CalMan Lakes

Watershed Management Plan
2014 - 2016

December 2014

CALUMET COUNTY RESOURCE MANAGEMENT DEPARTMENT

Onterra LLC
Lake Management Planning

This document is a companion piece to the

CalMan Lakes

Watershed Management Planning Project

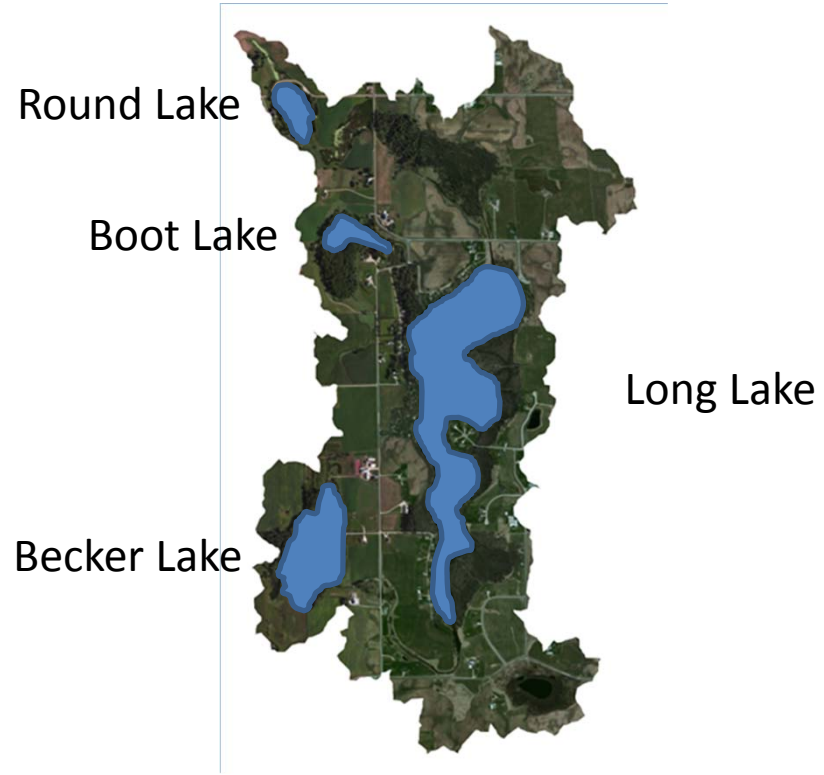
Phase I Report

The purpose of this document it provide decision-makers, stakeholders and the general public a guide to the information and recommendations identified in Phase I Report.

Phase I Report created by Onterra, LLC. Funding provided by the Wisconsin Department of Natural Resources Lake Planning Grant LPL-1521-13 awarded to Calumet County Resource Management Department. Collaborating partners include the Brillion Conservation Club, Long Lake Advancement Association, and the Wisconsin Department of Natural Resources.

A Glance at the Lakes

The CalMan Lakes consist of four lakes located along the Calumet-Manitowoc County border in northeastern Wisconsin. All lakes are surrounded by beautiful rolling farmlands and provide recreational opportunities for the area. Inlet and outlet streams flow during in spring months, but tend to dry up during summer. Algal blooms and water clarity problems are prevalent in all lakes, and fish kills have been observed on Boot, Round and Becker Lakes. Aquatic invasive species are present on most lakes. Development is relatively low on all lakes except Long Lake, which has the highest density of private residences.



		Round Lake	Boot Lake	Long Lake	Becker Lake
Morphology	Acreage	11.8	11.0	129.0	37.0
	Max. Depth (ft)	55.0	15.0	38.0	51.0
	Volume (acre-ft)	246.4	87.5	1,508.8	572.2
	Mean Depth (ft)	20.9	8.0	11.7	15.5
	Direct Watershed Size (acres)	45	232	474	348
Plants	Comprehensive Survey Date*	2013	2014	2012	2013
	Number of Native Species	9	n/a	8	7
	Non-Native Plant Species	2	1	4	4
Water Quality	Trophic State	Eutrophic			
	Limiting Nutrient	Phosphorus			
	pH	Range from 7.2 - 8.4			
	Sensitivity to Acid Rain	Non-sensitive			
	Watershed to Lake Area Ratio	33:1			

*Point-intercept surveys completed by the Wisconsin Department of Natural Resources.

Wisconsin's Lakes Program & Partnership

Wisconsin's Lakes Program evolved out of the need to manage Wisconsin's 15,000 lakes and meet the needs of local interests.

The Lakes Partnership consists of:

- WDNR (funding, research)
- UWEX (organizational assistance, outreach)
- Wisconsin Lakes Association (citizens, advocacy)

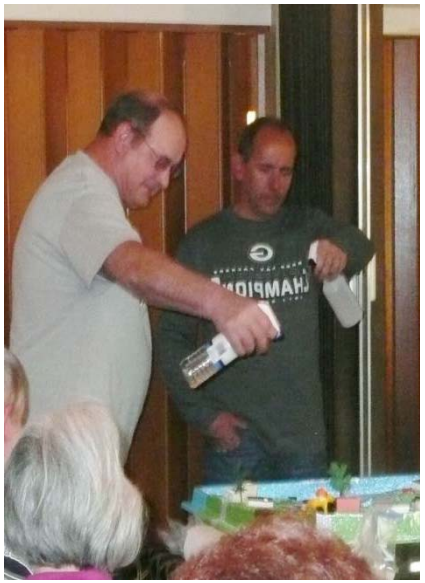
Although the State of Wisconsin (WDNR) is charged with protecting the "Waters of the State," through the Public Trust Doctrine, there simply is not enough resources within the WDNR to address all issues and concerns that citizens have for their lakes. By partnering with UWEX and creating a framework to empower local efforts through Lake Associations, Lake Districts, and local units of government, the WDNR is able to provide financial assistance to groups that are committed to improving their lake(s).

Lakes Grant Program

- Empowers local officials and citizens to improve their Lake(s).
- Delegates resources to the local level for planning and implementation

CalMan Watershed Planning

- Long Lake has a history of Lake Planning
  - Long Lake Advancement Association (LLAA)
  - Previous Lake Plan(s) indicate Nutrient Loading from the Northern Inlet
  - Developed an Aquatic Plant Management Plan, participate in Manitowoc County Lakes Association programs
  - Only focused on Long Lake, but acknowledge the role of the watershed.
- Becker, Round Lakes
  - Fish Kills 2009, 2010
  - Small Scale Organizational and Educational Grants
    - Water Quality Sampling
    - Stakeholder Engagement
    - Collaboration of Calumet Co., Manitowoc Co., LLAA, Brillion Conservation Club and other Citizens
- WDNR recommendations
  - Gain Local Support
  - Develop a comprehensive plan
    - Nutrient Budget
    - Identify and Prioritize External Nutrient Sources
    - Understand Internal Loading
  - Position the project for Protection Grants and other funding assistance.



Rain Clouds creating a runoff event on an Enviroscape Model

This report concludes Phase I of the watershed planning process. Understanding the entire watershed, not just water quality, is critical to improving the resource, maintaining a healthy fishery, and meeting other recreational needs of the local stakeholders. Although there is still progress to be made understanding this unique watershed, WDNR Water Management Specialist supports moving forward with actions identified in the Phase I plan.

Water Quality

"Reporting of water quality assessment results can often be a difficult and ambiguous task."

– Dan Cibulka, Aquatic Ecologist Onterra, LLC

Over the next several pages, readers will get a chance to understand current water quality trends, importance of all parameters in lake ecosystem dynamics, and gain a better understanding of what is needed to improve the CalMan Lakes.

Water Quality Parameters Include…..

1. Baseline Monitoring
   - Phosphorus
   - Chlorophyll
   - Secchi Disk Transparency
2. Trophic State

3. Profiles
   - Temperature
   - Dissolved Oxygen
4. Aquatic Plants
5. Nutrient Loading
   - External (Land)
   - Internal (Lake Bottom)

Phosphorus

Phosphorus (P) is the nutrient that controls the growth of plants in the vast majority of Wisconsin lakes.

Too much **phosphorus** leads to excessive plant growth or algal blooms. Excessive plant growth leads to unhealthy dissolved oxygen levels for fish and aquatic life.

The majority of streams and lakes listed on Wisconsin's Impaired Waters (303d) List are listed due to excessive **phosphorus** levels.

"When compared with other lakes in Manitowoc County, Long Lake consistently has the highest levels of TP recorded through Citizen Monitoring efforts"

- Rita Timm, LLAA President

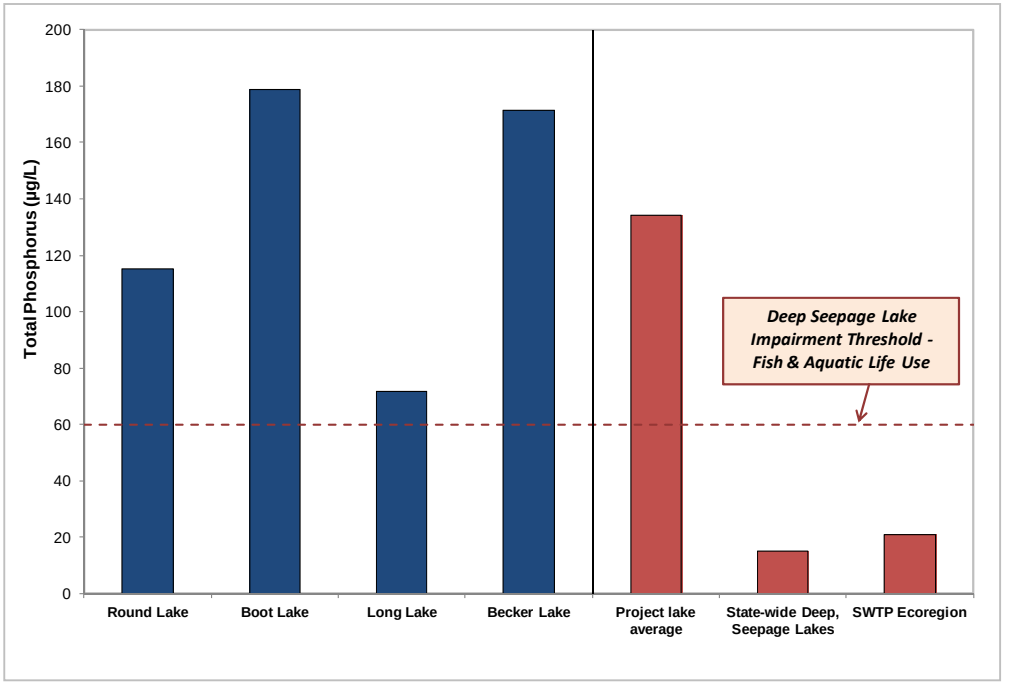
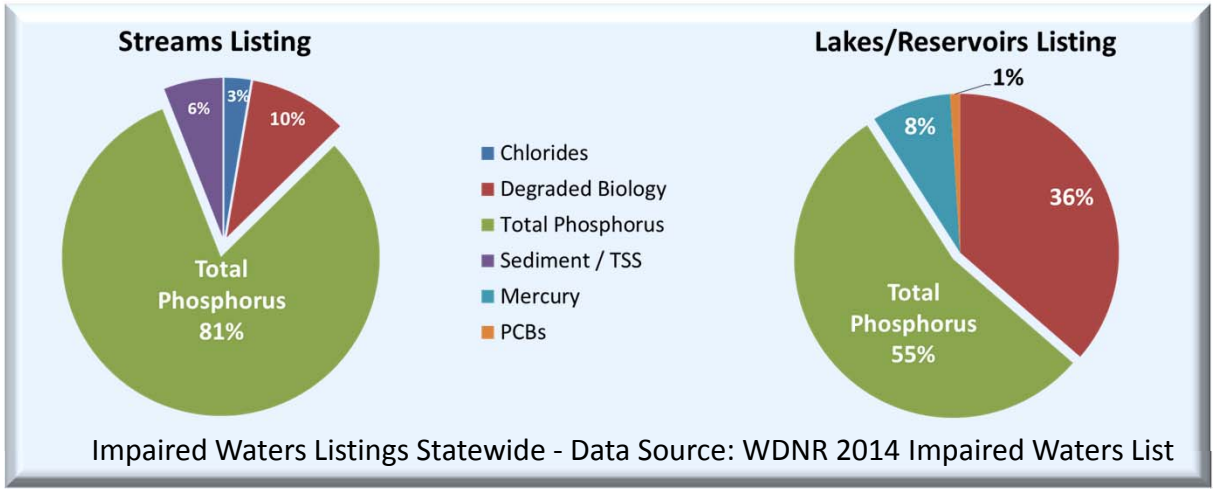


Figure 3.1-4. CalMan Lakes 2013 surface phosphorus concentrations and comparables. Comparables include statewide deep seepage lakes and Southern Wisconsin Till Plains ecoregion median values. Values calculated with summer month surface sample data and methodology from WDNR 2013.



Impaired Waters Listings Statewide - Data Source: WDNR 2014 Impaired Waters List

Chlorophyll-*a*

Chlorophyll-*a* is the green pigment in plants used during photosynthesis.

Concentrations of **Chlorophyll-*a*** are directly related to the abundance of free-floating algae in the lake.

Chlorophyll-*a* values increase during algal blooms.

In the majority of natural Wisconsin lakes, the primary particulate matter is algae; therefore, algal abundance directly affects water clarity.

"In 2013, algal blooms on Boot Lake were as consistent as the dates on my calendar, appearing on a monthly basis from March through October."

-Brian Schneider,
Boot Lake Property Owner

1) Baseline Monitoring

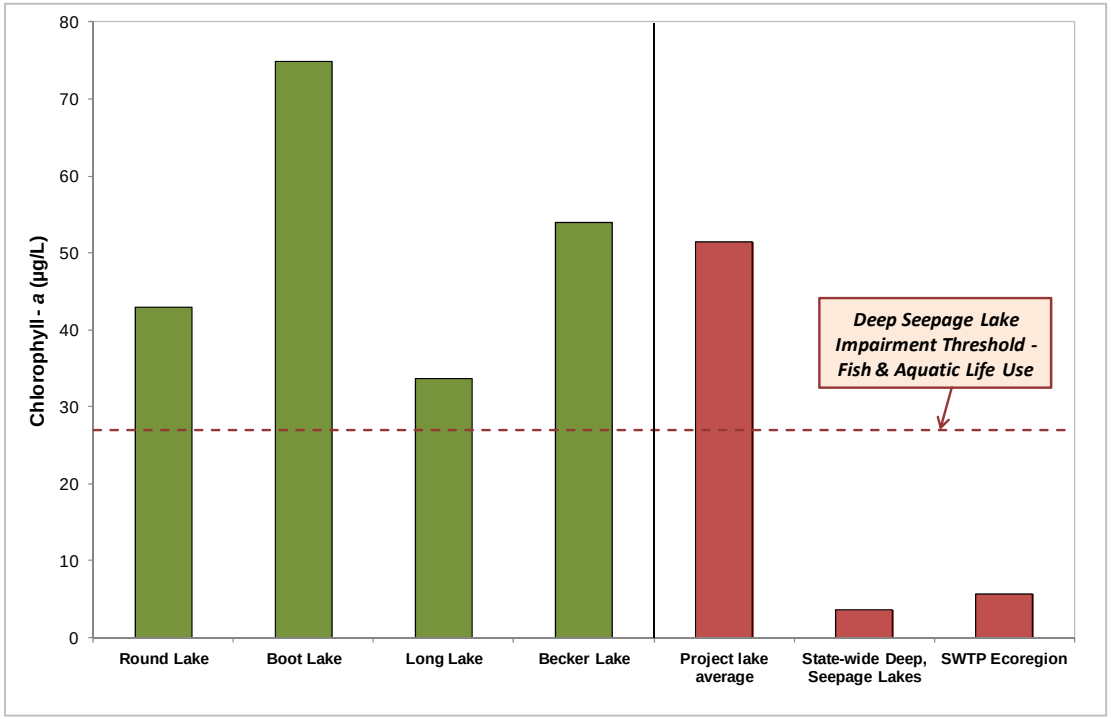


Figure 3.1-7. CalMan Lakes 2013 surface phosphorus concentrations and comparables. Comparables include statewide deep seepage lakes and Southern Wisconsin Till Plains ecoregion median values. Values calculated with summer month surface sample data and methodology from WDNR 2013.

Studies have shown that water clarity is used by most lake users to judge water quality – clear water equals clean water. (Canter et al. 1994, Dinius 2007, and Smith et al. 1991)

Water Clarity

Secchi disk transparency is a measurement of water clarity.

Secchi depth is the most used parameter and is the easiest for non-professionals to understand.

Measuring **Secchi** disk transparency over long periods of time is one of the best methods of monitoring the health of a lake.

Total Suspended Solids, or **TSS,** are a measure of inorganic and organic particles suspended in the water.

TSS include everything from algae to clay particles.

High **TSS** creates low water clarity, and prevents light from penetrating into the water to support aquatic plant growth.

1) Baseline Monitoring

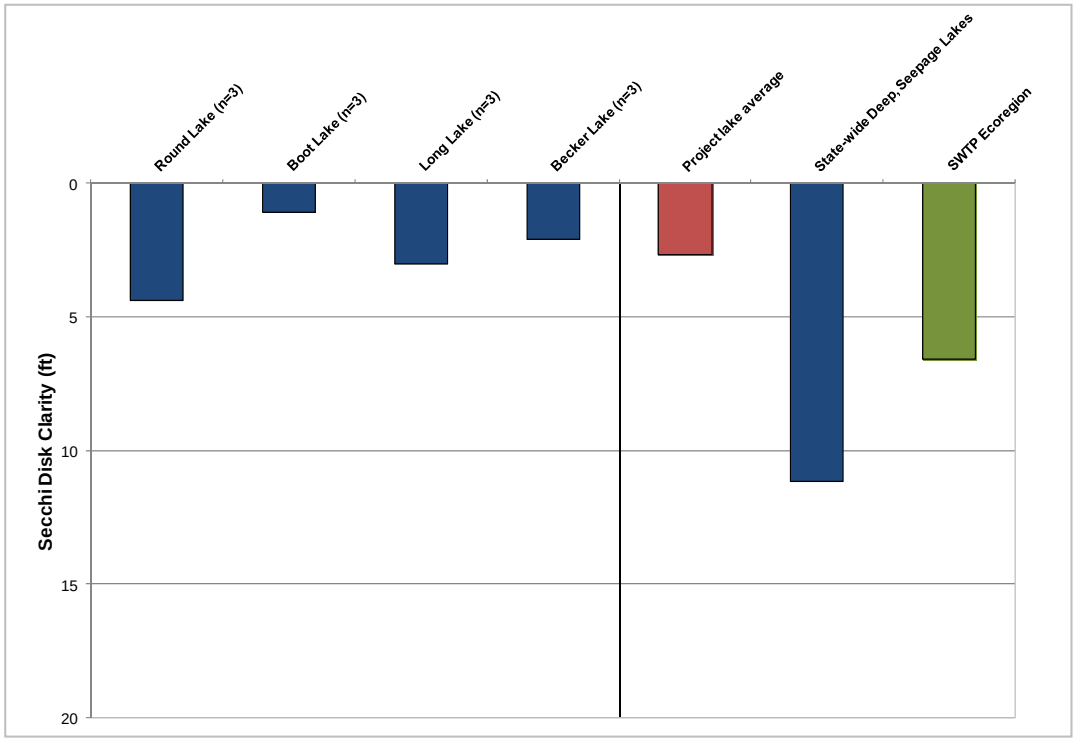


Figure 3.1-8. CalMan Lakes summer 2013 Secchi disk means. Comparables include statewide deep seepage lakes and Southern Wisconsin Till Plains ecoregion median values. Values calculated with summer month surface sample data and methodology using WDNR 2013.

*Average **TSS** values ranged between 8 mg/L in Round Lake and 23 mg/L in Boot Lake. While these values are somewhat low, it is likely that turbidity from TSS is quite high for short periods during high runoff events.*

Trophic State

Trophic state describes the lake's ability to produce plant matter (production) and include three continuous classifications.

- **Oligotrophic** lakes are the least productive lakes and are characterized by being deep, having cold water, and few plants.
- **Eutrophic** lakes are the most productive and normally have shallow depths, warm water, and high plant biomass.
- **Mesotrophic** lakes fall between these two categories.

The Trophic State Index (TSI) values are calculated with Secchi disk, chlorophyll-*a*, and total phosphorus values.

2) Trophic State

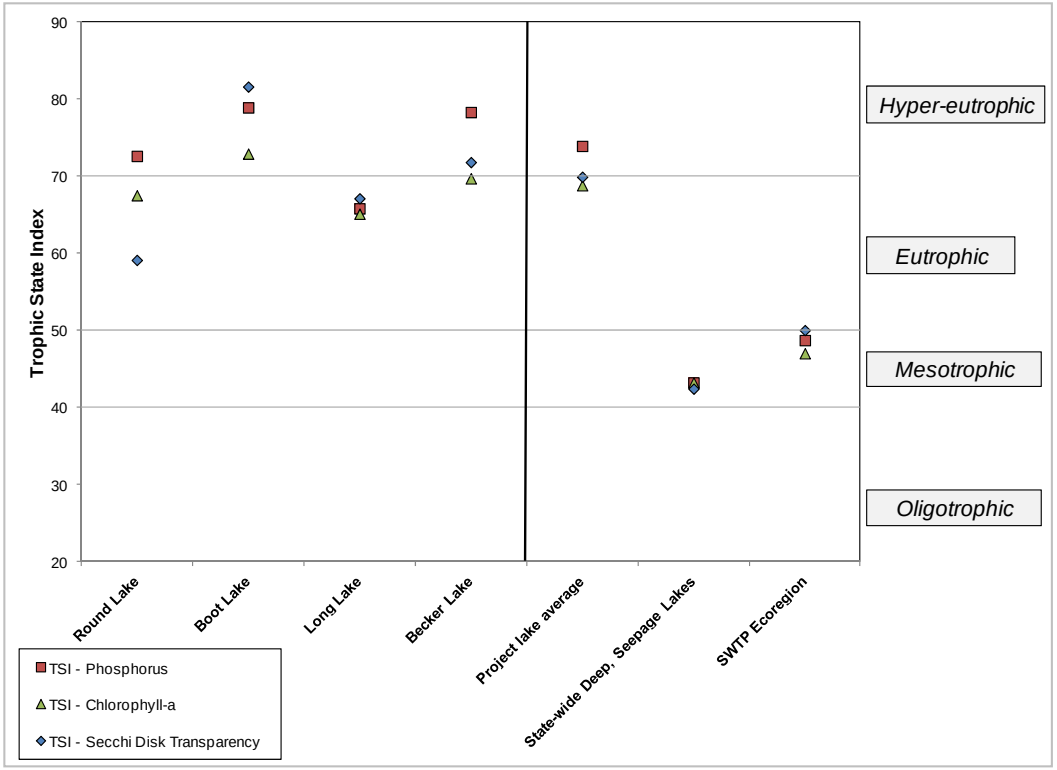


Figure 3.1-10. CalMan Lakes and comparable lakes Trophic State Index values. Comparables include statewide deep seepage lakes and Southern Wisconsin Till Plains ecoregion median values. Values calculated with summer month surface sample data and methodology from WDNR 2013.

The CalMan Lakes may be classified as upper eutrophic, with Boot and Becker Lakes extending in a higher, hyper-eutrophic category. WDNR considers hyper-eutrophic lakes to have POOR water quality. (Wisconsin Water Quality Report to Congress – Year 2012, WDNR)

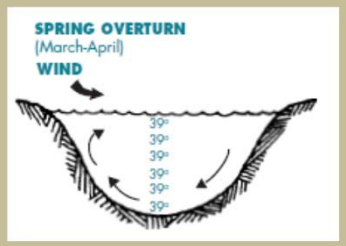
Temperature & Lake Stratification

Lake stratification occurs when temperature gradients are developed with depth in a lake.

- The **epiliminion** is the top layer of water which is the warmest water in the summer months and the coolest water in the winter months.
- The **hypolimnion** is the bottom layer and contains the coolest water in the summer months and the warmest water in the winter months.
- The **metalimnion**, often called the thermocline, is the middle layer containing the steepest temperature gradient.

Stratification is an important component in nutrient release near the bottom sediment.

3) Profiles



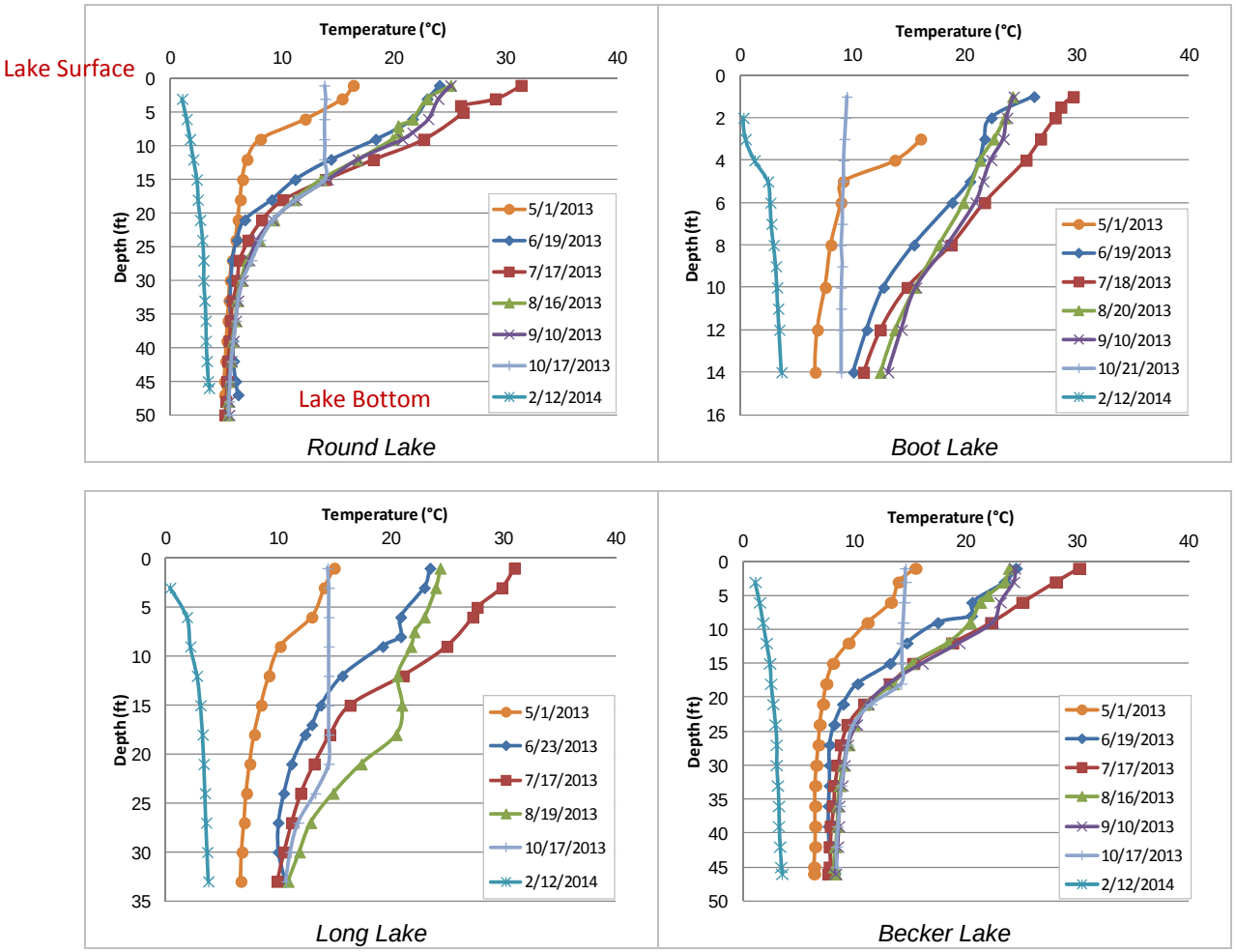
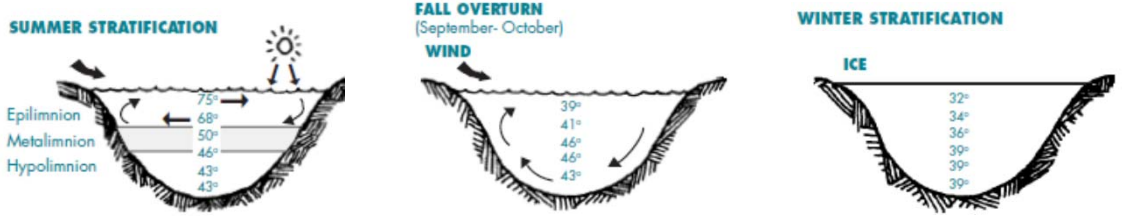


Figure 3.1-11. CalMan Lakes temperature profiles, 2013-2014. Note that the top of each graph represents the lake surface, and is labeled as zero (0) feet in depth. The X-axis changes with varying depths of the four lakes.



Figures taken from Understanding Lake Data: PUB G3582

Dissolved Oxygen

Dissolved oxygen (DO) is essential in the metabolism of nearly every organism that exists within a lake.

Fishkills are often the result of insufficient amounts of d**issolved oxygen**. Typically, trout need 5mg/L, warm water species need 2-3mg/L.

Dissolved oxygen's role in lake management extends beyond this basic need by living organisms.

DO's presence or absence impacts many chemical process that occur within a lake. Internal nutrient loading is an excellent example.

In lakes that stratify, **dissolved oxygen** levels deplete below the metalimnion, often reaching levels of 0 mg/L.

DO profiles indicate poor oxygen levels during ice cover and significant stratification during summer month, sometimes leaving only 5 feet or less of oxygen rich water.

3) Profiles

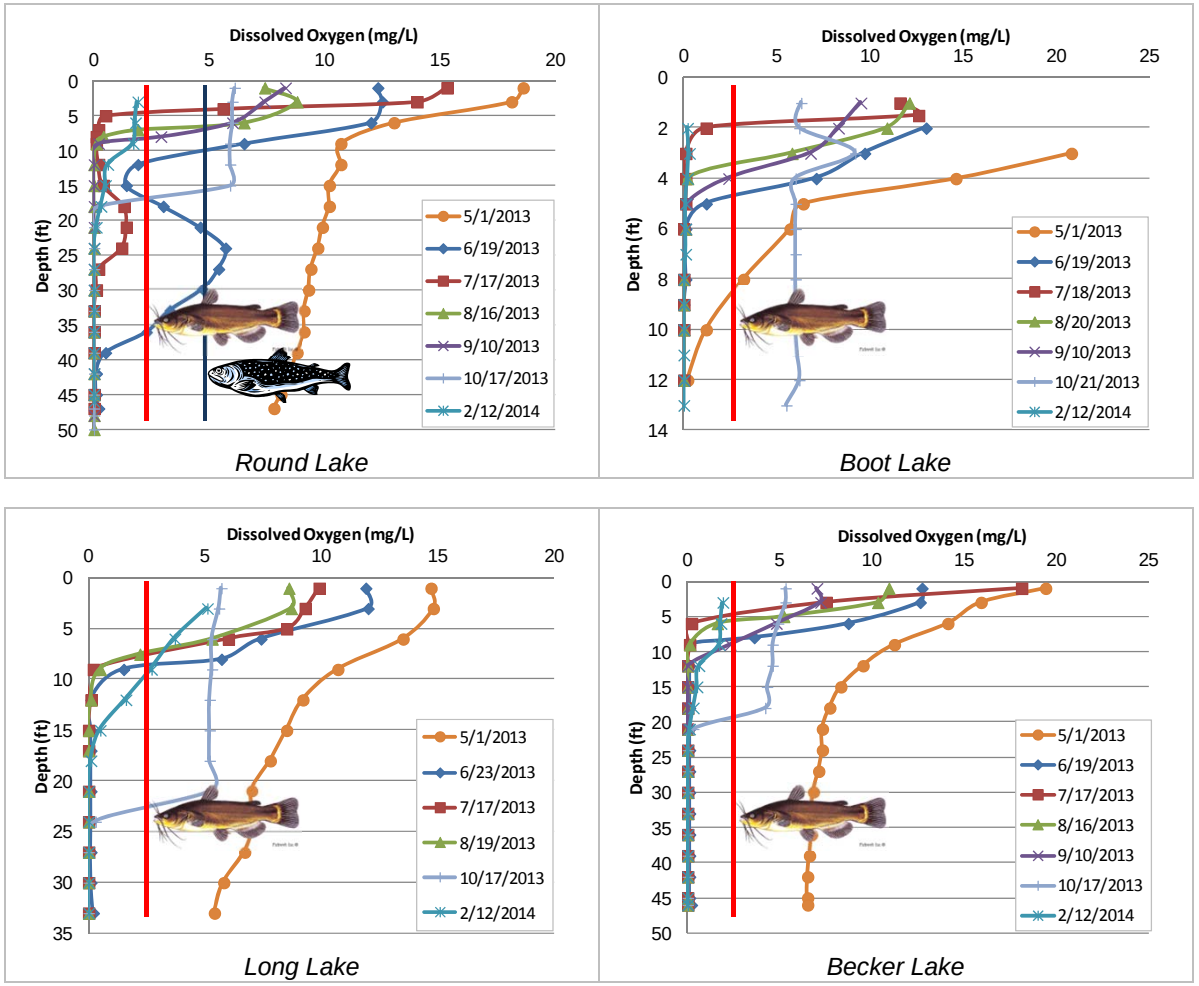


Figure 3.1-12. CalMan Lakes dissolved oxygen profiles, 2013-2014. Note that the top of each graph represents the lake surface, and is labeled as zero (0) feet in depth. The X-axis changes with varying depths of the four lakes.

"If additional low oxygen events occur during succeeding winters, fish stocking will not restore a desirable mix of self-reproducing fish back into the lakes. To achieve long term stability of a desirable mix of fish species, long term improvements in water quality will be necessary. To improve water quality in these lakes, changes in the watershed that reduce sediment and phosphorus runoff into the lake will be required. Additional management actions may be required even with decreases of external phosphorus levels to ensure long term stability of the lake and its fish community."

- Steve Hogler, WDNR Fisheries

Aquatic Plants

Although some consider **aquatic plants** to be "weeds" and a nuisance to the recreational use of the lake, **aquatic plants** are an essential element in a healthy and functioning lake ecosystem.

Aquatic plants serve as excellent food sources for wildlife.

Aquatic plants provide much needed habitat for zooplankton *(fish food)* and fish reproduction.

A healthy **aquatic plant** community protects nearshore areas from wave actions and shoreline erosion.

With low native species richness, poor water clarity restricting healthy plant growth, and dominance of AIS in some lakes, the aquatic plant community is not meeting the ecological needs of the CalMan watershed.

4) Aquatic Plants

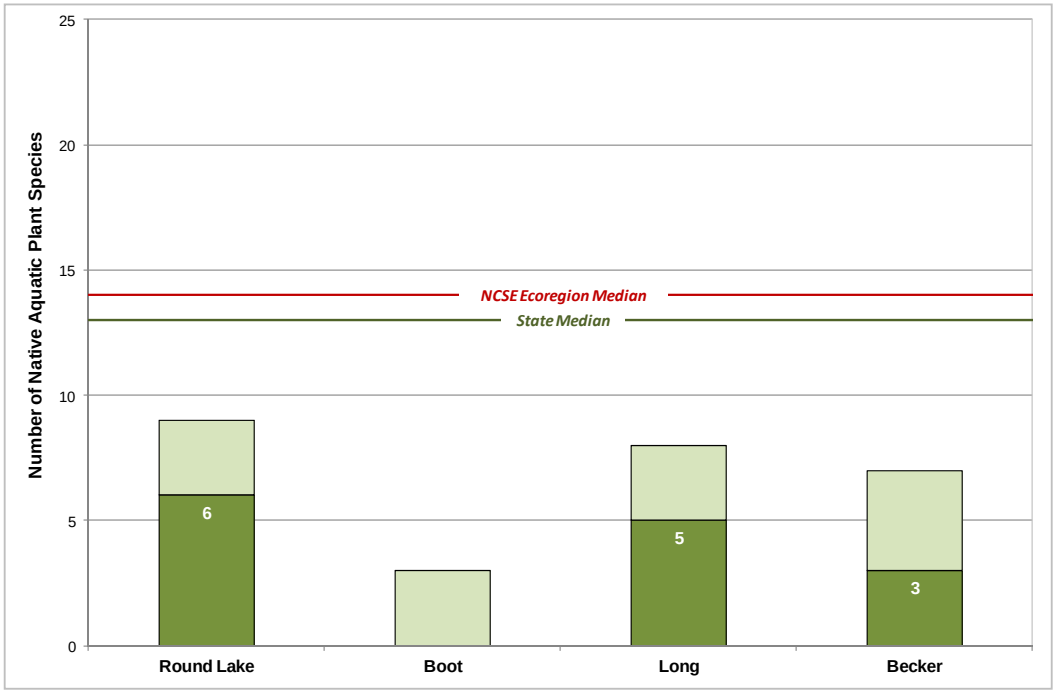


Figure 3.4-3 CalMan Lakes native species richness. Created using data from summer point-intercept and community mapping surveys. Chart includes species sampled directly during the point-intercept study (dark green) and species found incidentally (light green). Note that NCSE is the North Central and Southeastern Till Plains ecoregion after Nichols (1999).

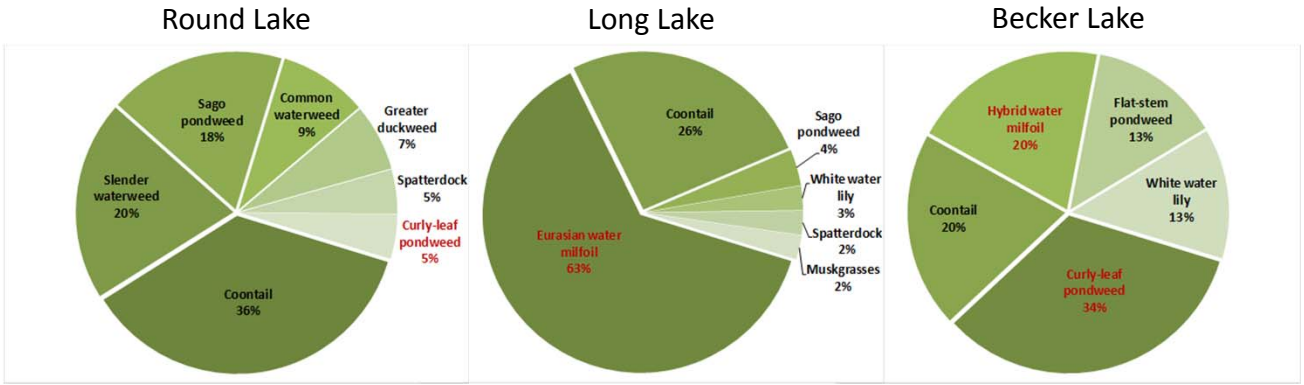


Figure 3.4-4 CalMan Lakes aquatic plant relative frequency of occurrence. Created using data from WDNR and Calumet County summer point-intercept surveys. Species in red are Aquatic Invasive Species.

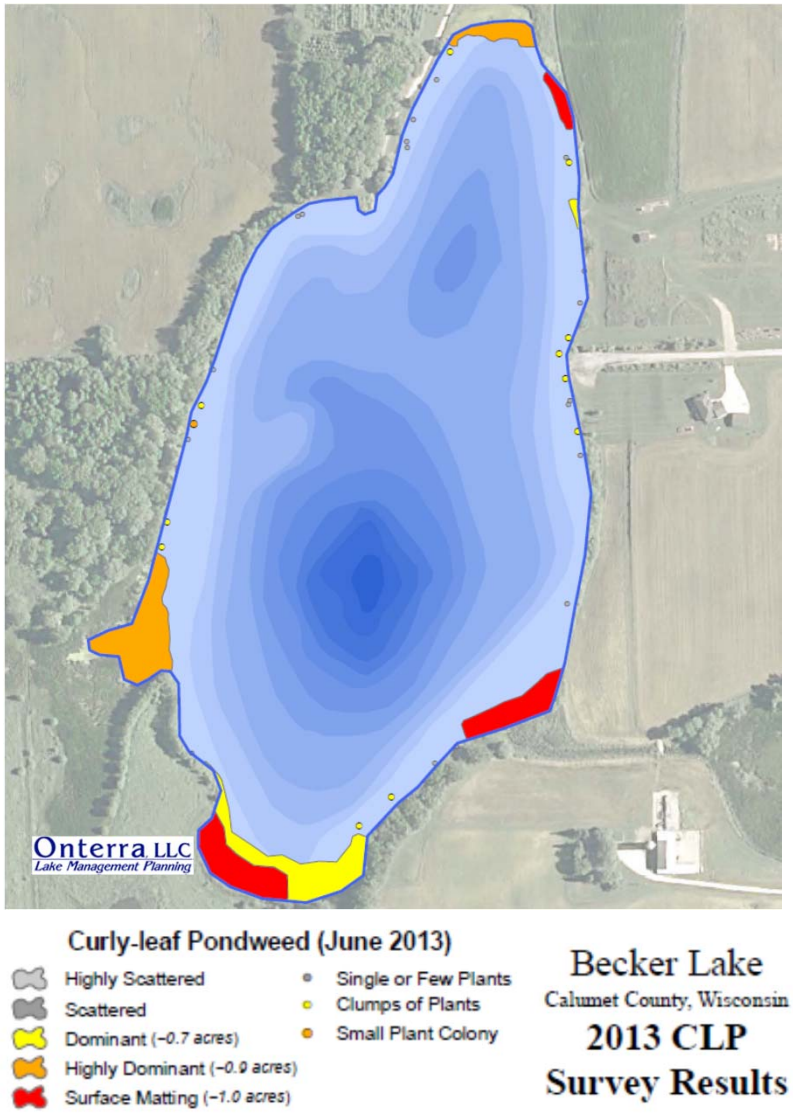
Aquatic Invasive Species (AIS)

AIS are a major concern in Wisconsin Waters.

AIS can outcompete native species, decreasing habitat quality and interfering with a lakes food web.

AIS are a nuisance to boaters, especially plants like Curly-Leaf Pondweed and Eurasian Water Milfoil which create dense mats and clog up motors.

Lake	AIS and Year Confirmed
Round Lake	Curly-leaf pondweed (2014) Purple loosestrife
Boot Lake	Purple loosestrife
Long Lake	Curly-leaf pondweed (1988) Eurasian water milfoil (2003) Pale yellow iris Purple loosestrife
Becker Lake	Curly-leaf pondweed (1993) Eurasian water milfoil (2009) Hybrid Eurasian/Northern water milfoil (2012) Purple loosestrife Phragmites



As water quality efforts improve clarity in the CalMan Lakes, AIS monitoring will be crucial to managing AIS populations that take advantage of improving water clarity.

Watershed Assessment

A lake's **watershed** has great influence over the water chemistry, hydrologic properties, and overall ecology of the lake.

Various characteristics of the **watershed** may determine the quantity of nutrients, sediments, inorganic pollutants and water that reach a lake.

"A lake is the landscape's most beautiful and expressive feature. It is earth's eye; looking into which the beholder measures the depth of his own nature."

-Henry David Thoreau

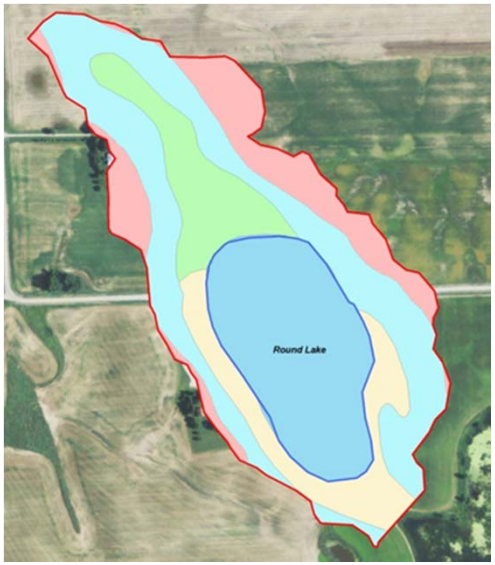
A lake's story is told by its watershed…

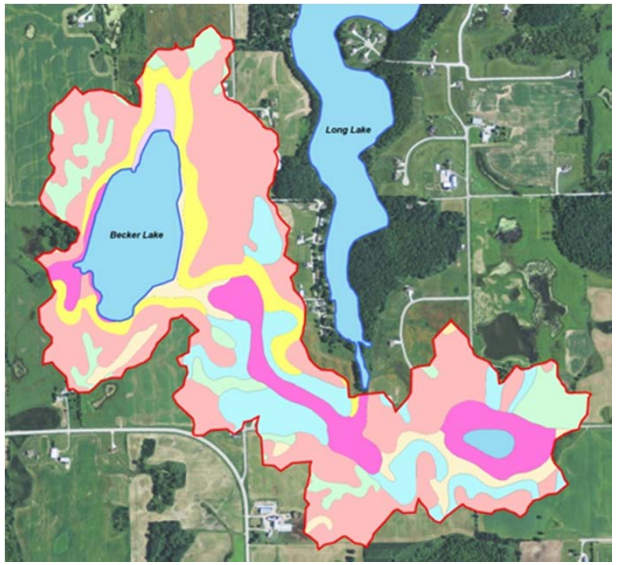
So, why such poor water quality and high levels of phosphorus? Answers lie within the watershed.

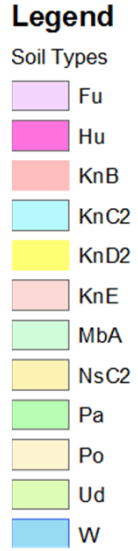
- Inventory of Nutrient Sources
  - Soils
  - Land Use
  - Nutrient Management
    - Agricultural
    - Residential (Properties)
    - POWTS
- Watershed Size to Lake Area Ratios

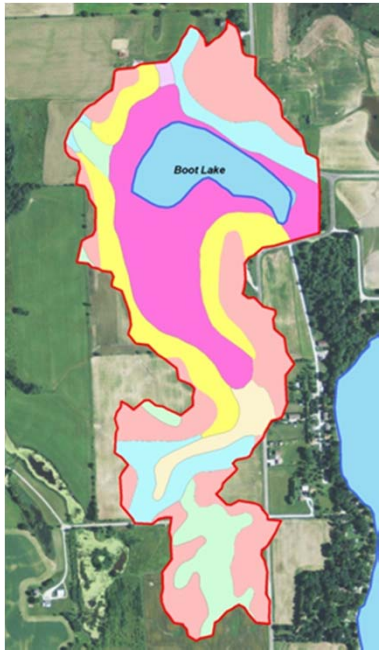
Soils

Geology and soils play an extremely important role in controlling how water moves over and through a watershed. By studying the properties, position in the landscape and watershed hydrology associated with geology and soils, a better understanding can be achieved about how the watershed functions. In addition to their impact on water flow and quality, soils and geology play a pivotal role in a number of human activities, such as agricultural production, home site development, road construction, landscaping, etc. Thus, a general knowledge of soils is essential for implementation of successful watershed management activities.

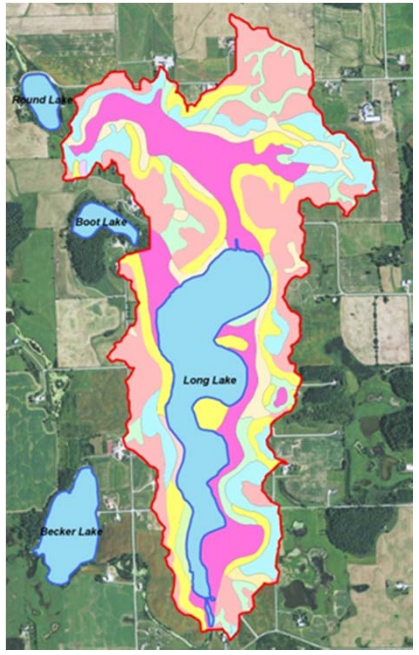








The soils in the CalMan Watershed are generally hydric (wet) soils, with high clay or organic content. These soils tend to remain saturated. This leads to increase erosion and nutrient loss, especially when left uncovered during rain and snowmelt events.

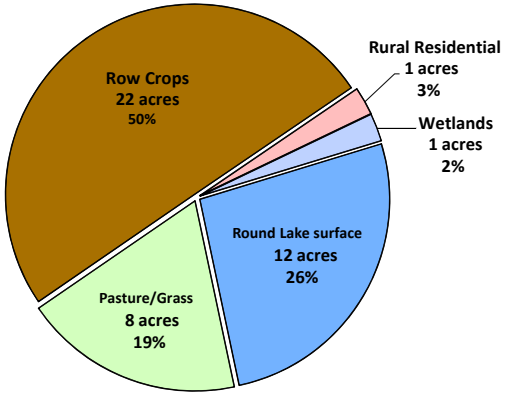


For more information on soil types, see section 3.2 in the Phase I Report

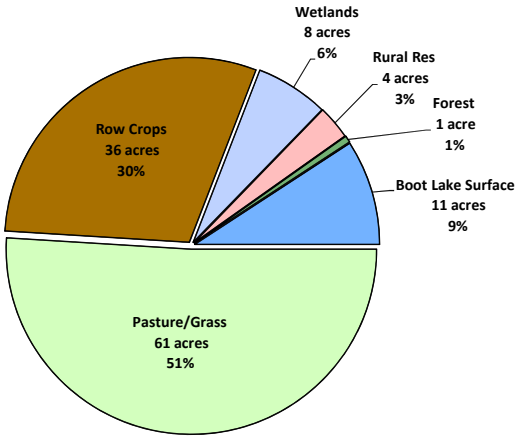
Land Use

The type of land cover that exists in the watershed helps determine the amount of phosphorus (and sediment) that runs off the land and eventually makes its way to the lake. The actual amount of pollutants (nutrients, sediment, toxins, etc.) depend greatly on how the land within the watershed is used. Vegetated areas, such as forests, grasslands and meadows, allow the water to infiltrate into the ground and do not produce much surface runoff. Agricultural areas, particularly row crops, and residential/urban areas minimize infiltration and increase surface runoff, leading to increased phosphorus and pollutant loading. In turn, it can lead to nuisance algal blooms, excessive sedimentation and/or overabundant macrophyte populations.

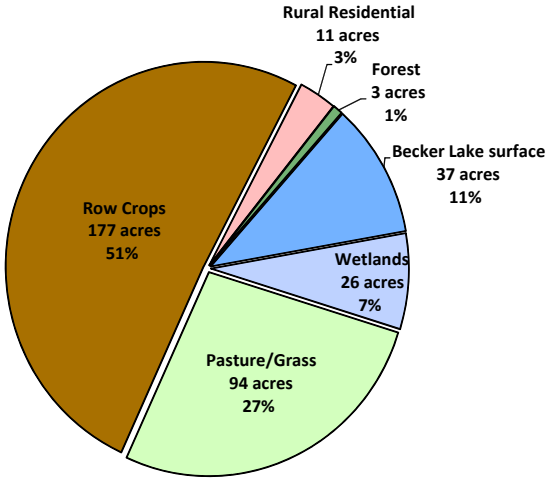
The majority of the land use within the watershed is agricultural. The given number of acres in row crops verses alfalfa (included in pasture / grass) will vary annually depending on crop rotations.



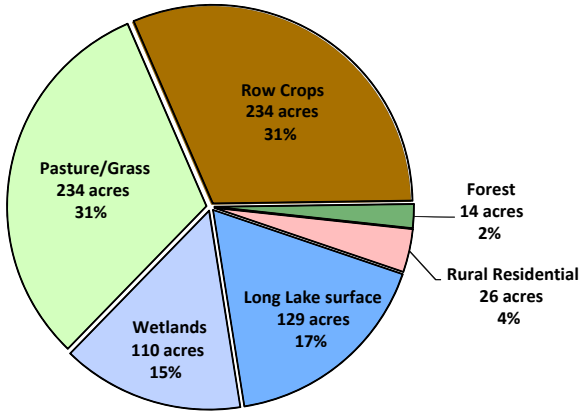
Round Lake
Total Watershed: 45 Acres



Boot Lake
Total Watershed: 119 Acres



Becker Lake
Total Watershed: 1,258 Acres
Long Lake Watershed: 910 Acres
Direct Watershed: 348 Acres



Long Lake
Total Watershed: 910 Acres
Round/Boot Watersheds: 183 acres
Direct Watershed: 747 acres

Figure 3.2-6. Land use within the CalMan Lakes sub-watersheds. Based upon National Land Cover Database (NLCD – Fry et. al 2011).

Nutrient Management

Managing nutrients within a watershed dominated by human land use is critical to preventing excess nutrient loading from the watershed.

Agricultural nutrient management is addressed through nutrient management planning which takes into account:

- Crop needs
- Separation distance from waters
- Slope of fields
- Timing of application

Human waste is addressed through County POWTS programs. Land applications should be accounted for in nutrient management plans.

Residential property management is addressed through a variety of programs including:

- Shoreline Zoning
- Stormwater Education
- Shoreline Restoration Assistance

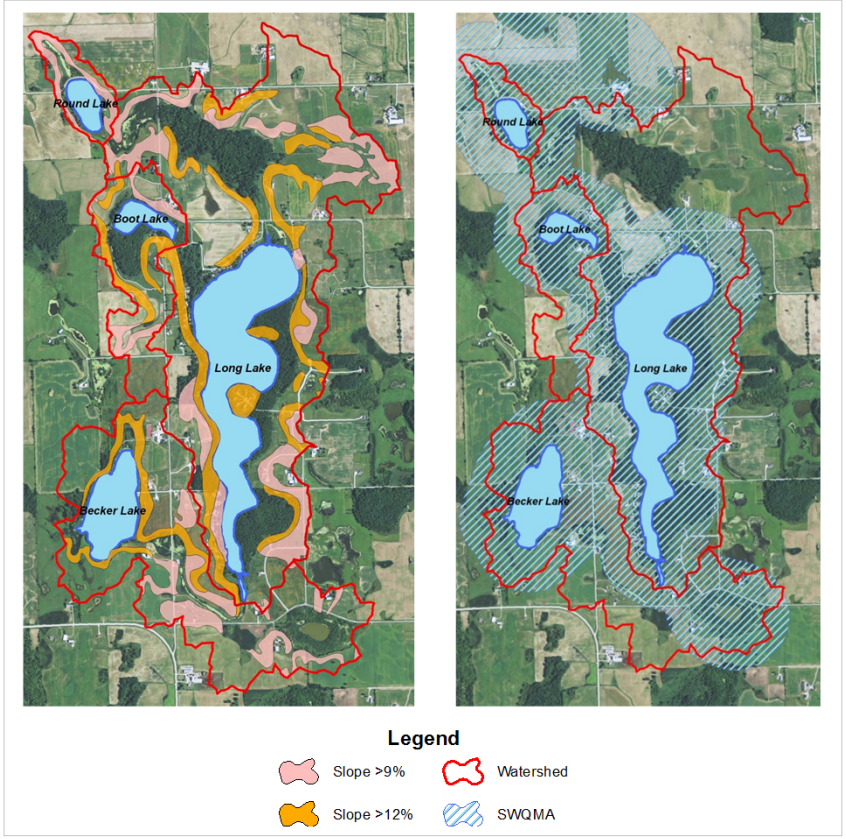


Figure 3.2-5. High slope zones and Surface Water Quality Management Areas. Data extracted from Wisconsin Manure Management Advisory System Interactive Map (http://www.manureadvisorysystem.wi.gov/).

Surface Water Quality Management Areas (SWQMAs) include areas within 1,000 feet of lakes and ponds or within 300 feet of perennial rivers and streams. While there are four lakes within the CalMan Lakes watershed, the streams that connect them are considered intermittent, and do not have established setbacks under Wisconsin's agricultural performance standards.

Winter mechanical nutrient applications are prohibited in SWQMAs. Nutrient applications on unfrozen ground in SWQMA's are restricted and must be accompanied by at least one of the following four management actions:

- ***Establish permanent vegetative buffers***
- ***Incorporate nutrient within three days***
- ***Maintain greater than 30% residue or vegetative cover***
- ***Establish cover crops after application***

Watershed Dynamics

Several additional factors influence how a lake reacts to what is flowing into it.

Watershed Size

- The **watershed to lake area ratio (WS:LA)** defines how many acres of watershed drains to each surface-acre of the lake.
- Larger **ratios** result in the watershed having a greater role in the lake's annual water budget and phosphorus load.

A lake's **flushing rate** is simply a determination of the time required for the lake's water volume to be completely exchanged.

Residence time describes how long a volume of water remains in the lake and is expressed in days, months, or years.

Lake Name	Direct Watershed to Lake Area Ratio	Lake Flushing Rate (1/yr)	Water Residence Time (years)
Round Lake	3:1	0.10	10.03
Boot Lake	10:1	0.53	1.90
Long Lake	6:1	0.37	2.70
Becker Lake	8:1	1.46	0.69

Table 3.2-1. CalMan Lakes watershed and hydrologic characteristics. Hydrology statistics computed through WiLMS (Panuska, 2003).

Pros & Cons of Watershed Dynamics

- A deeper lake with a greater volume can dilute more phosphorus within its waters which helps to keep production low.
- However, because of its low flushing rate, that same lake may experience a buildup of phosphorus in the bottom sediments. Eventually, P levels may reach levels where internal nutrient loading may become a problem rather suddenly.

- A shallow lake may respond to nutrient loading quicker due to low volume.
- However, the rapid flushing rate allows nutrients to be flushed out of the lake quickly. Such lakes, such as Becker Lake, may respond best to management practices that decrease nutrient input.

- Round Lake has a long residence time of 10 years.
- Boot Lake is more susceptible inputs from its watershed due to it's larger **WS:LA** ratio.
- Becker Lake, at the bottom of the CalMan Lakes watershed, has a large **WS:LA** ratio which is the result of a large watershed and a moderately small lake. However, the shorter **Residence Time** indicates it may respond best to management practices that decrease nutrient input.

Watershed Modeling

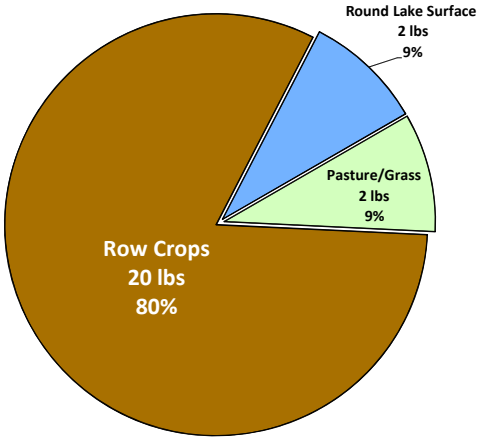
A reliable and cost-efficient method of creating a general picture of a watershed's affect on a lake can be obtained through modeling.

The WDNR created a useful suite of modeling tools called the Wisconsin Lake Modeling Suite (WiLMS – Panuska, 2003).

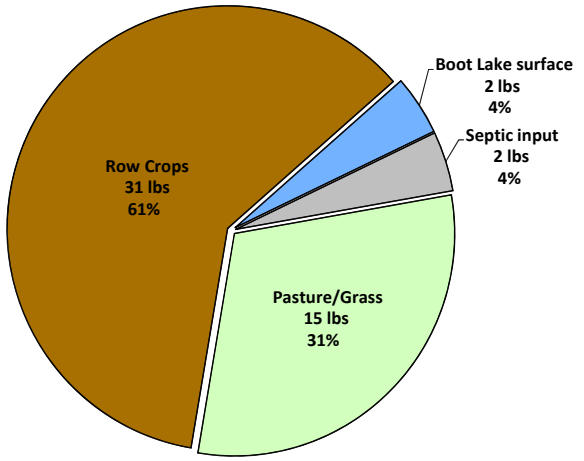
Certain morphological attributes of a lake and its watershed are entered into WiLMS along with the acreages of different types of land cover within the watershed to produce useful information about the lake ecosystem.

Preliminary modeling conducted in 2014 indicated a need to:

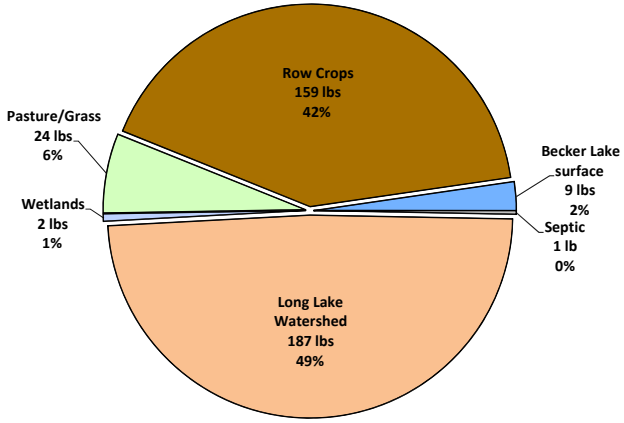
- Understand tributary flow and rain event impacts
- Understand internal loading
- Better understand actual crop rotations and nutrient management



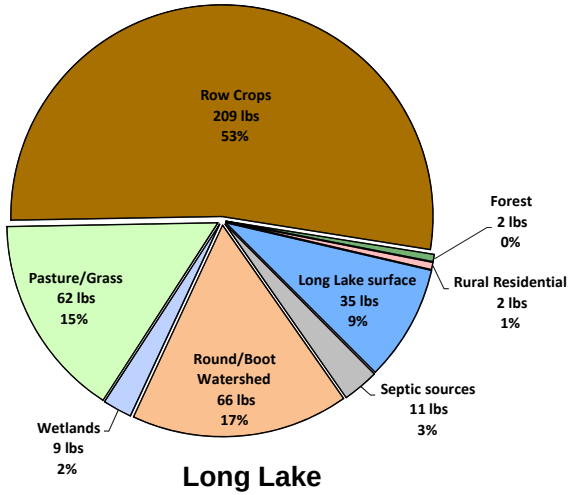
Round Lake
Total Load: 24 lbs / year



Boot Lake
Total Load: 51 lbs / year



Becker Lake
Total Load: 382 lbs / year



Long Lake
Total Load: 397 lbs / year

- Preliminary results from WiLMS using land use data from Figure 3.2-6.
- In all circumstances, WiLMS predicted total phosphorus concentrations were much lower than observed in the water quality sampling.
- Unique characteristics of the watershed lead to uncertainty in the initial modeling.
- Accuracy of upstream nutrient loading will improve after tributary monitoring in 2014 and 2015.

Plan Recommendations

- Continue Management Planning through a **Lake Protection Grant.**
  - Determine with more accuracy where pollution is originating and determine that applicability of Best Management Practices
- Continue Baseline Water Quality Monitoring
  - In-Lake Phosphorus Dynamics Monitoring
- Sediment Core Sampling
- *Tributary Monitoring (2014 – 2015)*
- *Shoreland Condition Assessment (2014)*
- Coarse Woody Debris Assessment
- Continued Stakeholder Engagement

Continue Water Quality Monitoring

Impaired Waters Lists (303d)

- Bi-annual submission by WDNR to EPA of streams and lakes that do not meet water quality standards.
- Waters listed have greater leverage for additional grant funds through
  - State Programs
  - Federal Programs
  - Some NGOs

CLMN

- Citizens Lake Monitoring Network
- Statewide program providing training and equipment to local citizens concerned about their lake(s).

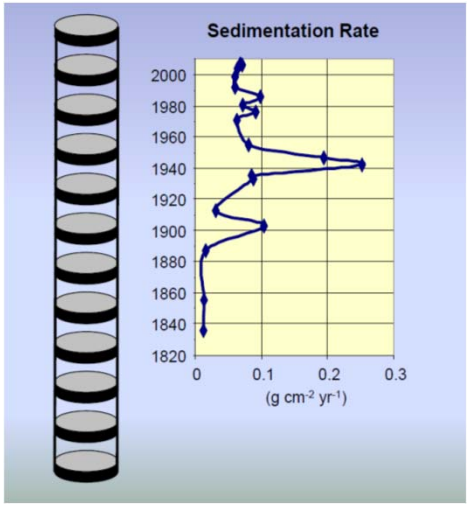
- *Baseline Monitoring 2014*
  - Monthly Sampling on Round and Boot Lakes to meet monitoring criteria for impaired waters listing (303d)
  - Continue CLMN on Becker, Long Lakes
- *In-Lake Phosphorus 2015*
  - Bi-weekly sampling (April through October)
  - Understand Internal Loading
  - Continue CLMN on Becker, Long Lakes

Sediment Core Sampling

- Photo and graphic taken from P. Garrison presentation, Lake Leaders Institute, 2014

Sediment Cores tell a story….

- Sedimentation Rate from pre-settlement to present.
- Important for understanding internal loading.



- Some elements and isotopes can document:
  - Changes in Aquatic Plant Communities over time.
  - Transition to commercial fertilizer.
  - How long Low Dissolved Oxygen Levels have been occurring.
  - Document Nuclear Testing
    - Used as a “known date” parameter.

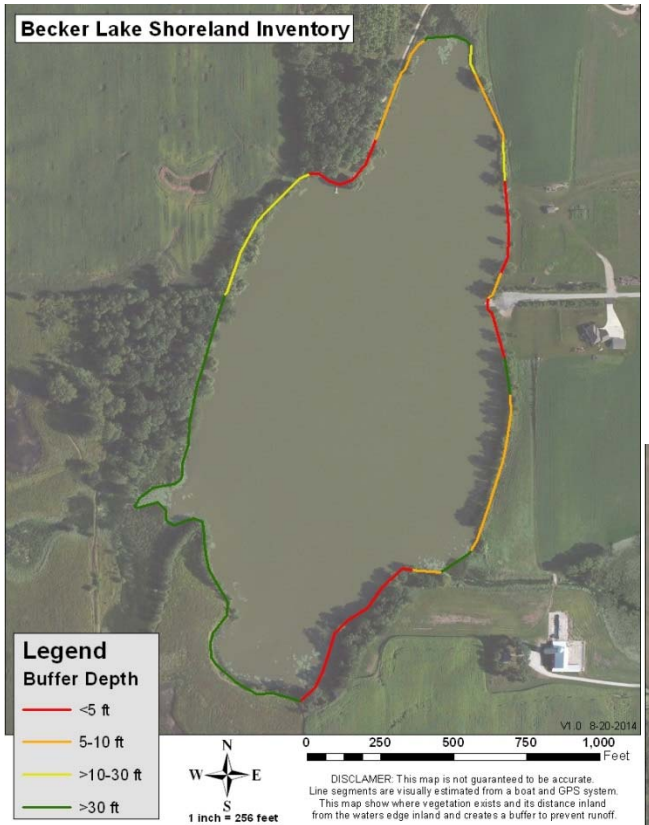
Shoreline Assessment

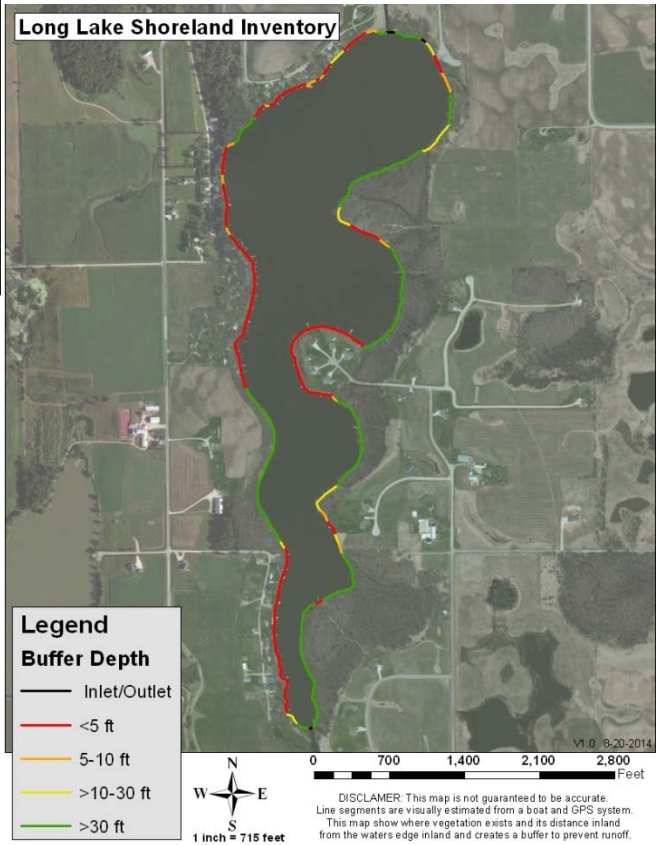
- Buffer Depth
- Buffer Type
- Development

Boot Lake has the best shoreline condition, with wetlands and shrubs providing excellent near shore habitat. Purple Loosestrife should be targeted for control in the near future.

Long Lake, with the most development pressure, has the greatest potential for restoration projects.

Completed In 2014



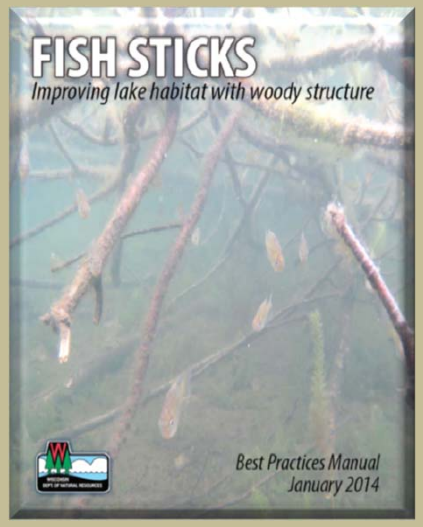


Continued Stakeholder Engagement

"…local property owners were the only group with enough personal interest and proximity to manage individual lakes."

- *Lowell Klessig*
UWSP Professor
UWEX Lakes

Coarse Woody Habitat



Brillion Conservation Club

- Responsible for Boat Launches and Public Access
- Membership has interest in re-establishing fisheries in Round and Becker Lakes
- Good relationships with land operators (members, or neighbors)
- Conversations with operators to make management changes.

Long Lake Advancement Association

- Only lake association established within the watershed.
- Lake knowledge is greater than general public.
- Recreational Uses & Financial Risk *(property values)* with declining water quality.
- Developing a Shoreline Restoration Program.

Coarse Woody Habitat

- Important fish habitat inventory
- In Lake Woody Debris helps decrease wave energy and decreases need for armored shorelines
- In-kind Donation

Tributary Monitoring

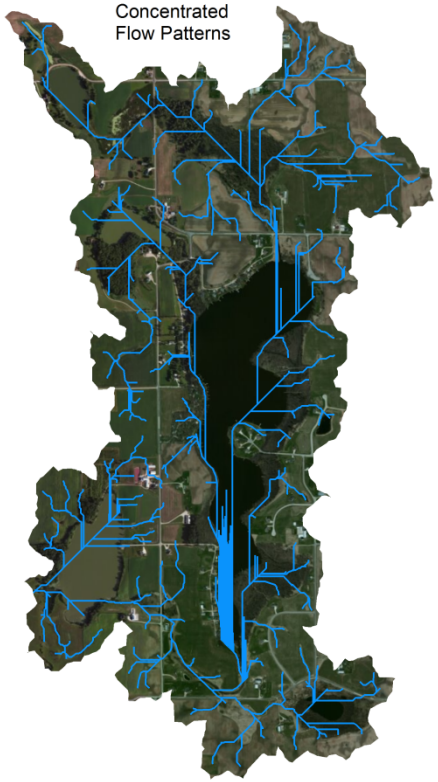
Most challenging parameter in the CalMan watershed

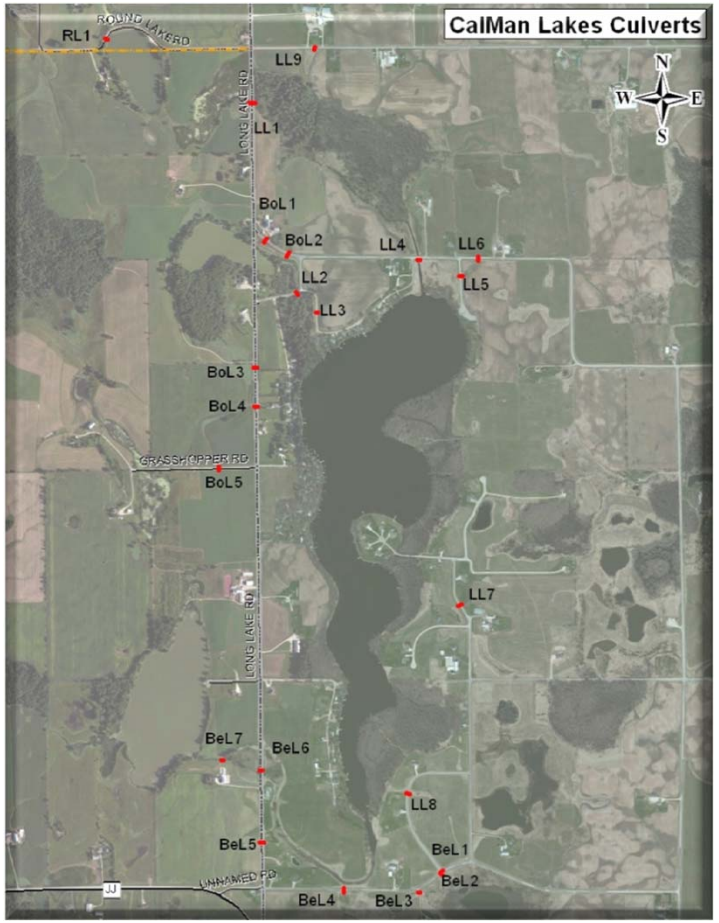
Most tributaries are intermittent

Most flow is event driven

Need data for

- Spring Runoff (2015)
- Fall Events (??)

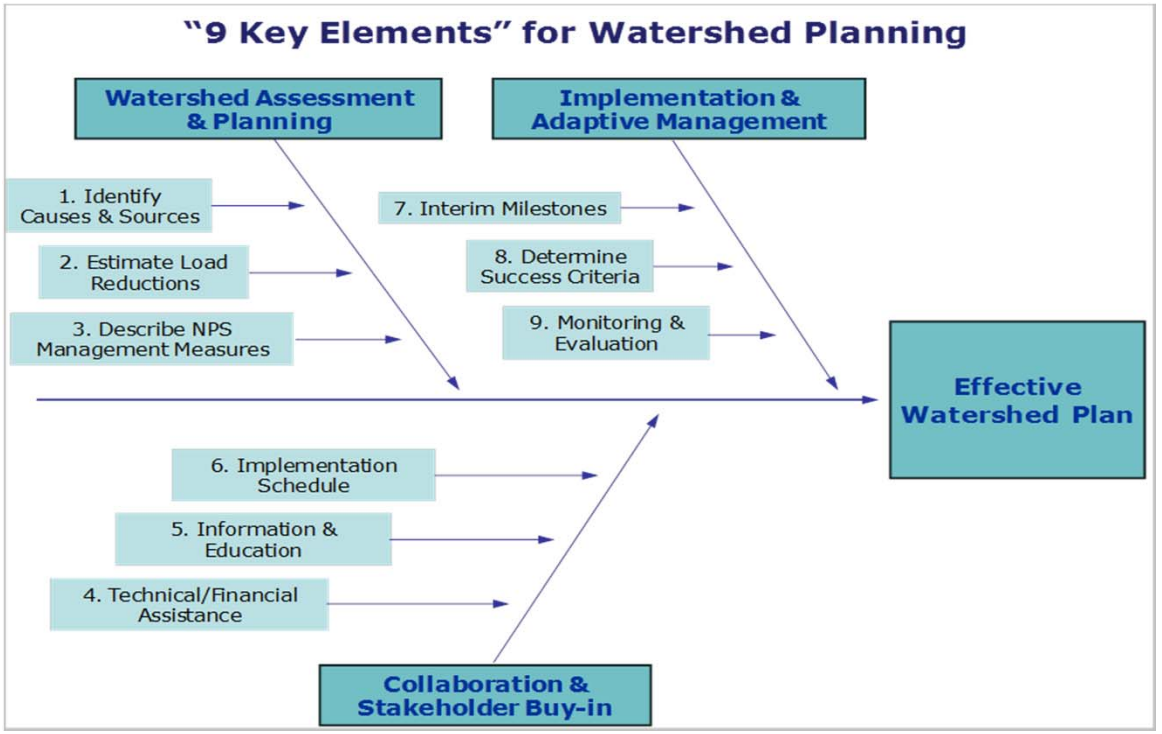




Nine Key Element Plan

The DNR recently adopted a policy of including nine key elements in watershed planning and implementation.

These 9 key elements characterize an effective yet dynamic state nonpoint pollution program designed to achieve and maintain water quality and habitat goals.



The CalMan Watershed Planning Process is incorporating these 9 elements. This will strength the plan not only by focusing more on civic engagement and ownership, but also will increase the project's ability to leverage additional federal and state funds.

- Engage Citizens and Build Partnerships
- Implement Plan
  - –Local Support
  - –DNR Protection Grants
  - –Federal Funds