PROTECTING AND ENHANCING THE WATER RESOURCES OF NORTHERN MICHIGAN

GREENBELT WORKSHOP

SATURDAY, JULY 13TH, 2013

MULLETT LAKE

PRESENTED BY:

TIP OF THE MITT WATERSHED COUNCIL
&
MULLETT LAKE AREA PRESERVATION SOCIETY

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FUNDING PARTNERS

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TIP OF THE MITT WATERSHED COUNCIL

FOUNDED IN 1979, THE WATERSHED COUNCIL IS THE LEAD ORGANIZATION FOR WATER RESOURCES PROTECTION IN ANTRIM, CHARLEVOIX, CHEBOYGAN, AND EMMET COUNTIES.

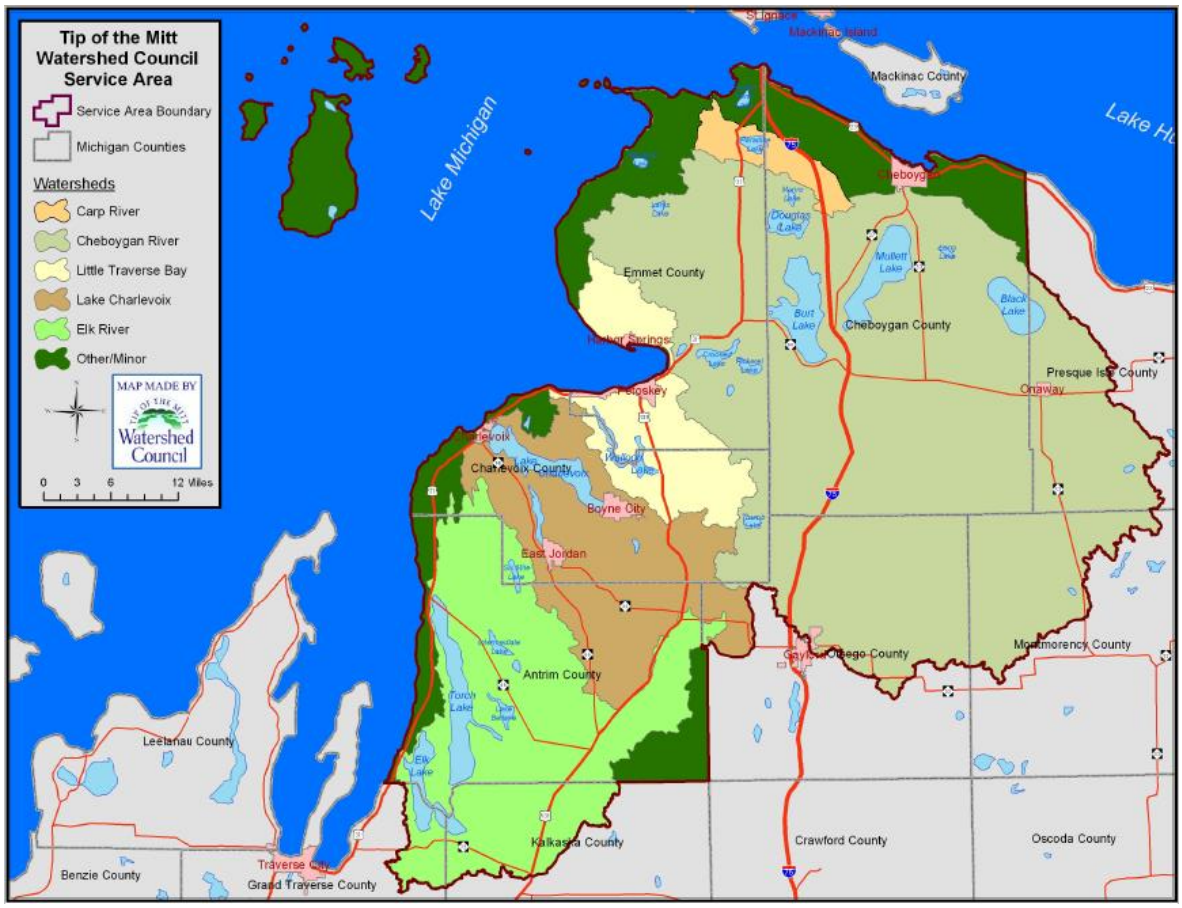
OUR MISSION

The Tip of the Mitt Watershed Council speaks for Northern Michigan's waters. We are dedicated to protecting our lakes, streams, wetlands, and groundwater through respected advocacy, innovative education, technically sound water quality monitoring, thorough research and restoration actions. We achieve our mission by empowering others and we believe in the capacity to make a positive difference. We work locally, regionally and throughout the Great Lakes Basin to achieve our goals.

OUR SERVICE AREA

Water resources in our service area include:

- More than 2,500 miles of rivers and streams
- multiple blue-ribbon trout streams
- 14 lakes larger than 1,000 acres (among the largest in the state)
- 339,000 acres of wetlands (according to 2000 landcover statistics)



MAP OF WATERSHED AREA

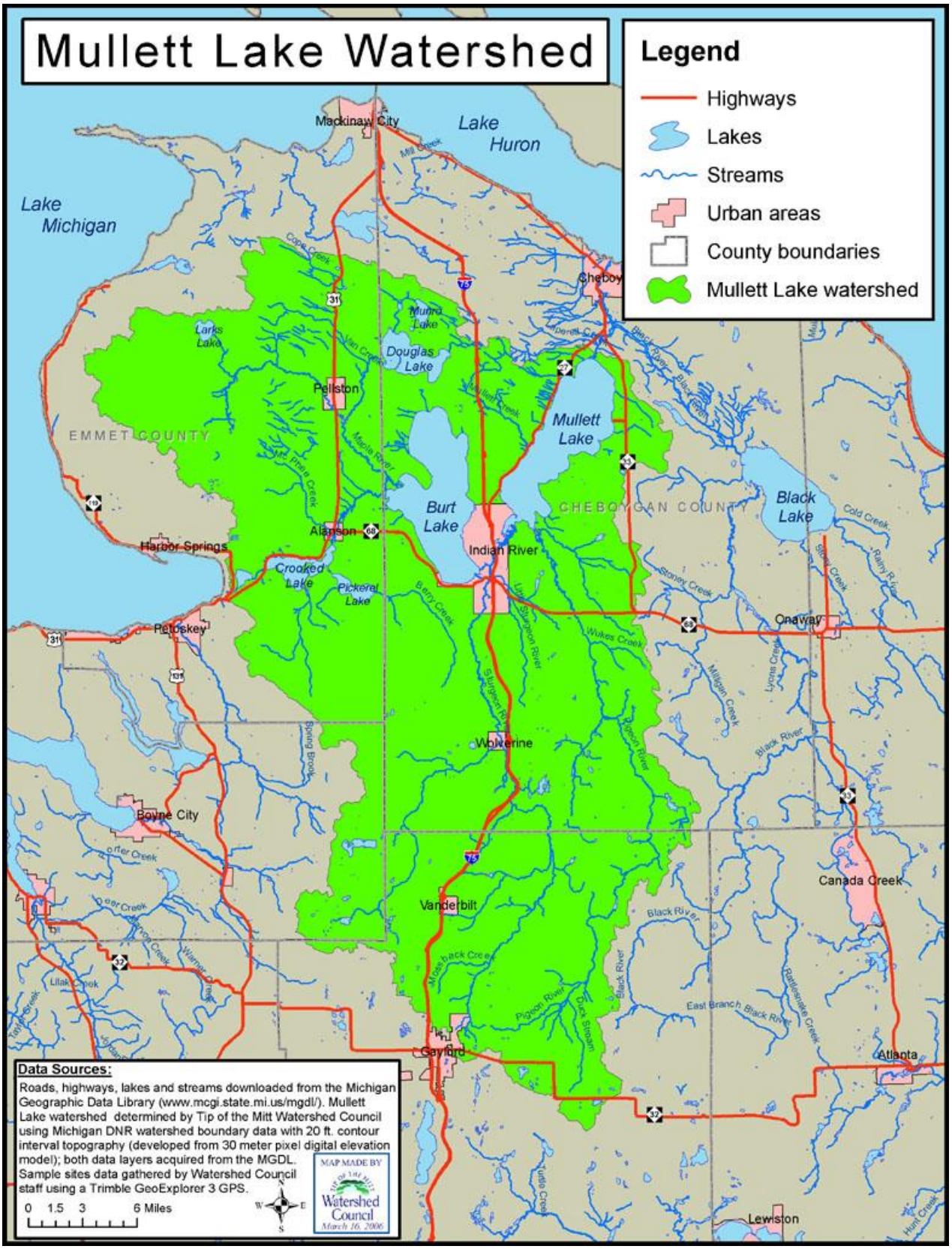


FIGURE 1: MULLETT LAKE WATERSHED

MULLETT LAKE SHORE SURVEY SUMMARY RESULTS

During the summer of 2008, the Tip of the Mitt Watershed Council conducted a comprehensive shoreline survey on Mullett Lake to document conditions that have the potential to impact water quality. Funding for this project was provided by the Mullet Lake Area Preservation Society (MAPS) and the National Fish and Wildlife Foundation. Shoreline property is the first and most important line of defense in protecting the lake ecosystem. Of all the land in the Mullett Lake Watershed, shoreline properties have the greatest potential to impact water quality. Therefore, Watershed Council staff traveled all 30 miles of Mullett Lake's shoreline by kayak to survey the following parameters that pose a threat to the lake's health:

- Nutrient Pollution. Nutrients are necessary to sustain a healthy aquatic ecosystem, but excess nutrients as well as other contaminants associated with nutrient pollution, can degrade the lake's water quality. Contaminants my include bacteria and pharmaceuticals from septic systems, automotive fluids and metals in stormwater runoff, and chemicals in lawn-care products. *Cladophora* algae occurring on the shoreline was noted because it is a reliable biological indicator of nutrient pollution.

- Greenbelt Health. Greenbelts are the vegetated areas along the shoreline. A greenbelt consisting of a variety of native woody and herbaceous plant species provides habitat for near-shore aquatic life, as well as birds, turtles, and amphibians. Deep-rooted plants help to control erosion while stabilizing the shoreline and providing protection against wave action and ice. The canopy of the greenbelt provides shade to near-shore areas, which is particularly important for lakes with cold-water fisheries. In addition, greenbelts provide a mechanism to reduce overland surface runoff and absorb pollutants carried by the flow during rainstorms and snowmelt. Thus, greenbelts provide many benefits to the lake ecosystem, but these benefits are lost when shoreline vegetation is removed.

- Shoreline Alterations. Shoreline development often includes the installation of seawalls, rip-rap, or other structures to stabilize the shoreline, but these structures have negative impacts on the lake ecosystem. These impacts stem primarily from the loss of natural vegetation and the many benefits associated with this vegetation, such as the loss of habitat and food sources for aquatic and terrestrial life in near-shore areas

- Shoreline Erosion. Erosion commonly occurs in near-shore areas followed by greenbelt removal, but is also caused by other factors such as recreational access. Eroding shorelines results in sediments washing into and impacting the lake ecosystem. Sediments clog fish and insect gills, smother spawning beds and habitat in near-shore areas, and increase water temperatures. Furthermore, nutrients adhere to sediment particles and lead to nutrient pollution.

The 2008 survey examined these stressors at all 1,292 properties on Mullett Lake and found that shoreline property management is undoubtedly impacting the lake ecosystem and water quality. Results of the survey are as follows:

- nearly 60% of shoreline properties show some sign of nutrient pollution
- 64% had greenbelts in poor condition
- 58% had altered shorelines
- erosion was present at 12%

Relative to other lakes in Northern Michigan, Mullett Lake had a high percentage of shoreline properties with signs of nutrient pollution, poor greenbelts, and altered shorelines. Properties with strong signs of nutrient pollution and those with poor greenbelts were scattered throughout the lake, but also concentrated in certain areas. Please see Table 1 for a comparison of shore survey statistics from other Northern Michigan Lake.

On a positive note, there are many properties that have healthy greenbelts. Approximately 10% of properties had greenbelts in excellent condition during the 2008 survey and another 18% of properties were rated as good. Considering recent reports of problems in the Mullett Lake fishery, having nearly 30% of greenbelts in good condition is great news because shoreline vegetation is critical for maintaining a healthy, diverse lake ecosystem and a strong fishery.

In spite of problems in near-shore areas exposed during this survey, data collected by Watershed Council staff and MAPS volunteers show that the water quality of Mullett Lake remains high. Great progress has been achieved during the last decade through the joint efforts of MAPS and Tip of the Mitt Watershed Council to document and address problems in Mullett Lake and its watershed. However, the Mullett Lake ecosystem will benefit most if those living around the lake make improvements in managing their properties. Each and every shoreline property owner can help protect and improve the lake ecosystem by doing simple things like properly maintaining septic systems, eliminating or reducing fertilizer use, properly managing stormwater, improving greenbelts, controlling erosion, and encouraging shorelines to revert to a more natural state.

TABLE 1: A COMPARISON OF SHORE SURVEY STATISTICS FROM OTHER NORTHERN MICHIGAN LAKES

Lake Name	Year	*Cladophora**	Heavy Algae	Erosion	Greenbelts*	Altered
Black Lake	2005	20%	21%	ND	ND	ND
Burt Lake	2009	47%	29%	4%	36%	46%
Charlevoix	2012	22%	19%	14%	34%	79%
Crooked	2012	29%	26%	14%	51%	65%
Huffman Lake	2006	60%	22%	ND	ND	76%
Larks Lake	2006	4%	0%	ND	12%	29%
Mullett Lake	2008	59%	50%	7%	64%	58%
Pickerel Lake	2012	27%	33%	15%	52%	645
Six Mile Lake	2008	14%	5%	5%	34%	30%
Thumb Lake	2007	4%	0%	ND	ND	39%
Walloon Lake	2010	46%	24%	7%	36%	545
AVERAGE		**29%**	**21%**	**9%**	**39%**	**57%**

**Percentages are in relation to number of parcels on the lake shore, except for "heavy algae", which is the percent of parcels with Cladophora growth. Greenbelt percentage reflects the percentage of parcels with greenbelts in poor condition. ND=no data.*

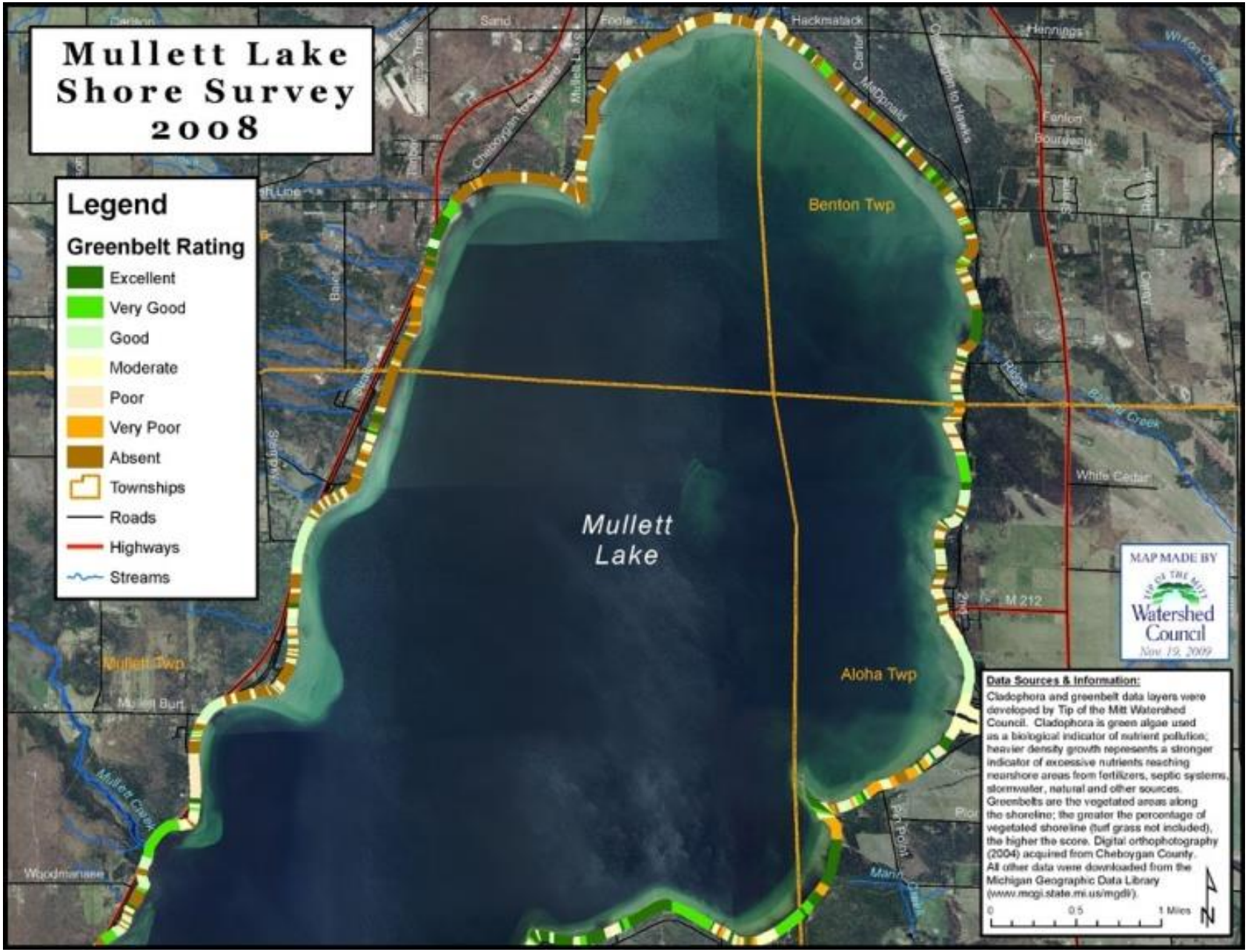


FIGURE 2A: GREENBELT SHORELINE SURVEY OF NORTH MULLETT LAKE

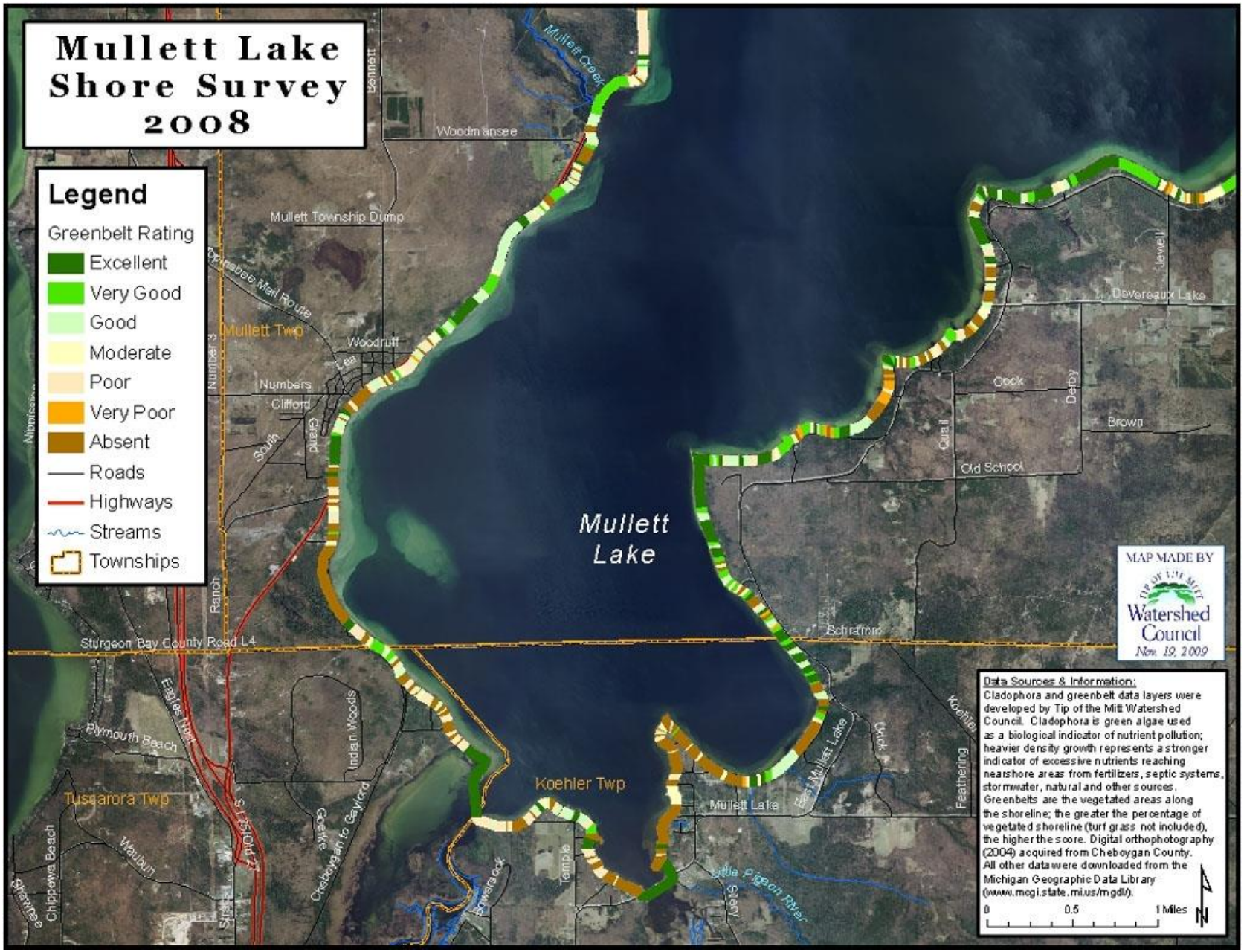


FIGURE 2B: GREENBELT SHORELINE SURVEY OF SOUTH MULLETT LAKE

ECONOMICAL

Northern Michigan is a wonderful place to reside for any number of months during the year and it has much to offer local communities. Valid concerns about local community's economies and property values have ensued after recent financial instability. A great example of how restoration projects and good environmental health can positively impact surrounding communities is the remediation and restoration of Muskegon Lake. The Great Lakes Commission newsletter provides details of the Muskegon Lake Habitat Restoration Project that received $10 million in 2009 to fund a restoration project on Muskegon Lake. The newsletter stats that, "A detailed study by Grand Valley State University, conducted as part of the Muskegon Lake Habitat Restoration Project, quantified economic benefits that will result from the project. Using well established methods and rigorous reviews by independent experts, the study found that the project will generate: a $12 million increase in property values, up to $600,000 in new tax revenue annually, and over $1 million in new recreational spending annually in Muskegon." Please visit the following website http://www.glc.org/announce/11/pdf/Muskegon-Lake-ARRA-econ-fact-sheet_Final_May2011.pdf for the entire article.

Water quality is a good indicator for ecosystem health and has also been found to be a factor in property values. A case study completed by the University of Maine's Holly Michael, Kevin Boyle and Roy Bouchard was completed to study the effects of water quality on property prices for selected lakes in Maine. This was done using hedonic pricing models, which have been used to make price estimations for ecosystem services, like water quality or risks, like earthquakes. The conclusion to this study was that by increasing the lake water clarity by 1 meter an increase in average property value ranged from $11 to $200 per foot of shoreline frontage. The full report of this case study, including the procedure and how the model was created, can be found at http://www.umaine.edu/mafes/elec_pubs/miscrepts/mr398.pdf

Shoreline buffers can help protect building structures close to shore by slowing down or blocking wind and water coming off of the adjacent lake. Ice ridges created by the "push" from a frozen lake surface can also cause property damage. Plant roots can help to stabilize the shoreline by holding the sediment together against the powerful forces of ice expansion.

ECOLOGICAL

Shorelines are complex habitats that support a large variety of species by providing space, shelter, and food. Many mammals, birds, reptiles, amphibians, fish, and insects make their homes on shorelines, whether using them as travel corridors along the lake, or to move between aquatic and terrestrial habitats during their life cycles. Fragmentation of crucial habitat causes a decline in the above populations.

Greenbelts primarily can consist of three different zones and each supports different species of plants. There is an upland zone, wetland zone and an aquatic zone. Please see Figure 3 for a depiction of each of the zones and how they combine to create a diverse habitat. The upland zone is the zone located the farthest inland and it contains plants that enjoy dry soils. Moving closer to the water is the wetland zone, plants living here can withstand consistently wet soils, standing water, and even dry periods. Although most trees prefer relatively dry soils some have adapted to semi-wet environments. Shoreline trees are important for providing shade, effectively cooling the water and shoreline property. Increasing water temperatures correlates to lower dissolved oxygen values, which creates an unfriendly environment for aquatic organisms. Trees also provide habitat for terrestrial insects that often fall into the water and serve as food for fish *(please see the Appendix for a study on the importance of shoreline trees titled, "A Second Life for Trees in Lakes")*. The soil zone within the lake is the aquatic zone. This area contains four sub-groups of plants that have adapted to increasingly deeper waters.

- **Emergent aquatic plants**, which are rooted in the benthic zone, but their leaves and stems reach above the water level. Some examples of emergent aquatic plant are sedges, and bulrushes.
- **Floating-leaf aquatic plants** have, of course, leaves that float on the water surface, but a majority of the plant grows below the surface. This group includes water lilies and pickerelweed.
- **Submergent aquatic plants** are also rooted on the bottom of the lake, but exist entirely below the water's surface. These plants do send flowers to the surface for pollination, so that they may reproduce, and have special adaptations to help retain the plants upright profile within the water.
- **Free-floating aquatic plants** are usually relatively small and they drift freely in eddies of wind and water currents. Although often mistaken for algae, duckweed is a free-floating plant.

A healthy lake ecosystem is supported by shoreline plants, and a summary of the important functions of plants in lake regions can be found in the table below. Please see Table 2 for a comparison and summary of these plants benefits. Shoreline plants can be seen as a nuisance when they interfere with recreational water uses and access, but removing them all is not a sustainable solution to maintaining a healthy lake system. Landscaped greenbelts are an effective alternative that can provide many benefits to the property owner, as listed in the above section, and to the natural environment.

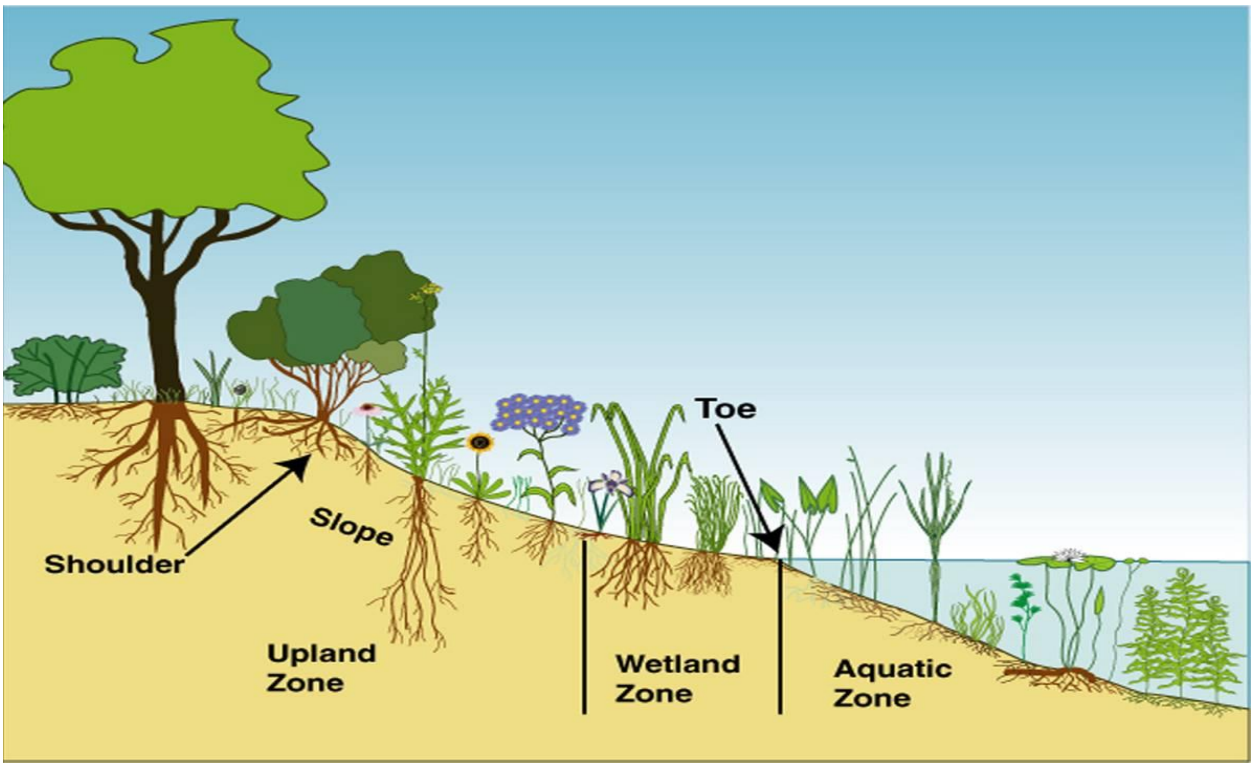


FIGURE 3: CROSS SECTION OF A NATURAL SHORELINE DEPICTING ECOLOGICAL ZONES. *Source: Michigan State University Extension Land & Water Unit*

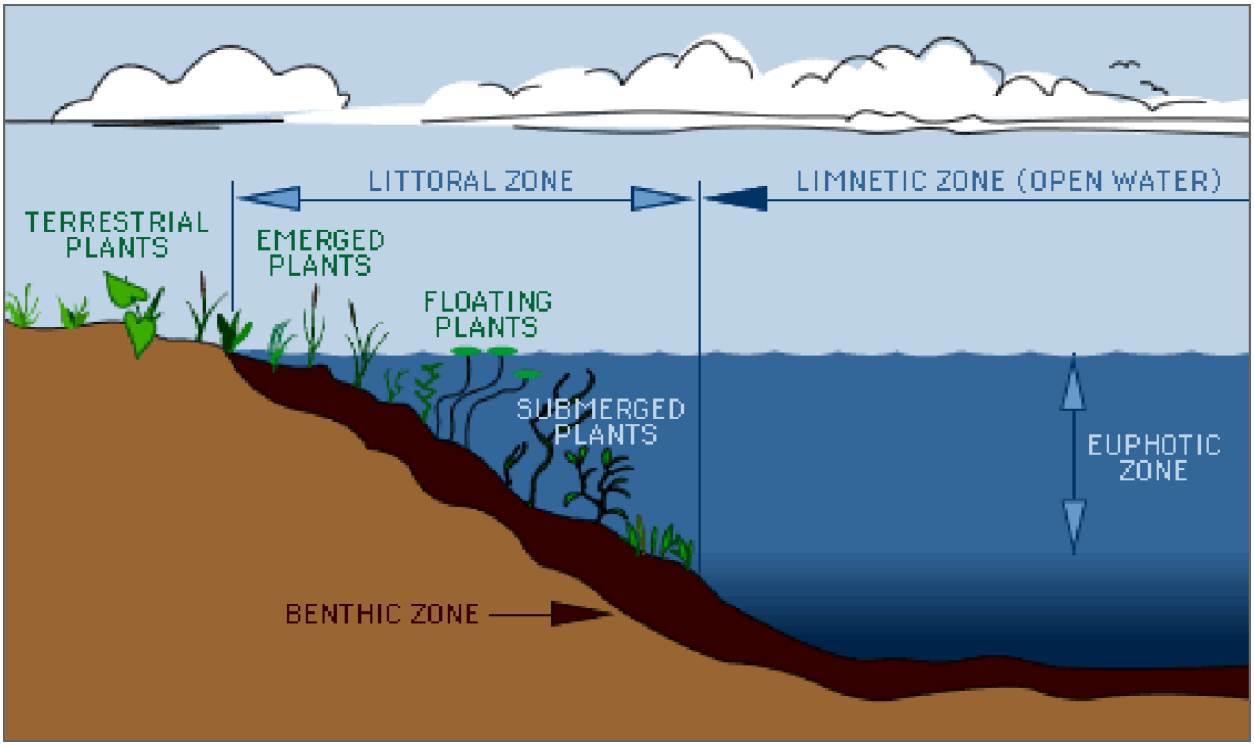


FIGURE 4: LAKE ECOLOGICAL ZONES. *Source: WOW [www.WaterontheWeb.org], University of Minnesota-Duluth, Duluth, Minn., 2009.*

TABLE 2: COMPARISON AND SUMMARY OF SHORELINE PLANT BENEFITS

Submergent and emergent plants	Shoreline and upland plants
• Plants produce leaves and stems (carbohydrates) that fuel an immense food web. • Aquatic plants produce oxygen through photosynthesis. The oxygen is released into lake water. • Submergent and emergent plants provide underwater cover for fish, amphibians, birds, insects and many other organisms. • Underwater plants provide a surface for algae and bacteria to adhere to. These important microorganisms break down polluting nutrients and chemicals in lake water and are an important source of food for organisms higher in the food chain. • Emergent plants break the energy of waves with their multitude of flexible stems, lessening the water's impact on banks and thus preventing erosion. • Plants stabilize bottom sediments, which otherwise can be re-suspended by currents and wave action. Stabilizing them reduces turbidity and nutrient cycling in the lake.	• Shoreline and upland plants provide food and cover for a variety of birds, amphibians, insects and mammals above the water. • The extensive root systems of shoreline plants stabilize lake-bank soils against pounding waves. Plants growing on upland slopes that reach down to lakes hold soil in place against the eroding forces of water running over the ground and help to keep lake water clean. • Upland plants absorb nutrients such as phosphorus and nitrogen, found in fertilizers and animal waste, which in excessive concentrations are lake pollutants.

Source: Kirkwood, Julia, Robert Schutzki, Jane Herbert, Kip Cronk, and Elise Tripp. "Healthy Lake Ecosystems." Natural Shoreline Landscapes on Michigan's Inland Lakes. 1st ed. N.p.: Michigan State University Extension, 2011. 9. Print.

GREENBELT BASICS

WHAT: A shoreline greenbelt is a strip of diverse vegetation, either naturally growing or planted, along the shoreline of a lake or stream, usually consisting of a mixture of trees, shrubs, ground cover, and wildflowers.

WHY: Shoreline greenbelts offer waterfront residents an attractive way to protect the water quality of their lakes and streams; and all the while maintaining lake access and use. Greenbelts can help to positively impact area water systems by supporting and enhancing the characteristics that make them so wonderful.

BENEFITS:

Improve Water Quality:

- Greenbelts minimize polluted runoff by trapping sediment and debris and by filtering more nutrients, toxic substances, and other pollutants from surface runoff. They also reduce nutrient pollution as growing plants filter nutrients from improperly maintained septic systems.

- Lawn fertilizers and pesticides applied near a shoreline can end up washing into our waterways—causing unwanted pollution. Pollutants can include excess nutrients, like phosphorus and nitrogen, which can aid in the growth of *cladophora*. Greenbelt vegetation reduces the need for chemical application and lawn maintenance.

Prevent Erosion:

- Deep roots of greenbelt vegetation bind the soil in place—in most cases, preventing shoreline erosion.

- Greenbelts are more cost-effective than seawalls or other engineered structures, and they can make effective windbreaks, saving energy by slowing the speed of the wind around buildings.

Enhance Property:

- Shoreline greenbelts can be very attractive—providing aesthetic beauty for your property and enhancing your waterfront views. Planting trees, shrubs, ground cover, and wildflowers may enhance the value of your waterfront property.

Screen Unsightly Views and Buffer Noise:

- Greenbelts offer privacy and protection from sound, because the vegetation absorbs sound waves. Thus, reducing the noises you may hear from motorboats, personal watercraft, or your neighbors.

Provide Habitat:

- Songbirds, butterflies, small mammals, and other animals have a greater chance of finding food, shelter, and nesting sites in greenbelt vegetation than a lawn.

Discourage Nuisance Species:

- Vegetation present on the shoreline can help deter geese from wandering up the banks and feeding on the short turf grass of a managed lawn, which they prefer being a grazing animal. Geese can be a nuisance, because of the accumulation of droppings and increased nutrient loads to waterways.

WHERE: Shorelines and streambanks on lakes and streams—everywhere! Especially those that are experiencing erosion problems and degraded water quality. Greenbelts can be installed even if erosion isn't a significant concern because of the many other benefits that they provide.

SHORELINE DEPENDENT SPECIES

The interface between land and water creates a unique, variable environment that supports a diverse community of plants and animals that have adapted to it. Shoreline species are important components of both terrestrial and aquatic food webs. The interplay of microorganisms, plants, mammals, reptiles, birds, and amphibians are needed to support the larger wildlife that is characteristic of beautiful Northern Michigan. Below is a gathering of some of the more sensitive shoreline species and why they are impacted so severely by habitat changes.

Turtles

Turtles are ectothermic or coldblooded, so they depend on an external heat source to stay alive. They manage to absorb necessary sunlight by basking on logs and stream banks. Most turtles are omnivorous, eating both plants and animals, and enjoy a diet of insects, aquatic plants, shellfish, and other small animals, because food sources are found in terrestrial and aquatic environments, they must have shoreline access. Turtles use the shore for mating and as an area to deposit/incubate their eggs.

The Michigan Department of Natural Resources (MDNR) list of turtles found in the state include the: Blanding's Turtle (*Emydoidea blandingii)*, Common Map Turtle *(Graptemys geographica)*, Common Musk Turtle *(Sternotherus odoratus)*, Common Snapping Turtle *(Chelydra serpentine)*, Eastern Box Turtle *(Terrapene carolina carolina)*, Painted Turtle *(Chrysemys picta)*, Red-eared Slider *(Trachemys scripta elegans)* (*shown above*), Spiny Soft-shell Turtle (*Apalone spinifera spinifera)*, Spotted Turtle *(Clemmys guttata)*, and the Wood Turtle *(Clemmys insculpta)*. All Michigan turtles are protected by legislation with the exception of the snapping turtle and soft-shelled turtles. Those two species can be harvested for **personal use only** under an all-species fishing license and during a specific season. There are also constraints on carapace size, and trap placement and construction. According to James M. Green from the Animal Legal & Historical Center, "An estimated 90% of wild-caught reptiles die in their first year of captivity because of physical trauma prior to purchase or because their owners cannot meet their complex dietary and habitat needs." Authorization for the removal and possession of a Blanding's Turtle, Wood Turtle, Eastern Box Turtle, or a Spotted Turtle must be obtained through a permit, and only for scientific research, conservation, or educational purposes. Please refer to the following link for more information http://www.michigan.gov /documents/dnr/FO-224-02_182417_7.pdf.

Loons

A loons' diet consists of small fish, crustaceans, shellfish, frogs, aquatic insects, and some aquatic plants. Loons are often-times found feeding at the shoreline, and nesting in the vegetation. Loons are not the only birds that utilize the shoreline; ducks, geese, swans and other large (and small) waterfowl rely on shoreline habitat components.

Frogs

The lifecycle of a frog begins in the water as a soft, gelatinous egg. Through maturity their tadpole gills and tail develop into air breathing lungs and hind legs, respectively. Thus, they are capable of living on land and water, but they are not independent of either environment. Water is necessary to prevent desiccation and habitat is needed for breeding and feeding. Frogs, like the northern spring peeper (pictured at left), are beneficial to people, because of their ability to control insect populations. Frogs are not the only amphibians impacted by habitat loss; salamanders and toads are affected as well.

According to the MDNR, Michigan's frog species include: Blanchard's Cricket Frog *(Acris crepitans blanchardi)*, Bull Frog *(Rana catesbeiana)*, Eastern American Toad *(Bufi americanus americanus)*, Fowler's Toad *(Bufo woodhousei fowleri)*, Gray Tree Frog *(Hyla versicolor* and *Hyla chrysoscelis)*, Green Frog *(Rana clamitans melanota)*, Mink Frog *(Rana septentrionalis)*, Northern Leopard Frog *(Rana pipiens)*, Northern Spring Peeper *(Pseudacris crucifer crucifer)*, Pickerel Frog *(Rana palustris)*, Western Chorus Frog *(Pseudacris triseriata triseriata)*, and the Wood Frog *(Rana sylvatica)*. Amphibians are also protected

Mink

Mink are nocturnal mammals that occupy forests bordering streams, lakes, and ponds. They use the shore as access to find food, often swimming and climbing trees, and to make a home by digging burrows in the banks. Abandoned muskrat and beaver dens have also been occupied by mink, as are hollow logs located near the water. Mink have a diet of small mammals, birds, frogs, and crayfish. Loss of habitat compresses a very territorial species that likes to be alone and increases competition for food sources. Valued for their fur, mink also face population decline from hunting and trapping. Other shoreline mammals include beavers, muskrats, and the river otter.

ESTABLISHING YOUR GREENBELT

Shorelines are dynamic and complex systems that are influenced by natural and human pressures. When planning a greenbelt project current shoreline conditions and factors should be taken into account before any changes are made. The following section provides guidelines for greenbelt establishment from its planning to installation.

PLANNING AND DESIGN

1.) Soil type (sand, silt, clay, loam, or organic soils; wet, dry, etc.)

Learn about your soils. Since each plant thrives in different soil types, a soil analysis on a site provides an idea of which plants could grow best there and how to manage them. If you are familiar with the basic soil types, dig a small hole to determine the type of soil present. You may also be interested in determining the soil's relative acidity or alkalinity as well as any nutrient deficiencies. A soil test can be purchased for $25 from the Michigan State University Extension (MSUE) office or at http://msusoiltest.com/get-your-soil-test/. For more information you can also call the MSUE Lawn and Garden toll-free hotline at 888-MSUE4MI (888-678-3464).

2.) Slope and orientation to the sun

Assess your shoreline's gradient—is it relatively flat or a steep slope? The natural slope and contour of the land affects water drainage and sun exposure. Determine which areas of your shoreline are shaded, wet or poorly drained. Also assess what direction the shoreline faces. This will tell you how much sun your shoreline area will receive and during what time of day. The amount of sunlight received throughout the day will influence the types of vegetation that can flourish under these conditions. For example, a west-facing shoreline receives sun later in the afternoon through to sunset, while an east-facing shoreline receives sun primarily in the morning hours. North-facing shorelines are generally cooler and receive less sun than south-facing shorelines that receive sun throughout most of the day.

3.) Wildlife—both existing and desired

Make a list of wildlife you are interested in attracting to your property. This will influence the type of vegetation you choose later. Installing bird houses, bird feeders, and nesting platforms as well as certain types of vegetation may increase your chances of attracting certain birds and enhance habitat for existing species. Insect pollinators include bumble bees, sweat bees, mining bees, honey bees, wasps, butterflies, moths and hummingbirds. They play an important role in fertilizing plants, which allows for the production of fruit and seeds. Plants support many wildlife and human needs, including food, shelter, clothing, medicine and aesthetic needs. Pollinator species are negatively impacted by increased pesticide use, climate changes, habitat loss, and poor land management. Placement, design, and other landscape considerations will influence your success in attracting other types of wildlife as well. Consult the Minnesota Department of Natural Resources' *Landscaping for Wildlife* by Carrol L. Henderson for more information on wildlife considerations.

4.) Existing natural vegetation

Determine the types of vegetation currently on or near the property and what is thriving. Consult tree, shrub, groundcover, and wildflower guidebooks or Cheboygan County Michigan State University

Extension office (231-627-8815) to learn more about vegetation identification. If new construction is going to occur on the property, protect existing trees and their root systems by avoiding driving heavy equipment under the dripline, shown in Figure 5, which extends the width of the tree canopy. However, it is important to note some tree species have root systems that extend 2-3 times beyond the branch area of the tree. Shallow-rooted trees are most susceptible to root system disturbance. Clay soils and soils in areas with high water tables are especially prone to compaction and subsequent damage to trees.

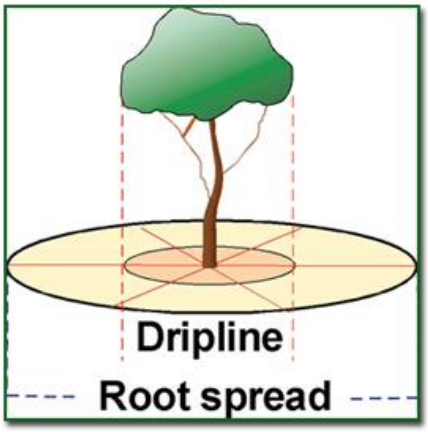


FIGURE 5: EXAMPLE OF DRIPLINE AROUND TREES. *Source http://www.treecareservice.ca/tree-fertilizing.html*

5.) Structures and their relation to the landscape

Identify any existing structural features, including building, power lines, buried cables, septic tanks, drain fields, and others. Also consider natural features on adjacent property. These features will influence the placement of your greenbelt vegetation and the amount of space you have to work with. Consider your recreational and family needs, such as areas for pets, benches, picnics, storage, playing, vegetable gardens, and footpaths. Those elements, in addition to providing adequate views and access to the waterfront, can be incorporated into any functional greenbelt design.

6.) Formal or natural landscaping design

Integrating the site characteristics into a design can be a lot of fun. An informal approach that mimics the natural shoreline and its vegetation is common, but a structured, formal design (e.g. with edged flower gardens) may also be functional. Implementing an informal design may have the advantage of requiring less maintenance than a highly structured, formal design.

7.) Determining greenbelt size

Size of the greenbelt is another important design aspect to consider. The wider the greenbelt strip the more effective it will be at protecting water quality. Minimum effective greenbelt widths can vary from 15 to 95 feet. An average minimum effective greenbelt width is 35 feet; however, determining the most appropriate width for your greenbelt will be dependent on your property's site-specific conditions, including soil type, and slope. Slope is important factor to consider, because greater slopes will increase the velocity of runoff and thus, a wider greenbelt is needed to help slow it down. In terms of runoff, think slow it down, spread it out, and soak it in.

8.) Selecting plants for your greenbelt

Once the environmental and physical conditions of your property have been assessed, learn which plants will grow well in these conditions. When selecting plants, your decision should be based on not only what you find aesthetically pleasing, but also what plants are adapted to the site conditions. You will want to select plants that include a mixture of ground covers; such as grasses, ferns, flowering perennials, trees, and shrubs. Both native and/or non-native plants may be used for landscaping a greenbelt. Native plants have the advantage of requiring less maintenance and have an aesthetic fit to the site which is difficult to achieve with a collection of non-native plants. Many of our favorite landscape plants from dogwoods to violets are native. After choosing the plants that will create your greenbelt, you can purchase them from nearby nurseries or landscapers, mail-order suppliers, and conservation district tree and shrub sales, or simply allow the natural shoreline vegetation of the site to flourish. For suggestions, talk to local nurseries and landscapers; refer to the Tip of the Mitt Watershed Council website www.watershedcouncil.org, the Cheboygan County Michigan State Extension Office, or the Cheboygan Conservation District. The Michigan Native Plant Producers Association is also a great source for locating local native plant nurseries and information regarding native plants. The benefits of native plant landscapes and some common species can be found in the section titled *Native Plants* beginning on page 30.

Did you know?

The Michigan Native Plant Producers Association comprises 12 independently owned nurseries located throughout the state of Michigan. Together we grow and sell over 400 species of Michigan native plants and seeds, including, trees, shrubs, wildflowers, grasses, and ferns.

Mission: *As an organization, our mission is to benefit member businesses by creating an ethical, profitable, and ecologically sound business environment. As responsible propagators of Michigan native plants, we are committed to enhancing the diversity and health of Michigan's unique natural heritage. By providing nursery-grown native plants and seed from Michigan genotypes, and promoting and expanding public awareness of the effective use of Michigan native plants.*

Source: www.mnppa.org

9.) Putting it all together

Now it is time to put together all the information you gathered into a site design or a plan of action. Perhaps you would like to hire a landscape professional to complete the design and implement the project, or perhaps you will carry out the project yourself. In either case, you need to be aware of a few regulations that may influence components of your plan (please see the section *Ordinances and Regulations* on pages 39-40. In addition, many townships and counties have zoning standards that require maintenance of natural vegetation along shoreline areas. Consult your local zoning official for more information on shoreline zoning regulations.

SITE PREPARATION

There are limitless possibilities for greenbelt design and shoreline restoration projects. One of the simplest ways to implement a shoreline greenbelt is to establish a "no-mow" zone. Then, native plants can be planted into the designated area, or it can simply be left undisturbed to allow for natural regeneration.

If you wish to incorporate a more manicured, landscaped design on the site, your plan must consider the vegetation already in place. To help the plants you are installing become well established it is important to remove the existing turf; thus, removing competition for water and nutrient resources. There are several methods that can be employed to accomplish this:

Herbicide: Using herbicides, or chemicals, to inhibit plant growth is one option for eliminating turf. Care must be taken on the timing and application of the herbicide product to minimize negative impact to the environment and weed/turf removal is maximized. If using herbicide, carefully read and follow all labels and instructions. This will allow the product to be the most effective at weed removal, and less detrimental to ecosystems. "Spot treating", by only applying herbicide where weeds are seen, instead of to the entire lawn, is preferred to reduce the amount chemicals entering the environment.

- **Pre-emergent herbicide:** A critical window exists to apply pre-emergent herbicides, because they prevent weeds from germinating and are ineffective if this has already occurred. This means applying in the spring before weeds have sprouted.

- **Broad leaf herbicide:** Also known as post-emergent herbicide, broad leaf herbicide is used to manage existing weeds and will not prevent seed germination. Spring and fall applications are suggested, because of the greatest impact to weeds and lowest impact to lawn grass and other desired plants.

- **Roundup:** Glyphosate is the main ingredient in Roundup, and it kills weeds by interfering with amino acid synthesis. Thus, it targets actively growing weeds, and should not be used as a pre-emergent herbicide. Roundup is one of the most well-known and commonly used herbicides worldwide. Glyphosate bonds to soil and has been found lingering in pond sediments. Concerns about roundups effects to humans and the environment are still under debate.

- **Aquatic safe herbicide:** **The Department of Environmental Quality's approved aquatic pesticides and related products list can be found in Appendix B.*

Cutting: Cutting out turf, also deemed "scalping", is the act of cutting strips of turf and removing the top layer of sod. Then, the turf can either be removed completely or flipped over and used in the landscaping plan.

When working on landscaping projects you may have the opportunity to work with topsoil. It should be noted that importing topsoil can introduce weed seeds and other undesired plants. Compared to other amendments to soils, topsoil is not nutritionally valuable and is better used as "filler". Compost is a great soil amendment, because of its physical, chemical, and biological benefits. The US Composting Council lists the benefits of using compost as follows:

- Improves the soil structure, porosity, and density, thus creating a better plant root environment.
- Increases infiltration and permeability of heavy soils, thus reducing erosion and runoff.

- Improves water holding capacity, thus reducing water loss and leaching in sandy soils.
- Supplies a variety of macro and micronutrients.
- May control or suppress certain soil-borne plant pathogens.
- Supplies significant quantities of organic matter.
- Improves cation exchange capacity (CEC) of soils and growing media, thus improving their ability to hold nutrients for plant use.
- Supplies beneficial microorganisms to soils and growing media.
- Improves and stabilizes soil pH.
- Can bind and degrade specific pollutants.

The full fact sheet can be found at http://compostingcouncil.org/factsheets-and-free-reports/. As an example composted leaf mulch can be added to sandy soils to improve its ability to hold water and provide more nutrients. On the other hand sand is helpful to increase drainage in clay soils.

INSTALLATION

Timing: Greenbelt plants can be installed after danger of frost has passed. Typically mid-to-late May in Northern Michigan through September. Plantings during the summer months must be carefully watered, so they are able to become well established. Coordinate nursery plant arrival with their installation date so that interim care is not needed before they are planted.

Professional help: Landscaping professionals can provide specific information on existing turf removal practices, estimates on installation costs, and plant selection. For sites with extensive erosion issues, where more site work is needed, consult with a professional shoreline contractor. A list of certified natural shoreline professionals is available at https://sites.google.com/site/mishorelinepartnership/certified-natural-shoreline-professionals-listing

MAINTENANCE

SHORT-TERM

Short-term maintenance is the support provided to the greenbelt within the first year/season of its installation. Careful attendance to watering and weeding during this time period is necessary to help plants become established in the site. Weeding will decrease competition for nutrients and moisture and watering will reduce plant stress.

LONG-TERM

Once plants have become established, weeding can be reduced to a couple of times a year, but careful monitoring of the shoreline/greenbelt should be done regularly. Weather conditions such as heavy rains, drought, extreme temperatures, ice, and waves can impact the site. Fertilizing greenbelt plants is not recommended, because excess nutrients added to the environment can cause nutrient pollution and native plants do not need it. Awareness of invasive plant species is also important. Remove invasives as soon as possible, to reduce further spread. Controlling weeds by pulling is the best for invasive plant removal, especially when located so close to the lake. A permit is not required for herbicide use in inland areas where the treated plants are not located in standing water at the time they are treated. Applying herbicides as a method of aquatic plant/algae removal in Michigan requires a permit from the Michigan Department of Environmental Quality (MDEQ) Aquatic Nuisance Control Program. Please visit the following website for more information www.mi.gov/anc.

Some common Michigan invasive plant species are:

Dame's Rocket

Black Medick

Myrtle

RECOMMENDATIONS

SHORELINE MANAGEMENT

The best option for managing your shoreline is to leave as much of the existing, native vegetation as possible. If restoration or stabilization is necessary, several options are available, but not all are recommended as several can lead to other problems. Table 3 below provides comparison of erosion control methods. Vegetation and bioengineering are recommended as the most effective erosion control methods, because they have the most significant ecological, environmental and property benefits. These methods also have the lowest overall maintenance requirements and can potentially cost less than traditional methods depending on the scale of the project and degree of erosion. Hardening of the shoreline is not recommended, because of its low habitat value and wave-energy concerns. The ebb-flow system of a "soft" shoreline is interrupted with the installation of sea-walls, because an uncompromising barrier is created between the land and water. Figure 6 below demonstrates the problems created by "hard" shorelines. Upland terrestrial plants are often-times buried with fill when a flat lawn is created to the sea-wall. The energy from the waves deflecting off the hardened barrier scours the lake bottom, which destroys plant communities in the littoral zone and deepens it by removing sediment. Thus, this important ecological zone can no longer contribute to a healthy lake ecosystem.

TABLE 3: COMPARISON OF EROSION CONTROL METHODS

Method	Estimated Cost per linear foot	Effectiveness	Maintenance	Appearance	Habitat Value
Vegetation	$5 to $20, depending on type and size	Excellent at reducing erosion and stabilizing flat or moderate slopes	Little maintenance required. Varies depending on desired effect	Preserves natural, scenic beauty of shoreline. Can provide a privacy screen for lake residents	Reduces soil erosion and nutrient contamination of lake. Excellent habitat for fish and wildlife
Soft armoring: Bioengineering	$30 - $100 depending on method selected and severity of erosion	Excellent at dissipating moderate waves, controlling erosion and stabilizing slopes	If installed properly, requires little maintenance beyond aesthetic management	Supports natural vegetation and scenic value	Dampens wave action. Strength and habitat value for fish and wildlife improve over time
Hard armoring: Field stone or riprap	$20 - $40 for a shoreline with 8 feet between high and low lake levels	Excellent at dissipating moderate waves and stabilizing slopes up to 2 horizontal to 1 vertical	Occasional maintenance necessary to move and replace rocks	Provides natural appearing rocky shoreline. Allows native vegetation to grow between stones	Dampens wave action. Good habitat for fish and wildlife especially if plant growth is allowed
Hard armoring: Concrete, steel or vinyl piling	$50 - $200 depending on type of seawall	Structural barrier against strong waves and ice. Increases erosion in lake and along nearby shoreline	Requires regular maintenance to repair cracks and check for toe erosion. Must be completely replaced upon breaking	Permanently alters shoreline contour and prevents establishment of native vegetation along lake shoreline	Poor habitat value. Increases wave action. Reduces diverse feeding and spawning areas for fish and other aquatic animals. Creates a barrier for shoreline-dependent species.

* These are 2000 figures. Actual costs may vary considerable, depending on local prices, the conditions at your lakeshore, and the level of erosion protection needed.

Source: Adapted from: Lakeshore Protection in Indiana; Indiana Department of Natural Resources, 2007

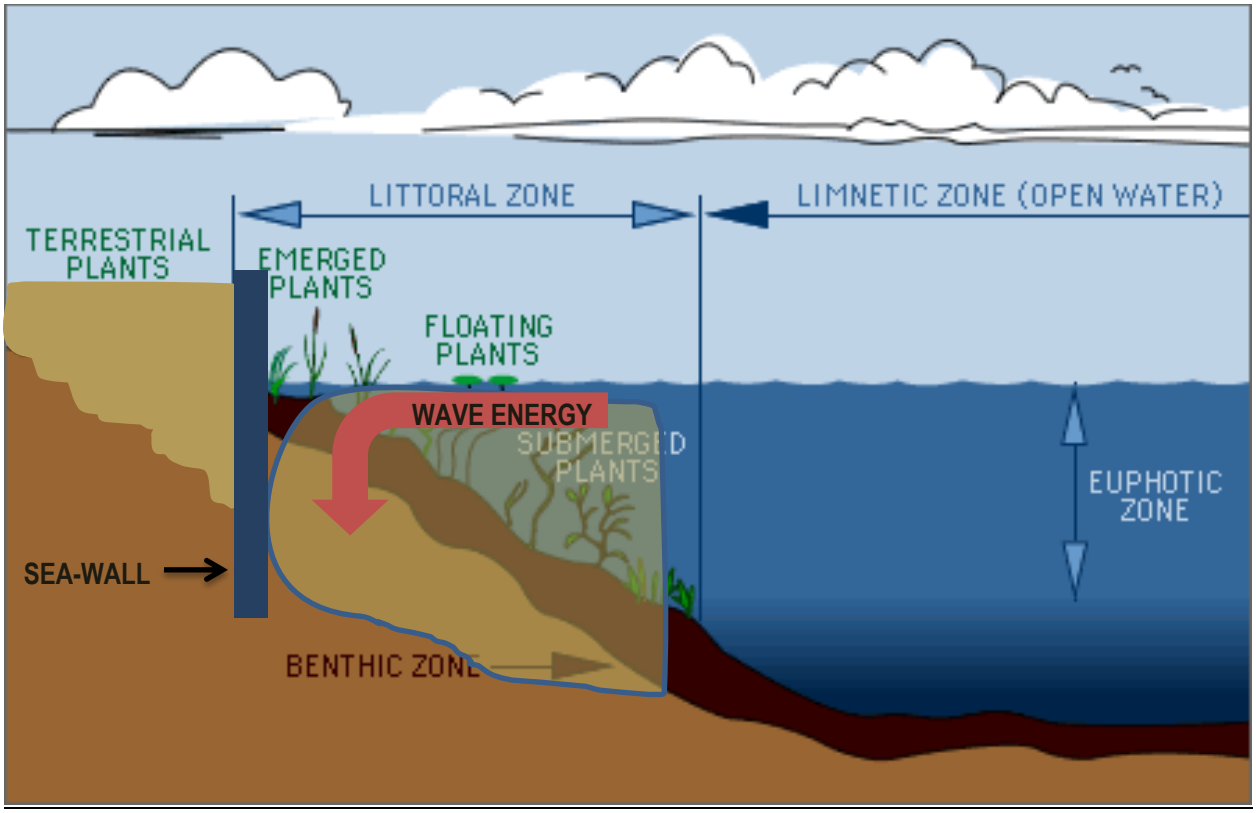


FIGURE 6: EFFECTS OF A HARDENED SHORELINE. *Source: Modified from WOW [www.WaterontheWeb.org], University of Minnesota-Duluth, Duluth, Minn., 2009, and Michigan Natural Shoreline Partnership Property Ownership Workshop.*

SET A HEALTHY TREND FOR YOUR COMMUNITY

Research shows our landscape preferences are strongly tied to cultural norms. University of Michigan Joan Iverson Nassuer, Professor of Landscape Architecture, has studied the topic and published numerous articles and research including the following titles, which can be downloaded from http://www-personal.umich.edu/~nassauer/publications.html.

- *The shared landscape: what does aesthetics have to do with ecology?*
- *The Economics of Native Plants in Residential Landscape Designs*
- *Landscape care: Perceptions of local people in landscape ecology and sustainable development*
- *Ecological Function and the Perception of Suburban Residential Landscapes*

Residential lawns have a visual aspect to them in a way that allows, perhaps even encourages, public viewing. Subsequently, what can be seen by others, can be judged by others. This apparent judgment of attractiveness by others is an influential force for property owners to adjust and adopt their landscape practices and aesthetics. Natural landscape designs are comprised of diverse sizes and types of native plants, and a small percentage containing conventional turf. They are often considered weedy and untidy. This stereotype can be avoided by implementing a well-designed plan for your shoreline and adjacent property that highlights both natural features and functions. According to Nassuar, "Perceived care is powerfully related to landscape preference in residential areas, and an apparent lack of care makes the landscape look unattractive." Thus, the appearance of our landscape is a reflection of our personal character. And so we mow, prune, trim, weed, mulch, water, plant, fertilize, and weed whip our landscapes into neat and tidy, colorful and contained, orderly and managed yards that we hope reflect who we are: hardworking, thoughtful, good citizens who care.

When it comes to shorelines, however, traditional landscape practices can be detrimental to lake health. A neat and tidy lakeshore may reflect our hard-working nature, but they are not in the best interest of the resource. Consider a natural shoreline: undisturbed and untouched. Emergent vegetation grows along the shallow lake margin, toppled trees lie submerged in the lake and their upright neighbors remain, for now, offering shade and cooling water temperatures. Organic, or "mucky," lake bottoms sustain populations of macroinvertebrates, which in turn provide food for other wildlife. Submerged rocks shift with waves and ice over the seasons. There isn't much "neatness" to this picture, but there is order: ecological order.

Achieving some degree of balance between cultural norms and ecological order is, however, obtainable. An important concept from Nassauer's research is termed "cues to care," or things you can do with a landscape that let people know that you are actually caring for it. These cues can be formal, casual, functional, or frivolous. They can be big or small, but they have to be noticeable to a casual observer. They have to provide some sort of evidence that you care for your landscape. You can easily include traditional cues to care in your "lakescape" by incorporating pathways, maintaining a crisp edge between lawn and your greenbelt (or other landscaped or no-mow areas), and by adding the occasional bench, birdhouse, or other accent. We know you care, but consider how to show it by trying these lakescape-centric cues. We promise your lake will approve!

1. Allow emergent plants, such as bulrushes or 'reeds', to grow along the shoreline. They help buffer wave energy, break up the ice cover, and provide critical habitat for fish, invertebrates, and birds.

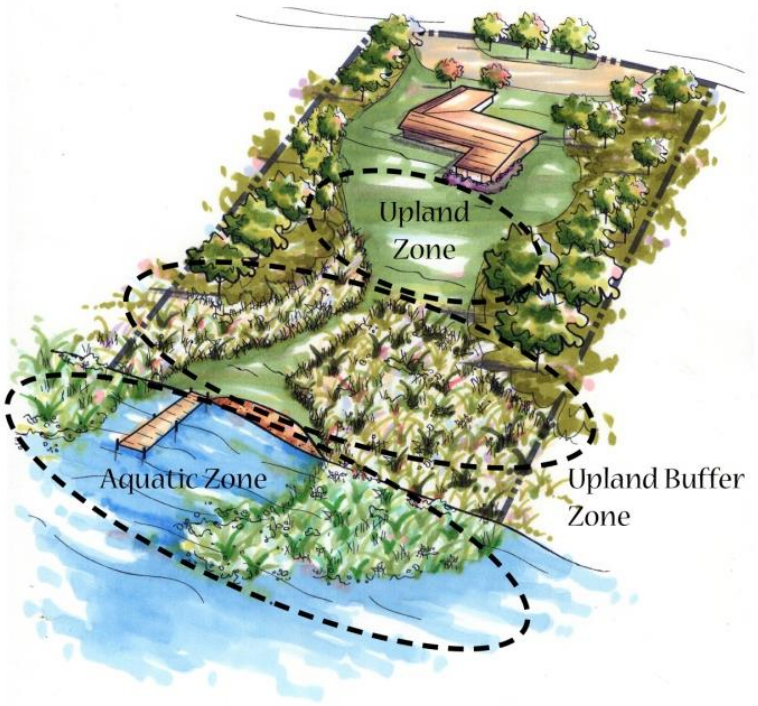
2. If a tree falls in the lake, leave it. Resist the temptation to remove fallen trees. Trees in the lake are essential to a lake's "carbon diet," plus they offer valuable habitat.
3. If you don't already have a greenbelt, a strip of vegetation that is either deliberately planted or allowed to naturally grow along the shoreline, then get growing!
4. Don't flatten ice shove berms if they are stable and vegetated because altering them may lead to shoreline erosion.

Source: Michigan State University Extension

FIGURE 7. TRADITIONAL LAKE FRONT LANDSCAPE. This residential lot depicts a conventional lakefront landscape and while it may match your neighbors' properties, the benefits it provides to you and the environment are minimal.

Source: Michigan State University Extension

FIGURE 8. RESIDENTIAL LAKE FRONT LANDSCAPE: MANICURED LANDSCAPE WITH BUFFER ZONES. This example property employs a manicured lawn with some buffering. The buffer creates some habitat and provides some runoff filtration, while still providing property access to the water and space for lawn use. Lake views are not compromised with this design.



Source: Michigan State University Extension

FIGURE 9. RESIDENTAIL LAKE FRONT LANDSCAPE: LANDSCAPE WITH PROPER ZONES. The following figure shows a landscaping plan that is ideal for creating the different zones needed for a diverse shoreline ecosystem. This plan creates the largest habitat size and is able to support a larger variety of wildlife. The property is now a beneficial asset to the lake and the owner.

Source: Michigan State University Extension

FIGURE 10A. GRADUAL SLOPE EXAMPLE. This figure depicts example landscaping for a gradual slope extending from the ordinary high water mark (OHWM) and the water level. In this scenario, the area is primarily wet and floods during high water, but may experience dry periods. The design includes the following native plants: 1. Tussock sedge. 2. Lake sedge. 3. Marsh milkweed. 4. Swamp aster. 5. Boneset. 6. Allegheny monkeyflower. 7. Great blue lobelia.

Source: Michigan State University Extension

FIGURE 10B. STEEP SLOPE EXAMPLE. This figure depicts example landscaping for a steep slope extending from the ordinary high water mark (OHWM) and the water level. Here the shoreline greenbelt is smaller than above in Figure 4, because of the swift transition to upland soil conditions. Consistent flooding above the OHWM, but the area is still moist for a majority of the year. The native plants used in the plan above are as follows: 1. Soft rush. 2. Canada blue-joint grass. 3. Golden Alexanders. 4. Sensitive fern. 5. Dense blazing star. 6. Canada anemone. 7. Turtlehead.

PIGEON RIVER CASE STUDY: STREAMBANK RESTORATION AND EROSION CONTROL

With the generous support of Mullett Area Preservation Society (MAPS), the Watershed Council provided bioengineering design, permit application services, and installation supervision to stabilize a stretch of the Pigeon River stream bank. The bioengineering solution included using prefab soil lift structures made from coir (coconut fibers) and alternating with bare-root dogwood and ninebark shrubs. Cobble was installed at the toe of the streambank. In order to provide additional support to the streambank, the property owners have implemented a no-mow zone extending the length of the former slump. Installation was limited to hand tools to avoid further stress to the streambank.

BEFORE
Approximately 35 linear feet on the Pigeon River slumped likely as a result of high water levels in early spring of 2008.

AFTER INSTALLATION
The exposed face of the soil lifts can be seen. Dogwood and ninebark saplings are planted between the layers.

1 YEAR AFTER INSTALLATION
Nearly one year after installation, the shrubs have begun to fill in and the slope remains stable. Over time, the project will become less and less evident as the vegetation grows and the area blends in with the natural riparian areas.

"Without the able assistance of the professional staff at TOMWC we would be stymied as to how to keep restoring various problem areas of stream bank erosion on the Pigeon River that MAPS has been financing for many years."

Mullett Lake Preservation Society (MAPS)

NATIVE PLANTS

What is a native plant? The Federal Native Plant Committee provides the definition as, "a native plant species is one that occurs naturally in a particular region, state, ecosystem, and habitat without direct or indirect human actions." Native plants are ideal, because of the multitude of benefits and services they can provide. With deep root systems they require less water and are more effective at filtering and absorbing stormwater than turf grass. The comparison of root length between native and non-native plants can be found in Figure 11. Native plants also attract birds, butterflies, and other pollinators, by providing food and habitat space. Michigan native species are adapted to the seasonal climate changes and local soil types. They require less maintenance, including fertilizers and supplemental watering. Native plants are easy to maintain once established, because they aren't water or nutrient sinks, thus reducing costs as well. The following is a brief summary of some native plants commonly used in greenbelts. A plants affinity for water will decide which shoreline zone it should be planted in for success. Plants suitable for each zone can be found in the following section.

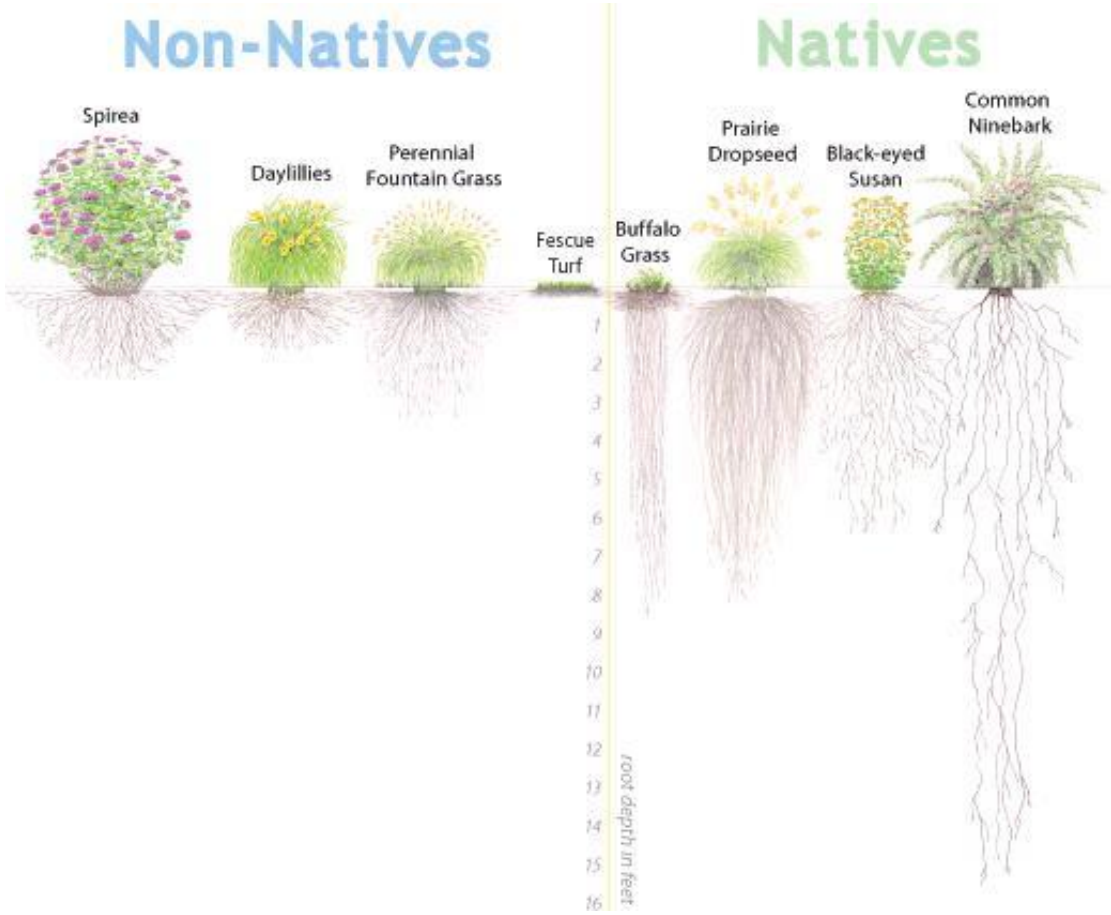


FIGURE 11: COMPARISON OF NON-NATIVE AND NATIVE PLANT ROOT LENGTH.

Source: Mid-America Regional Council (http://marc.org/environment/Water/know_your_roots.htm)

Did you know?

Installation of native plant landscaping costs 48% less than traditional landscaping. In a traditional landscape, the frequency and intensity of mowing, turf maintenance, weeding, and early plant replacement initially keeps costs in the same general area as a new native landscape. However, after about 5-years the stresses of herbicide application, shrub and tree mortality, and other aging syndromes of a landscape that does not renew itself results in greater maintenance costs than for sustainable or native landscapes.

Source: Conservation Design Forum, Inc., Elmhurst, IL

WOODY SHRUBS

Red Osier Dogwood
Cornus sericea

This species has a fibrous root system that is ideal for soil stabilization. It is a hardy shrub that thrives in wetland areas, but will adapt and flourish in drier site conditions as well. Red osier dogwood can propagate through cuttings or live stakes, which is an inexpensive method of acquiring new plants. White blooms are present from approximately May to September and it looks great during the fall/winter seasons, because of its deep red stems and white berries, which give this dogwood an ornamental look. This shrub has a mature height of 6 to 10 feet and a similar width.

Gro-Low Fragrant Sumac
Rhus Aromatica

This sumac cultivar is a great option for a ground covering plant, especially on shorelines and rough terrain, because of its affinity for sandy, gravelly soil, and low growth tendencies. It has an appealing look due to its dense collection of branches, glossy leaves, and delicate yellow flowers. During the fall season the dark green foliage changes to varying shades of red to yellow. Its height at maturity is approximately 1 to 2 feet, and has a spread of 6 to 8 feet in width.

Highbush Cranberry
Viburnum trilobum

Grows approximately 10 to 12 feet tall and wide, resulting in a large, rounded shrub. This shrub is ideal for boarders and screening, and has the benefit of edible fruits that can be used in preserves or left to attract birds. While preferring slightly acidic, well-drained soils, in a site that has full sun varying to partial shade, this shrub can endure less ideal conditions when mature.

Ninebark
Physocarpus opulifolius

This shrub consists of a yellowish to green foliage over shaggy bark stems and small clusters of white flowers that turn into pretty red to brown colored fruits. Ideal site conditions include full sun and rocky soils. It is commonly found along Michigan lakes and streams. The average plant size is 6 to 9 feet tall and wide. Plants can be shaped by pruning and while hardy, only light pruning should be employed after blooming. Ninebark is a great foundation plant for hedges and borders. This fully foliaged shrub provides habitat for wildlife, privacy on property, and arrangements can be made from the flowers and foliage.

GRASSES

Little Bluestem
Schizachyrium scoparium

This grass prefers well drained, sandy soils and sun to partial shade. It grows in clumps approximately 2 to 3 feet high and 1 foot in diameter. Summertime shows green to blue colored stems, which turn in the fall turn to a golden to reddish brown color. Little Bluestem is often used to accent borders, along walkways, and is ideal for upland landscaping, because of its small size.

Switch Grass
Panicum virgatum

Switch grass is a hardy plant that can endure poor drainage and occasional flooding. This grass stands in large upright clumps reaching 3 to 6 feet and spreading 1 to 3 feet wide. These dense clumps consist of textured foliage that can stand up well in winter conditions, and is often used in mixed boarders, screens, and even snow fences. Living snow fences can protect buildings and property from wind and snow drifts. Light flower heads appear in late summer and have a pinkish-red cast that contrasts nicely with the green foliage.

SEDGES

Pennsylvania Sedge
Carex pensylvanica

Pennsylvania sedge has dark green foliage and is clump forming. It is preferred in landscape design for its tolerance of shady lawn space, especially as ground cover beneath trees. This sedge doesn't require mowing, because it remains under 8 inches and while it spreads through rhizomes it is not overly aggressive. Pennsylvania sedge is adapted to many soil types, but well-drained conditions are ideal.

Palm Sedge
Carex muskingumensis

This densely clumping sedge grows 2 to 3 feet tall and wide. Clumps are formed by slender, pointed, light green leaves that resemble palm fronds, hence the name. It displays simple, yellow blooms from May to September, and enjoys full sun to partial shade. Palm sedge requires consistently moist soils and therefore works well along shorelines or in rain gardens. No significant insect or disease problems have been identified for this plant and it is also deer tolerant.

FORBS/PERENNIALS

Oxeye/False Sunflower
Heliopsis helianthoides

This perennial is found throughout Michigan on woodland edges, open woods and prairies. It commonly reaches 3 to 5 feet in height and has a 2 to 4 feet spread. Ideal site conditions for this plant are full sun and drier, well-drained soils. False sunflower received its name by the resemblance of its bright, yellow flowers to other varieties in the sun/helios genus. It is often used in landscaping for midsummer color.

Swamp Milkweed
Asclepias incarnata

Swamp milkweed grows best in consistently moist soils and full sun. It is often found in wet fields, swamps, and along shores. This 3 foot tall plant terminates in clusters of pale rose to purple colored flowers that bloom from June to August. Monarch eggs can often be found under the leaves and on the stems, because their larvae depend on the plant as a food source, and the adults use the blooms as a nectar source.

Common Milkweed
Asclepias syriaca

Related to the swamp milkweed (above), the common milkweed also thrives in full sun, but has adapted to poor, dryish soils. Clusters of small pinkish flowers, that attract butterflies, form at the top of the plant, which turn into large, lumpy seed pods at the end of the summer season. This species can grow to a height of 2 to 5 feet and spread 1 to 2 feet.

Yellow Coneflower
Rudbeckia hirta

The yellow coneflower, also known as black-eyed Susan, grows to 2 to 3 feet tall and 1 to 2 feet wide. This perennial enjoys sandy, well-drained soils and full sun to partial shade. Deep green stalks end in bright yellow to orange flowers with black centers. Yellow cone flower is tolerant to drought and heat.

TREES

Paper Birch
Betula papyrifera

Paper birch is known for is peeling, bright white bark. Landscape designs usually incorporate clusters of 2-3 trunks, instead of planting the trees individually. This is a fast growing tree that likes full sun, but is sensitive to pests. To be successful, paper birch trees require adequate moisture and a cool site for the roots to become established. In the summertime its leaves are a dark green, and in the fall, they turn a bright yellow.

Northern White Cedar
Thuja occidentalis

This medium sized tree, growing between 25 and 50 feet tall, is characterized by flat, scale-like leaves and small, oblong cones. Northern white cedars are commonly found in excessively moist, cool habitats, and are often referred to as "swamp cedars", but they are also adapted to well-drained, rocky soils. They thrive in neutral soils, often involving limestone or calcium, and provide habitat for a variety of wildlife. Deer use cedar thickets for shelter from winter weather, as often evidence by the unmistakable "browse line".

FERNS

Ostrich Fern
Matteuccia struthiopteris

The ostrich fern is characterized by an upright, vase-like shape with large airy fronds that can range in height from 2 to 5 feet. This fern is commonly found in swamps and wet woods, as it prefers moist, slightly acidic soils, in partial to full sun. Often used in landscaping for shade gardens and mixed boarders, ferns are also a good backdrop for other plantings. They propagate readily through rhizomes, which is an easy way for the ostrich fern to spread and fill in landscape space.

Cinnamon Fern
Osmunda cinnamomea

The cinnamon fern, like the ostrich fern, prefers moist soils typical of marshy spaces and wooded swamps. This fern is distinguished by the deep cinnamon color of the fertile fronds that appear as spikes in the center of the plant in spring. The dark green foliage of the cinnamon fern can stand from 2.5 to 3 feet tall. These plants are common to landscaping projects, because they require little maintenance once established and they make a bold statement in the background of a garden or along the shoreline.

NATIVE PLANT SUPPLIERS

Below is a list of native plant growers and organizations that can provide a comprehensive selection of Michigan native plants and insightful information.

Michigan Native Plant Producers Association
www.mnppa.org

The Native Plant Nursery (734) 677-3260
www.nativeplant.com

Wildtype Nursery (517) 244-1140
www.wildtypeplants.com

Otsego Conservation District (989) 732-4021
http://www.otsego.org/conservationdistrict/

When planning a shoreline or streambank project, or an activity that may impact wetlands on your property, you will need local, state, and possibly federal, permits before you begin. Use the guide below to learn more about the permitting process.

The Department of Environmental Quality (DEQ) defines the Ordinary High Water Mark (OHWM) as the, "line between upland and bottomland that persists through successive changes in water levels below which the presence and action of the water is so common or recurrent that the character of the land is marked distinctly." This simply means evidence of a common boundary persists as the water levels change, whether it is indicated by a vegetation line or a non-vegetation line, like a stain on a seawall.

If you plan to do anything along the shoreline below the Ordinary High Water Mark (OHWM) you will need the following:

PART 301 INLAND LAKES AND STREAMS PERMIT

The Michigan Department of Environmental Quality (MDEQ) regulates any shoreline activity that occurs below the Ordinary High water Mark (OHWM) under the authority of Part 301, Inland Lakes and Streams of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA). This applies to construction, dredging, or filling of any part of a lake or riverbed, including the deposit or installation of materials along the shoreline, such as sand, rip rap, a breakwater, or a permanent dock. It also applies to the alteration of the natural flow of an inland lake or stream, activities within bottomlands, and connection of any natural or artificially constructed waterway, pond, or lake to an existing inland lake or stream. Protection of the shoreline is critical to preserving water quality. Degraded shoreline can result in soil erosion and sedimentation problems.

Michigan Department of Environmental Quality Land and Water Management Division (LWMD)
Gaylord Field Office – Phone: (989) 731-4920

If you plan to dig, fill, drain or build in a wetland, you will need the following:

PART 303, WETLAND PROTECTION PERMIT

The Michigan Department of Environmental Quality (MDEQ) regulates wetlands within 500 feet of a lake or stream or within 1,000 feet of the Great Lakes under the authority of the Natural Resources and Environmental Protection Act (NREPA) (Act 451 of 1994). Any activity that could compromise the ecological integrity of a wetland must be first carefully evaluated. MDEQ staff stress optimum utilization of upland areas first, and then minimizing wetland impacts if the wetland activity is necessary. Oftentimes, permits are denied if viable alternatives are available. Wetlands are extremely valuable resources. Protecting wetlands helps protect water quality.

Michigan Department of Environmental Quality Land and Water Management Division (LWMD)
Gaylord Field Office – Phone: (989) 731-4920

The Michigan Department Environmental Quality regulates minor bioengineering projects.

The minor bioengineering project category, also under Part 301, supports inland lake shoreline stabilization using bioengineering practices. In doing so, preventing erosion, and restoring and enhancing wildlife habitat.

- Projects are of no more than 300 linear feet.
- Top of the bank is no more than 3 feet above the ordinary high water mark.
- Vegetation used, including plantings, live stakes and others, must be native vegetation, below the OHWM.
- Engineered materials shall be made up of inert plant fiber, which may be non-native.
- Excavation and backfill are limited to the extent necessary to stabilize slopes.
- All engineered and natural materials shall be staked and secured.
- All raw areas from construction shall be promptly stabilized with native plant material.
- Projects shall not destroy native wetland or aquatic vegetation.
- Projects shall not harm threatened or endangered species.
- The minor project is not applicable to streams, rivers or Great Lake shorelines.

If you plan to move or fill earth within 500 feet of a lake or stream, or if the earth change will disturb an acre or more of land you will need the following:

SOIL EROSION AND SEDIMENTATION CONTROL PERMIT (ACT 451, PART 91)

The County Soil Erosion Offices issue permits for any earth changes which disturb one or more acres of land and changes which are within 500 feet of any lake or stream. Provisions concerning soil erosion are particularly important for water quality protection.

www.michigan.gov/soilerosion

Cheboygan County Soil Zoning Department - 231.627.2440
Hank Jankoviak-Soil Erosion Officer
Phone: (231)627-8427 Fax: (231)627-3646
dirtguy@cheboygancounty.net

RESOURCES

BOOKS

Henderson, Carrol L. *Landscaping for Wildlife*. St. Paul, MN: Nongame Wildlife Program, Section of Wildlife, Minnesota Dept. of Natural Resources, 1987. Print.

Steiner, Lynn M. *Landscaping with Native Plants of Michigan*. St. Paul, MN: MBI Pub., 2006. Print.

Tallamy, Douglas W. *Bringing Nature Home: How Native Plants Sustain Wildlife in Our Gardens*. Portland, Or.: Timber, 2007. Print.

Borland, Kim, Suzan Campbell, Rebecca Schillo, and Phyllis Higman, comps. *A Field Identification Guide to Invasive Plants in Michigan's Natural Communities*. N.p.: Michigan Natural Features Inventory, 2009. Print.

*The above invasive plants field guide is also available at http://mnfi.anr.msu.edu/invasive-species/InvasivePlantsFieldGuide.pdf

AGENCIES AND ORGANIZATIONS

Army Corps of Engineers
http://www.usace.army.mil/

Detroit District
477 Michigan Avenue
Detroit, MI 48226
General Information: 1-888-694-8313
lrepao@usace.army.mil

Michigan Department of Environmental Quality
Gaylord Field Office
2100 West M-32
Gaylord, MI 49735
Phone: (989) 731-4920
Fax: (989) 731-6181
http://www.michigan.gov/deq

Michigan Department of Natural Resources
Customer Service Guide
http://www.michigan.gov/documents/dnr/DNR_customer_service_guide_407568_7.pdf
http://www.michigan.gov/dnr

Michigan Natural Shoreline Partnership
https://sites.google.com/site/mishorelinepartnership/

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Tip of the Mitt Watershed Council
426 Bay Street
Petoskey, MI 49770
Phone: (231) 347-1181
Fax: (231) 347-5928
www.watershedcouncil.org

United States Department of Agriculture- Michigan Natural Resources Conservation Service
Northern Lower Peninsula Office
271 W. McCoy
Gaylord MI 49735
Phone: (989) 732-6526
Fax: (989) 731-0744
http://www.nrcs.usda.gov/wps/portal/nrcs/site/mi/home/

State Administrative Office
3001 Coolidge Road, Suite 250
East Lansing, MI 48823
Phone: (517) 324-5135
http://www.nrcs.usda.gov/wps/portal/nrcs/main/mi/contact/state/

COUNTY CONTACTS

Cheboygan Conservation District
Peggy Bannatyne-Administrator
825 South Huron, Suite 2
Cheboygan, MI 49721
Phone: (231) 627-3383
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Cheboygan County Michigan State University Extension Office
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APPENDIXES

APPENDIX A

PLANT SPECIES USED AT GREENBELT DEMONSTRATION SITE

Allium cernuum	Nodding Wild Onion
Amelanchier spp.	Serviceberry
Andropogon gerardii	Big Bluestem
Asarum canadense	Wild Ginger
Asclepias tuberosa	Butterfly Weed
Aquilegia canadensis	Columbine
Campanula rotundifolia	Harebell
Carex pennsylvanica	Pennsylvania Sedge
Cornus sericea	Red-osier Dogwood
Diervilla lonicera	Bush honeysuckle
Echinacea pallida	Pale Purple Cone Flower
Helianthus occidentalis	Western Sunflower
Heliopsis helianthoides	False Sunflower
Liatris aspera	Rough Blazing Star
Penstemon digitalis	Beardtongue
Potentilla fruticosa	Shrubby Cinqefoil
Rhus aromatica "Grow-low"	'Grow-Low' Fragrant Sumac
Rudbeckia hirta	Black-eyed Susan
Schizachyrium scoparium	Little Bluestem
Silphium terebinthinaceum	Prairie Dock
Verbena stricta	Hoary Vervain

PLANT SPECIES INCLUDED IN NATIVE PLANT KITS

Allium cernuum	Nodding Wild Onion
Andropogon gerardii	Big Bluestem
Anemone virginiana	Thimbleweed
Asclepias incarnata	Swamp Milkweed
Asclepias syriaca	Common Milkweed
Asclepias tuberosa	Butterfly Weed
Aster novae-angliae	New England Aster
Chelone glabra	Turtlehead
Desmodium canadense	Showy Tick Trefoil
Diervilla lonicera	Bush Honeysuckle
Eupatorium maculatum	Joe-Pye Weed
Helianthus divaricatus	Woodland Sunflower
Helianthus occidentalis	Western Sunflower
Heliopsis helianthoides	False Sunflower
Heuchera americana	Alum Root
Liatris aspera	Rough Blazing Star
Liatris spicata	Marsh Blazing Star
Lobelia cardinalis	Cardinal Flower
Lobelia siphilitica	Blue Lobelia
Monarda punctata	Horsemint
Panicum virgatum	Switch Grass
Penstemon digitalis	Beardtongue
Pycnanthemum virginianum	Mountain-Mint
Ratibida pinnata	Yellow Coneflower
Rudbeckia fulgida	Black-eyed Susan
Rudbeckia laciniata	Green-headed Coneflower
Schizachyrium scoparium	Little Bluestem
Scutellaria lateriflora	Mad-Dog Skullcap
Senna hebecarpa	Wild Senna
Silphium terebinthinaceum	Prairie-Dock
Solidago rigida	Stiff Goldenrod
Thalictrum dioicum	Early Meadow Rue
Vernonia missurica	Ironweed
Zizia aurea	Golden Alexanders

APPENDIX B

A SECOND LIFE FOR TREES IN LAKES: AS USEFUL IN WATER AS THEY WERE ON LAND

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College of Natural Resources University of Wisconsin-Stevens Point | Stevens Point | Wisconsin 54481

Ten thousand years ago, a tree grew near a lakeshore somewhere in North America. For 140 years or more, fish swam in its shade and insects hatched on its branches and leaves; some were eaten by birds, some fell into the water to be eaten by fish, some survived to continue the cycle of life. Birds nested and foraged in its branches, perhaps kingfishers dropped like rocks, propelled by gravity to their next meal; eagles perched among its highest branches. A wood frog chorus would start each evening in spring near the first crotch, and often red squirrels would chatter for whatever reason red squirrels chatter. Then one day it happened: after years of increasing decay near the end of its life, the tree snapped at the butt during a windstorm, and fell with a thunderous crash into the lake; 140 years of silence and quiet rustling, punctuated by a single quick loud finale. Within a minute, the waves that had acknowledged the tree's entry into the water subsided, and all was quiet again.

The tree had lived a full and accomplished life. It had crossed paths with countless generations and species of organisms that used or relied on the structural characteristics of its bole and branches or functional processes to carry on with their own life, changing with seasons, changing with age. Yet now, it began its second life…in the lake. Within hours, crayfish crawled beneath its partially submerged trunk, to be followed by a mudpuppy and tadpoles, while minnows and small fish hovered within the lattice of its branches. Within days, logperch, darters, sunfish, bass, burbot, pike, and even walleye and muskellunge had also entered the complex network of the newly established community. Algae and diatoms began establishing colonies, while dragonfly nymphs and mayflies followed to forage among the branches. A wood duck competed with a softshell turtle for basking space on the bole that once contained its nest site cavity. Herons, green and blue, alternated use as well: a fine place to access the fish below. And use of the tree by a variety of organisms would continue again for much longer than its life on land; remarkably perhaps 300 to 600 years, slowly changing shape over time as it yields to father time. Different organisms continue to use the tree until the cellulose had completely been broken down and its chemical constituents had been fully integrated into the web of life in the lake. And even in the remaining shallow depression it left on the lake bottom, leaves and needles of trees still standing, accumulate creating more habitat for aquatic insects. All this and more occurred from a single tree. A habitat as diverse as this, a relationship between flora and fauna, a union of land and water, evolved to perfection over millennia.

For millennia, trees have fallen into lakes and fish have been associated with them. It is no mistake then that among numerous paleontological sites of ancient lakes that I study in the western United States, some as old as 65 million years, I often find fossils of trees and fish together, remnants of ancient littoral zones. Early pike (Esox tiemani) and eight other species of fish are found among leaves and branches of numerous species of trees including the now extinct Ginko trees in an ancient lake in western North Dakota. In Wyoming, palm fronds and other trees are found among mass mortalities of ancient herring and a community of other fish species preserved together in stone. And even today, a plethora of species still can be found among the bole and branches of submerged trees in lakes. This evidence clearly underscores the long lasting relationship between aquatic and riparian ecosystems, between trees and fish, perhaps as long as both have existed on earth. The structural and functional linkage between littoral zones and riparian areas is forged by the concomitant juxtaposition of the land-water interface. Trees in riparian areas grow, mature, and fall into lakes; seedlings mature and replace older trees, thus continuing the cycle. Throughout time, this union has been interrupted only occasionally by some large scale catastrophic event; a fire, windstorm, or perhaps even some volcanic eruption such as witnessed at Mount St. Helens in Oregon eliminates trees precluding any recruitment into aquatic systems. Despite the size and extent of these largescale events, they all have one thing in common: nature recovers if given the opportunity. Ecosystems are resilient; they bounce back. Some slopes of Mt. St. Helens, for instance, have been largely reforested by natural processes. Similarly, riparian areas of lakes and streams burned in 1987 in Yellowstone National Park now exhibit an abundance of new young trees, some of which may later fall into lakes and streams to become habitat for aquatic life. Clearly, once riparian areas reestablish, the relationship between trees and fish can continue. More recently, changes to riparian areas of lakes in north central North America differ

from those caused by natural phenomenon: they face man. Man has altered riparian areas of lakes at rapid rates across a large portion of the landscape, first by logging and more recently by lakeshore development. However, it is this latter perturbation that is potentially more problematic. In the upper midwestern United States, forest stands have recovered, more or less, in previously logged areas and now sustain second growth forests. As a result, trees again recruit to lakes by a variety of natural processes and anthropogenic events. In contrast, along developed shorelines of lakes, many riparian landowners have removed some or all trees from both land and water, thus eliminating the beneficial uses they provide in natural systems, as have other perturbations. However, the recovery process has now been altered by shoreline development. After the initial perturbation where trees are removed (similar to timber harvesting), succession is often held in check as many landowners continually manicure their property. Where landowners have removed understory trees, seedlings and saplings, they further delay recovery, perhaps indefinitely until attitudes regarding land use change. However, management that fails to take into account both short term (i.e., removal of older trees) and long term (i.e., removal of understory, seedlings, and saplings) processes, will ultimately converge toward the same consequence: no trees. No riparian trees means that one source of one component of littoral zone habitat is eliminated.

Large woody structure

Trees in lakes are often referred to as "large woody debris", a misnomer specifically derived from debris torrents in steeper western mountain terrain where debris jams full of soil, sod, shrubs, sticks, twigs and whole trees collect during a mass wasting event clogging streams and often creating temporary ponds in streams. The term "debris" also connotes something to dispose of and having little value. Because of the value of large wood in both streams and lakes, and because of the aforementioned derivation of the term "large woody debris" is largely inappropriate. The more appropriate term should be large woody structure or submerged wood, used herein.

Use of large woody structure by fish

Fish use submerged trees in a variety of ways. Many species spawn adjacent to or under trees that provide cover which helps them protect their incubating brood. In smallmouth bass and other centrarchids, nests adjacent to or under submerged trees reduce the nest perimeter that needs to be defended against predators. Small sticks and twigs are often found in the nests of bluegills; eggs are attached to the sticks keeping them above the bottom where they may be exposed to fungus. Fathead minnows spawn on the underside of wood in cavities. The young of many species of fish are dispersed throughout the branches for protection while predators, such as northern pike and muskellunge, use the same trees for ambush foraging. Shade from branches and the bole provides daytime refuge for diurnal species such as walleye. Use of trees can be species, age, and season dependent but regardless of how different species of fish use trees, trees clearly attract fish.

Our current research shows that the association of fish to trees clearly is related to the complexity of branches and to a lesser extent, the location and position of the tree in water. More fish and more species of fish use more complex trees and in fact, individual, large, complex trees host entire fish communities. In north temperate lakes, up to 15 species or more may inhabit a single tree at a time (Table 1). Walleye and white suckers can be found beneath trees in deeper water, adult smallmouth bass can be found beneath the bole, and many of the other species from cyprinids (i.e., minnows), to bluegills, pumpkinseed, rock, bass, to muskellunge and more can be found throughout the complex web of branches. But we need to look beyond single trees to understand how they function in lakes which in turn, helps foster proper stewardship. For instance, submerged trees located closer to other submerged trees result in even greater numbers and diversity of fish compared to individual trees. Larger numbers of submerged trees create a mosaic of habitats over greater shoreline areas than single trees do. This underscores the importance of riparian areas;

we need to manage entire riparian areas that help develop complex littoral zone habitats, not just individual trees. In lakes with depauperate natural habitat features, such as large woody structure, just about any structure, such as cribs will attract fish. Fish cribs are often built to attract fish for anglers in the guise of "habitat management" and in essence attract both fish and anglers, yet the role of cribs as actual habitat is not well established. The attraction of fish to a crib can be substantial, provided it is designed correctly. However, natural trees are inherently more complex, providing better habitat than cribs.

Table 1. Fish species found in one submerged white pine tree in Katherine Lake, Wisconsin:

Black Crappie	Smallmouth Bass	Yellow Perch	Walleye
Largemouth Bass	White Sucker	Johnny Darter	Bluegill
Muskellunge	Rock Bass	Mottled Sculpin	Logperch
Pumpkinseed	Cyprinids*		

Trees differ in their suitability to different species of fish based on architectural differences that change over time and differ among tree species. After falling into a lake, trees decompose and decay, losing their structural complexity. Concurrently, the number of species and the abundance of fish associated with that tree decline. If trees are alive at the time they fall into the lake (and provided it is the right season), they will have leaves or needles intact for a short period of time (usually a season), further increasing their complexity. Over time, they then lose fine branching first, followed by coarser branching, until a simple bole remains; then even the bole, resistant to decay, finally succumbs to decomposition. Unfortunately, the rate of decay and decomposition relative to its use by fish is not well studied. There are also differences in the architecture of tree branching, the largest difference occurring between hardwoods and conifers. Conifers tend to have a denser, more compact arrangement of branches, than do hardwoods primarily because their branches extend in concentric whorls.

Habitat management and sustainability

Clearly, large woody structure in lakes creates habitat, but it is still not well understood. One question unanswered is what level of large woody structure actually increases the abundance of a particular species of fish, a fundamental problem in understanding habitat in general. Habitat is one of those words that is supposed to make people feel good. Use the term among anglers at a fish club meeting and you can see members grinning and nodding with satisfaction as the general concept of habitat is something everyone can relate to and agree on. Habitat is good. In fact, it is as good and wholesome as mothers, apple pie, and that truck company that begins with a "C". Moreover, the person mentioning habitat among his peers instantly elevates his stature just simply by invoking the term. However, understanding habitat and managing habitat is far from simple. Why is that? It probably results because the word habitat invokes a wide variety of images among lay people and biologists alike and because a conceptual basis for understanding and quantitative research on habitat is lacking. Habitat in lakes could be any or all of the following: rock bars, macrophytes, a series of docks along a lakeshore, fish cribs placed by management agencies, rip-rap shorelines, sunken Christmas trees, sunken boats, etc. In fact, just about anything ever naturally occurring in lakes or placed in them by people can be construed as habitat by someone for some species. In extreme cases, power companies propose building reefs in the Great Lakes with waste material from coal-fired power plants that increase their profitability because of the ease at which this material can be barged and "dumped". Yet, this material is so heavily laden with an alphabet soup of toxic chemicals from arsenic to zinc and nearly every nasty element in the periodic chart in between that it would constitute a superfund site were it not for political verbal Gerrymandering that allows people and agencies to fondly refer to this as "habitat"…" Well, if it walks like a duck…". Oil companies abandon offshore oil rigs that are so readily deemed habitat that one wonders how oceanic fish ever survived since the Devonian 450 million years ago without them. Used tires, more commonly used in the southern U.S. are "habitat" and clearly can be readily had and placed into lakes. The list goes on. The variation in conceptualizing habitat results largely from

biases that arise from different life experiences among people or different training among biologists as well as the selfish self-interest of people and corporations. One person's excellent panfish macrophyte bed is of less interest as habitat by smallmouth bass anglers, just as the reverse may be true for late summer mid-water rock humps. Quickly a dilemma arises, what habitat do we manage for when two different people view habitat differently, depending on their self-interests and value systems? Taken to the extreme, with unlimited funds, we actually can (i.e., we have the ability to) restructure entire littoral zones of lakes. Already, lake management groups and agencies try to remediate habitat limitations by placing aerators in lakes, draw down water bodies to compact sediments in millponds, allow macrophyte control by a variety of methods, etc. But the question remains, how should we design or restore the littoral zone? Because our perceptions vary among people and value systems, the only sure guide we have is to look at how habitat is created naturally under the conditions in which natural systems evolved with fish and allow natural processes to structure it again. Since fish evolved with natural terrestrial and aquatic processes at absolutely no cost to anyone for millennia, doesn't it make sense to facilitate the natural processes in these systems? Who can argue with that long-term track record of success? Clearly, this would be the most cost-effective long-term management strategy, certainly until we have more answers.

Recruitment dynamics of trees

Large woody structure is most abundant in smaller lakes with undeveloped shorelines. The rate and pattern in which wood recruits into lakes depends upon the stand dynamics of trees in the riparian area including age, species, site conditions, and stage of succession. This process can be referred to as a recruitment cycle: trees grow in the riparian area, mature, and then fall into the lake. Seedlings develop into saplings and then mature trees, which in turn, continue the recruitment process via succession. Other factors aside, such as disease, extreme weather, fire, etc., mixed-age (i.e., uneven-age) stands would tend to recruit wood periodically in some random fashion depending upon the species present and age of individual trees in the stand. In contrast, even-age stands would recruit in a pulsed fashion; early in the stand age, tree recruitment would be negligible but as the overall stand matures, trees would recruit to the lake at a greater rate. Either episodic natural events or perturbations caused by human activity can interrupt the recruitment cycles. In extreme cases, recruitment rates of trees into lakes are interrupted by catastrophic events such as fire, extreme weather, disease, etc. that can modify riparian vegetation quickly. The immediate consequences are determined by specific properties of the structuring events. For instance, high straight line winds or tornadoes can blow trees down: trees on the windward shore may blow onto land, whereas on lateral or leeward side of the wind, the entire shorelines can have trees blown into the water. The patchy pattern of fires determines which portions of riparian areas burn and which survive. Humans also alter the abundance and distribution of wood into lakes. Fire and logging riparian areas eliminate trees, thus affecting long-term recruitment rates. For instance, Guyette and Cole (1999) found that no trees had entered Swan Lake Ontario since being logged around the turn of the century. However, succession in the riparian area has allowed trees to grow back and the recruitment process will resume in time, bar any additional setbacks. The interval between the structuring event and recovery clearly depends upon stand dynamics. However, the most far-reaching perturbation to the natural recruitment cycle is the development of shoreline properties (i.e., houses and activities) combined with the incessant artificial over manicuring of riparian areas and direct modifications done to littoral zones. Future forest stand composition in the riparian area depends on succession dynamics of younger trees in the understory that carry the recruitment process into the future. Without it, there is no potential for future recruitment. Christensen et al. (1996) found that humans greatly influenced the abundance of trees in littoral zones of lakes. In their study of undeveloped lakes in northern Wisconsin and the upper peninsula of Michigan, they found that in lakes with no development, forested shorelines averaged 555 logs/km of shoreline. On developed lakes, undeveloped shorelines contained an average of 379 logs/km of shoreline versus just 57 logs/km along shorelines where cabins (i.e., houses to mansions) have been built. Jennings et al. (1999) showed that levels of wood in littoral zones of lakes that

had more advanced shoreline perturbations (i.e., having seawalls and rip-rap) was reduced, apparently due to direct removal by riparian landowners interested in having an uncluttered shoreline. But it is the loss of seedlings that delay recovery and sustain the perturbation with the "golf course lawns" being the most extreme case. Another purpose of forested riparian areas is that they buffer lakes and streams from contaminants transported during runoff, particularly from developed watersheds. Ironically, not only have these areas been eliminated where forested riparian areas have been replaced by lawns, often the pesticides and fertilizers added to these artificial environments, exacerbates transport to lakes. In short, we removed the vegetated buffer and on top of that, we've added more pollutants. This role of intact riparian benefits has been well studied and need not be examined here in more detail.

Habitat remediation for wood in lakes

After extolling the virtues of trees in lakes as habitat, it is necessary to caution against remediating treeless littoral zones by directly felling trees as an enhancement technique unless the short term needs are so extreme as to warrant such measures (e.g., endangered fish habitat). Short-term fixes, albeit well-intentioned, often have long-term consequences that need to be fully explored. In a previous job that I once held for an agency in the western United States, I was told that I needed to fell a prescribed number of trees per mile to enhance steelhead and chinook salmon habitat in streams. Initially, we felled trees into the rivers and cabled them to stumps to anchor them in place to increase the length of time they would be habitat for fish. In the short term, we enhanced tree recruitment in excess of the natural rate of recruitment, but over the long haul, we in essence, stole those trees from the future. This is not unlike the debate about the budget deficit. We benefit from current programs by overspending revenues that have consequences for future generations; now future generations must pay for our programs plus theirs. Clearly, more sustainable solutions are needed. Perhaps it's time to revisit Aldo Leopold's land ethic and apply it to managing riparian areas of lakes. Wise management of large woody structure requires we protect both the sources and fate of trees. For fish biologists, taking the lead in helping people restore riparian areas rather than just focus directly on fish in lakes is paramount, but this will require long-range planning and commitments. While the benefits may take generations to be realized, the earlier we start, the sooner we can benefit from reestablishing natural vegetation to riparian areas. Isn't it ironic, that on many lakes, we have reduced or eliminated trees in riparian areas thus preventing their recruitment as habitat into lakes, only to then build fish cribs made of trees at substantial additional cost? Pure craziness. Riparian vegetation is a "free commodity" provided by nature. All we need to do is recognize its benefits and utilize its full potential. Unfortunately, our unwillingness to use this source of free habitat says a lot about our generation. We must first change our perception of what shorelines features are healthy and thus desirable and accept the look of "natural" shorelines as the first step toward restoring littoral zone habitats. Are we willing to plan to improve the future without necessarily being able to immediately reap the rewards of proper stewardship? A tough sell perhaps, but its time has come. If we think hard about the virtues of sustainability, hopefully the course of action will be second nature.

Literature cited

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Jennings, M.J., M.A. Bozek, G.R. Hatzenbeler, E.E. Emmons, and M.D. Staggs. 1999. Cumulative effects of incremental shoreline habitat modification on fish assemblages in north temperate lakes. North American Journal of Fisheries Management 19:18-27.

APPENDIX C

DEQ APPROVED AQUATIC PESTICIDES

DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER RESOURCES DIVISION

AQUATIC PESTICIDES AND RELATED PRODUCTS
CURRENTLY APPROVED FOR USE IN WATERS OF THE STATE

The following products are currently registered with the U.S. Environmental Protection Agency (USEPA) and the Michigan Department of Agriculture and Rural Development (DARD), and have been approved for use in the waters of the state by the Michigan Department Environmental Quality (DEQ). A permit may be required prior to treatment.
Additional products may be approved in the future, pending registration with USEPA and MDARD and satisfactory review by DEQ.

BRAND NAME	REGISTRANT	Liquid or Granular	EPA REGISTRATION NUMBERS	MAXIMUM APPLICATION RATE[1]
Reminder: You should confirm that the product you purchase is labeled for your application site.				
+ Indicates that product is in the process of being discontinued and supplies may be limited.				
ALGAECIDES				
CHELATED COPPER				
AIRMAX ALGAE DEFENSE	AIRMAX ECO-SYSTEMS INC	L	83742-1	0.7 gal/acre-foot, 1.7 gal/acre-foot (macroalgae only)
ALGI-CURE ALGAECIDE	APPLIED BIOCHEMISTS INC	L	7364-09-8959	1.06 gal/acre-foot, 2.13 gal/acre-foot (macroalgae only)
ALGIMYCIN PWF	APPLIED BIOCHEMISTS INC	L	7364-09-8959	1.06 gal/acre-foot, 2.13 gal/acre-foot (macroalgae only)
CAPTAIN LIQUID COPPER ALGAECIDE CAPTAIN XTR	SEPRO	L	67690-9	0.6 gal/acre-foot, 1.2 gal/acre-foot (macroalgae only)
CUTRINE-PLUS ALGAECIDE/HERBICIDE	APPLIED BIOCHEMISTS INC	L	8959-10	0.6 gal/acre-foot, 1.2 gal/acre-foot (macroalgae only)
CUTRINE-PLUS GRANULAR ALGAECIDE	APPLIED BIOCHEMISTS INC	G	8959-12	60 lbs/acre
CUTRINE ULTRA	APPLIED BIOCHEMISTS INC	L	8959-53	0.6 gal/acre-foot, 1.2 gal/acre-foot (macroalgae only)
FORMULA F-30 ALGAE CONTROL	DIVERSIFIED WATERSCAPES INC	L	27588-2	2.0 gal/acre-foot
K-TEA ALGAECIDE	SEPRO	L	67690-24	0.7 gal/acre-foot, 1.7 gal/acre-foot (macroalgae only)
PHOENIX SYMMETRY ALGAECIDE SYMMETRY NXG ALGAECIDE	PHOENIX ENVIRONMENTAL CARE LLC	L	81943-2	0.7 gal/acre-foot, 1.7 gal/acre-foot (macroalgae only)
COPPER				
AQUATROLS RADIANCE ALGICIDE FOR LAKES AND PONDS	AQUATROLS	L	64962-1-83940	0.33 gal/acre-foot, 0.55 gal/acre-foot (macroalgae only)
COPPER SULFATE[2]	VARIOUS	G	various	2.6 lbs/acre-foot, 4.4 lbs/acre-foot (macroalgae only)
EARTHTEC ALGICIDE/BACTERICIDE	EARTH SCIENCE LABORATORIES INC	L	64962-1	0.33 gal/acre-foot, 0.55 gal/acre-foot (macroalgae only)
ENDOTHALL, AMINE SALTS				
HYDROTHOL 191 AQUATIC ALGICIDE & HERBICIDE	UNITED PHOSPHORUS INC	L	70506-175	2.2 pints/acre-foot
HYDROTHOL 191 GRANULAR AQUATIC ALGICIDE & HERBICIDE[3]	UNITED PHOSPHORUS INC	G	70506-174	11 lbs/acre-foot
HYDROGEN DIOXIDE (HYDROGEN PEROXIDE)				
GREENCLEAN BROAD SPECTRUM ALGAECIDE/FUNGICIDE LIQUID	BIOSAFE SYSTEMS LLC	L	70299-2	1.2 - 30.0 gal/acre-foot (depending on algae type and density)

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BRAND NAME	REGISTRANT	Liquid or Granular	EPA REGISTRATION NUMBERS	MAXIMUM APPLICATION RATE[1]
SODIUM CARBONATE PEROXYHYDRATE				
GREENCLEAN GRANULAR ALGAECIDE	BIOSAFE SYSTEMS LLC	G	70299-4	17 lbs/acre-foot, 170 lbs/acre-foot (heavy algae growth)
GREENCLEAN PRO GRANULAR ALGAECIDE/FUNGICIDE	BIOSAFE SYSTEMS LLC	G	70299-6	9 lbs/acre-foot, 90 lbs/acre-foot (heavy algae growth)
PAK 27 ALGAECIDE	SOLVAY CHEMICALS INC	G	68660-9	16.9 lbs/acre-foot
PHYCOMYCIN SCP ALGAECIDE AND OXIDIZER	APPLIED BIOCHEMISTS INC	G	68660-9-8959	3 - 100 lbs/acre-foot
HERBICIDES				
2,4-DICHLOROPHENOXYACETIC ACID (2,4-D)				
AQUACIDE PELLETS AQUATIC HERBICIDE[3]	AQUACIDE COMPANY	G	5080-2	15-60 lbs/acre-foot (depending on treatment area and time of application)
NAVIGATE[3]	APPLIED BIOCHEMISTS INC	G	228-378-8959	old (acre basis label): 100 lbs/acre (milfoil), 200 lbs/acre (coontail, lilies) new (acre-foot basis label): 28.4 - 56.8 lbs/acre-foot (milfoil), 21 lbs/acre (lilies)
SCULPIN G AQUATIC HERBICIDE	SEPRO	G	67690-49	16.3 - 65.4 lbs/acre-foot
2,4-DICHLOROPHENOXYACETIC ACID (2,4-D) AND TRICLOPYR				
RENOVATE MAX G3 AQUATIC HERBICIDE RENOVATE LZR MAX AQUATIC HERBICIDE	SEPRO	G	67690-50	4.7 - 93.7 lbs/acre-foot
CHELATED COPPER				
COPPER EDA AQUATIC HERBICIDE	APPLIED BIOCHEMISTS INC	L	8959-54	3.3 gal/acre-foot
PHOENIX CURRENT AQUATIC HERBICIDE	PHOENIX ENVIRONMENTAL CARE LLC	L	81943-1	3.3 gal/acre-foot
HARPOON AQUATIC HERBICIDE	APPLIED BIOCHEMISTS INC	L	8959-54	3.3 gal/acre-foot
HARPOON GRANULAR AQUATIC HERBICIDE	APPLIED BIOCHEMISTS INC	G	8959-55	40-80 lbs/acre-foot of plant height
KOMEEN AQUATIC HERBICIDE	SEPRO	L	67690-25	3.34 gal/acre-foot
NAUTIQUE AQUATIC HERBICIDE	SEPRO	L	67690-10	3.0 gal/acre-foot
AIRMAX PONDWEED DEFENSE	AIRMAX ECO-SYSTEMS INC	L	83742-2	3.3 gal/acre-foot
DIQUAT DIBROMIDE[4]				
DIQUASH LANDSCAPE AND AQUATIC HERBICIDE	SHARDA USA LLC	L	83529-12	2 gal/acre
HARVESTER LANDSCAPE AND AQUATIC HERBICIDE	APPLIED BIOCHEMISTS INC	L	100-1091-8959	2 gal/acre
HELM DIQUAT AQUATIC AND LANDSCAPE HERBICIDE	HELM AGRO US INC	L	74530-25	2 gal/acre
KNOCKOUT	SYNGENTA CROP PROTECTION INC	L	100-1091	2 gal/acre
LITTORA AQUATIC HERBICIDE	SEPRO	L	100-1091-67690 67690-53	2 gal/acre
NUFARM DIQUAT SPC 2L LANDSCAPE AND AQUATIC HERBICIDE NUFARM DIQUAT 2L HERBICIDE	NUFARM AMERICAS INC	L	228-675	2 gal/acre
PHOENIX REDWING LANDSCAPE AND AQUATIC HERBICIDE	PHOENIX ENVIRONMENTAL CARE LLC	L	81943-23	2 gal/acre
REWARD LANDSCAPE AND AQUATIC HERBICIDE	SYNGENTA CROP PROTECTION INC	L	100-1091	2 gal/acre
SOLERA DIQUAT LANDSCAPE AND AQUATIC HERBICIDE	SOLERA ATO LLC	L	82542-14-84237	2 gal/acre
TRIBUNE HERBICIDE	SYNGENTA CROP PROTECTION INC	L	100-1390	2 gal/acre
TSUNAMI DQ LANDSCAPE AND AQUATIC HERBICIDE	SANCO INDUSTRIES	L	83190-3-72838	2 gal/acre
WEEDPLEX PRO LANDSCAPE AND AQUATIC HERBICIDE	SANCO INDUSTRIES	L	100-1091-72838	2 gal/acre
WEEDTRINE -D- AQUATIC HERBICIDE	APPLIED BIOCHEMISTS INC	L	8959-9	10 gal/acre

BRAND NAME	REGISTRANT	Liquid or Granular	EPA REGISTRATION NUMBERS	MAXIMUM APPLICATION RATE[1]
ENDOTHALL, AMINE/DIPOTASSIUM SALTS				
AQUATHOL K AQUATIC HERBICIDE	UNITED PHOSPHORUS INC	L	70506-176	1.9 gal/acre-foot
AQUATHOL SUPER K GRANULAR AQUATIC HERBICIDE[3]	UNITED PHOSPHORUS INC	G	70506-191	13.2 lbs/acre-foot
HYDROTHOL 191 AQUATIC ALGICIDE & HERBICIDE	UNITED PHOSPHORUS INC	L	70506-175	1 gal/acre
HYDROTHOL 191 GRANULAR AQUATIC ALGICIDE & HERBICIDE[3]	UNITED PHOSPHORUS INC	G	70506-174	dependent on target species (see product label) and DEQ approval
FLUMIOXAZIN				
CLIPPER HERBICIDE	VALENT USA CORPORATION	G	59639-161	0.53 - 2.1 lbs/acre-foot (submergent) 6.0 - 12.0 ounces/acre-foot (emergent)
FLURIDONE[5]				
AVASTI SC AQUATIC HERBICIDE	SEPRO	L	67690-30	6 parts per billion
RESTORE S.M.A.R.T. AQUATIC HERBICIDE	APPLIED BIOCHEMISTS INC	L	8959-57	6 parts per billion
SONAR A.S. AQUATIC HERBICIDE	SEPRO	L	67690-4	6 parts per billion
SONAR GENESIS	SEPRO	L	67690-54	6 parts per billion
SONAR PR PRECISION RELEASE	SEPRO	G	67690-12	6 parts per billion
SONAR Q AQUATIC HERBICIDE	SEPRO	G	67690-3	6 parts per billion
SONAR SRP AQUATIC HERBICIDE	SEPRO	G	67690-3	6 parts per billion
SONAR RTU AQUATIC WEED HERBICIDE FOR PONDS	SEPRO	L	67690-48	6 parts per billion
SONARONE AQUATIC HERBICIDE	SEPRO	G	67690-45	6 parts per billion
WHITECAP SC AQUATIC HERBICIDE	TESSENDERLO KERLEY	L	61842-11	6 parts per billion
GLYPHOSATE				
ACCORD CONCENTRATE	DOW AGROSCIENCES LLC	L	62719-324	6.0 pints/acre
AQUAMASTER HERBICIDE	MONSANTO CO	L	524-343	6.0 pints/acre
AQUAPRO HERBICIDE	SEPRO	L	62719-324-67690	6.0 pints/acre
AQUA STAR	ALBAUGH, INC	L	42750-59	6.0 pints/acre
PHOENIX AVOCET AQUATIC HERBICIDE	PHOENIX ENVIRONMENTAL CARE LLC	L	81943-5	6.0 pints/acre
GLYFOS AQUATIC HERBICIDE	CHEMINOVA A/S	L	4787-34	6.0 pints/acre
REFUGE HERBICIDE	SYNGENTA CROP PROTECTION LLC	L	100-1362	6.0 pints/acre
RIVERDALE AQUA NEAT AQUATIC HERBICIDE AQUA NEAT AQUATIC HERBICIDE	NUFARM AMERICAS INC	L	228-365	6.0 pints/acre
RODEO	DOW AGROSCIENCES LLC	L	62719-324	6.0 pints/acre
SHORE-KLEAR AQUATIC HERBICIDE	APPLIED BIOCHEMISTS INC	L	228-365-8959	6.0 pints/acre
GLYPHOSATE PLUS SURFACTANT				
GLYPHOMATE 41 WEED AND GRASS KILLER PLUS AQUATIC HERBICIDE	PBI/GORDON CORPORATION	L	2217-847	dependent on target species (see product label) and DEQ approval
SHOREKLEAR-PLUS AQUATIC HERBICIDE	APPLIED BIOCHEMISTS INC	L	228-367-8959	2.6 gal/acre broadcast, 2.75% spot treatment
IMAZAMOX				
CLEARCAST	BASF CORPORATION SEPRO	L	241-437 241-437-67690	2 qts/acre (foliar broadcast), 173 oz/acre-foot (submerged), up to 5% by volume (foliar spot treatment)

BRAND NAME	REGISTRANT	Liquid or Granular	EPA REGISTRATION NUMBERS	MAXIMUM APPLICATION RATE[1]
IMAZAPYR				
AQUAPIER AQUATIC HERBICIDE	SEPRO	L	74477-6-67690	dependent on target species (see product label) and DEQ approval
PHOENIX GULLWING AQUATIC HERBICIDE	PHOENIX ENVIRONMENTAL CARE LLC	L	81943-17	dependent on target species (see product label) and DEQ approval
HABITAT HERBICIDE	BASF CORPORATION SEPRO	L	241-426 241-426-67690	dependent on target species (see product label) and DEQ approval
NUFARM POLARIS AC COMPLETE HERBICIDE	NUFARM AMERICAS INC	L	228-570	dependent on target species (see product label) and DEQ approval
NUFARM POLARIS HERBICIDE	NUFARM AMERICAS INC	L	228-534	dependent on target species (see product label) and DEQ approval
PENOXSULAM[5]				
GALLEON SC AQUATIC HERBICIDE	SEPRO	L	67690-47	consult with DEQ and SEPRO
TRICLOPYR				
NAVITROL DPF AQUATIC HERBICIDE	APPLIED BIOCHEMISTS INC	G	228-597-8959	67 lbs/acre-foot
NAVITROL LANDSCAPE AND AQUATIC HERBICIDE	APPLIED BIOCHEMISTS INC	L	8959-56	2.3 gal/acre-foot
RENOVATE 3 AQUATIC HERBICIDE	SEPRO	L	62719-37-67690	2.3 gal/acre-foot
RENOVATE OTF RENOVATE LZR	SEPRO	G	67690-42	67 lbs/acre-foot
SWIMMER'S ITCH				
COPPER SULFATE				
COPPER SULFATE CRYSTALS[6]	CHEM ONE LTD	G	56576-1	2 lbs/100 sq. foot
OTHER				
ADJUVANTS, SINK/DRIFT CONTROL				
AGRI-DEX	HELENA CHEMICAL COMPANY	L	N/A	4.0 pints/acre
CYGNET PLUS	BREWER INTERNATIONAL	L	N/A	2.5 pints/acre-foot
POLYAN	BREWER INTERNATIONAL	L	N/A	1.0 gal/acre-foot
TOPFILM	BIOSORB INC	L	N/A	1.0 pint/acre
SHADE PRODUCTS (DYES)				
DYE PRODUCTS LABELED AS HERBICIDES[7]				
ADMIRAL LIQUID	BECKER UNDERWOOD	L	67064-2	0.25 gal/acre-foot
ADMIRAL WSP	BECKER UNDERWOOD	G	67064-1	0.25 gal/acre-foot
AQUASHADE AQUATIC PLANT GROWTH CONTROL	APPLIED BIOCHEMISTS	L	33068-1	0.25 gal/acre-foot
DYE PRODUCTS NOT LABELED AS HERBICIDES (MANY)				
EXAMPLE: CYGNET SELECT	CYGNET ENTERPRISES	L	N/A	0.25 gal/acre-foot
FORMULA F-40	DIVERSIFIED WATERSCAPES INC	L	N/A	0.25 gal/acre-foot

[1] Maximum rate generally approved by the DEQ. Actual rate required for control may depend on the target species and other site-specific conditions. Refer to product label.
[2] Various copper sulfate products registered with the DARD (517-373-9750) may be used.

BRAND NAME	REGISTRANT	Liquid or Granular	EPA REGISTRATION NUMBERS	MAXIMUM APPLICATION RATE[1]

[3] Granular endothall and granular 2,4-D products may not be applied within 75 feet of any well OR within 250 feet of wells less than 30 feet deep. Isolation distances are measured from the well location, not the shoreline.
[4] Diquat dibromide products are on Michigan DARD's restricted use pesticide list. You must be a certified applicator to purchase and use these products in waters of the state, except for small ponds that have no outflow and are under the control of the user.
[5] Fluridone and penoxsulam use may be subject to Lake Management Plan and/or Evaluation protocols. Contact DEQ for current guidelines
[6] The medium granular size should be used.
[7] Only dyes that are labeled as herbicides must be registered with the USEPA and DARD. Dye product labels which claim herbicidal properties cannot be used in waterbodies where there is an outflow.

NOTES