Waushara County Lakes Study
Kusel Lake

Final Report
to Waushara County and
Wisconsin Department of Natural Resources

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KUSEL LAKE STUDY RESULTS

WAUSHARA COUNTY LAKES STUDY BACKGROUND

Lakes and rivers contribute to the way of life in Waushara County. Local residents and visitors alike enjoy fishing, swimming, boating, wildlife viewing, and the peaceful nature of the lakes. Healthy lakes add value to our communities. They provide places to relax and recreate, and they can stimulate tourism. Like other infrastructure in our communities, lakes require attention and good management practices to remain healthy in our developing watersheds.

Thirty-three lakes in Waushara County were selected for this study. The study focused on learning about the lakes’ water quality, aquatic plant communities, shoreland habitats, watersheds and histories in order to help people make informed lake management decisions. This report summarizes data collected for Kusel Lake between fall 2010 and fall 2012.

ABOUT KUSEL LAKE

To understand a lake and its potential for water quality, fish and wildlife, and recreational opportunities, we need to understand its physical characteristics and setting within the surrounding landscape. The lake is located in the township of Springwater, west of Saxeville, and east of County Highway H, with one public boat launch located on its eastern side. Kusel Lake is a 74-acre seepage lake with surface runoff and groundwater contributing most of its water. The maximum depth in Kusel Lake is 29 feet; the lakebed has a moderate slope with three distinct deep areas (Figure 1). Its bottom sediments are mostly sand with a small amount of muck.
FIGURE 1. CONTOUR MAP OF THE KUSEL LAKE LAKEBED.
The water quality in Kusel Lake is a reflection of the land that drains to it. The water quality, the amount of algae, aquatic plants, the fishery and other animals in the lake are all affected by natural and manmade characteristics. Natural characteristics that affect a lake include the amount of land that drains to the lake, the hilliness of the landscape, types of soil, extent of wetlands, and the type of lake. Within the lake’s watershed, alterations to the landscape, the types of land use, and the land management practices are examples of how people may affect the lake.

It is important to understand where Kusel Lake’s water originates in order to understand the lake’s health. During snowmelt or a rainstorm, water moves across the surface of the landscape (runoff) towards lower elevations such as lakes, streams, and wetlands. The land area that contributes runoff to Kusel Lake is called a surface watershed. Groundwater also feeds Kusel Lake; its land area may be slightly different than the surface watershed. The surface watershed is shown in Figure 2.

The capacity of the landscape to shed or hold water and contribute or filter particles determines the amount of erosion that may occur, the amount of groundwater feeding a lake, and ultimately, the lake’s water quality and quantity. Essentially, landscapes with a greater capacity to hold water during rain events and snowmelt help to slow the delivery of the water to the lake. Minimizing excess runoff is desirable because it allows more water to recharge the groundwater, which feeds the lake year-round - even during dry periods or when the lake is covered with ice.

Land use and land management practices within a lake’s watershed can affect both its water quantity and quality. While forests and grasslands allow a fair amount of precipitation to soak into the ground, resulting in more groundwater and better water quality, other types of land uses may result in increased runoff and less groundwater recharge, and may be sources of pollutants that can impact the lake and its inhabitants. Areas of land with exposed soil can produce soil erosion. Soil entering the lake can make the water cloudy and cover fish spawning beds. Soil also contains nutrients that increase the growth of algae and aquatic plants. Development on the land often results in changes to natural drainage patterns, alterations to vegetation on the landscape, and may be a source of pollutants. Impervious (hard) surfaces such as roads, rooftops, and compacted soil prevent rainfall from soaking into the ground, which may result in more runoff that carries pollutants to the lake. Wastewater, animal waste, and fertilizers used on lawns, gardens and crops can contribute nutrients that can enhance the growth of algae and aquatic plants in our lakes.

A variety of land management practices can be put in place to help reduce impacts to our lakes. Some practices are designed to reduce runoff. These include protecting/restoring wetlands, installing rain gardens, swales, rain barrels, and routing drainage from pavement and roofs away from the lake. Some practices are used to help reduce nutrients from moving across the landscape towards the lake. Examples include manure management practices, eliminating/reducing the use of fertilizers, increasing the distance between the lake and a septic drainfield, protecting/restoring native vegetation in the shoreland, and using erosion control practices. Waushara County staff and other professionals can work with landowners to determine which practices are best suited to a particular property.
The surface watershed for Kusel Lake is approximately 1,179 acres (Figure 2). The dominant types of land use in the watershed are forests (56%) and developed lands (35%). The land closest to the lake often has the greatest impact on water quality and habitat; Kusel Lake’s shoreland is surrounded primarily by development, forests and wetlands.

**FIGURE 2. LAND USE IN THE KUSEL LAKE SURFACE WATERSHED.**
The more the lake’s water interacts with groundwater, the more influence the geology has on the lake. The length of time water remains below ground affects the temperature and chemistry of the groundwater. Groundwater temperature is near constant year round; during the summer, groundwater feeding Kusel Lake will help keep the lake water cooler.

Groundwater flows below ground from higher to lower elevations, discharging into wetlands, streams, and lakes. The groundwater feeding the lakes in Waushara County originates nearby. The black arrows in Figure 3 indicate the general direction of groundwater flow. Much of the groundwater enters Kusel Lake from the southwest.

**Figure 3. Groundwater flow direction near Kusel Lake.**
Lake water quality is a result of many factors including the underlying geology, the climate, and land management practices. Assessing lake water quality allows us to evaluate current lake health and changes from the past. We can then identify what is needed to achieve a more desirable state or preserve an existing state for aesthetics, recreation, wildlife and the fishery. During this study, water quality in Kusel Lake was assessed by measuring different characteristics including temperature, dissolved oxygen, water clarity, water chemistry, and algae.

The source of a lake’s water supply is important in determining its water quality and choosing management practices to preserve or influence that quality. Kusel Lake is classified as a seepage lake, or a lake that receives its water primarily through groundwater, and, to a lesser extent, direct runoff and precipitation (Figure 4). Seepage lakes generally have longer retention time (length of time water remains in the lake), which affects contact time with nutrients that feed the growth of algae and aquatic plants. Seepage lakes have higher concentrations of minerals, which are picked up as groundwater moves through soil and rock. Seepage lakes are generally more vulnerable to contamination moving towards the lake in the groundwater. Examples for Kusel Lake may include septic systems, agriculture, and road salt.

The geologic composition that lies beneath a lake has the ability to influence the temperature, pH, minerals, and other properties in a lake. As groundwater moves, some substances are filtered out, but some materials in the soil dissolve into the groundwater. Minerals such as calcium and magnesium in the soil around Kusel Lake are dissolved in the water, making the water hard. The average hardness for Kusel Lake during the 2010-2012 sampling period was 114 mg/L, which is considered hard (Table 1). Hard water provides calcium necessary for building bones and shells for animals in the lake. The average alkalinity was 122 mg/L; higher alkalinity in inland lakes can support greater species productivity. Hardness and alkalinity also play roles in the type of aquatic plants that are found in a lake (Shaw et al., 2000; Wetzel, 2001).

**Figure 4. Cartoon showing inflow and outflow of water in a seepage lake.**

**Table 1. Minerals and physical measurements in Kusel Lake, 2010-2012.**

<table>
<thead>
<tr>
<th>Kusel Lake</th>
<th>Alkalinity (mg/L)</th>
<th>Calcium (mg/L)</th>
<th>Magnesium (mg/L)</th>
<th>Hardness (mg/L as CaCO₃)</th>
<th>Color (SU)</th>
<th>Turbidity (NTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Value</td>
<td>122</td>
<td>23.8</td>
<td>12.1</td>
<td>114</td>
<td>12</td>
<td>1.8</td>
</tr>
</tbody>
</table>
Chloride concentrations, and to a lesser degree sodium and potassium concentrations, are commonly used as indicators of how a lake is being impacted by human activity. The presence of these compounds where they do not naturally occur indicates sources of water contaminants.

Water in Kusel Lake had low average chloride concentrations and moderate sodium and potassium concentrations over the monitoring period, suggesting that certain human activities may be impacting the lake (Table 2). Sources of sodium include animal waste, septic systems, fertilizer, and road-salting chemicals. Sources of potassium are similar to sodium with the exception of road-salting chemicals. Atrazine, an herbicide commonly used on corn, was found in low concentrations in Kusel Lake (0.11 µg/L DACT); however, some toxicity studies have indicated that reproductive system abnormalities can occur in frogs at these levels (Hayes et al., 2003). The presence of this chemical suggests that agricultural activities in the surrounding watershed are impacting Kusel Lake.

Table 2. Kusel Lake average water chemistry, 2010-2012.

<table>
<thead>
<tr>
<th>Kusel Lake (mg/L)</th>
<th>Average Value</th>
<th>Reference Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low Medium High</td>
<td>Low Medium High</td>
</tr>
<tr>
<td>Potassium</td>
<td>1.0</td>
<td>&lt;.75 0.75-1.5 &gt;1.5</td>
</tr>
<tr>
<td>Chloride</td>
<td>2.6</td>
<td>&lt;3 3.0-10.0 &gt;10</td>
</tr>
<tr>
<td>Sodium</td>
<td>2.0</td>
<td>&lt;2 2.0-4.0 &gt;4</td>
</tr>
</tbody>
</table>

Dissolved oxygen is an important measure in aquatic ecosystems because a majority of organisms in the water depend on oxygen to survive. Oxygen is dissolved into the water from contact with the air, which is increased by wind and wave action. Algae and aquatic plants also produce oxygen when sunlight enters the water, but the decomposition of dead plants and algae reduces oxygen in the lake. Some forms of iron and other metals carried by groundwater can also consume oxygen when the groundwater discharges to the lake.

In a lake, the water temperature changes throughout the year and may vary with depth. During winter and summer when lakes stratify (layer), the amount of dissolved oxygen is often lower towards the bottom of the lake. Dissolved oxygen concentrations below 5 mg/L can stress some species of cold water fish and over time can reduce the amount of available habitat for sensitive cold water species of fish and other aquatic organisms.

Water temperature and dissolved oxygen were measured in Kusel Lake from surface to bottom at the time of sample collection in the 2010-2012 study. Typical of many Wisconsin lakes, Kusel Lake exhibited periods of mixing in the spring and fall and stratification (layering) during summer and winter. Temperature data (Figure 5) illustrated a very typical late winter profile for February 2011 and 2012, with freezing temperatures at the surface and gradual warming with depth. Vertical profiles for spring and fall turnover clearly showed thorough mixing in November 2010 and April 2011, then again in late October 2011 and early May 2012. Thermal stratification was well developed by June in Kusel Lake, with similar profiles observed between the two years (2011-2012). The data illustrated decreasing temperatures with depth, ranging as high as 27C (80ºF) at the surface in mid-summer to 8C (46ºF) near the bottom.
Dissolved oxygen concentrations in Kusel Lake followed a pattern similar to temperature. When the lake was mixed, the oxygen was consistent throughout the depths, and during summer and winter the dissolved oxygen concentrations were highest near the surface and lowest near the bottom of the lake (Figure 6). During the summer, dissolved oxygen was sufficient to support many species of fish in the upper 12 feet of water. Winter saw the greatest decline in dissolved oxygen, as identified on February 24, 2011. During the winter, ice cover prevents contact with oxygen from the atmosphere and the decomposers at the bottom of the lake consume available oxygen. Algae can produce oxygen below ice, but snow cover on the ice can prevent algae from receiving the sunlight needed for growth and oxygen production.
Water clarity is a measure of the depth that light can penetrate into the water. It is an aesthetic measure and is also related to the depth that rooted aquatic plants can grow. Water clarity is affected by water color, turbidity (suspended sediment), and algae, so it is normal for water clarity to change throughout the year and from year to year.

In Kusel Lake, color was relatively low (Table 1), so the variability in transparency throughout the year is primarily due to fluctuating algae concentrations and re-suspended sediment following storms, heavy boating, and sometimes during the formation of marl.

The water clarity measured in Kusel Lake during the study period was considered fair. For Kusel Lake, water clarity ranged from 7 feet to 13.7 feet, with an average of 10.6 feet over the two-year monitoring period (Figure 7). When compared with historic data collected between 1999 and 2005, the average water clarity measured during the study was about the same in July and slightly poorer in June and August. Water clarity in Kusel Lake was typically poorer in early summer and in the fall.

![Kusel Lake Secchi Depth](image)

**Figure 7. Water clarity in Kusel Lake, 2010-2012 and historic.**

Nutrients (phosphorus and nitrogen) are used by algae and aquatic plants for growth. Phosphorus is present naturally throughout the watershed in soil, plants, animals and wetlands. Common sources from human activities include soil erosion, animal waste, fertilizers and septic systems.

It is most common for phosphorus to move from the land to the water through surface runoff, but it can also travel to the lake in groundwater. Once in a lake, a portion of the phosphorus becomes part of the aquatic system in the form of plant and animal tissue, and sediment. The phosphorus continues to cycle within the lake for many years.

During the study, total phosphorus concentrations in samples collected from Kusel Lake ranged from a high of 30 ug/L when the lake was mixed in April 2012 to a low of 6 ug/L in August (Table 3). Summer median total phosphorus concentrations were 14 ug/L and 15 ug/L in 2011 and 2012, respectively. This is below Wisconsin’s phosphorus standard of 20 ug/L for deep seepage lakes such as Kusel Lake. Nitrogen...
concentrations were similar to background concentrations. Inorganic nitrogen concentrations were at background levels for lakes in central Wisconsin.

Chlorophyll \(a\) is a measurement of algae in the water. Chlorophyll \(a\) concentrations in Kusel Lake varied slightly throughout the monitoring period, ranging from a high of 2.4 \(\mu g/L\) in February 2012 to a low of 0.5 \(\mu g/L\) in April and July 2011. The average for the monitoring period was 1.5 \(\mu g/L\). These low concentrations were similar to earlier chlorophyll \(a\) data dating back to 2000.

**Table 3. Seasonal Summary of Nutrient Concentrations in Kusel Lake, 2010-2012.**

<table>
<thead>
<tr>
<th>Kusel Lake</th>
<th>Inorganic Nitrogen (mg/L)</th>
<th>Organic Nitrogen (mg/L)</th>
<th>Total Nitrogen (mg/L)</th>
<th>Soluble Reactive Phosphorus ((\mu g/L))</th>
<th>Total Phosphorus ((\mu g/L))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Avg</td>
<td>Max</td>
<td>Min</td>
<td>Avg</td>
</tr>
<tr>
<td>Fall</td>
<td>0.03</td>
<td>0.04</td>
<td>0.05</td>
<td>0.62</td>
<td>0.65</td>
</tr>
<tr>
<td>Spring</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.50</td>
<td>0.57</td>
</tr>
<tr>
<td>Summer</td>
<td>0.08</td>
<td>0.08</td>
<td>0.08</td>
<td>0.50</td>
<td>0.57</td>
</tr>
<tr>
<td>Winter</td>
<td>0.08</td>
<td>0.08</td>
<td>0.08</td>
<td>0.50</td>
<td>0.57</td>
</tr>
</tbody>
</table>

Estimates of phosphorus from the landscape can help to understand the phosphorus sources to Kusel Lake. Land use in the surface watershed was evaluated and used to populate the Wisconsin Lakes Modeling Suite (WILMS) model. In general, each type of land use contributes different amounts of phosphorus in runoff and through groundwater. The types of land management practices that are used and their distances from the lake also affect the contributions to the lake from a parcel of land. Based on modeling results, developed land and forests had the greatest percentages of phosphorus contributions from the watershed to Kusel Lake (Figure 8). The phosphorus contributions by land use category, called phosphorus export coefficients, are shown in Table 4. The phosphorus export coefficients have been obtained from studies throughout Wisconsin (Panuska and Lillie, 1995).
Figure 8. Estimated phosphorus loads from land uses in the Kusel Lake watershed.

Table 4. Modeling data used to estimate phosphorus inputs from land uses in the Kusel Lake watershed (low and most likely coefficients used to calculate range in pounds).

<table>
<thead>
<tr>
<th>Kusel Lake Land Use</th>
<th>Phosphorus Export Coefficient (lbs/acre-yr)</th>
<th>Land Use Area Within the Watershed</th>
<th>Estimated Phosphorus Load</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Acres</td>
<td>Percent</td>
</tr>
<tr>
<td>Water</td>
<td>0.1</td>
<td>152</td>
<td>13</td>
</tr>
<tr>
<td>Developed</td>
<td>0.13</td>
<td>355</td>
<td>30</td>
</tr>
<tr>
<td>Barren/Herbaceous/Wetland</td>
<td>0.09</td>
<td>82</td>
<td>7</td>
</tr>
<tr>
<td>Forest</td>
<td>0.04</td>
<td>581</td>
<td>49</td>
</tr>
<tr>
<td>Cultivated Agriculture</td>
<td>0.45</td>
<td>9</td>
<td>1</td>
</tr>
</tbody>
</table>

*Values are not exact due to rounding and conversion.
AQUATIC PLANTS

Aquatic plants are the forested landscape within a lake. They provide food and habitat for a wide range of species including fish, waterfowl, turtles, amphibians, as well as invertebrates and other aquatic animals. They improve water quality by releasing oxygen into the water and utilizing nutrients that would otherwise be used by algae. A healthy lake typically has a variety of aquatic plant species which creates diversity that makes the aquatic plant community more resilient and can help to prevent the establishment of non-native aquatic species.

In 2011, the Wisconsin Department of Natural Resources conducted an aquatic plant survey of Kusel Lake. During the survey, 53% (125 of 236) of sites visited had vegetative growth. Of the sampled sites, the average depth was 9.2 feet and the maximum depth was 20 feet.

The diversity of an aquatic plant community is defined by the type and number of species present throughout the lake. Twenty-seven species of aquatic plants were found in Kusel Lake (Table 5). When compared with other lakes in Waushara County, Kusel Lake had the second highest number of species. The greatest diversity was located in the northern and northwestern shallows of the lake (Figure 9).

The dominant plant species in Kusel Lake during the survey was muskgrass (Chara spp.), followed by variable pondweed (Potamogeton gramineus) and water celery (Valisneria americana). Muskgrass is a favorite food source for a wide variety of waterfowl. Muskgrass beds offer cover and food for fish, especially young trout, largemouth bass, and smallmouth bass. The fruits and tubers of variable pondweed provide food for geese and ducks, and the entire plant may be eaten by a variety of wildlife such as deer, muskrat, beaver, and moose. Water celery is a favorite food for waterfowl grazing (Borman et al., 2001).

The Floristic Quality Index (FQI) evaluates the closeness of a plant community to undisturbed conditions. Each plant is assigned a coefficient of conservatism (C-value) that reflects its sensitivity to disturbance. These numbers are used to calculate the FQI. C-values range from 0 to 10. The higher the number, the more intolerant the plant is of disturbance. A C-value of zero is assigned to exotic and most nonvascular species; therefore, these species are not included in the calculation. The FQI for Kusel Lake was 29.2. This value was slightly above average for lakes in the Waushara County Lakes Study.

Of the aquatic plant species within Kusel Lake, three had a C-value equal to or greater than 8 (Table 5). No species of special concern in Wisconsin were found in Kusel Lake.

The Simpson Diversity Index (SDI) quantifies biodiversity of the aquatic plant community based on a formula that uses the number of species surveyed and the number of individuals per site. The SDI uses a decimal scale from zero to one. Values closer to one represent higher amounts of biodiversity. Kusel Lake had an SDI value of 0.83, which represents average biodiversity when compared to all the other lakes in the Waushara County Lakes Study.

During the 2011 aquatic plant survey of Kusel Lake, the aquatic invasive Eurasian water-milfoil (EWM) was found at five sampling sites. It is critical to take action against invasive plants early in their infestation. A reconnaissance survey was conducted for aquatic invasive species in 2013 by staff from Golden Sands Resource Conservation & Development Council, Inc. Fragments of uprooted EWM were found, but rooted plants were not observed during the survey. EWM can grow in dense beds that can damage boat motors, make areas less navigable, stunt or alter the fishery, create problems with dissolved oxygen, and affect activities like fishing and swimming. This plant can produce a viable seed; however,
its primary mode of reproduction and spread is fragmentation. A one-inch fragment is enough to start a new plant, making EWM very successful at reproducing.

Minimizing disturbance to the native plant community helps to reduce the ability of invasive species to become established in a lake. Diligence in inspecting watercraft before entering the lake and before leaving the boat landing is necessary to prevent the spread of undesirable exotics.

Overall, the aquatic plant community in Kusel Lake can be characterized as having average species diversity. The identification of Eurasian water-milfoil within the lake is cause for concern and the densities and population within the lake should continue to be monitored. When considering future lake management strategies, protection against the introduction of additional invasive species should be combined with efforts to preserve the habitat, food source, and water quality benefits of the native plant community.

Table 5. List of aquatic plant species identified in the 2011 aquatic plant survey of Kusel Lake.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Coefficient of Conservatism Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Emergent Species</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>needle spikerush</td>
<td><em>Eleocharis acicularis</em></td>
<td>5</td>
</tr>
<tr>
<td>creeping spikerush</td>
<td><em>Eleocharis palustris</em></td>
<td>6</td>
</tr>
<tr>
<td>hardstem bulrush</td>
<td><em>Schoenoplectus acutus</em></td>
<td>6</td>
</tr>
<tr>
<td>three-square bulrush</td>
<td><em>Schoenoplectus pungens</em></td>
<td>5</td>
</tr>
<tr>
<td>water bulrush</td>
<td><em>Schoenoplectus subterminalis</em></td>
<td>5</td>
</tr>
<tr>
<td><strong>Floating Leaf Species</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>white water lily</td>
<td><em>Nymphaea odorata</em></td>
<td>6</td>
</tr>
<tr>
<td><strong>Submergent Species</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>coontail</td>
<td><em>Ceratophyllum demersum</em></td>
<td>3</td>
</tr>
<tr>
<td>muskgrass</td>
<td><em>Chara spp.</em></td>
<td>7</td>
</tr>
<tr>
<td>common waterweed</td>
<td><em>Elodea canadensis</em></td>
<td>3</td>
</tr>
<tr>
<td>water star-grass</td>
<td><em>Heteranthera dubia</em></td>
<td>6</td>
</tr>
<tr>
<td>Eurasian water-milfoil*</td>
<td><em>Myriophyllum spicatum</em></td>
<td>0</td>
</tr>
<tr>
<td>slender naiad</td>
<td><em>Najas flexilis</em></td>
<td>6</td>
</tr>
<tr>
<td>southern naiad</td>
<td><em>Najas guadalupensis</em></td>
<td>8</td>
</tr>
<tr>
<td>nitella</td>
<td><em>Nitella spp.</em></td>
<td>7</td>
</tr>
<tr>
<td>large-leaf pondweed</td>
<td><em>Potamogeton amplifolius</em></td>
<td>7</td>
</tr>
<tr>
<td>Fries’ pondweed</td>
<td><em>Potamogeton friessii</em></td>
<td>8</td>
</tr>
<tr>
<td>variable pondweed</td>
<td><em>Potamogeton gramineus</em></td>
<td>7</td>
</tr>
<tr>
<td>Illinois pondweed</td>
<td><em>Potamogeton illinoensis</em></td>
<td>6</td>
</tr>
<tr>
<td>floating-leaf pondweed</td>
<td><em>Potamogeton natans</em></td>
<td>5</td>
</tr>
<tr>
<td>stiff pondweed</td>
<td><em>Potamogeton strictifolius</em></td>
<td>8</td>
</tr>
<tr>
<td>flat-stem pondweed</td>
<td><em>Potamogeton zosteriformis</em></td>
<td>6</td>
</tr>
<tr>
<td>sago pondweed</td>
<td><em>Stuckenia pectinata</em></td>
<td>3</td>
</tr>
<tr>
<td>common bladderwort</td>
<td><em>Utricularia vulgaris</em></td>
<td>7</td>
</tr>
<tr>
<td>water celery</td>
<td><em>Valisneria americana</em></td>
<td>6</td>
</tr>
</tbody>
</table>

*=non-native species in Wisconsin.
Figure 9. Number of aquatic plant species observed at each sample site in Kusel Lake, 2011.
Shoreland vegetation is critical to a healthy lake’s ecosystem. It provides habitat for many aquatic and terrestrial animals including birds, frogs, turtles, and many small and large mammals. It also helps to improve the quality of the runoff that is flowing across the landscape towards the lake. Healthy shoreland vegetation includes a mix of tall grasses/flowers, shrubs and trees which extend at least 35 feet landward from the water’s edge.

To better understand the health of the Waushara County lakes, shorelands were evaluated by professionals from the Center for Land Use Education and Waushara County as a part of the Waushara County Lakes Study. The survey inventoried the type and extent of shoreland vegetation. Areas with erosion, rip-rap, barren ground, sea walls, structures and docks were also inventoried.

A scoring system was developed for the collected data to provide a more holistic assessment. Healthy areas need strategies to keep them healthy, and areas with potential problem areas and where management and conservation may be warranted need different strategies for improvement. The scoring system is based on the presence/absence and abundance of shoreline features, as well as their proximity to the water’s edge. Values were tallied for each shoreline category and then summed to produce an overall score. Higher scores denote a healthier shoreline with good land management practices. These are areas where protection and/or conservation should be targeted. On the other hand, lower scores signify an ecologically unhealthy shoreline. These are areas where management and/or mitigation practices may be desirable for improving water quality.

The summary of scores for shorelands around Kusel Lake is displayed in Figure 10. The shorelands were color-coded to show their overall health based on natural and physical characteristics. Blue shorelands identify healthy shorelands with sufficient vegetation and few human disturbances. Red shorelands indicate locations where changes in management or mitigation may be warranted. Large stretches of Kusel Lake’s shorelands were in good shape, especially along the southern shore. However, some portions along the northern and northeastern shore had challenges that may still need to be addressed. Some of these areas ranked as poor. For a more complete understanding of the ranking, an interactive map showing results of the shoreland surveys can be found on Waushara County’s website at http://gis.co.waushara.wi.us/ShorelineViewer/.
Figure 10. Overall shoreland health around Kusel Lake, 2011.
KUSEL LAKE CONCLUSIONS & RECOMMENDATIONS

In general, Kusel Lake had good water quality; however, a few water quality measurements such as sodium, potassium, and atrazine indicated that land use management practices in the watershed are influencing the water quality in Kusel Lake. Although sources of phosphorus from developed land exist in the Kusel Lake watershed, the hard water (from calcium in the groundwater) in Kusel Lake has helped to buffer the additional nutrients. This is evidenced by lower measures of algae and average density of aquatic plants.

- The hard water has the ability to buffer the effects of phosphorus, however, this ability has limits so measures should be taken to reduce near shore and watershed-wide impacts to the lake.
- Atrazine was present in Kusel Lake. This chemical, commonly applied to cropland, is likely traveling in the groundwater that flows into the lake.
  - Low concentrations of atrazine have been shown to impact frogs and some fish species.
  - Private well owners should consider testing their well water for atrazine as there are health concerns associated with atrazine.
- Over-application of chemicals and nutrients should be avoided. Landowners in the watershed should work to reduce their impacts through the implementation of water quality-based best management practices on the landscape.
- Routine monitoring should be done to evaluate changes in water quality in Kusel Lake.
- The Waushara County Land Conservation Department and Natural Resources Conservation Service (NRCS) have professional staff available to assist landowners interested in learning how to improve water quality through changes in land management practices.

Large stretches of Kusel Lake’s shorelands were in good shape, especially along the southern shore. However, some portions along the northern and northeastern shore had challenges that may still need to be addressed. Some of these areas ranked as poor.

- Strategies should be developed to ensure that healthy shorelands remain intact and efforts should be made to improve shorelands that have disturbance. Depending upon the source of disturbance, erosion should be controlled, vegetation should be restored, and/or excess runoff should be minimized.
- Dissemination of relevant information to property owners is the recommended first step towards maintaining healthy shorelands.
- The Waushara County Land Conservation Department has professional staff available to assist shoreland property owners interested in learning how they can improve water quality through changes in land management practices.

The aquatic plant community in Kusel Lake appeared to be quite healthy based on the 2011 survey by professionals from the Wisconsin Department of Natural Resources; however, Eurasian water-milfoil (EWM) was identified at five sites within the lake. The quality of aquatic plants in Kusel Lake was slightly above average compared with the other lakes in the Waushara County Lakes Study. Three high quality plants were identified in Kusel Lake: Fries’ pondweed, stiff pondweed, and southern naiad.

- Minimizing disturbance to aquatic plants can greatly benefit Kusel Lake. Aquatic plants help to reduce the amount of sediment stirred up during windy high boating periods – re-suspended sediments can result in algal blooms and reduce the quality of fish spawning beds. Aquatic plants
also act as baffles, helping to break up the energy of waves and reduce shoreland erosion. Healthy native aquatic plant beds also make it difficult for non-native, potentially invasive aquatic plant species to become established.

- A follow-up survey for aquatic invasive species conducted in 2013 by staff from Golden Sands Resource Conservation & Development Council, Inc. also confirmed the presence of Eurasian water-milfoil (EWM). Fragments of uprooted EWM were located, but rooted plants were not found. EWM can grow in dense beds that can damage boat motors, make areas less navigable, stunt or alter the fishery, create problems with dissolved oxygen, and affect activities like fishing and swimming. This plant produces a viable seed; however, its primary mode of reproduction and spread is fragmentation. A one-inch fragment is enough to start a new plant, making EWM very successful at reproducing.

- Efforts should be made to control or eliminate EWM. Using proper techniques to manually remove EWM plants is the best approach to controlling a small infestation. Anyone interested in helping with this effort should be trained in proper removal techniques to ensure that EWM plants are not fragmented during the removal process.

- The presence of EWM in the lake is a clear indication that aquatic invasive species are able to make their way into Kusel Lake. Lake residents and lake users should be made aware of boat and trailer hygiene techniques to prevent the introduction of new species.

- Early identification of new infestations is helpful in their control and possible eradication. Efforts should be made to learn how to identify non-native aquatic plant species and routinely look for them.
REFERENCES


GLOSSARY OF TERMS

**Algae:** One-celled (phytoplankton) or multicellular plants either suspended in water (plankton) or attached to rocks and other substrates (periphyton). Their abundance, as measured by the amount of chlorophyll a (green pigment) in an open water sample, is commonly used to classify the trophic status of a lake. Numerous species occur. Algae are an essential part of the lake ecosystem and provide the food base for most lake organisms, including fish. Phytoplankton populations vary widely from day to day, as life cycles are short.

**Atrazine:** A commonly used herbicide. Transports to lakes and rivers by groundwater or runoff. Has been shown to have toxic effects on amphibians.

**Blue-Green Algae:** Algae that are often associated with problem blooms in lakes. Some produce chemicals toxic to other organisms, including humans. They often form floating scum as they die. Many can fix nitrogen (N2) from the air to provide their own nutrient.

**Calcium (Ca++):** The most abundant cation found in Wisconsin lakes. Its abundance is related to the presence of calcium-bearing minerals in the lake watershed. Reported as milligrams per liter (mg/l) as calcium carbonate (CaCO3), or milligrams per liter as calcium ion (Ca++).

**Chloride (Cl-):** The chloride ion (Cl-) in lake water is commonly considered an indicator of human activity. Agricultural chemicals, human and animal wastes, and road salt are the major sources of chloride in lake water.

**Chlorophyll a:** Green pigment present in all plant life and necessary for photosynthesis. The amount present in lake water depends on the amount of algae, and is therefore used as a common indicator of algae and water quality.

**Clarity:** See “Secchi disk.”

**Color:** Color affects light penetration and therefore the depth at which plants can grow. A yellow-brown natural color is associated with lakes or rivers receiving wetland drainage. Measured in color units that relate to a standard. The average color value for Wisconsin lakes is 39 units, with the color of state lakes ranging from zero to 320 units.

**Concentration units:** Express the amount of a chemical dissolved in water. The most common ways chemical data is expressed is in milligrams per liter (mg/l) and micrograms per liter (ug/l). One milligram per liter is equal to one part per million (ppm). To convert micrograms per liter (ug/l) to milligrams per liter (mg/l), divide by 1000 (e.g. 30 ug/l = 0.03 mg/l). To convert milligrams per liter (mg/l) to micrograms per liter (ug/l), multiply by 1000 (e.g. 0.5 mg/l = 500 ug/l).

**Cyanobacteria:** See “Blue-Green Algae.”

**Dissolved oxygen:** The amount of oxygen dissolved or carried in the water. Essential for a healthy aquatic ecosystem in Wisconsin lakes.

**Drainage basin:** The total land area that drains runoff towards a lake.

**Drainage lakes:** Lakes fed primarily by streams and with outlets into streams or rivers. They are more subject to surface runoff problems, but generally have shorter residence times than seepage lakes.

**Emergent:** A plant rooted in shallow water and having most of its vegetative growth above water.

**Eutrophication:** The process by which lakes and streams are enriched by nutrients, and the resulting increase in plant and algae. The extent to which this process has occurred is reflected in a lake's trophic classification: oligotrophic (nutrient poor), mesotrophic (moderately productive), and eutrophic (very productive and fertile).

**Groundwater drainage lake:** Often referred to as a spring-fed lake, it has large amounts of groundwater as its source and a surface outlet. Areas of high groundwater inflow may be visible as springs or sand boils. Groundwater drainage lakes often have intermediate retention times with water quality dependent on groundwater quality.
**Hardness:** The quantity of multivalent cations (cations with more than one +), primarily calcium (Ca++) and magnesium (Mg++) in the water expressed as milligrams per liter of CaCO3. Amount of hardness relates to the presence of soluble minerals, especially limestone or dolomite, in the lake watershed.

**Intermittent:** Coming and going at intervals, not continuous.

**Macrophytes:** See “Rooted aquatic plants.”

**Marl:** White to gray accumulation on lake bottoms caused by precipitation of calcium carbonate (CaCO3) in hard water lakes. Marl may contain many snail and clam shells. While it gradually fills in lakes, marl also precipitates phosphorus, resulting in low algae populations and good water clarity. In the past, marl was recovered and used to lime agricultural fields.

**Mesotrophic:** A lake with an intermediate level of productivity. Commonly clear water lakes and ponds with beds of submerged aquatic plants and mediums levels of nutrients. See also “eutrophication”.

**Nitrate (NO3-):** An inorganic form of nitrogen important for plant growth. Nitrate often contaminates groundwater when water originates from manure, fertilized fields, lawns or septic systems. In drinking water, high levels (over 10 mg/L) are dangerous to infants and expectant mothers. A concentration of nitrate-nitrogen (NO3-N) plus ammonium-nitrogen (N\textsubscript{H}\textsubscript{4}-N) of 0.3 mg/L in spring will support summer algae blooms if enough phosphorus is present.

**Oligotrophic:** Lakes with low productivity, the result of low nutrients. Often these lakes have very clear waters with lots of oxygen and little vegetative growth. See also “eutrophication”.

**Overturn:** Fall cooling and spring warming of surface water increases density, and gradually makes lake temperatures and density uniform from top to bottom. This allows wind and wave action to mix the entire lake. Mixing allows bottom waters to contact the atmosphere, raising the water's oxygen content. Common in many lakes in Wisconsin.

**Phosphorus:** Key nutrient influencing plant growth in more than 80% of Wisconsin lakes. Soluble reactive phosphorus is the amount of phosphorus in solution that is available to plants. Total phosphorus includes the amount of phosphorus in solution (reactive) and in particulate form.

**Rooted aquatic plants (macrophytes):** Refers to higher (multi-celled) plants growing in or near water. Macrophytes are beneficial to lakes because they produce oxygen and provide substrate for fish habitat and aquatic insects and provide food for many aquatic and terrestrial animals. Overabundance of such plants, especially problem species, is related to shallow water depth and high nutrient levels.

**Secchi disk:** An 8-inch diameter plate with alternating quadrants painted black and white that is used to measure water clarity (light penetration).

**Sedimentation:** Materials that are deposited after settling out of the water.

**Stratification:** The layering of water due to differences in density. As water warms during the summer, it remains near the surface while colder water remains near the bottom. Wind mixing determines the thickness of the warm surface water layer (epilimnion), which usually extends to a depth of about 20 feet. The narrow transition zone between the epilimnion and cold bottom water (hypolimnion) is called the metalimnion. Common in many deeper lakes in Wisconsin.

**Watershed:** See “Drainage basin.”