Healthy lakes have value to a community for a number of reasons. They provide a place to relax and recreate, and can stimulate tourism. Like other infrastructure, lakes require attention and management to remain healthy in developed watersheds.

The purpose of this study is to learn about the current conditions of water quality, the fishery, habitat, and aquatic ecosystems to help people make good choices to prevent damaging what’s good and improve the problems that exist.
To protect the lake we must protect the “watershed,” the land that drains or sheds its water into the lake.
Mud Lake
Northeast of Hatley,
East of Co Rd. Y in the
Township of Norrie
**Surface Area:** 70 Acres
**Maximum Depth:** 17 feet

**Water Flow**
- Mud Lake is a seepage lake the received most of its water from groundwater inflow.
- Surface water runoff and direct precipitation also contribute water to a lesser extent.
- Water exits Mud Lake as groundwater.
**Surface Watershed**: The land where water runs off the surface of the land and drains toward the lake.

**Mud Lake Watershed: Land Cover**

- **Land use** and land management practices occurring in a watershed affect the water quality in a lake.
- Land use and land management also play a large role in how water moves across the landscape and how much water soaks into the ground (for long term storage) or quickly runs off the land.
- The surface watershed of Mud Lake is 354 acres.
- The primary land uses in the watershed are forests and agriculture.
- Forests and wetlands border the entire lake. In general, the lands closest to the lake have the greatest immediate impact on water quality.

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>88</td>
</tr>
<tr>
<td>Developed</td>
<td>6</td>
</tr>
<tr>
<td>Forested</td>
<td>133</td>
</tr>
<tr>
<td>Roads</td>
<td>5</td>
</tr>
<tr>
<td>Water</td>
<td>70</td>
</tr>
<tr>
<td>Wetland</td>
<td>51</td>
</tr>
</tbody>
</table>

Marathon County Lake Study – Preliminary Results Summer 2012
**Groundwater Watershed:** The land where water soaks into the ground and travels underground to the lake.

- **Groundwater** slowly contributes water to our lakes throughout the year. Hard surfaces on the landscape prevent water from sinking into the ground and becoming groundwater. This results in less water flowing to the lake during the winter and between rains.
- The quality of groundwater reflects what is happening on the land surface. Precipitation falling on forested land produces clean groundwater, whereas precipitation falling on lands that have chemical use can leach contaminants to groundwater. Groundwater contamination in central Wisconsin may include nitrogen, pesticides, herbicides, and other soluble chemicals originating from septic systems, cropping, barnyards, road maintenance, etc. Once in the groundwater, these chemicals slowly move towards a lake or river.
- The groundwater watershed for Mud Lake is 339 acres.
- The primary land uses in the Mud Lake groundwater watershed are agriculture and forests.
- In general, the land adjacent to the lake where groundwater is flowing into the lake has the greatest immediate impact on water quality. Wetlands and forests are nearest the lake in the areas of groundwater inflow.

**Looking at Groundwater Up Close:**

- Groundwater enters Mud Lake from the northeast.
- Water exits the western part of the lake.

### Land Use Table

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>132</td>
</tr>
<tr>
<td>Developed</td>
<td>8</td>
</tr>
<tr>
<td>Forested</td>
<td>126</td>
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<tr>
<td>Roads</td>
<td>4</td>
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<tr>
<td>Water</td>
<td>27</td>
</tr>
<tr>
<td>Wetland</td>
<td>42</td>
</tr>
</tbody>
</table>
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.

The map below shows how far the 0.5 to 3 foot tall vegetation exists landward from the edge of Bass Lake. A greater vegetative buffer provides more habitat and better water quality.
The assessment of a fish community includes a variety of measures. Most people think about the number and type of fish, but a holistic view of the fishery also includes an assessment of habitat. A healthy and balanced fishery requires sufficient habitat. Fish need places to hide, places to spawn, and food to eat.

During this study, a number of techniques will be used to assess the fish community and habitat in each of the Eastern Marathon County lakes.

**Fyke netting** (passive sampling, trap style nets) and seining (active sampling, dragged nets) are the backbone of the fish work on the lakes. They will provide us with a broad swath of fish data that should include most sexes and age/size classes of most species. Fyke netting works best for larger bodied individuals (most game fishes) and seining should capture all but the largest, most illusive individuals of larger species.

**Beach seining** works best over harder substrates in areas of gradually sloping bathymetry. Mini-purse seines hang over the bottom by floats. These are particularly important for use in lakes with soft substrates and/or steep slopes.

**Habitat surveys** consist of information collected in the aquatic plant survey, shoreland survey, mapping of lake bed, woody structure near the shoreline, and lake depths.

Results of the fishery surveys will be presented in the final report.
Aquatic plants are the forest landscape within a lake. They provide food for some creatures including fish, ducks, and turtles; as well as habitat for fish, invertebrates, and other aquatic animals. They create oxygen in the water and utilize nutrients that would otherwise be used by algae. A healthy lake typically has a variety of aquatic plant species creating diversity that can help to prevent the establishment of aquatic invasive species.

All of the lakes in the Eastern Marathon County Lake Study will have aquatic plant surveys. This information will be available in the final report.
Mud Lake – Aquatic Invasive Species

Aquatic Invasive Species are non-native plants or animals that may cause significant harm to a lake’s ecosystem. Typically they are introduced to a lake by hitching a ride on boats, trailers, clothing, and other water recreation equipment. Invasive species can be introduced to a lake accidentally or intentionally.

Once in a lake, aquatic invasive species can be difficult and costly to control or may even be impossible to remove. Prevention and early detection are the best ways to keep aquatic invasive species from establishing in a lake.

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| Lakes With Aquatic Invasive Species in Marathon and Northern Portage County, 2012 |
|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Lake Name                       | Banded Mystery Snail            | Chinese Mystery Snail           | Rusty Crayfish                  | Curly-Leaf Pondweed             | Eurasian Water Milfoil          | Purple Loosestrife               |
| Big Bass Lake                   | ✓                               |                                 |                                 |                                 |                                 |                                 |
| Big Rib River                   |                                 | ✓                               |                                 |                                 |                                 |                                 |
| Eau Claire Flowage              |                                 |                                 | ✓                               |                                 |                                 |                                 |
| Flume Creek                     |                                 |                                 |                                 | ✓                               |                                 |                                 |
| Johnson Creek                   |                                 |                                 |                                 |                                 | ✓                               |                                 |
| Lake Wausau                     |                                 |                                 |                                 |                                 |                                 | ✓                               |
| Little Rib River                |                                 |                                 |                                 |                                 |                                 | ✓                               |
| Little Trappe River             |                                 |                                 |                                 |                                 |                                 | ✓                               |
| Lost Lake                       |                                 |                                 |                                 |                                 | ✓                               |                                 |
| Mayflower Lake                  |                                 | ✓                               |                                 |                                 |                                 | ✓                               |
| Mission Lake                    | ✓                               |                                 |                                 |                                 | ✓                               |                                 |
| Pike Lake                       | ✓                               |                                 |                                 | ✓                               |                                 |                                 |
| Rice Lake                       | ✓                               | ✓                               |                                 | ✓                               |                                 | ✓                               |
| South Branch Embarrass River    |                                 |                                 |                                 |                                 | ✓                               |                                 |
| Spring Brook                    |                                 |                                 |                                 |                                 |                                 | ✓                               |
| Trappe River                    |                                 |                                 |                                 |                                 |                                 | ✓                               |
| Wadley Lake                     | ✓                               | ✓                               | ✓                               | ✓                               | ✓                               | ✓                               |
| Wausau Dam Lake                 |                                 |                                 |                                 |                                 | ✓                               |                                 |
| Wisconsin River                 |                                 |                                 |                                 |                                 | ✓                               |                                 |
|                              |                                 |                                 |                                 |                                 |                                 |                                 |
| Northern Portage County         |                                 |                                 |                                 |                                 |                                 |                                 |
| Tree Lake                       | ✓                               | ✓                               | ✓                               |                                 |                                 |                                 |
| Plover River                    |                                 |                                 |                                 | ✓                               |                                 |                                 |
| Lake Du Bay                     | ✓                               | ✓                               | ✓                               | ✓                               |                                 | ✓                               |

Marathon County-(Bolded lakes are part of Eastern Marathon Co. Lake Study)

Learn to identify invasive species & look for them in your lake!
Lakes go through a natural aging process that results in an increase of aquatic plant growth, fish, and wildlife over time. Within a lake’s watershed, human activity on the land, in a wetland, or in the lake can dramatically accelerate this process. Depending on land management practices, changes in a lake that may have normally taken centuries to occur may take place in decades or even years. The amount of nutrients, algal growth, and water clarity measures help to define the age of a lake. Based on these measures, lakes can be classified for comparison to one another.

**Oligotrophic Lakes**

*Common uses:*

- Swimming
- Skiing
- Boating

*Vegetation of oligotrophic lakes:*

- Very little vegetation

**Mesotrophic Lakes**

*Common uses:*

- Boating
- Fishing

*Vegetation of mesotrophic lakes:*

- Increased vegetation
- Occasional algal blooms

**Eutrophic Lakes**

*Common uses:*

- Fishing
- Wildlife watching

*Vegetation of eutrophic lakes:*

- Lots of aquatic plants
- Frequent algal blooms

*Winter fish kills can occur in shallow lakes due to low oxygen levels.*
**Phosphorus** is a major nutrient that can lead to excessive algae and rooted aquatic plant growth in Marathon County lakes. All Marathon County lakes have either sufficient or excessive nutrients for aquatic plant growth, so all lakes will benefit from limiting the addition of more nutrients. Sources of phosphorus include septic systems, animal waste, storm water runoff, soil erosion, and fertilizers for lawns, gardens, and agriculture.

Total phosphorus levels that were measured when the lake was well mixed (overturn) are displayed in the graph to the left.

During fall 2010/spring 2011 the average total phosphorus level indicated that Mud Lake was transitioning towards a mesotrophic lake.

**Water clarity** is a measure of how deep light can penetrate (secchi depth). Water clarity is affected by water color, turbidity (suspended sediment), and algae. This depth also controls how deep rooted aquatic plants can grow.

The graph to the left shows water clarity data collected from June-October 2011.

During the summer, the poorest secchi depth measured in Mud Lake was 4.5 feet in July and the best secchi depth was 5.75 feet in June. It is typical for water clarity to vary throughout the year.
Stop the Spread of Aquatic Invasive Species!

Wetlands and Shorelands:
- LEARN how to identify invasive plants and animals, and who to contact if found.
- DO NOT PURCHASE prohibited and restricted species! Whenever possible purchase native plants.
- NEVER transplant water garden plants or aquarium plants into lakes, streams, wetlands, or storm water ponds. Properly dispose of unwanted plants and animals!
- REMOVE invasive exotic plants from your landscape and replace them with native plants or non-invasive exotic plants. Scout annually for new invasive plants.
- AVOID using garden plants from other regions whose invasive potential is poorly understood.

Lakes and Rivers:
- LEARN what Wisconsin invasive plants and animals look like and who to contact if seen in a lake or river.
- INSPECT your boat, trailer and equipment when traveling to different water bodies and REMOVE any attached aquatic plants or animals (before launching, after loading, and before transporting on a public highway).
- DRAIN all water from boats, motors, and all equipment after use at a lake.
- NEVER release live fish, bait or pets into a wetland or water body.
- BUY minnows from a Wisconsin bait dealer. Only use leftover minnows at that same water body.
Mud Lake – What can you do?

Algae
Dr. Bob Bell

Aquatic Plants
Jen McNelly

Cultural Survey
Dr. Kristin Floress

Fisheries and Lake Maps
Drs. Ron Crunkilton and Justin Sipiorski
Christine Koeller

Paleolimnology
Dr. Samantha Kaplan and Paul Garrison (WDNR)

Shoreland Assessments and Build Out
Dan McFarlane

Water Quality and Watersheds
Nancy Turyk
Zooplankton
Dr. Chris Hartleb

UWSP Graduate and Undergraduate Students

Project support provided by:
- Wisconsin DNR Lake Protection grants
- UW-Stevens Point and Faculty
- Marathon County
- Marathon County Citizens

For more information about the study:
UW-Stevens Point: Nancy Turyk at 715-346-4155  Email: mclakes@uwsp.edu
Marathon County: Shawn Esser at 715-261-6010
http://www.co.marathon.wi.us/Departments/ConservationPlanningZoning/ConservationDivision/LakePrograms.aspx
Algae are able to perform photosynthesis like plants, and they are the foundation of an aquatic ecosystem because so many organisms depend on them for food. However, like fish and aquatic plants, there are many varieties of algae. Some are single-celled, others are colonies of cells, and some form chains of cells called filaments. They vary in color from almost black to blue-green, green, yellow, and golden-brown. Some lack a firm outer wall while some have walls made of the same material as plants (cellulose), and others have walls composed of glass (yes – the same material as in your window!).

Some algae are nutritious, some are unpalatable, and yet others can produce dangerous toxins. As a rule, animals eat the smaller, more delicate organisms the most. Consumer organisms avoid organisms that are larger, have tougher walls, or are not palatable. These less eaten algae can then overgrow the populations of the more desirable, but more heavily consumed algae.

In northern temperate zone lakes like in Marathon County there are usually three dominant groups of algae – Cyanobacteria (blue-green algae), Chlorophyta (green algae), and Bacillariophyceae (diatoms). The various algal groups and even species within these groups wax and wane during the ice-free season as nutrient availability, temperature, and sunlight change.

If you’ve ever slipped on a slimy, golden-fuzz-covered rock around the edge of your lake then you can curse the diatoms (the ones with the glass covering). These algae are preferred food items and they grow abundantly in many different types of water quality. Some types are indicators of oligotrophic waters while others are associated with eutrophic lakes.

The green algae vary a lot in size, the smaller ones are good food items, the larger ones can become nuisance organisms if temperatures rise and nutrients are abundant. These algae are most common in mesotrophic and eutrophic waters.

Blue-green algae secrete sticky, hard-to-digest materials that make most organisms avoid them or pass them undigested. They have the widest tolerance range for temperatures and nutrient concentrations, and they produce overwintering stages that lead to more cyanobacteria in the lake over time. This combination of lower predation, greater tolerance, and increased survival can lead to blue-green algal blooms that reduce recreational and aesthetic uses. A few varieties of cyanobacteria can produce toxins that are potentially harmful to livestock, pets, and humans. Once well established in a lake, blue-green algae are tough to control and remove. They do not respond well, or for long, to most commercial algicidal chemicals. These algae dominate eutrophic waters.

In oligotrophic lakes (see above lake type definitions), the algae are typically nutritious, small unicells and colonies with delicate coverings, that are easy for small animals to ingest and digest. Oligotrophic lakes are nutrient-limited and growth rates are slow, often with little diversity.
Mesotrophic lakes have a greater diversity of organisms than the other lake types, and while there are many small, tasty, and digestible organisms still present, there are increasing amounts of less desirable algae. Most lakes across the upper Midwest are mesotrophic.

The blue-green algae dominate eutrophic lakes. Their dense growth can shade out aquatic macrophytes and other algae. The excessive nutrients present in eutrophic lakes can lead to shallow areas choked with blooms of sticky, smelly, inedible cyanobacteria. Eutrophic lakes have reduced diversity and a small group of blue-green algae with no natural predators usually dominates.

Cyanobacteria dominated the algal community in Mud Lake during the 2011 sampling season. These cyanobacteria accounted for 43 - 64% of all cells counted across the season. Green algae accounted for 14-39% of all cells counted. The diatom and green algal species present were typical of mesotrophic lakes and the blue-green algae did include bloom-forming species. These bloom-forming species could lead to the production of toxins that are harmful to pets, livestock, and humans. Based on phosphorus, Secchi disk, and algal data, Mud Lake appears to be mesotrophic but is trending towards degradation to eutrophic status.