Big and Little Twin Lakes
Shoreline Assessment
Summary Report

June 2017

Developed by Golden Sands Resource & Development Council and Green Lake County Land Conservation Department

Golden Sands
Resource Conservation
& Development Council, Inc.

1100 Main St, Suite #150
Stevens Point, WI 54481
(715) 343-6215
www.goldensandsrcd.org
info@goldensandsrcd.org

Green Lake County

571 County Road A
PO Box 3188
Green Lake, WI 54941-3188
(920) 294-4051
www.co.green-lake.wi.us
lcd@co.green-lake.wi.us

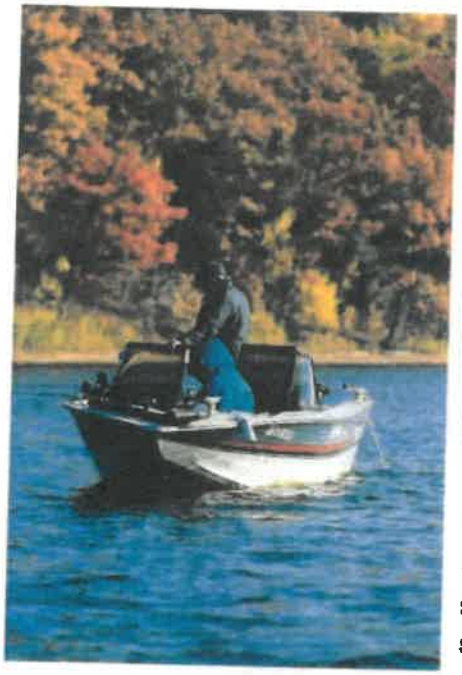
Table of Contents

Introduction

This report is a summary of the shoreline conditions found by Golden Sands Resource Conservation and Development Council staff and Green Lake County Land Conservation Department staff during the summer of 2015.

The goal of the shoreline inventory project was to capture a snapshot in time, the relative shoreline conditions across Green Lake County, and use the resulting data to prioritize individual sites and whole lakes for conservation or restoration projects to protect and enhance water quality of our local lakes.

A healthy shoreline is important to the overall health of a lake, as well as to the individual shoreline property owners. A healthy shoreline is defined as one that contains a variety of native vegetation ranging from ground cover, grasses, wildflowers, herbaceous forbs, shrubs, and trees. It is also important to have structural complexity, such as fallen logs and aquatic plants, to provide habitat for a variety of wildlife.



Shoreline vegetation helps maintain good water quality by reducing nutrient inputs to the lake and preventing soil erosion by stabilizing the soil with deep plant roots. A natural shoreline provides wildlife with food and habitat near the shoreline, which is critical to many species.

Alternatively, disturbed shorelines experience problems, such as shoreline erosion, and negatively influence the lake by contributing to poor water quality, nutrient and sediment runoff, habitat loss, and excessive weed growth. Disturbed shoreline are typically observed with areas that have been cleared of all or most vegetation, lawns which extend to the water's edge along the entire property, and hard structures, such as seawalls or riprap, which have replaced natural vegetation.

Field staff were locally trained utilizing the Wisconsin Department of Natural Resources Shoreline Assessment Protocol (2015). Standardized monitoring protocol and data collection allow relative comparisons of conditions across the County and State.

In 2015, 64 properties were assessed on Big and Little Twin Lakes, totaling approximately 4.1 miles of shoreline. The shoreline inventory included an assessment of the entire shoreline of Big and Little Twin Lakes.

This report presents data collected from inventory into a lake level summary on shoreline conditions, building setbacks, development (including structures, docks, boatlifts, etc.), retaining walls, erosion, aquatic plants, slopes, lawns, and existing buffers. This report can be used to direct future restoration/preservation efforts and programs, and as a baseline for future inventories.

This report is a summary of the findings for the entire lake. Generalizations have been made for reporting purposes. This summary report is not intended to be used as a standalone document for planning purposes. It should be used in conjunction with recorded GIS data for analytical purposes.

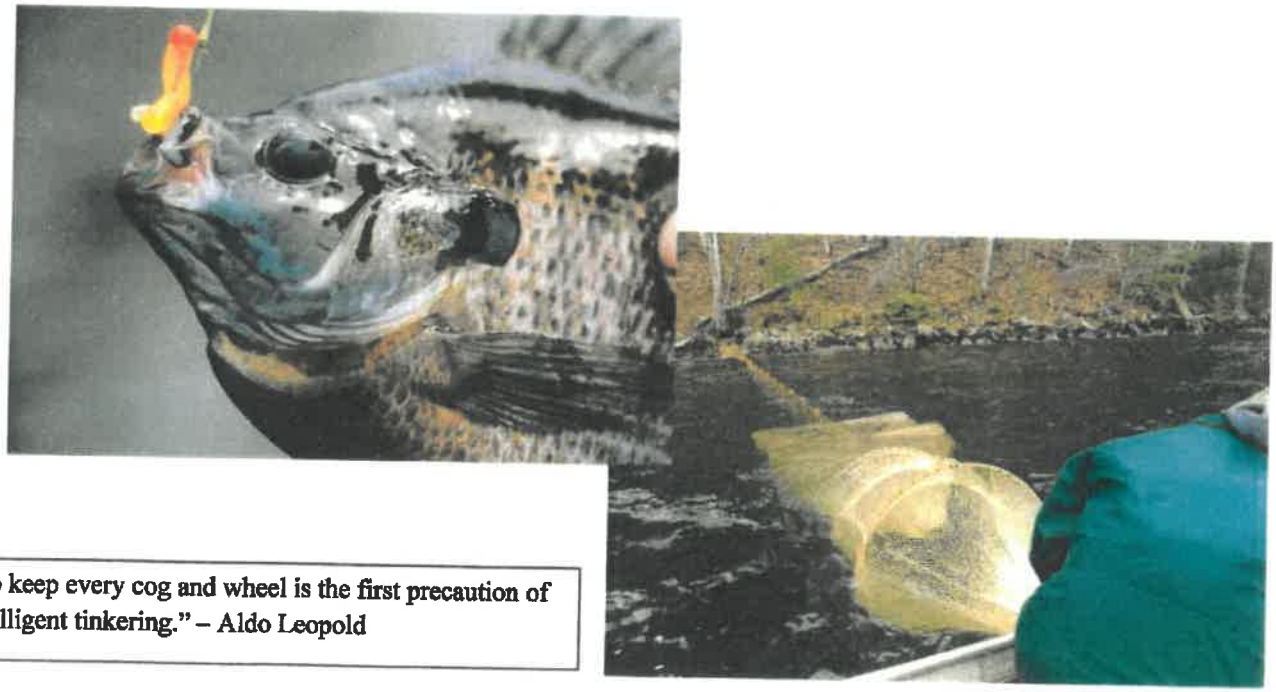
"Many go fishing all their lives without knowing that it is not fish they are after."
~ Henry David Thoreau

Big and Little Twin Lakes Overview

Big and Little Twin Lake cover 111 acres combined. Big Twin Lake has a surface area of 78 acres, with a maximum depth of 46 feet, and Little Twin Lake has a surface area of 33 acres, with a maximum depth of 10 feet. Twin Lakes are natural drainage lakes. A dam, located at the outflow of Little Twin Lake, modifies the water level of the lakes.

The lakes have one main tributary, an unnamed stream which flows into Big Twin Lake on the south shore. It has one outflow, Hill Creek, which drains to Green Lake, a short distance away.

The lakeshore of Big Twin is moderately developed on the north and south shores. Setbacks are greater than average, due to long, steep slopes surrounding the lake. The east and west ends consist of wetlands, and therefore are not developed. The lakeshore of Little Twin Lake is mostly undeveloped due to extensive wetlands surrounding the lake. There is one home located near the south shore of the lake.



"To keep every cog and wheel is the first precaution of intelligent tinkering." – Aldo Leopold

Survey Methodology

The survey crew consisted of a 2-person crew supplied by Golden Sands RC&D, Stevens Point. The crew consisted of a team leader/navigator and data recorder. The crew was trained utilizing the DNR Protocol by a combined team of DNR and County LCD Staff. Daily operations were conducted by Golden Sands RC&D staff with Green Lake County Land Conservation Department Staff responsible for overall project management.

The boat crew navigated the shoreline of the lake, approximately 50-100 yards from shore utilizing a GPS enabled tablet, which was capable of displaying an aerial background image, parcel lines, and the boat's position.

The boat navigator would station the boat in front of each parcel, drop anchor, and begin the survey. Up to 40 data metrics were collected at each parcel regarding the level of disturbance/development present at the site. A laser range finder was used to determine if buildings or other structures were within the primary shoreland area (35 feet from the water's edge). The crew would then navigate to the adjacent parcel and continue the survey.

After the entire lake was completed, the crew would navigate the edge of the shoreline a second time, and record a digital image of the shoreline with a GPS position. Images were recorded for the purpose of data quality assurance and quality control.

At the completion of each lake, datasheets were entered into a spreadsheet for analysis and mapping.

Shoreline lengths for each property were obtained from municipal property records.

(A copy of the protocol manual is located in the appendix of this report)

The following information was recorded for the entire lake:

- Riparian Zone Vegetative Cover (Canopy, Shrub, Ground)
- Impervious Surface
- Manicured Lawn
- Row Crop
- Gully Erosion
- Slumping/eroding Banks
- Littoral Structures (Dock. Lifts, Boathouses)
- Riparian Structures (within 35 feet of water)
- Shore Alterations (Seawall, Riprap, Beach)

(A sample data form is located in the appendix of this report)

Note: Total quantities and percentages calculated for various parameters in the charts and graphs may not add up to the total or 100% due to rounding errors or properties will have no data or have multiple parameters on a single property.

Property Classification & Description

Shoreline conditions exist within a large continual spectrum of conditions. The results of the survey were divided into several defined sectors. Below are some examples of the types of shorelines that were encountered during the survey.

Natural – A healthy buffer of vegetation and/or natural shoreline, which is undisturbed and undeveloped.

Impacted – Some layers of natural vegetation (shrub and/or canopy) have been removed, but the majority of the shoreline buffer is intact. Structures such as docks are present, but are not predominantly present at the shore.

Developed – All natural vegetation has been removed and replaced with manicured lawns, and non-native vegetation. Structures such as docks, decks, retaining wall, boathouses, and/or other structures are predominantly present at the shore.

Degraded – Soil erosion, undercutting of the bank, and/or exposed roots of trees and shrubs are significant.

Note: Examples of shoreline conditions are for illustration purposes only. The properties depicted above are not located within Green Lake County.

For anyone who gone fishing as a child, kayaked, or watched wildlife along the shore, lakes are special places. Healthy lakes are central to many people's lifestyle in Green Lake County, and they enhance the quality our life. A lake's ecosystem is important in providing habitat for wildlife, recreation, aesthetics, and shaping the landscapes around us. Lakes provide habitat for wildlife and enjoyment for people while supporting intrinsic ecological values for all living things. It is difficult to put a price on a natural environment. Certainly, from a vacationer's perspective, lakes are invaluable, providing endless enjoyment and relaxation year-round. Thousands of people head to Wisconsin lakes each summer to enjoy relaxation and scenes of undisturbed shorelines. According to the U.S. Fish and Wildlife Service, 30 million Americans went fishing in 2006 and $30 billion was spent on recreational fishing. Locally, this translates into important economic and recreational benefits. Much of the tax base for Green Lake County is derived from lakeshore properties. In order to protect both property values, and the tax base as a whole, it is important to preserve healthy lakes, which generate demand from homebuyers. As more and more people use lakes for their livelihood and recreation, the competition for lake resources will continue.

Several studies have shown a direct link of property value to water quality and overall lake health. Lakes with clearer water and lack of invasive species commanded higher market prices than similar nearby properties, lacking these amenities.

Protecting lake ecosystems is crucial to not only protecting our local public and economic health, but also to preserving and restoring the natural environment for all aquatic and terrestrial living things. Lake protection and preservation can only be achieved by making informed lake management decisions.

"A thing is right when it tends to preserve the integrity, the stability, and beauty of the biotic community. It is wrong when it tends otherwise." — **Aldo Leopold**

Structures in the Shoreline Buffers

As lakeshores are developed, they typically take on more urban characteristics, such as manicured lawns, landscaping, and outbuildings. Riparian vegetation is typically completely removed or significantly decreased as properties are developed, altering the functionality of riparian areas. Urbanization of the shoreland also increases the amount of impervious area of a watershed. The total percent impervious tends to be greatest near lakeshores where stormwater has the shortest distance to reach the lake, compounding the problem.

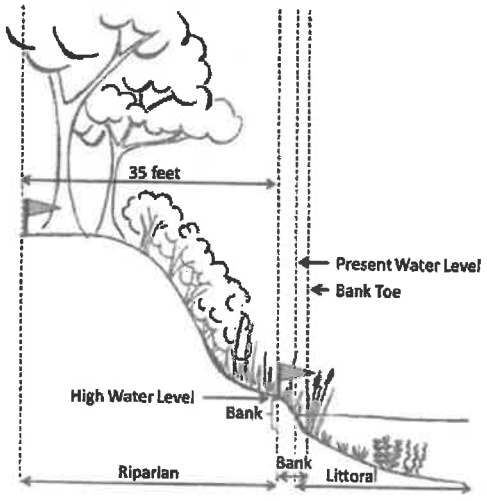
Structures are an important component when looking at the overall shoreland development and riparian disturbance, because they are usually associated with other amenities, such as sidewalks, landscaping and lawns. The presence or absence of buildings can usually be directly correlated with shoreland development on many area lakes. The nearer the structures are to the shoreline the more potential they have to influence the riparian area negatively.

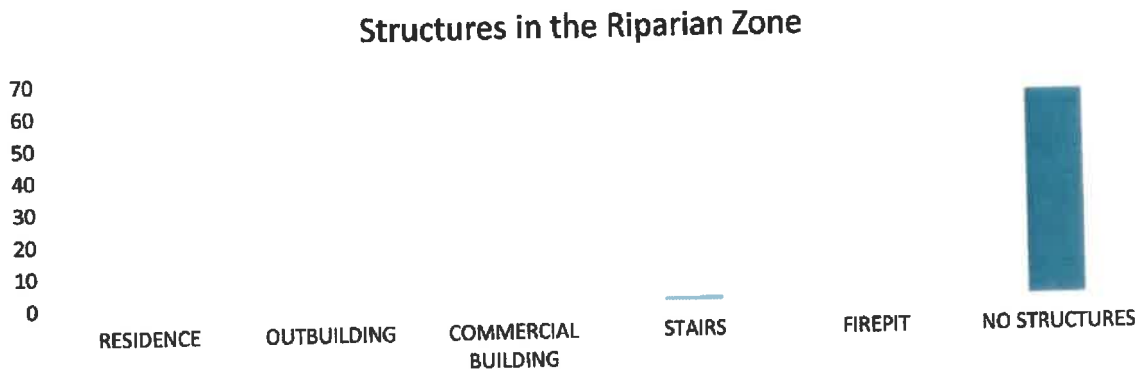
Another concern in regards to homes located close to the water is the location of the septic system. A conventional septic system works by discharging sewage water into the soil at a specified rate. Septic systems are designed to remove pathogens from the water, utilizing the natural soil bacteria. They are not designed to remove nutrients. This means a completely functioning septic system can still discharge nutrients to the lake. The closer the home and septic system is located to the water's edge, the greater chance it has of contributing nutrients the lake. Excessive nutrients can lead to algae blooms and excessive vegetation growth.

Under current standards, there is a required setback from the water's edge of 75 feet; however, outbuildings and older homes or rebuilt homes may have been placed closer due to differing setbacks at the time they were built.

While it is not usually economically feasible to move buildings further away from the shoreline, the area around the buildings can be partially or completely restored to natural vegetation, and runoff can be rerouted.

Future development should be encouraged to be setback from the water as far as practical, and water from impervious surfaces should be directed into infiltration devices or grassed swales.





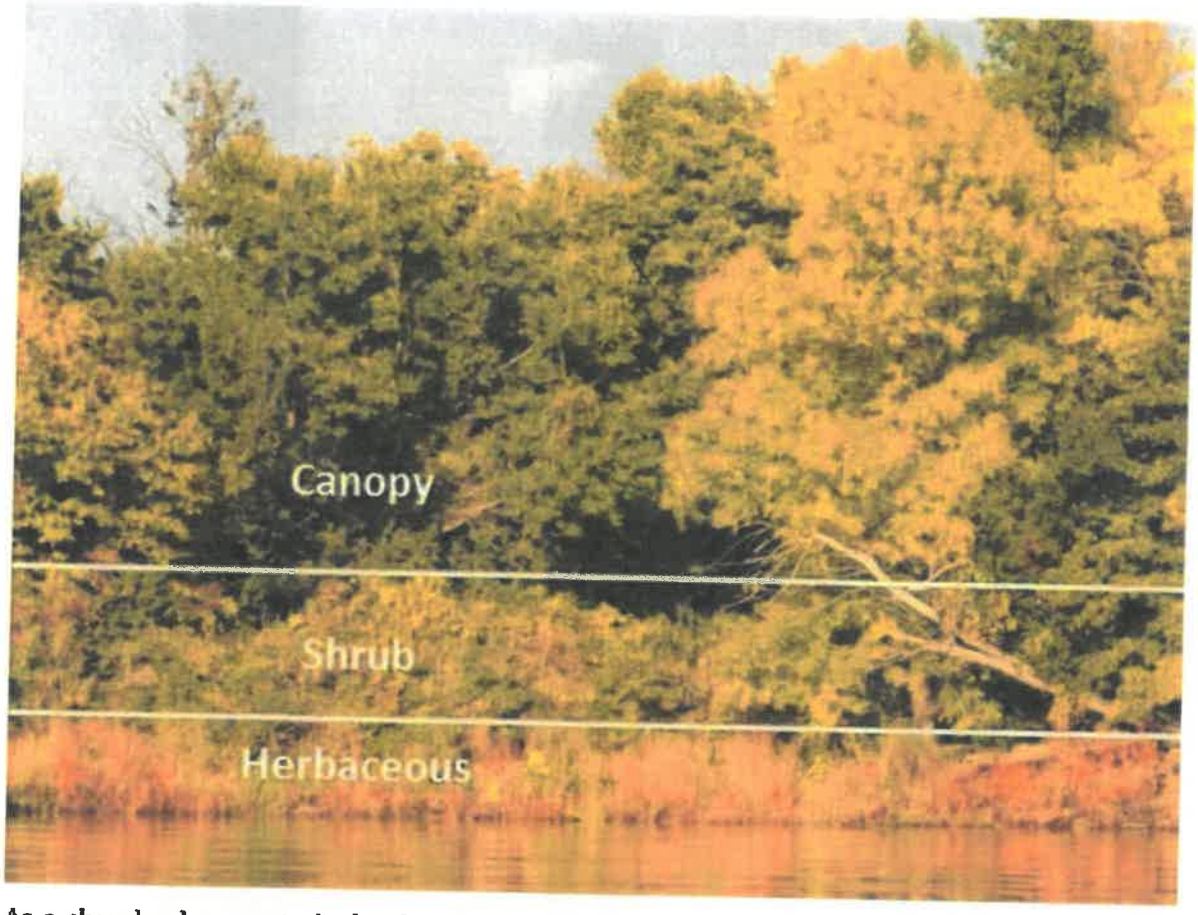
There are no primary residences were located within 35 feet of the waterline on Twin Lakes. The number of parcels with other buildings or structures within 35 feet of the waterline were insignificant ((1%).

Parcel D

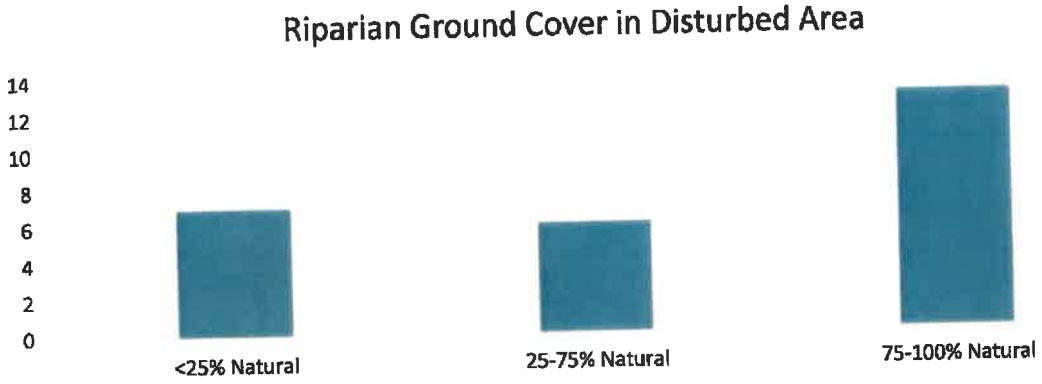
Example of a highly impacted shoreland.

Shoreline Development

A diverse native shoreline buffer typically consists of three vegetation layers and a protective ground layer. Trees, shrubs, ground cover, and duff layer shield the soil from runoff and erosion.

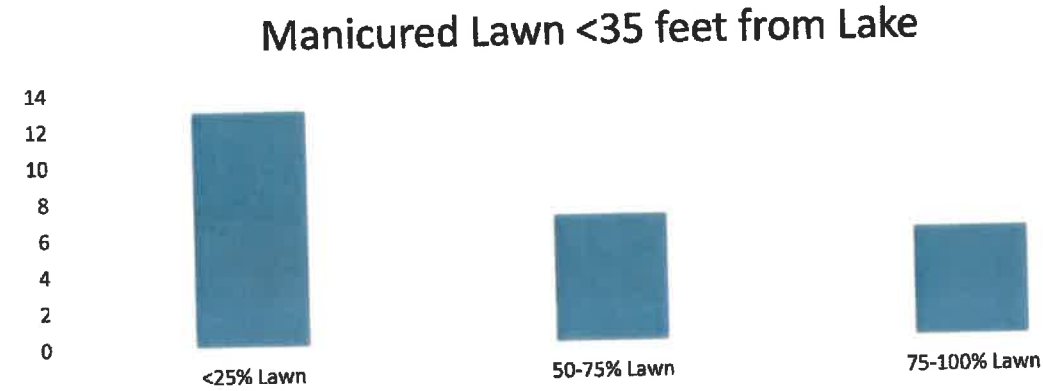


As a shoreland property is developed, the ground layer is usually the first to be removed. The mixture of grasses, wildflowers, ferns, and sedges are replaced with a homogenous lawn grass mixture of bluegrass and fescues. Removing the ground layer immediately removes most of the habitat for many wildlife species including the elimination of food sources, rearing areas for young, travel corridors, and areas to hide from predators.



Of the 64 parcels located on Twin Lakes, 26 (41%) showed some level of disturbance within the primary buffer (35 feet). Of those 26 parcels, approximately 50% of them had 75-100% ground cover remaining intact, which means the groundcover was preserved by using access corridors. This contradicts the trend observed across most lakes in the region.

Viewing corridors, are an area where the majority of the vegetation along the shore remains in place, and a narrow (<=30 ft) access corridor is maintained for accessing the shoreline. The remainind 50% of the developed properties are divided 23% moderately disturbed (25-75%) and 26% highly disturbed (<25%).



Manicured lawns have been shown to greatly increases runoff compared to similar forested parcels. Grassed lawns usually act the opposite of trees and native vegetation. Water will quickly run off lawns due to the shallow root zone and increased soil compaction. While lawn areas are technically considered 'pervious', many in reality are not very pervious at all.

About half (50%) of the disturbed parcels had replaced the ground cover vegetation with manicured lawn. Lawn maintenance and water quality impacts can be reduced by converting some underutilized areas of the lawn to native vegetation.

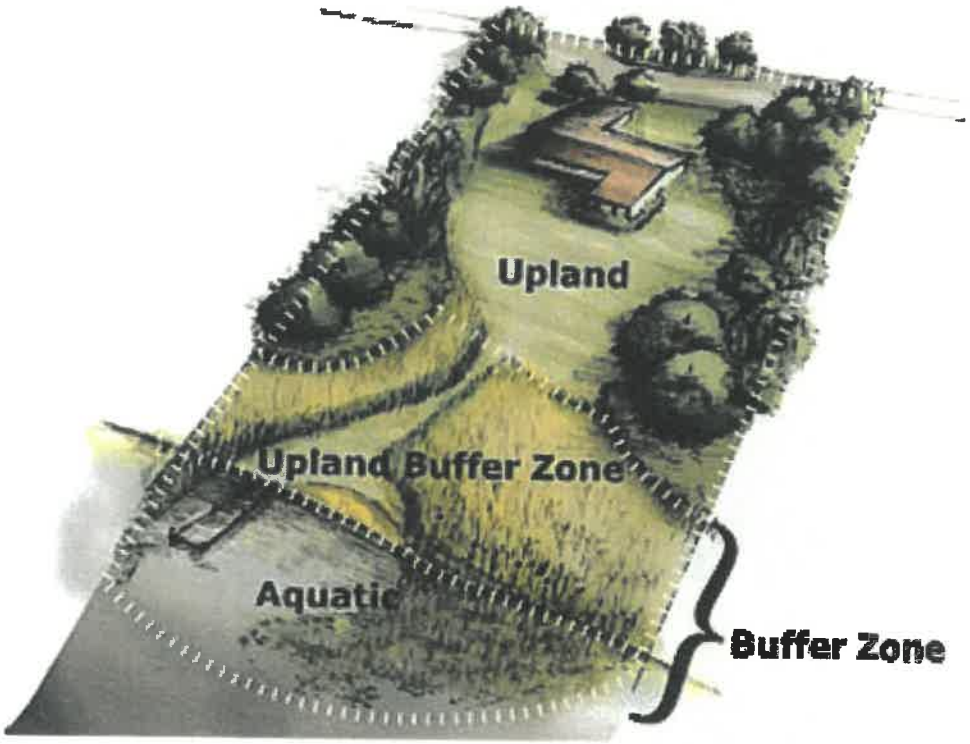
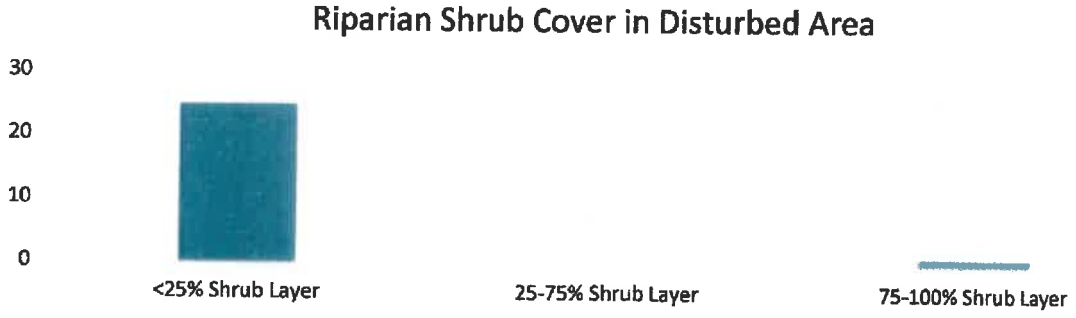


Photo Credit: MN Sea Grant

The second layer that is usually removed is the shrub layer. People like to view the water, and the shrub layer can obstruct views. There are many species of animals, particularly many bird species that rely heavily on a diverse shrub layer along the shoreline. They perch over the water looking for a meal in the shallow waters, or feed on fruit-bearing or nut-bearing shrubs nearby. Fish also rely on overhanging shrubs and brush near the water for shade and protection.



The impact of development on the shrub layer is illustrated by the parcels on Twin Lakes, where 95% of the developed properties contained very little (0-25%) shrub layer. The shrub layer can be restored by selectively planting shrubs where they will not interfere with the use of the property or the view of the lake. In most cases, they can be intentionally placed where it will provide additional privacy to lakeshore homes.

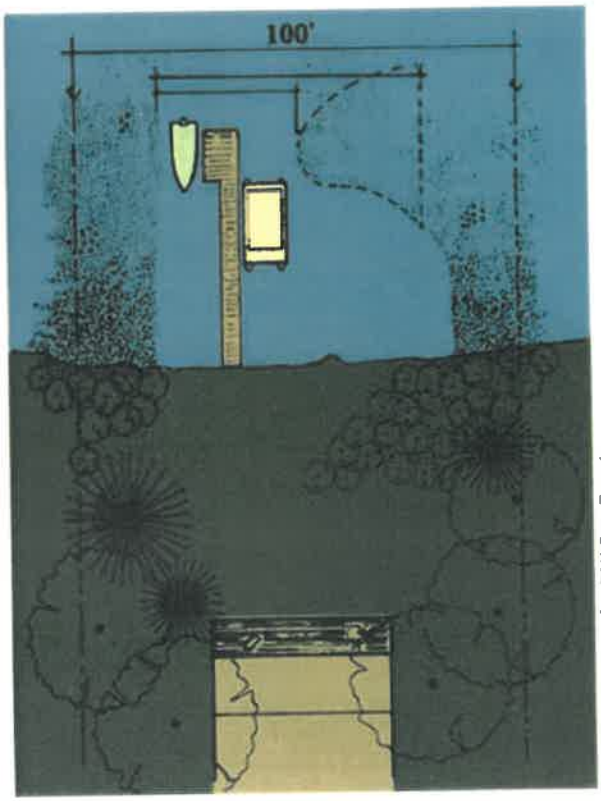
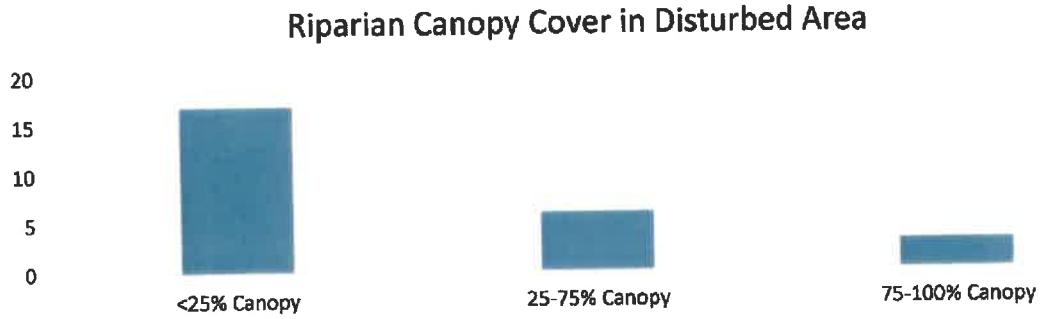


Photo Credit: MN Sea Grant

The third layer, the tree, or canopy layer usually survives somewhat intact. Trees provide shade for many plants and animal species, which require or prefer partial shade for survival. Various trees species also provide food and homes to many wildlife species. Additionally, trees uptake a large amount of water and add to the duff layer, which is important for water infiltration and erosion protection.



Twin Lakes parcels had overall more tree removal or lack of tree cover in the near-shore area than is typically observed in regional lakes. Typically it is observed that developed properties are realtively evenly divided amongst the three categories. However, on Twin Lakes, the parcels were observed to tend towards more tree removal than average. This could be due to cultural changes or landscape.

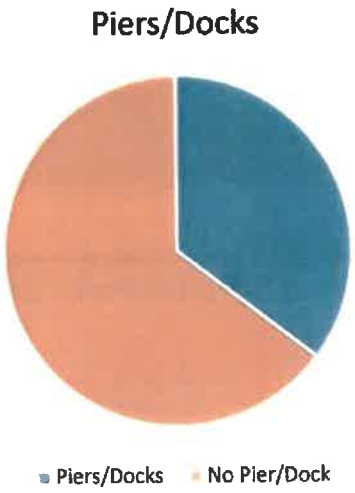
There are many options for lakeshore owners to restore, enhance, or protect riparian buffers. They can be designed in a manner that does not impact the use of the shoreline or the view of the water.

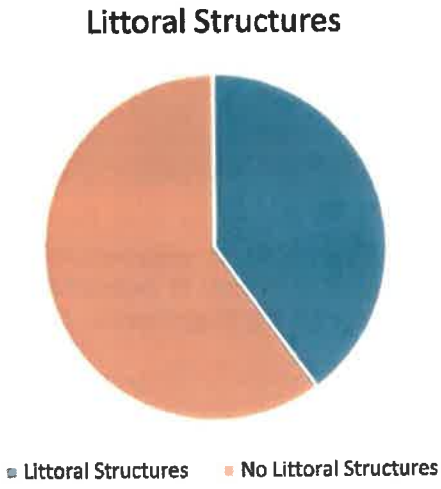
Shoreland Editing is a design approach that utilizes viewing corridors and trimming in place of clear cutting or complete removal of vegetation. This provides both ecological benefits for the lake, and increased privacy for the homeowner.

The majority of the shoreline length surrounding Twin Lakes is in a natural state. This is largely due to the large among of riparian wetlands present around both lakes. The east and west shore of Big Twin Lake, consist of low-lying wetlands, along with nearly all of the shoreline of Little Twin Lake.

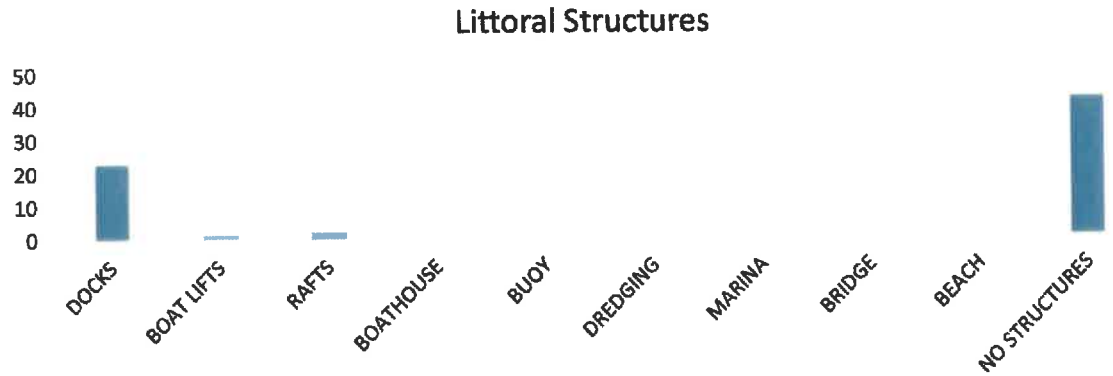
Littoral Zone Structures

The littoral zone of the lake is the area of the water where sunlight penetrates all the way to the bottom, allowing rooted plants to grow. This is a very important area for several reasons. Most species of fish use the plants in the littoral zone for reproduction. They lay their eggs amongst the vegetation, the young fry and adult fish use the plants for protection, and they feed on the small invertebrate creatures that live on the plants. Many amphibian and upland species also rely on the near shore vegetation for feeding, protection, and nesting. Wildlife such as frogs, salamanders, herons, and ducks are a few of the common species found utilizing the littoral zone.





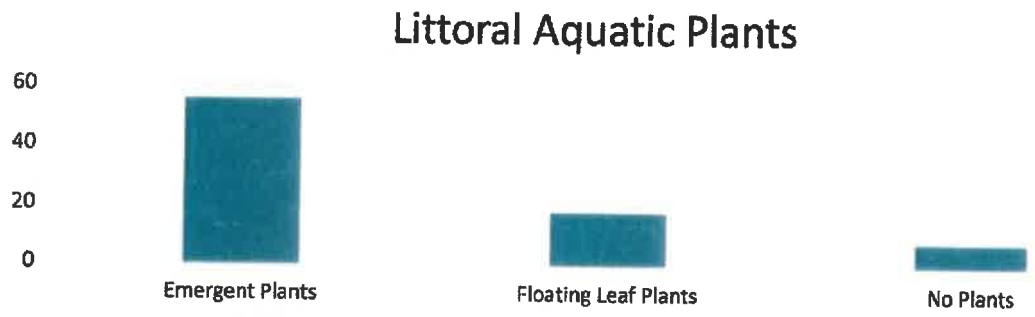
A minority of the parcels (36%) on the water have at least 1 dock or pier. When taking into consideration only the developed parcels around the lake, approximately 88% have a pier placed in the water. The lake association does subscribe to annual chemical treatment of cattails near piers to reduce the encroachment of the plants for many of the parcels with docks.



As a shoreland is developed, in-water accessory structures are common, such as docks, boatlifts, rafts, and water trampolines. As these structures are added to the littoral area of a lake, the area around these items are typically cleared of plants and fallen trees, on which many species rely. For example, a 60-foot dock (standard width of 4 feet) covers approximately 240 SF, but if the vegetation is removed 15 feet on each side, the total impact is 2040 SF, or 850% more impact than just the dock. There is a strong correlation between littoral disturbance and littoral development. The more docks, boatlifts, and other structures that are placed in the water, usually result in a greater removal of aquatic habitat.

Disturbance around docks and boatlifts should be minimized. Encourage clearing only enough vegetation necessary to operate boat motor or boat. It is usually not necessary to clear both sides of the dock. Boat widths are typically under 8 feet. Encourage clearing vegetation on one side of the dock, and only long enough to moor a boat. Rafts should be placed in water deep enough that plant removal is not needed, if legally allowed.

Aquatic Plants



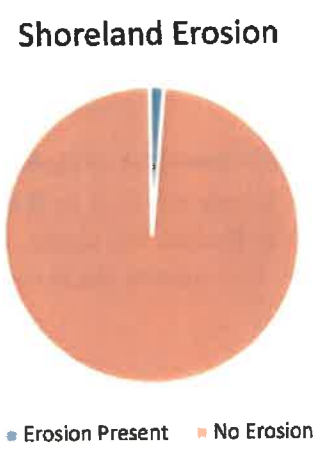
Approximately 87% of the shoreline surrounding the lake had either emergent or floating leaf plants adjacent to the parcel. Submergent plants were not part of the survey protocol, as their impact on shoreland stability and nearshore habitat differs from emergent or floating leaf plants. Only a small minority (13%) of parcels had no emergent or floating leaf plants. This may be due to removal, water depth, substrates, or other localized conditions.

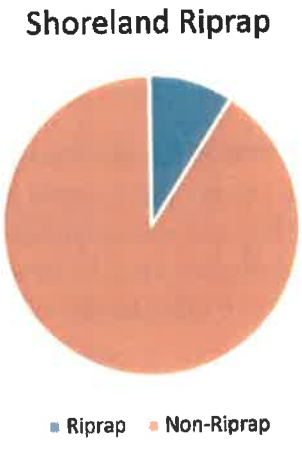
Shoreline Alterations

Artificial structural approaches to protect or increase shoreline stability include riprap, concrete, gabions, matting and bulkheads. Their main purpose is typically to protect shoreline, buildings, and other structures along the shore from erosion. In some cases, these structures are installed for aesthetic or utilitarian purposes. Although these structures can be very effective, typically their negative impacts on riparian areas have been ignored. By using structural approaches, any niches for riparian vegetation and associated wildlife is eliminated. In addition, wave energy of the lake is reflected and results in bottom scour or energy transfer to neighboring properties, which suffer the impacts of increased erosion. Because these structures do not absorb wave energy in ways similar to natural vegetation, this energy is redirected, causing negative impacts to adjacent properties. The replacement of riparian vegetation with hardened structure can impact the in-lake ecosystem because the vegetation provides benefits such as shade and organic matter, a significant food source for in-lake organisms. These artificial structures can also cause problems to the animals that use riparian corridors as travel routes. Studies have found that undisturbed shorelines had double to triple the number of bird species as compared to lakes with artificial structures along their banks.

Landowners should consider replacing seawalls with a less intrusive structures. Failing seawalls can be replaced with vegetated riprap if it is determined erosion protection is required at the site. Other options include a multitude of native plantings, and new technological approaches that mimic natural shorelines with the added benefits of structural support.

Riprap should only extend to the height of the splash zone, or typically 12 inches above the normal water level. Plants and shrubs can be interplanted thru the riprap to restore some of the ecological benefits of a natural shoreline.





A small percent (0.9%) of parcels showed signs of some level of erosion at the shoreline. This may be due to several factors, including removal of shoreline vegetation, removal of aquatic vegetation, improperly installed shoreland protection, boat driven waves, or wind driven waves. A detailed assessment of each individual property would be required to determine the cause and extent of erosion present, which is beyond the scope of this survey.

Summary

In the 2012 National Lakes Assessment, a study of over 1,000 lakes across the country found that habitat disturbance was the number one factor impact overall lake health and ecology. We have observed similar trends in our local lakes. As shorelines are developed and redeveloped, the natural vegetation and substrates are replaced with monotypic vegetation and hardened surfaces. This removes both the habitat and increases runoff and pollution to the lakes. Attention should be given to how shoreland properties can be developed or restored to minimize impacts on the lake to the greatest degree practical.

Twins Lakes have a small number of larger developed parcels with large building setbacks. While there is a prevalence of large expanses of lawn, many of the properties have at least some natural vegetation in the primary buffer. There are opportunities to improve and enlarge the current buffer. There is very little shoreland development in the terms of structures within the primary buffer. This may be due to the fact the lakeshore was developed at a later date than many of the regional lakes. Steep shorelines have encourage larger setbacks on the north shore. On the south shore the steeper shorelines have led to little disturbance of the natural vegetation, and the use of access corridors. Big Twin Lake is plant dominated, and has little need for shoreland armoring, such as riprap to control shoreline erosion. Development on Little Twin Lake is very limited due to riparian wetlands. The lake has large expanses of cattail surrounding all sides of the lake, which discourage shoreland development.

At the time of this survey, the Lake association was updating a comprehensive lake management plan. It would be beneficial to carefully consider the impacts of riparian development around the shoreline.

In the words of the famous conservationist, Aldo Leopold "...the oldest task in human history, to live on a piece of land without spoiling it."

Twin Lakes

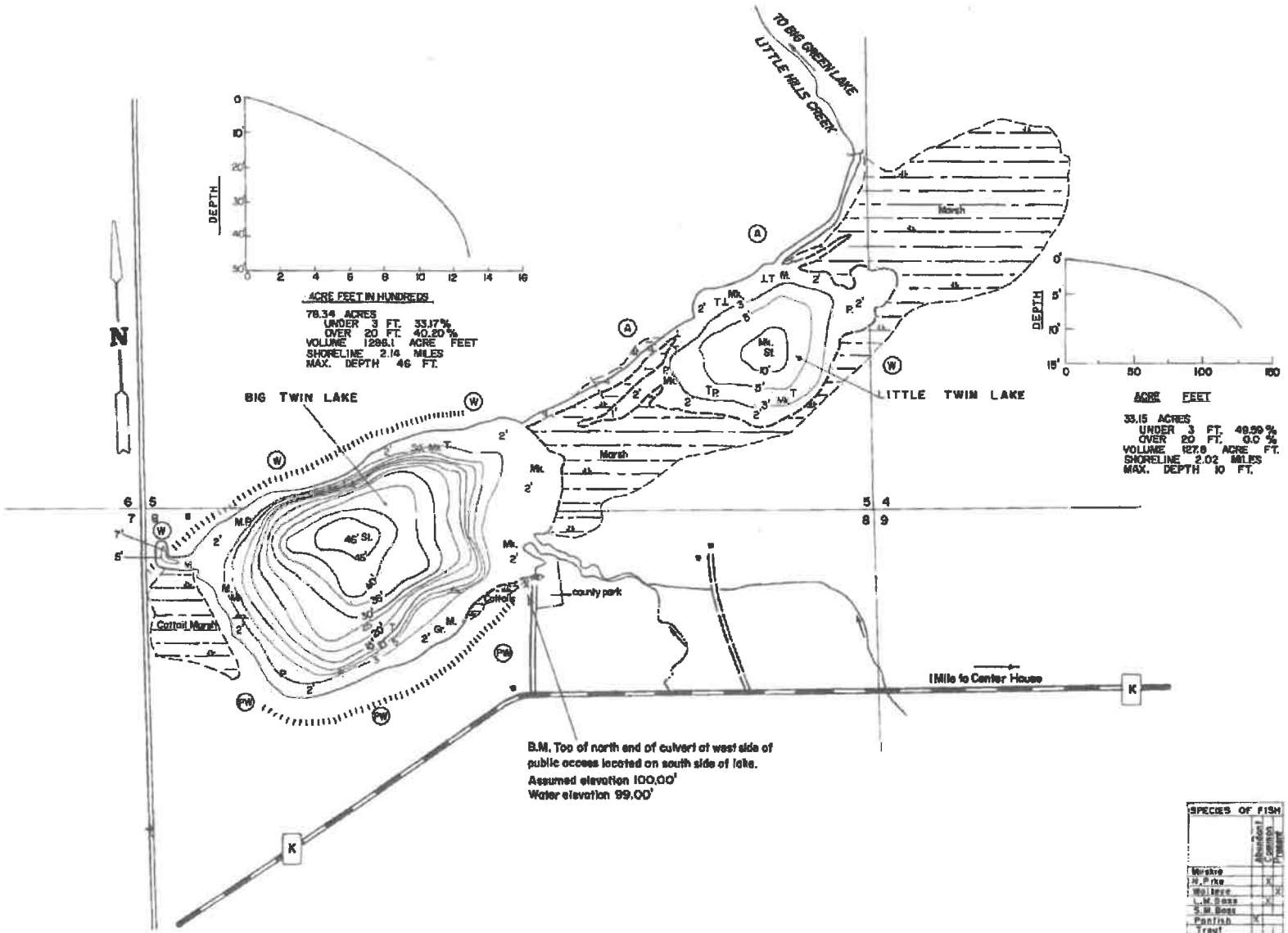
	2016 Twin Lakes (n=64)
Natural Shoreline Conditions (by Parcel)	
>50%	86% (55)
>75%	80% (51)
100%	59% (38)
Bank Modifications	
RipRap	9% (6)
Seawall	0% (0)
Erosion	1.5% (1)
Littoral Modifications	
Pier/Dock	36% (23)
Boat Lift	1.5% (1)
Swim Raft	3% (2)
Mooring Buoys	0
Homes <35 feet	0
Buildings <35 feet	0
Commercial <35 feet	0
Stairs <35 feet	1
Other Modifications	0
Aquatic Plants	
Emergent	88% (56)
Floating Leaf	28% (18)
Natural Shoreline (% of Shoreline)	91%

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

LAKE SURVEY MAP

TWIN LAKES — GREEN LAKE COUNTY

SEC. 4,5,8 T. 15 N. R. 13 E.



B.M. Top of north end of culvert at west side of public access located on south side of lake.
Assumed elevation 100.00'
Water elevation 99.00'

EQUIPMENT RECORDING SONAR MAPPED MAY (MO.) 1966 (YR.)

WATER ELEV. 99.00'

TOPOGRAPHIC SYMBOLS

- (B) Brush
- (PW) Partially wooded
- (W) Wooded
- (C) Cleared
- (P) Pastured
- (A) Agricultural
- B.M. Bench Mark
- a Dwelling
- (R) Resort
- Steep slope
- Indefinite shoreline
- Marsh
- Spring
- Intermittent stream
- Permanent inlet
- Permanent outlet
- Dam

LAKE BOTTOM SYMBOLS

- P. Peat
- Mk. Muck
- C. Clay
- M. Marl
- Sd. Sand
- Sl. Silt
- Gr. Gravel
- R. Rubble
- Br. Bedrock
- T Submergent vegetation
- Emergent vegetation
- Floating vegetation
- Stumps & Snags

SCALE: 500' 0 500' 1000' 1500' 2000' 2500'

◇ Access ◆ Access with Parking ◆ Boat Livery

Field work by: H.Schmude, T.Corbett Drawn by: J.Roth

SPECIES OF FISH

	Abundant	Common	Present
Muskie			
N. Pike			X
Walleye			X
L.M. Bass			X
S.M. Bass			
Panfish		X	
Trout			

TOTALS

- AREA 111.49 ACRES
- UNDER 3FT. 38.6 %
- OVER 20FT. 28.3 %
- VOLUME 1413.9 ACRE FT.
- TOTAL ALK. 280 P.P.M.
- SHORELINE 4.1 MILES
- MAX. DEPTH 46 FEET

Source: Wisconsin Department of Natural Resources 608-266-2621
Big Twin Lake (Twin Lakes) and Little Twin Lake – Green Lake County, Wisconsin DNR Lake Map
Date – May 1966 - Historical Lake Map - Not for Navigation
A Public Document - Please Identify the Source when using it.

Habitat Assessment Data Sheet (one per parcel)

Date _____ Lake name _____ WBIC _____
Parcel ID _____ Observers _____

RIPARIAN BUFFER ZONE

Percent Cover	Percent
Canopy	(0-100)
Shrub ☐ Herbaceous ☐	
Shrub/Herbaceous	sum=100
Impervious surface	
Manicured lawn	
Agriculture	
Other (e.g. duff, soil, mulch)	

description: _____

Human Structures	Number
Buildings	
Boats on shore	
Fire pits	
Other	

description: _____

Runoff Concerns In Riparian or Entire Parcel	Present in Riparian	Present out of Riparian
Point source	☐	☐
Channelized water flow/gully	☐	☐
Stair/trail/road to lake	☐	☐
Lawn/soil sloping to lake	☐	☐
Bare soil	☐	☐
Sand/silt deposits	☐	☐
Other	☐	☐

description: _____

Notes:

BANK ZONE

	Length (ft)
Vertical sea wall	
Rip rap	
Other erosion control structures	
Artificial beach	
Bank erosion > 1 ft face	
Bank erosion < 1 ft face	

LITTORAL ZONE

Human Structures	Number
Piers	
Boat lifts	
Swim rafts/water trampolines	
Boathouses (over water)	
Marinas	
Other	

description: _____

Aquatic Plants	Present
Emergents	☐
Floating	☐
Plant Removal	☐

If Applicable (low water level):
EXPOSED LAKE BED ZONE

Plants	Present
Canopy	☐
Shrubs	☐
Herbaceous	☐
Disturbed	
Plants (mowed or removed)	☐
Sediment (tilled or dug)	☐

DRAFT Lake Shoreland & Shallows Habitat Monitoring Field Protocol

Wisconsin Department of Natural Resources
May 27, 2016

Contributors: Katie Hein[1], Scott Van Egeren[1], Patricia Cicero[2], Paul Cunningham[1], Kevin Gauthier[1], Patrick Goggin[3], Derek Kavanaugh[4], Jodi Lepsch[1], Dan McFarlane[5], Kevin Olson[1], Alex Smith[1], Buzz Sorge[1], Shelly Thomsen[1], Pamela Toshner[1]

Affiliations: [1]Wisconsin Department of Natural Resources, [2]Jefferson County Land and Water Conservation, [3]University of Wisconsin Extension, [4]Green Lake County Land and Water Conservation, [5]Waupaca County Land and Water Conservation

Contents

Overview and Purpose

This guidance document provides a standard methodology for surveying, assessing, and mapping habitat in lakeshore areas, including the Riparian Buffer, Bank, and Littoral Zones. This survey will be conducted by county staff, consultants, Wisconsin Department of Natural Resources (WDNR) staff, and other professionals and can be funded through the surface water grant program (Lake Protection, River Protection, and Aquatic Invasive Species are authorized by ss. 281.68, 281.69, 281.70, 281.71, 281.72, and 23.22(2)(c), Wis. Stats. and administered under chapters NR 190, 191, 192, 195, and 198, Wis. Admin. Codes).

The data is being collected to provide important and useful information to local and regional resource managers, community stakeholders, and others who are interested in protecting and enhancing Wisconsin's lakes. We anticipate that the data generated from this protocol will be used for:

- Teaching and outreach
- Identifying areas for protection or restoration
- Targeting future Critical Habitat Designations within lakes
- Creating lake management plans
- Creating county comprehensive plans
- Aiding management at the county level
- Planning Aquatic Plant Management
- Evaluating trends in lakeshore habitat over time (repeat survey every ~5 years)
- Understanding trends in lake ecology (e.g., fish, wildlife, invasive species)

Reporting tools that stem from this survey are currently under development. Examples of information to be gathered lake-wide include: percent cover of impervious surface, mowed lawn, or plants in the Riparian Buffer Zone, number of parcels with erosion concerns, total length of modified banks, density of human structures (piers, buildings, etc.), general distribution of floating and emergent aquatic plants, and density of coarse woody habitat. For each metric, a threshold identifying healthy habitat will be developed. This information may eventually be used for the WDNR Water Quality Report to Congress, which summarizes the condition of surface waters in Wisconsin.

The time commitment to complete the protocol is reasonable for most Wisconsin lakes, although it will take substantial effort on lakes with long shorelines. We recommend conducting this protocol by circling the lake three times with two people in a small boat:

1. Loop 1 - Take georeferenced photos that slightly overlap
2. Loop 2 - Assess the riparian, bank, and littoral habitat by parcel
3. Loop 3 - Count and map all pieces of large woody habitat in water less than 2 feet deep

Loops 1 and 2 could be combined into a single lap if the team is able to take photos from a consistent perspective and track photo boundaries while also conducting the habitat assessment. Woody habitat should be inventoried separately because the team will need to get close to shore and use extreme focus to find all pieces of large woody habitat.

Requirements

- The habitat assessment should be conducted during the growing season at a date late enough for plants to have leafed out and landowners to have landscaped their property, but before plants senesce and landowners store piers and other equipment for the winter.
- The woody habitat survey could occur at a separate time; spring and fall provide optimal conditions with clear water and few aquatic plants in many lakes.
- The same people should assess all properties on the lake.
- The team should calibrate their eyes to recognize distances by physically measuring common distances with a tape measure or range finder (see Estimating Distance).
- The team should calibrate their eyes to recognize log diameters using the wood calibration stick (see Estimating Diameter and Length of Coarse Woody Habitat).

Equipment

General

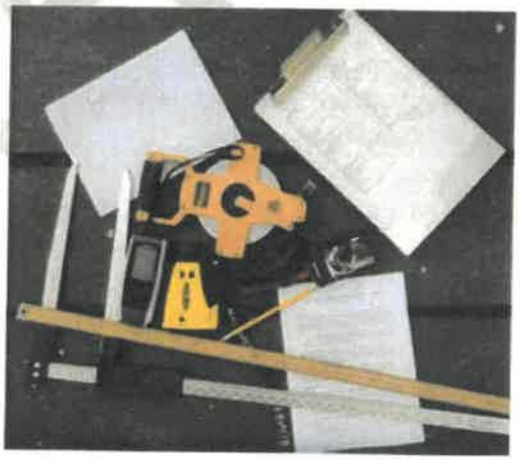
- Data sheets ("Rite in the Rain" paper)
  OR
- Tablet computer with GPS, digital camera, and virtual forms (optional, but useful)
- Pencils
- Boat Equipment
  - Life Jackets
  - Anchor
  - Oars
  - Motor & Fuel

Georeferenced Photos

- Digital camera with GPS
  - Spare SD Card (or other storage)
  - Spare batteries

Habitat Assessment

- GPS
  - Pre-loaded coordinates of shoreland parcel property boundaries
  - Spare batteries
  - Spare GPS unit
- Maps
- Range finder in feet
- Forestry tape measure (50 feet)
- Yard stick or handheld depth finder
- Flagging tape or cones
- Polarized sunglasses



Coarse Woody Habitat Inventory

- GPS
- Secchi disk
- Wood calibration stick
- Polarized sunglasses

Georeferenced Photos (Loop 1)

This is an opportunity to document shoreland habitat condition at a single point in time, and the results may be referred to years later. The entire shoreline should be photographed with slightly overlapping images that are taken from a vantage point ~50 feet from and perpendicular to shore. The water's edge and understory vegetation 35 feet inland should be visible in the photo. Tree crowns may be partially cropped out of the photo.

Photographic Equipment

A variety of cameras may be used:

1. Digital Camera with internal GPS – this option results in high quality, georeferenced photos. The latitude and longitude of the camera's position when the photo was taken is stored with the photo, and locations can be uploaded directly to GIS.
2. Digital Camera and separate GPS unit – this option results in high quality photos that can be georeferenced with post-processing work. Manually adjust your camera's clock so that it displays the same time as your GPS clock. The locations of individual photos can be derived by matching the date/time of each photo with the date/time of the location recorded by the GPS. Check to make sure that the date and time is recorded for each photo and that the GPS unit is continuously recording your path.
3. Smartphone with camera and georeferencing capacity – this option may result in lower photo quality depending on the phone, but has the ability to georeference each photo.
4. Tablet computer with internal GPS and camera – this option has the ability to georeference and store each photo. Check the quality of the camera.

Photo Tips

- If possible, photograph early in the morning or early in the evening to avoid harsh sunlight conditions (or do half the lake in the morning and half in the evening to avoid backlit conditions).
- Do not take photos into the sun.
- Make sure the photo is level and in focus.
- Increase the focal length (high f-stop) to improve depth of field (full frame in focus) or use auto settings with Landscape option.
- Increase the shutter speed to prevent blur.
- Avoid zooming in too close. Try to frame the water's edge up to the canopy with sufficient detail for assessment.
- Respect privacy:
    - Notify the lake association or local paper about the habitat survey in advance.
    - Do not take photos with people in them (weekday mornings are ideal).
    - Avoid taking photos too close to shore or into windows.
    - Listen and respect resident's concerns. These photos will primarily be used for shoreland habitat assessment and lake management plans, but will be a public record and may be used for additional purposes.

Habitat Assessment (Loop 2)

Mapping Prior to Field Work

The shoreland habitat assessment is conducted for each parcel around the lake. Prior to doing field work, maps must be created. At a minimum, maps should include:

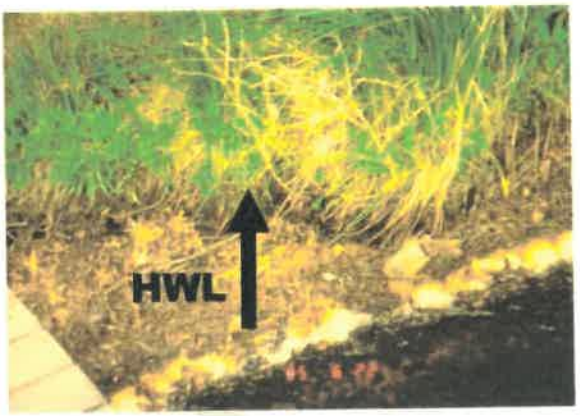
1. Satellite imagery of the lake (e.g., Google or World Imagery in ArcMap)
2. Parcel layer that shows the parcel boundaries: http://www.sco.wisc.edu/wisconsin-geospatial-news/statewide-parcel-database-of-wisconsin-now-available-online.html
3. Parcel ID and the feet of frontage for each parcel
4. Line depicting the 35 foot riparian buffer (use the lake edge of the parcel boundary, not a separate lake polygon file)
5. GPS coordinates where each parcel boundary intersects the lake shore (depending on technology used)

Depending on available technology, there are a variety of ways that navigation in the field may be accomplished. The first option is to use a handheld GPS to navigate to the parcels in conjunction with a paper map. This option requires uploading x,y coordinates for each parcel-lakeshore intersection point to the GPS unit. Use the GPS to navigate close to each point and reference the paper maps to determine the parcel boundaries.

Alternatively, you may take a tablet computer loaded with all necessary map layers into the field. The GPS within the tablet will allow you to view your location relative to the mapped parcel boundaries. This works well with ArcPad, an ESRI software package. If you do not have a license for ArcPad, you may instead use free software (ArcGIS Collector and Google Maps) on a tablet computer or a smartphone. However, a 3G/4G signal is required to view your location relative to the map.

Quality Assurance – Determining High Water Level and Estimating Distances

High Water Level



This protocol is meant to assess habitat regardless of water levels. Before initiating monitoring, the lake level in relation to the approximate Ordinary High Water Mark (OHWM) should be determined and recorded on the quality assurance data sheet. **The OHWM has legal ramifications and must be determined by qualified staff. This protocol will not make legal OHWM determinations, but will borrow the concept to approximate a boundary between land and water called the "High Water Level" or "HWL" in this protocol.** Check the corresponding box if the current water level is below, at, or above the HWL (see Definitions). If water levels are low, the Riparian Buffer Zone could be tens of feet (or more) inland from the present waterline. If the water level is above the HWL, expect to find terrestrial vegetation underwater.

Estimating Distance

This protocol requires estimating distances inland and along the length of shore. Improving your ability to estimate distance inland and along the shore requires practice, so all observers should practice estimating both types of distances before conducting the survey. One quality assurance data sheet must be filled out per crew and lake.

MEASURE & FLAG:
Find a riparian property where you may enter to measure and flag various distances onshore. Measure and flag distances **only** on land you may legally access: public land or private land you were given permission to access.

1. Measure distance inland: Measure 35 feet inland from the HWL perpendicular to shore and place a flag at that point. If possible, repeat this exercise on public land with varying degrees of vegetation (e.g., an open boat landing vs. dense forest) and varying slopes. Measure the 35 foot distance inland horizontally (do not follow the slope angle).
2. Measure distances parallel to shore: Measure five 10-foot intervals, one 50-foot interval, and one 100-foot interval on shore and flag them. Bank modifications require estimating horizontal distances.
3. Observe those distances from the water: Go out on the boat and observe the flags; try to get a sense of the 35 foot buffer inland distance and the varying distances parallel to shore (Fig. 1).

ESTIMATE:

Next, practice estimating the length of shoreline features of unknown distance. Make all estimations from the boat as if you were conducting the survey.

4. For each of 3 replicates, record the estimated and measured distances. You may either:
    a. Flag at least 3 unknown distances of each type (3 inland and 3 parallel to shore) for the rest of the crew to estimate before going out on the boat.
    b. Choose landmarks on shore and estimate their distances from the water (at least 3 distances of each type for a total of 6). Then go back to shore to measure the actual length of the estimated feature with a tape measure.
    c. Choose landmarks on shore and estimate their distances from the water (at least 3 distances of each type for a total of 6). Then use a range finder to test your inland distances. Use a tape measure on land to test the parallel distances.
5. Test the accuracy of your range finder by shooting it to at least 3 different objects on land and then measuring the distance with a tape measure. For each replicate, record the distance estimated by the range finder and the distance measured with a tape measure. Ensure that the range finder is accurate within 2 feet.

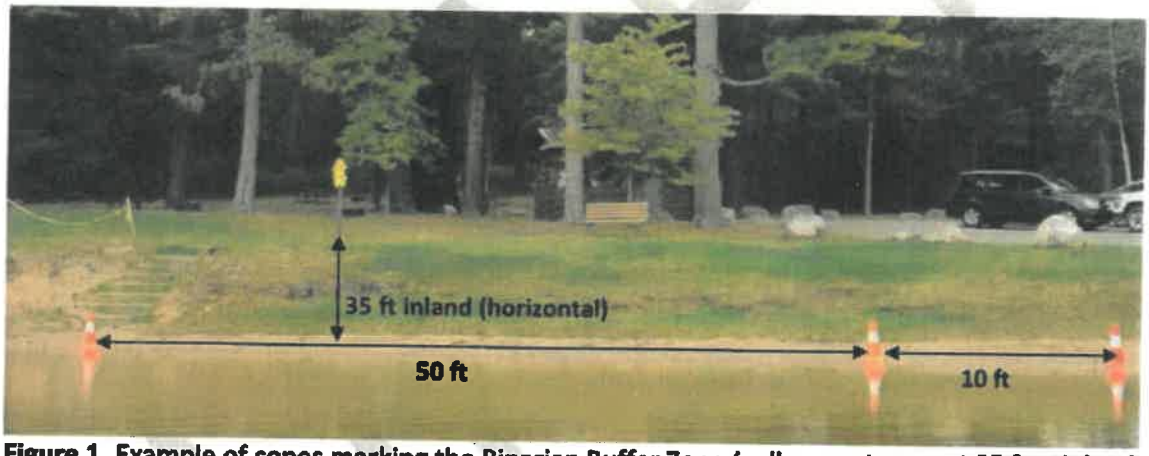
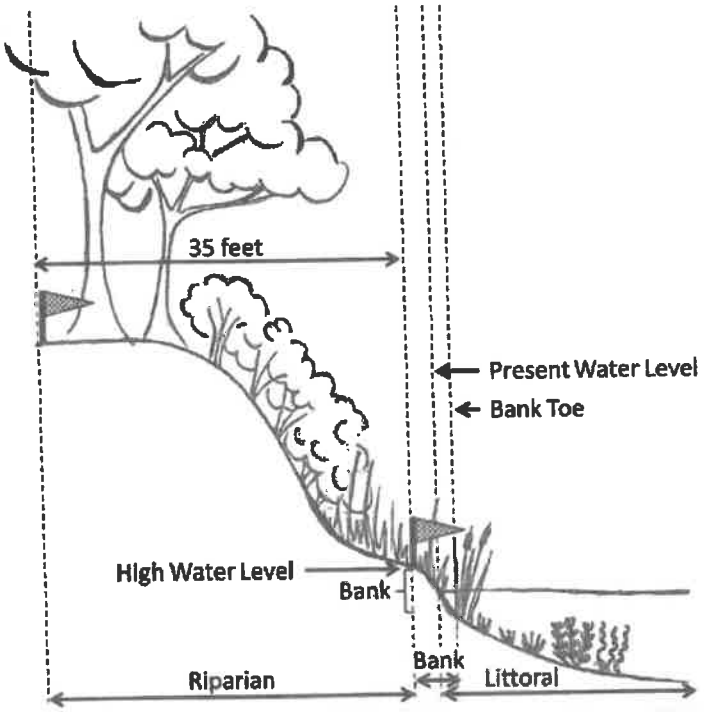


Figure 1. Example of cones marking the Riparian Buffer Zone (yellow vest on post 35 feet inland along the horizontal) and distances parallel to shore as viewed from a boat.

Defining an Assessment Boundary



Shoreland habitat will be evaluated within each parcel. The *Riparian Buffer Zone* begins at the HWL and extends inland 35 feet (Fig. 2). The *Littoral Zone* extends from the present waterline into the lake. The width of the Littoral Zone may vary, but generally includes the area near shore where aquatic plants and human structures are present in the water. The *Bank Zone* is the region between the edge of the top-of-the-bank lip and the bank toe, which is the inflection point between the bank face and the lake bed. It includes the bank face and the shore.

Figure 2. Profile view of lake shore illustrating three habitat zones when water level is average.

The HWL will normally be on the bank face (Fig. 3). Note that depending on where the HWL and the present water levels fall, the Bank Zone can overlap with the riparian and Littoral Zones. In Fig. 3, the Riparian Buffer Zone includes the upper part of the bank. When water levels are low, the lake bed is exposed (Fig. 3). Exposed Lake Bed should be assessed if the present water line is at least 3 feet horizontally out from the bank toe.

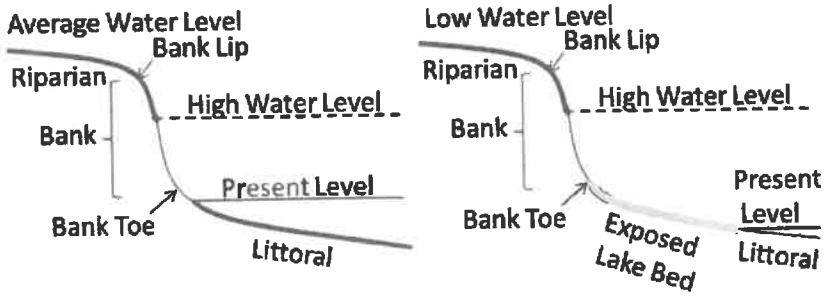


Figure 3. Habitat zones in relation to the High Water Level when the present water level is average (left) or low (right).

From a boat, navigate to the first parcel you will assess. Use landmarks and aerial photography from your map together with GPS coordinates and the rangefinder to define the parcel boundaries and the 35 foot setback. Go close to shore to view the parcel.

Riparian Buffer Zone

Percent Cover

Using your satellite imagery map and observations from the boat, visualize looking down on the Riparian Buffer Zone from the air. If a rain drop fell from the sky, what would it land on? Estimate the percent covered by each of the following in the Riparian Buffer Zone only:

1. Canopy - large trees at least ~16 feet tall (0-100%)

Ground layers (sum to 100%):

2. Shrubs and herbaceous plants - shrubs are woody plants with multiple stems or tree saplings approximately < 16 feet tall and herbaceous plants are grasses and forbs
3. Impervious surface – concrete, decking, boulders, stone, rip rap, rooftops, compacted gravel/soil, boats flipped over on shore
4. Manicured lawn
5. Agriculture - row crops, pasture, range, hay field
6. Other - duff, bedrock, gravel, bare soil, sand, mulch, etc.

Percent canopy cover can be up to 100% regardless of the other percent cover categories because tree canopies can overlap with the other categories. For example, tree branches may shade patio, lawn, and herbaceous plants. The sum of all "ground layers" (shrub/herbaceous plants, impervious surface, manicured lawn, agriculture, and other) must equal 100%. Shrubs and herbaceous plants may overlap and be difficult to distinguish. Estimate their combined percent cover and mark whether the estimate included shrubs and/or herbaceous plants. Check both boxes if both were present. Report percent covers in multiples of 5%. For example, if impervious surface only includes a couple of stairs on a 100 foot long parcel, report 5% cover.

Plants are only quantified in terms of their growth form, but not their taxonomic identity. Percent cover of non-native plants are quantified together with native plants. Species identification skills are not required to conduct this survey. Thus, a Riparian Buffer Zone with 100% cover of reed canary grass, an invasive, will appear the same as a buffer with 100% cover of native sedges. Species identification could be added for individual surveys if desired.

On some lakes, individual parcels could be very large, covering miles of shoreline. If the shoreline is completely undeveloped (i.e., no buildings, mowing, cleared vegetation, etc.), list 100% canopy cover and 100% shrub/herbaceous cover. If a lot of shoreline is covered by wetlands or prairie without trees, try to estimate the actual percent canopy cover (do not assign 100%). If there are signs of human disturbance (structures, cleared vegetation, etc.) in a small section of the entire parcel (e.g., 50 feet of shoreline on a 1600 foot long parcel), then you may assume the disturbed area covers 5% of the entire Riparian Buffer Zone (see example Parcel E on page 28).

Human Structures in the Riparian Buffer Zone

Count the number of structures that are present within the Riparian Buffer Zone of the parcel.

- Buildings (e.g., residence, shed, boathouse, garage, commercial building)
- Boats (generally flipped upside down on shore for storage)
- Fire pits (free standing or built in the ground)
- Other – include written description (e.g., retaining wall), but avoid counting small objects that are easily moved (e.g., toys or lawn chairs)

Runoff Concerns

Look for changes to the land that would increase runoff into the lake (see list below). Record whether the runoff concern occurs within the Riparian Buffer Zone ("Present in Riparian") or within the parcel but outside of the Riparian Buffer Zone ("Present out of Riparian"). If the runoff concern is present in the Riparian Buffer Zone, you do not need to search in detail outside of the Riparian Buffer Zone. You may still check both boxes if the concern occurs both in and out of the Riparian Buffer Zone.

Record presence of:

- Point sources (e.g., culverts, drain pipes, rain gutters, sump pumps, gray water outflow)
- Channelized flow or gullies
- Stairways, trails or roads leading directly to the Bank Zone (top of the bank lip)
- Sloped lawn/soil (such that water runoff leads directly to the lake)
- Bare soil
- Sand/silt deposits
- Other – include written description

Bank Zone

Bank Modifications and Erosion

Estimate the length (to the nearest 10 feet) of the following items if present. Train your eye to recognize 10 foot increments along the shoreline. You may also use the recorded shoreline length of the parcel to aid length estimation.

- Vertical sea wall
- Rip rap
- Other erosion control structures (note what the material is under "Notes")
- Artificial beach
- Slumping banks or bank erosion > 1 foot vertical bank face
- Slumping banks or bank erosion < 1 foot vertical bank face

Littoral Zone

Human Structures

Count the number of human structures present within the Littoral Zone:

- Piers
- Boat lifts (count lifts with and without canopies the same)
- Swim rafts/water trampolines (Do not count rafts beyond ~50 feet out into the water from shore. Rafts may be placed up to 200 feet from shore.)
- Boat houses (over the water)
- Marinas
- Other – include written description

Aquatic Plants

Check the box if emergent and/or rooted floating aquatic plants are present within the Littoral Zone of the parcel. Plants growing only underwater (submergent) are not included in the survey because they may be difficult to observe. Check the box if there are obvious aquatic plant removal areas in the Littoral Zone of the parcel. Aquatic plant removal areas are generally demarcated by straight lines of cleared vegetation that are perpendicular to shore and adjacent to plant beds.

Exposed Lake Bed Zone

When lake levels are low and expose at least 3 horizontal feet of the lake bed (Fig. 3 and 4), this portion of the data sheet should be filled out. Otherwise, skip the Exposed Lake Bed Zone portion of the data sheet. Wisconsin case law grants an owner of riparian property the right to exclude members of the public from the Exposed Lake Bed abutting his property. Members of the public may only access Exposed Lake Bed adjacent to public land or to private land with the consent of the adjacent riparian landowner. Thus, do not step out of the boat and walk on the Exposed Lake Bed toward the HWL unless you have permission from the owner of the private abutting land. This means that the Riparian Buffer and Bank Zones cannot be accurately surveyed when the Exposed Lake Bed becomes very wide. In Fig. 4b, the observers would be too far away to assess the Riparian Buffer and Bank Zones. When lake levels are extremely low, only surveys of the Littoral and Exposed Lake Bed Zones are appropriate. The full survey should be postponed or repeated when water levels are higher.

Plants

Check the appropriate box if plants are growing on the Exposed Lake Bed. Use the same 3 plant growth forms as in the Riparian Buffer Zone: canopy, shrub, herbaceous. At left, the Exposed Lake Bed is sandy with herbaceous plants (Fig. 4a). At right, the Exposed Lake Bed is completely covered with Fasset's Loco Weed, an herbaceous plant (Fig. 4b).

Disturbances

Look for signs of disturbances to the Exposed Lake Bed and check the appropriate box. Specifically, look to see if plants were mowed or removed and look for signs of tilling or digging up the sediment.

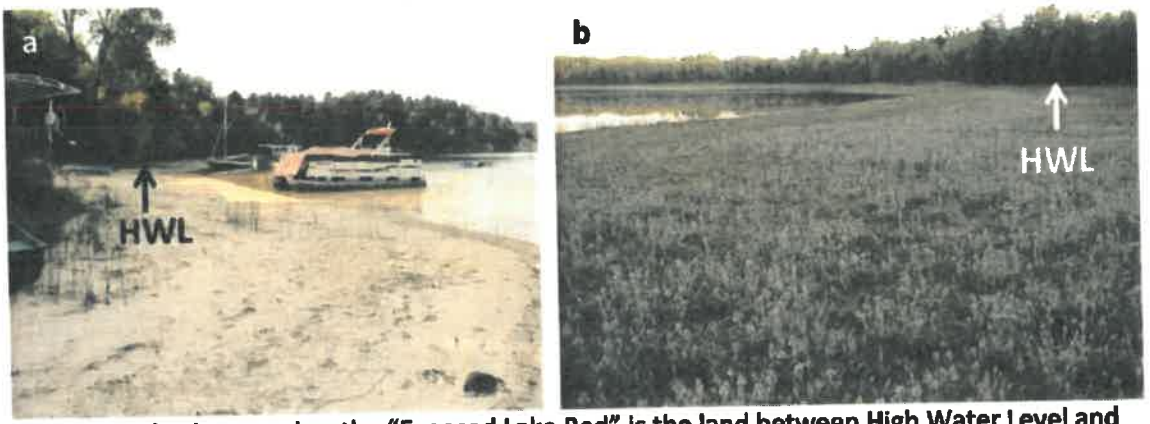


Figure 4. In both examples, the "Exposed Lake Bed" is the land between High Water Level and the present water level.

Coarse Woody Habitat Inventory (Loop 3)

Conduct the woody habitat protocol from a small boat or kayak, not a pontoon or large boat. Small boats can be maneuvered close enough to shore to see woody habitat. First, observe Secchi depth near shore. If the Secchi depth is less than 2 feet, this protocol should not be used because visual estimates of woody habitat will be unreliable.

Second, observe the current water level as compared to the High Water Level (HWL). Check the corresponding box if the current water level is below, at, or above the HWL. If water levels are low, the Riparian Buffer Zone could be tens of feet (or more) inland from the present waterline (Fig. 4 and 5). Coarse woody habitat below the HWL and above the present waterline should still be counted.

Figure 5. Wood stranded above water should be counted if below the HWL.

The woody habitat survey does not need to be associated with parcels. The boat driver should slowly drive the perimeter of the lake at the 2 foot depth contour with help from the observer, who shall periodically check water depth and find the 2 foot depth contour (use a yardstick, handheld depth finder, or marked wood calibration stick). If the Littoral Zone is relatively flat, then follow the 2 foot depth contour at the nearest point to shore. The observer should search for wood while wearing polarized sun glasses to improve visibility. The observer will mark a GPS waypoint for each piece of large wood.

This protocol only enumerates "large wood," defined as greater than 4 inches in diameter somewhere along its length and at least 5 feet long. Only count wood that is between the HWL and the 2 foot depth contour. The large wood section must be in the water or below the HWL. Tree branches hanging over the water may be counted if the required size occurs below the HWL. If water levels are low, note that you will also be counting wood lying on the ground that is out of the water, but still below the HWL. Live branches and non-anchored logs count if they meet the other requirements. Live/dead wood standing vertically in the water and tree stumps with roots should be counted if they meet the size criteria. Do not count lumber (e.g., railroad ties, fish cribs, rip rap).

Coarse Woody Habitat Step by Step Instructions

1. Before searching for wood, measure the Secchi depth in deep water.
2. Record whether the current water level is below, at, or above the HWL.
3. Mark a GPS waypoint for each piece of large wood between the HWL and the 2 foot depth contour.

4. Give each piece of large wood a branchiness ranking:
   0 = no branches
   1 = a few branches
   2 = tree trunk has a full crown

Figure 6. From left to right, woody habitat without branches (0), with few branches (1), and with a full crown (2).

5. Touch Shore: Mark "1" if the log crosses the HWL (comes out of the water onto shore); mark "0" if it does not. Logs parallel to shore count if they touch the HWL.

Figure 7. Example of woody habitat connected to shore (top). If bog mats extend far out from shore, count as connected to shore when wood extends above water and touches the bog mat. Woody habitat parallel to shore may be counted if the log touches shore. In the bottom photo, the piece of wood is off shore and would not be counted as connected to shore.

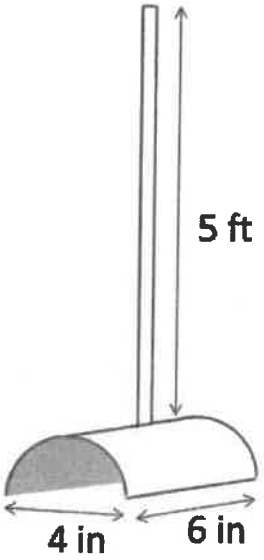
6. In Water: Mark "1" if at least 5 feet of log is currently underwater; mark "0" if the log is below the HWL, but less than 5 feet of the log is currently underwater.

Figure 8. This photo illustrates an example of trees hanging over the water. In this case, only the trunk closest to the water with inundated branches will be counted. It has few branches, touches shore, and is out of the water (Branch = 1, Touch Shore = 1, In Water = 0). The other trunks are too far above the water.

Estimating Diameter and Length of Coarse Woody Habitat

Coarse woody habitat greater than 4 inches diameter and 5 feet long that is in the water and/or below the HWL will be counted. First, the observers must familiarize themselves with wood of this size. Use the "wood calibration stick" to find trees on shore whose largest diameter is greater than or less than 4 inches diameter.

Bring the "wood calibration stick" on the boat. This is a 6 inch length of 4 inch inner diameter PVC pipe cut in half lengthwise and attached perpendicular to a 5 foot long pole. The pole is used to judge whether the piece of wood is at least 5 feet long and the PVC section is used to judge wood diameter at its widest point. If the PVC fits over the wood, the wood is too small to count. If it does not fit over the wood, it is large enough to count. One foot intervals should be marked on the pole, which can then be used to measure the 2-foot depth contour.



Measure various sized pieces until you begin to recognize the size thresholds. Before you begin the survey, use your eye to identify "large wood" and then measure the length and diameter with the wood calibration stick.

- After you are correct on at least 5 consecutive pieces of wood, you may begin the survey.
- As you proceed with the survey, use the wood calibration stick to measure the diameter and length of 1 in every 20 pieces of wood as a quality assurance measure.

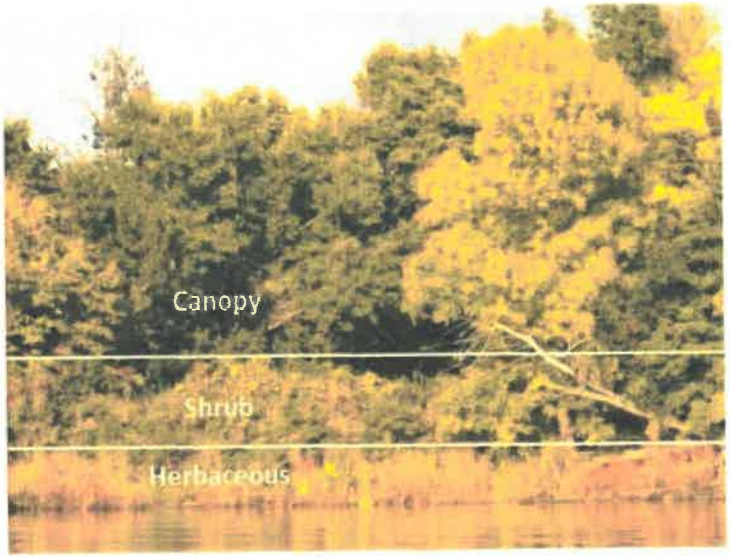
The measurements do not need to be recorded.

Definitions

Percent Cover – an estimation of the fraction of the plot that is dominated by each of a number of categories, such as lawn, impervious surface, and plants. The fraction is given as a percentage from 0 to 100 at 5% intervals.

Riparian Buffer Zone Definitions

Riparian Buffer Zone – land area from the High Water Level to 35 feet inland along the horizontal

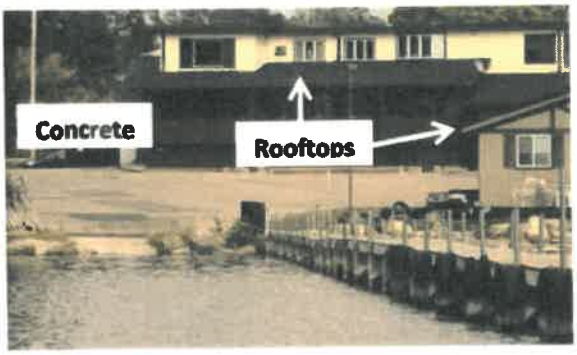


Canopy layer – area that is shaded by trees that are at least 16 feet tall

Shrub layer – woody plants with multiple stems and small trees less than 16 feet tall

Herbaceous plant layer – plants without woody stems. Grasses and sedges have slender leaves and inconspicuous flowers. Forbs are broad-leaved plants that often have showy flowers.

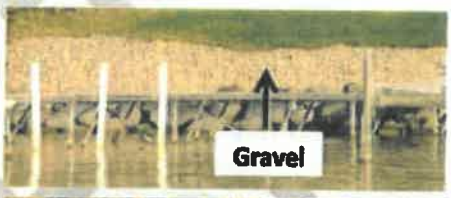
Impervious surface – an area that releases as runoff all or a majority of the precipitation that falls onto it (e.g. rooftops, sidewalks, driveways, parking lots, concrete, boulders, stone, decks, stairs, compacted gravel/soil, and boats flipped over on shore). Rocks used for rip rap also count as impervious surface.



Rocks for rip rap →

Agriculture – agricultural fields planted in rows or grasslands used for grazing livestock

Manicured lawn – grass that is mowed short



Other Percent Cover – this category includes cover types that are not on the data sheet, such as bedrock, gravel, bare soil, sand, mulch, and dead plant material (duff)

Building – any roofed structure (house, cabin, shed, boathouse, garage, commercial)

Fire pit – circular indentation in the ground or portable structure used for fires

Boats on shore – boats flipped upside down for storage in the Riparian Buffer Zone

Point Source – look for a pipe bringing water directly to the lake. This pipe could be directing stormwater, gray water, or other water sources to the lake.

Channelized water flow/gully – sharp indentation into the ground where water flows downhill and has eroded away the soil

Stair/trail/road to lake – stairs, dirt or paved trails, or roads that lead directly to the lake and would cause rainfall to flow into the water. Roads to the lake may be old, private boat landings.

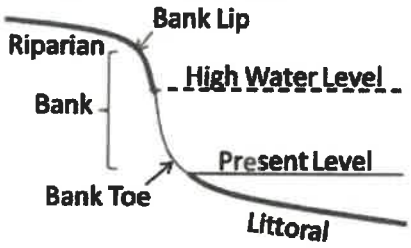
Lawn/Soil Sloping to Lake – the land slopes toward the lake and lacks natural vegetation that would prevent runoff/erosion (e.g., slope covered by lawn, bare soil, gravel, mulch)

Bare soil – unvegetated ground that could be eroded in a rain storm

Eroding, Slumping bank – obvious signs that soil on the bank is washing into the lake, location on the shoreline where the bank is lower than expected due to erosion

Sand/silt deposit – pile of fine sediments (< 2 mm diameter) that collected at a site due to erosion

Bank Zone Definitions



Bank Zone - The Bank Zone is variable in width, and is the region between the edge of the top-of-the-bank lip and the lake bed. The Bank Zone includes the bank face, high water level and the shore (or beach).

Bank Toe – the inflection point between the bank face and the lake bed

High Water Level (HWL) – the point on the bank or shore where the water is present often enough so that the lake or streambed begins to look different from the upland. Specifically, the HWL is the point on the bank or shore up to which the water, by its presence, wave action, or flow, leaves a distinct mark on the shore or bank. The mark may be indicated by erosion, destruction of or change in vegetation, or other easily recognizable characteristics. The HWL can be located through on-site studies of physical and biological conditions at the shoreline. The principal indicator is the change from water plants to land plants. In the area where the plants change, the investigator may also use indicators such as change in soil type, ridges, or other erosion marks or water stains on rocks, soils, trees, or structures. If none of these indicators are available in the immediate location, the elevation of the HWL may be found at another spot and transferred to that site in question (from NRCS 643A). The water level is below the HWL in the two sites pictured to the upper right (arrows point to the HWL).

Vertical Sea Wall – upright structure that is steeper than 1.5 feet vertical to one foot horizontal installed parallel to the shore to prevent the sliding or slumping of the land and to protect the adjacent upland from wave action. **Note:** Seawalls are commonly constructed of timber, rock (including gabions), concrete, steel or aluminum sheet piling and may incorporate biological components

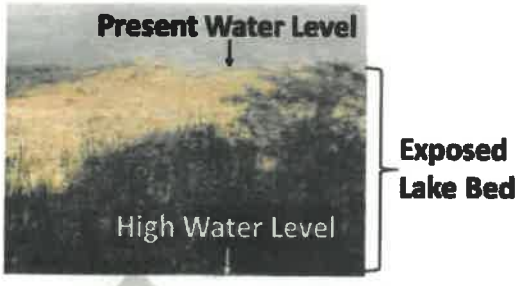
Rip rap – rock or concrete piles used to armor shorelines and prevent erosion; this may also include natural cobbles and gravel that were clearly taken from the water and piled on the bank

Other erosion control structures – any other type of erosion control structure on the shoreline; may include inert materials (rocks) at the bank toe and biological materials on the upper portion of the bank, non-treated wood, stakes and posts, jute netting, biologs, fiber rolls and mats, logs, and branches

Artificial beach– sand along the shoreline used to create a beach (versus shorelines that naturally have sand substrate). It may have been created by dumping sand along the bank or by scraping away top soil and vegetation to expose sand underneath.

Erosion >/< 1 ft. face – estimate the length (to the nearest 10 feet) of shoreline with eroding banks that are less than or greater than 1 foot vertical height. The picture to the left shows about 10 ft. of eroding bank face > 1 ft. tall.

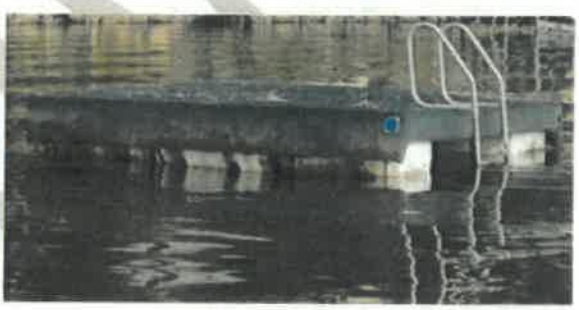
Littoral Zone Definitions



Littoral Zone – water area from the present water line into the lake (~50 ft.), generally including the area near shore where aquatic plants and human structures are present in the water

Exposed Lake Bed – land area between the High Water Level and present water level (when water level is low)

Pier – structure leading out from shore into a body of water. One pier may have multiple mooring locations for boats. One pier should be counted for each access to shore. Count wharves, which are structures that run parallel to shore, as additional piers.



Boat lift and shelter – the lift stores a boat over and above the water. Some lifts have a canopy over the boat. Count together as 1.

Swim raft/water trampoline – floating structure that is anchored up to 200 ft. from shore. Count rafts within ~50 ft. from shore.

Boathouse – roofed structure over the water used to store boats

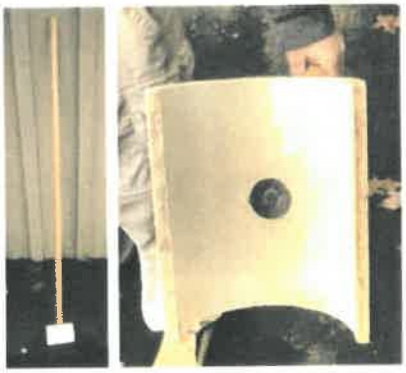
Marina – facility that provides secured moorings or dry storage for boats

Emergent aquatic plant – plants that live in the water and have leaves that extend above the water surface (e.g., bulrush, sedge, wild rice, arrowhead, cattails)

Floating aquatic plant – rooted plants with leaves that float on the water surface (e.g., lily pads)

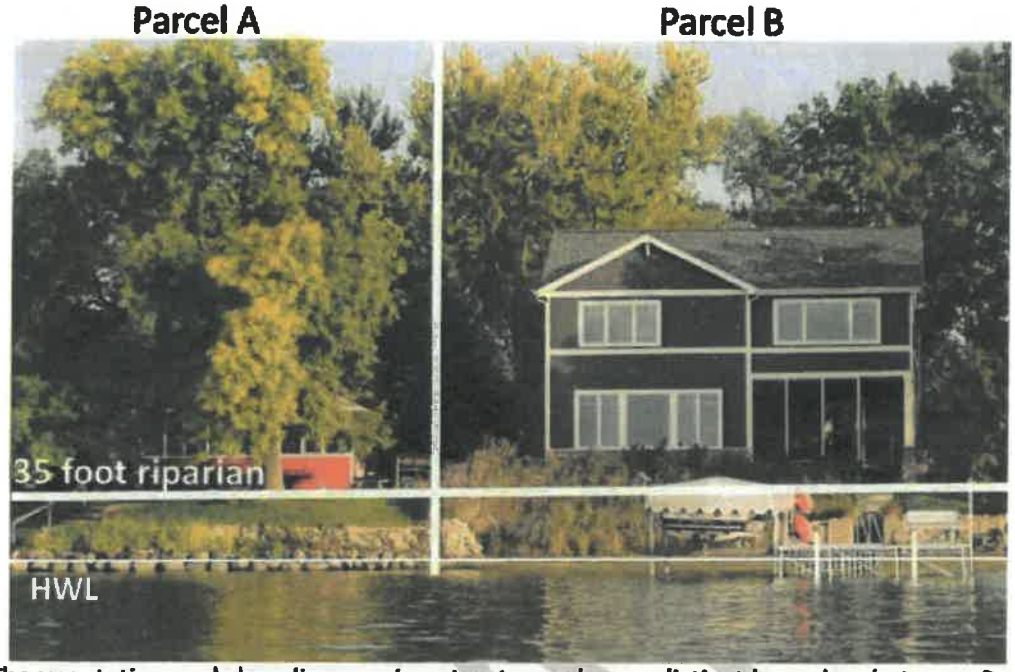
Removed aquatic plants – littoral area where submergent or emergent aquatic plants have obviously been removed as evidenced by adjacent plant beds on both sides of the removal area. The removed area will often be along a straight line perpendicular to shore.

Coarse Woody Habitat – a piece of wood greater than 4 inches in diameter and 5 feet in length that is in the water or below the HWL. Live and dead wood standing vertically in the water should be counted if it is large enough. Tree stumps with roots should only be counted if they meet the size criteria.



Wood Calibration Stick – a 6 inch length of 4 inch inner diameter PVC pipe cut in half lengthwise attached perpendicular to a 5 foot long pole that is used to measure large wood in the water. One foot intervals should also be marked on the stick (to measure 2-foot depth).

Sample Parcel Assessments



The vegetation and shoreline erosion structures show a distinct boundary between Parcel A and B. The Riparian Buffer Zone is marked by the horizontal white line, but a rangefinder would be used to find the 35 foot inland distance in the field.

In Parcel A, the tree trunk is behind the Riparian Buffer Zone, but part of the canopy extends over the Riparian Buffer Zone (~10%). There are some herbaceous plants growing in the rip rap, but very few (5%). Mark herbaceous plants as present, but not shrubs. The rest of the parcel is made up of lawn and impervious surface (stairs and rip rap that extend landward from the water). Estimate impervious surface in the Riparian Buffer Zone as 15% and the remainder as lawn (100 – 5 – 15 = 80%). None of the "Human Structures" listed on the data sheet in the Riparian Buffer Zone or Littoral Zone boxes are present, so write "0" beside each item. There is sloped lawn present in the Riparian Buffer Zone, as well as a straight stairway to the lake that would deliver runoff during rain events, so check the appropriate boxes under Runoff Concerns. The entire Bank Zone is covered in rip rap; use the parcel shoreline length to record length of rip rap in feet. Aquatic plants are absent (leave blank).

There is no canopy cover in Parcel B. The majority of the parcel has been restored with native prairie plants (herbaceous cover). Approximately 5% is impervious surface (stairs and stone wall on the right), 10% is lawn, and the remaining 85% is herbaceous plants (no shrubs). There are no human structures in the Riparian Buffer Zone. There is 1 pier and 1 boat lift in the Littoral Zone. Under Runoff Concerns, sloped lawn and straight stair to lake are present in the Riparian Buffer Zone. There is a vertical sea wall along the entire length of the parcel. Aquatic plants are absent. The Exposed Lake Bed section does not apply.

Parcel C

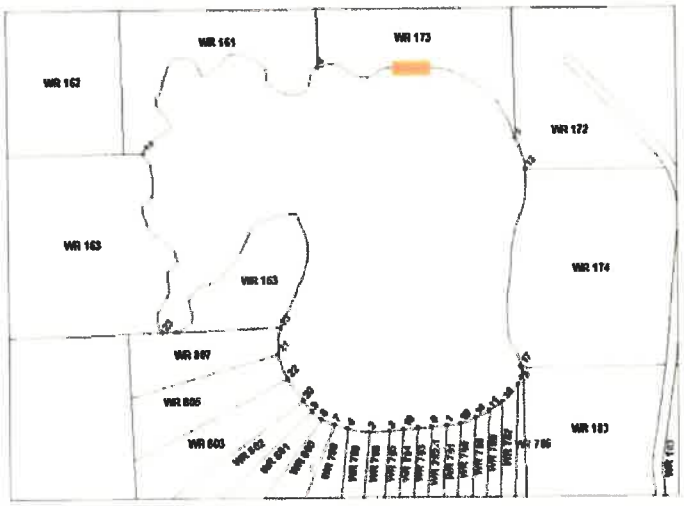
Note that the HWL is slightly above the present waterline, so the sand and small grasses between the present waterline and HWL will not be a part of the percent cover estimation in the Riparian Buffer Zone. There are a lot of trees on the parcel, but some gaps near shore (90% canopy cover). The entire parcel except for the path leading to the water is covered by shrubs and herbaceous plants (mark as 95% cover and check both the shrub and herbaceous boxes). The remaining 5% cover is other (bare dirt on the path). There are no human structures in the Riparian Buffer Zone, but there is 1 pier in the Littoral Zone. There is a narrow path leading to the lake, which should be checked under "Present in Riparian" as "Stair/trail/road to lake" and "Bare soil". Emergent plants are present. The Exposed Lake Bed Zone applies to this parcel because the width of the Exposed Lake Bed is at least 3 feet between the HWL and present water level. Herbaceous plants are present and there are no signs of disturbance.

Parcel D

For instructional purposes, we will describe how to assess the portion of Parcel D pictured here. The house is just barely outside the Riparian Buffer Zone. Canopy cover is 0%. The garden area may be counted for shrub and herbaceous vegetation because it serves a structural function even though many of the species are ornamentals. Note the spaces between plants that are mulched; mulch will count as "other". The top of the wooden boards that form the planter and the rip rap will count as impervious surface, but not the upside down pier section, which may only be stored there temporarily. Thus, the percent cover of shrub/herbaceous vegetation is 30%, impervious surface is 15%, lawn is 50%, and other is 5%. The garden planter may be counted as a human structure in the Riparian Buffer Zone under "Other". There is 1 pier in the Littoral Zone. There are no runoff concerns. Rip rap covers the entire shoreline (approximately 20 feet in this photo). There are no aquatic plants and no visible plant removal areas. The Exposed Lake Bed Zone does not apply.

Parcel E

This is an example of state land that is natural, but shows signs of previous human disturbance. Parcels WR 163 – 183 in the map below are state land; the orange bar depicts the disturbed area in the photo above. There is an old forest road in the Riparian Buffer Zone. The area in the center of the photo lacks shrubs and trees, has sparse herbaceous vegetation, and large areas of bare soil with pine needles on top, but the majority of the 1600 feet of shoreline in parcel WR 173 has full coverage of herbaceous plants, shrubs, and trees. Assume that this disturbed area is 5% of the entire Riparian Buffer Zone in this parcel. Report 95% canopy cover, 95% shrub/herbaceous, and 5% other for the entire parcel. After "description", note that other percent cover is bare soil with pine needles. Runoff Concerns Present in Riparian include: "Lawn/soil sloping to lake" and "Bare soil". Human structures are absent in the Riparian Buffer and Littoral Zones. The Bank Zone is not modified. Emergent plants are present.



Time Estimate

This protocol is designed for a crew of 2 people in a small motor boat or, in some cases, a kayak. To help with planning, we approximate the time spent per monitoring activity. Time estimates represent the time that it takes a well-trained crew to complete a parcel. During training, the time to complete a parcel was approximately twice that reported here. Photos were taken on 13 lakes, the habitat assessment was done on 15 lakes, and the coarse woody habitat assessment was done on 5 lakes. The lakes range from very natural to highly developed and are spread throughout the state.

Table 1. Minimum and maximum time spent on each of the three parts of the protocol.

Protocol	Min	Max
Photos (minutes/mile of shoreline)	14	50
Parcel Assessment (minutes/parcel)	3.5	4
Coarse Woody Habitat (minutes/mile of shoreline)	29	120

Taking photos from a kayak added a substantial amount of time (max. in Table 1). This mode of transportation was required because the lake was so shallow. The time spent on the woody habitat inventory varied greatly as well. On most lakes, the time ranged from 29 to 50 minutes per mile, but one lake took 120 minutes per mile. This lake was stained and had very dense floating aquatic plants, making it hard to see and navigate. In this type of lake, the woody habitat inventory would be more efficient and accurate if conducted in early spring or late fall. The time spent managing data post-field work is not accounted for here. It takes approximately one hour to enter data from 35 parcels into Excel. However, data management effort will depend on whether data is captured on paper sheets or in a tablet computer. Eventually, data will be entered directly into the SWIMS database.

The total amount of time to complete the habitat survey on a lake depends largely on the length of shoreline and number of parcels. Green Lake (in Green Lake County) is one of the largest lakes in the state and will take at least two weeks to complete under the best conditions. Rock Lake (Jefferson County) is still quite large with a lot of parcels, and could be completed in less than a week. Small lakes with a lot of state land could be completed in a half day. Note that the time estimates in Table 2 do not account for travel time, set up, breaks, bad weather, etc.

Table 2. Examples of lakes that were sampled during summer of 2015. The total hours spent monitoring each lake was estimated using the minimum number of minutes per mile or parcel listed in Table 1.

Lake	Area (acre)	Shoreline length (mi)	Parcels	Total Hours Photos	Total Hours Parcels	Total Hours Wood	Total Hours
Green	7433	23.6	~1000	5.5	58.3	11.4	75
Rock	1364	11.2	341	2.6	17.5	6.5	27
Buffalo	105	2.1	26	0.5	1.5	1.0	3

This protocol will be a major undertaking on Wisconsin's largest lakes and flowages. Lake Chippewa (250 miles) and Turtle Flambeau flowage (209 miles) have the longest shorelines in the state and could take ~950 hours to complete all three aspects of the survey. However, this protocol could be accomplished quickly on smaller lakes, and most lakes in the state are small; 88% of the 1793 lakes with boat launches have <10 miles of shoreline (Fig. 9). Lakes with approximately 10 miles of shoreline should take approximately 2.5, 5, and 31 hours to complete the photo, woody habitat, and parcel assessments, respectively. This assumes the minimum time per mile or parcel in Table 1 and assumes that all parcels on a lake are 100 feet wide. The estimated time to complete the photo survey varies from < 10 minutes to 58 hours (Fig. 10), and the time to complete the woody habitat inventory varies from < 10 minutes to 120 hours (Fig. 11). It is harder to estimate total time on the parcel survey because the size of parcels can vary greatly. A lot of lakes have large parcels with state or federal land and will take less time than the estimate assuming 100 foot parcels around the entire lake.

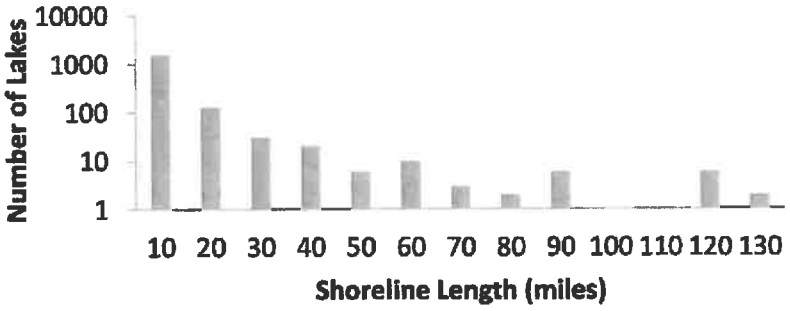


Figure 9. Frequency distribution of lake size for all lakes in the state with boat launches. Lake Chippewa and Turtle Flambeau Flowage are not included here.

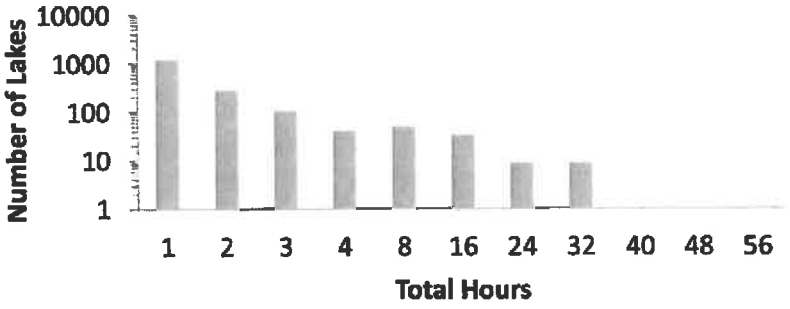


Figure 10. Total hours to complete the photo survey on lakes with boat launches given shoreline length. It will take 1 hour or less to complete the survey on 1244 lakes.

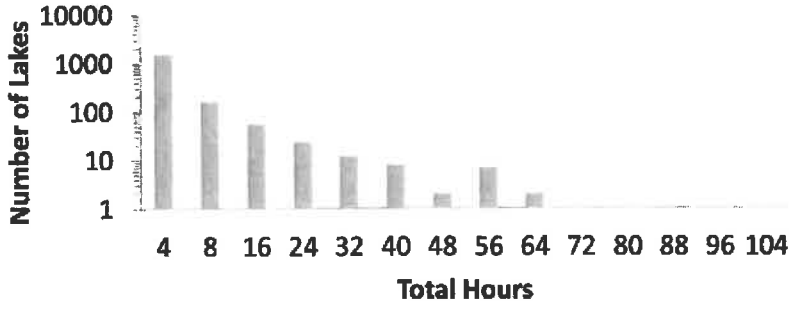


Figure 11. Total hours to complete the coarse woody habitat survey on lakes with boat launches given shoreline length. It will take 4 hours or less to complete the survey on 1518 lakes.

Data Sheets

Quality Assurance

Date _____ Lake name _____ WBIC_____

Observers_____

Present water level is ☐ Below ☐ At ☐ Above the High Water Level

Riparian Distance (landward)

Replicate	Estimated	Measured
1		
2		
3		

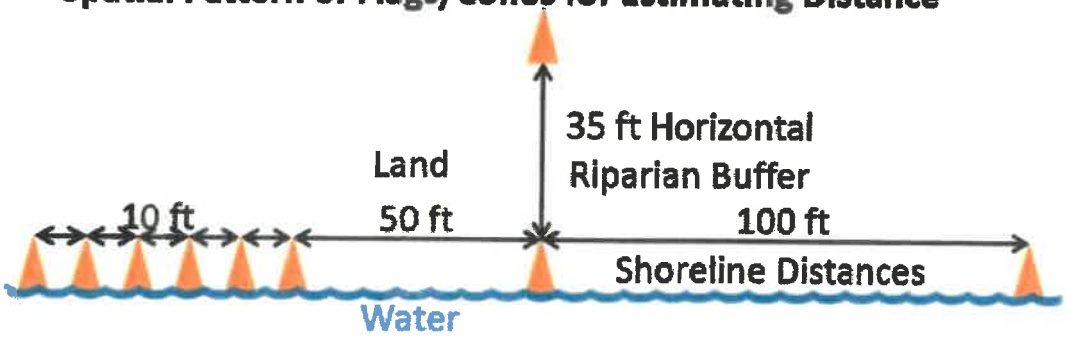
Shoreline Length

Replicate	Estimated	Measured
1		
2		
3		

Rangefinder Calibration

Replicate	Rangefinder	Tape Measure
1		
2		
3		

Spatial Pattern of Flags/Cones for Estimating Distance



Habitat Assessment Data Sheet (one per parcel)

Date _____ Lake name _____ WBIC_____
Parcel ID_____ Observers_____

RIPARIAN BUFFER ZONE

Percent Cover	Percent
Canopy	(0-100)
Shrub ☐ Herbaceous ☐	
Shrub/Herbaceous	sum=100
Impervious surface	
Manicured lawn	
Agriculture	
Other (e.g. duff, soil, mulch)	

description:_____

Human Structures	Number
Buildings	
Boats on shore	
Fire pits	
Other	

description:_____

Runoff Concerns in Riparian or Entire Parcel	Present in Riparian	Present out of Riparian
Point source	☐	☐
Channelized water flow/gully	☐	☐
Stair/trail/road to lake	☐	☐
Lawn/soil sloping to lake	☐	☐
Bare soil	☐	☐
Sand/silt deposits	☐	☐
Other	☐	☐

description:_____

Notes:

BANK ZONE	Length (ft)
Vertical sea wall	
Rip rap	
Other erosion control structures	
Artificial beach	
Bank erosion > 1 ft face	
Bank erosion < 1 ft face	

LITTORAL ZONE

Human Structures	Number
Piers	
Boat lifts	
Swim rafts/water trampolines	
Boathouses (over water)	
Marinas	
Other	

description:_____

Aquatic Plants	Present
Emergents	☐
Floating	☐
Plant Removal	☐

If Applicable (low water level):
EXPOSED LAKE BED ZONE

Plants	Present
Canopy	☐
Shrubs	☐
Herbaceous	☐
Disturbed	
Plants (mowed or removed)	☐
Sediment (tilled or dug)	☐

Coarse Woody Habitat Inventory Data Sheet

Date _____ Lake name _____ WBIC_____

Observers _____

Present water level is ☐ Below ☐ At ☐ Above the High Water Level Secchi depth _____ ft

ID	Branch	Touch Shore	In Water	ID	Branch	Touch Shore	In Water	ID	Branch	Touch Shore	In Water	ID	Branch	Touch Shore	In Water
1				26				51				76			
2				27				52				77			
3				28				53				78			
4				29				54				79			
5				30				55				80			
6				31				56				81			
7				32				57				82			
8				33				58				83			
9				34				59				84			
10				35				60				85			
11				36				61				86			
12				37				62				87			
13				38				63				88			
14				39				64				89			
15				40				65				90			
16				41				66				91			
17				42				67				92			
18				43				68				93			
19				44				69				94			
20				45				70				95			
21				46				71				96			
22				47				72				97			
23				48				73				98			
24				49				74				99			
25				50				75				100			

Branch: 0 = no branches, 1 = a few branches, 2 = full tree crown

Touch Shore: 0 = entirely below High Water Level (HWL), 1 = crosses HWL

In Water: 0 = less than 5 ft of log is currently underwater, 1 = at least 5 ft of log is currently underwater

Appendix. Additional Parameters of Interest

There may be local reasons for including additional parameters into the minimum protocols described in this document. The following list gives a few examples that were included in past surveys. This list is not meant to be exhaustive.

General

Average width of natural vegetation from water's edge landward

Human Structures in Riparian Buffer

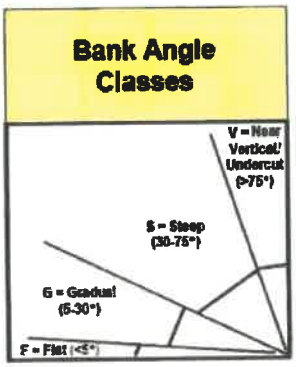
Boathouse – the number of boathouses on the lake could be quantified separately from buildings

Littoral Zone

Watercraft in the water – the number of watercraft in the water at piers and mooring buoys could be counted in addition to boat lifts if the lake group wants to find out the total number of watercraft at riparian lots. This count could be compared to counts from previous years and analyzed for a historical trend.

Bank Zone

Bank slope – this parameter could be documented with the use of GIS or by visually estimating categories of bank slope as in the National Lakes Assessment protocol



Aquatic Plants

Submergent Plants – submergent plants could be marked as present, absent, or unknown if water clarity was too low to judge.

Invasive Species

Percent cover of canopy, shrub, and herbaceous plants is quantified regardless of whether the species are native or invasive. In addition to estimating percent cover of each vegetation layer, percent cover of invasive species could be quantified separately. A checklist of invasive species could also be filled in for each parcel with special attention to riparian plant species.