDEQ maintains a current list of waters with TMDL's throughout the state, the impairments still exist on many water bodies (Jermalowicz-Jones, *unpublished data*). The monitoring frequency needed to obtain accurate information is often not executed and the runoff of phosphorus from farmland is often unmeasured and unknown. Furthermore, intense monitoring of agricultural non-point pollutant loads would be expensive and transaction costs associated with regulation policies would likely be high (Dosi and Zeitouni, 2001).

## Local Sources of Nutrients to Inland Lakes:

Nutrient pollution of inland lakes from septic systems and other land use activities is not a modern realization and has been known for multiple decades. The problem is also not unique to Michigan Lakes and was earlier described in Montreal, Canada by Lesauteur (1968) who noticed that summer cottages were having negative impacts on many water bodies. He further noted that a broader policy was needed to garner control of these systems because they were becoming more common over time.

Many of our inland lakes are in rural areas and thus sewer systems or other centralized wastewater collection methods are not practical. Thus, septic systems have been common in those areas since development on inland lakes began. Septic systems have four main components consisting of a pipe from the residence, a septic tank or reservoir, a drainage field, and the surrounding soils Figures 3 and 4). On ideal soil types, microbes in the soil are able to decompose nutrients and reduce the probability of groundwater contamination. However, the land around many lakes in Michigan contain soils that are not suitable for septic systems. Soils that are not very permeable, prone to saturation or ponding and have mucks, exist around many lakes and residences with septic systems.

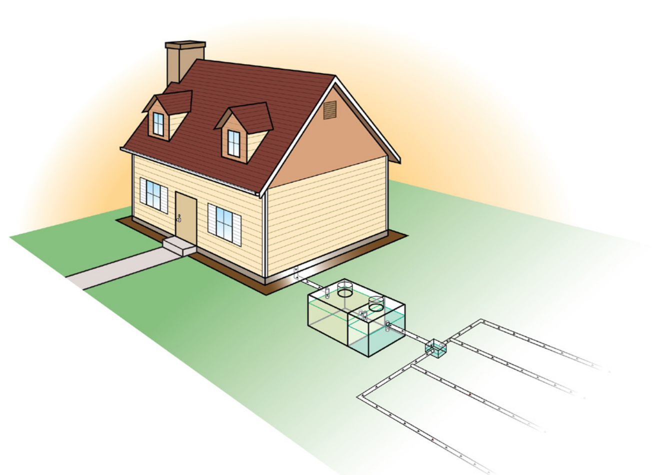

*Figure 3: A concept drawing of a cottage and its associated drain field. Photo: Restorative Lake Sciences.*

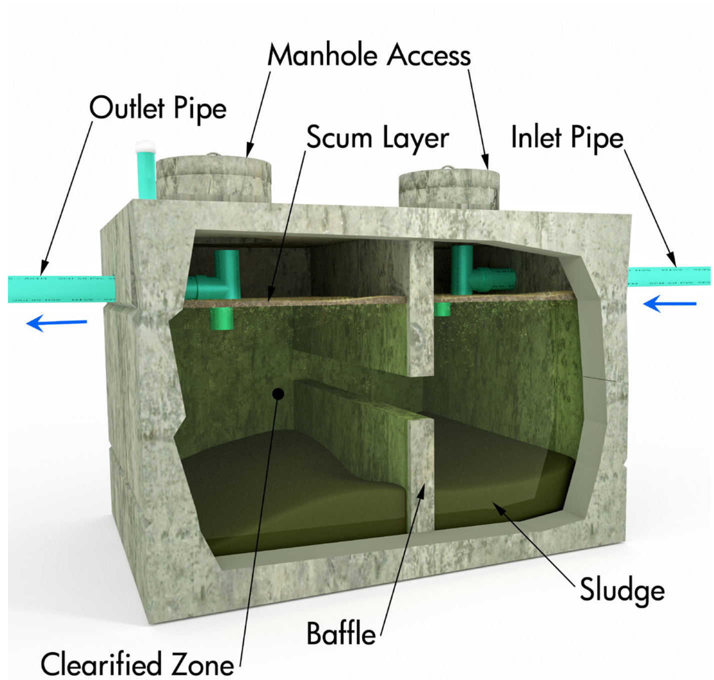


*Figure 4: The components of a typical septic tank. Photo: Restorative Lake Sciences.*

In fact, soils that are saturated may be associated with a marked reduction in phosphorus assimilation and adsorption (Gilliom and Patmont, 1983; Shawney and Starr, 1977) which leads to the discharge of phosphorus into the groundwater, especially in areas with a high water table. In the study by Gilliom and Patmont (1983) on Pine Lake in the Puget Sound of the western U.S., they found that it make take 20-30 years for the phosphorus to make its way to the lake and cause negative impacts on water quality. This may be why cottages built many decades ago are now having impacts on the water quality of those lakes.

Typical septic tank effluents are rich in nutrients such as phosphorus and nitrogen, chlorides, fecal coliform, sulfates, and carbon (Cantor and Knox, 1985). Phosphorus and nitrogen have long been identified as the key causes of nuisance aquatic plant and algae growth in inland lakes. Although phosphorus is often the limiting growth factor for aquatic plant growth, nitrogen is often more mobile in the groundwater and thus is found in abundance in the groundwater. A groundwater seepage study on submersed aquatic plant growth in White Lake, Muskegon County, Michigan, was conducted in 2005 by Jermalowicz-Jones (MS thesis, Grand Valley State University) and found that both phosphorus and nitrogen concentrations were higher in developed areas than in undeveloped areas. This helped to explain why the relatively undeveloped northern shore of White Lake contained significantly less submersed aquatic plant growth than the developed southern shoreline. The research also showed that more nutrients were entering the lake from groundwater than from some of the major tributaries.

Spence-Cheruvelil and Soranno (2008) studied 54 inland lakes in Michigan and found that total aquatic plant cover (including submersed plants) was most related to secchi depth and mean depth. However, they also determined that man-made land use activities were also predictors of aquatic plant cover since such variables can also influence aquatic plant growth. Prior to changes in offshore aquatic plant communities, an additional indicator of land use impacts on lake water quality in oligotrophic lakes (lakes that are low in nutrients) included changes in periphytic algae associated with development nearshore. Such algae can determine impacts of septic leachate before other more noticeable changes offshore are found (Rosenberger et *al*., 2008). Development in the watershed also may influence the relative species abundance of individual aquatic plant species. Sass et *al*., (2010) found that lakes associated with rigorous development in surrounding watersheds had more invasive species and less native aquatic plant diversity than less developed lakes. Thus, **land use activities such as failing septic systems may not only affect aquatic plant biomass and algal biomass, but also the composition and species richness of aquatic plant communities.**

A groundwater investigation of nutrient contributions to Narrow Lake in Central Alberta, Canada by Shaw et *al*., 1990, utilized minipiezometers and seepage meters to measure contributions of groundwater flow to the lake. They estimated that groundwater was a significant source of water to the lake by contributing approximately 30% of the annual load to the lake. Additionally, phosphorus concentrations in the sediment pore water were up to eight times higher than groundwater from nearby lake wells.

## What You Can Do for Your Lake:

The U.S. Environmental Protection Agency (USEPA) offers excellent educational resources and reference materials that riparians can use to care for their septic systems. To learn more about septic systems and how to care for them, visit the website: http://water.epa.gov/infrastructure/septic/. Some lake associations have created "annual septic tank pump out" days where septic tank specialists visit individual properties and clean out the septic tanks as well as inspect the drain fields for any issues that may negatively affect water quality. Annual septic tank pump out days are a great way to interact with riparian neighbors and learn about the many different types and locations of individual septic systems. Additionally, riparians should always maintain an awareness of the aquatic vegetation and algae in their lake so they can report any significant deviations from the normal observations. An awareness of the ambient lake water quality is also useful since degradations in water quality often occur over a long period of time and can be subtle.

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