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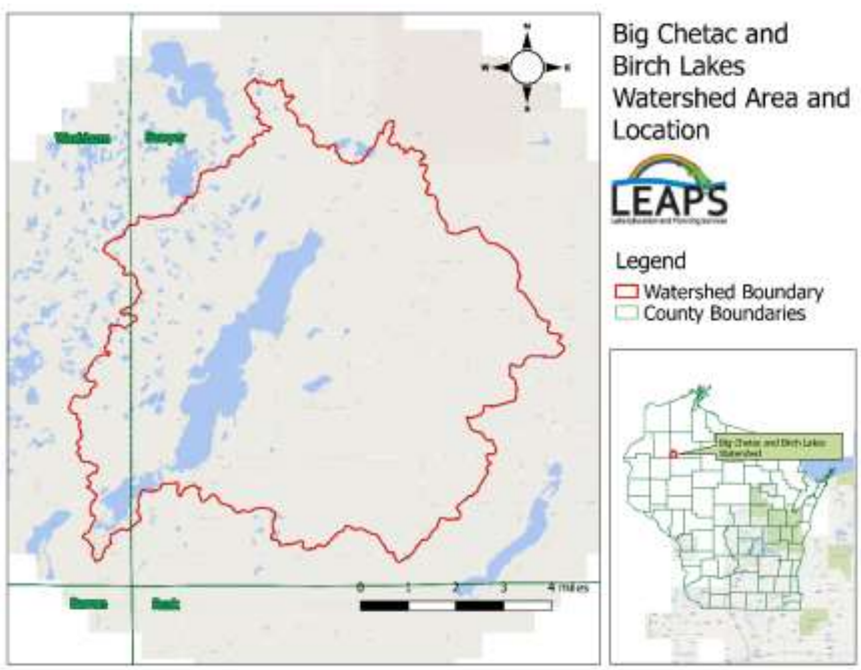
BIG CHETAC AND BIRCH LAKES, SAWYER/WASHBURN COUNTY

2020-24 Comprehensive Management Plan
WDNR WBIC: 2113300 & 2113000

Prepared by: Dave Blumer, Lake Educator
December, 2019



Big Chetac and Birch Lakes Association
Birchwood, WI 54817

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PREPARED FOR THE BIG CHETAC AND BIRCH LAKES ASSOCIATION

INTRODUCTION

In the mid-2000's Big Chetac, Birch, and Little Birch lakes experienced severe algae blooms such that during the summer of 2005, the Sawyer County Land and Water Conservation Department placed environmental hazard warning signs on the lake due to the high blue-green algae concentrations. Deteriorating water quality conditions in the system drove the Big Chetac and Birch Lakes Association (BCABLA) to pursue a series of Wisconsin Department of Natural Resources (WDNR) Lake Management Planning Grants to complete a comprehensive "Getting Rid of the Green" lake study. The goal of this study, which began in 2007 and was completed in 2010, was to identify the contributing factors to the blue-green algae blooms in Big Chetac Lake. It included a comprehensive look at the nutrient levels in the system, their sources, and the impact they have. It included a whole-lake early season curly-leaf pondweed (CLP) and mid-summer point-intercept (PI) aquatic plant survey, groundwater and watershed assessment, septic system survey, and a paleo-ecological study of the sediments in the lake to determine historical conditions. The end result of this study was a Comprehensive Lake Management Plan (LMP) for the Big Chetac Lake written by Short, Elliot, Hendrickson (SEH) Inc. Recommendations for improving water quality were presented to the BCABLA and the WDNR in June 2010.

That LMP was reviewed and commented on by a WDNR Technical Review Team in September 2010; and then adopted in part by the BCABLA in November 2010 based on recommendation made by the BCABLA Lake Management Plan Committee. Between 2013 and 2015 several management actions were implemented with support from a majority of BCABLA members and the WDNR (technical support and grant funding) including large-scale chemical management of CLP in Big Chetac Lake and an Alum Dosage Study for Big Chetac Lake. Implementation of these management actions was not entirely supported however. In 2013, opposition to management actions being implemented surfaced from three local units of government: Town of Edgewater, Town of Birchwood, and the Village of Birchwood. Additional opposition was voiced by a few members of the community. Despite this opposition management implementation continued through 2015

In 2015, the BCABLA Lake Management Plan Committee completed an update of the 2010 plan and submitted their efforts to the WDNR for review. The update highlighted what had been done between 2010 and 2015 and how it impacted certain aspects of Big Chetac Lake including water quality, the fishery, and aquatic plants both native and non-native. The WDNR completed its review of the updated plan and put its determinations into a letter sent to the BCABLA in January 2016.

The WDNR did not approve the rewrite, and did not support chemical management of CLP proposals for 2016 made by the BCABLA based on the 2015 update. Instead the WDNR suggested that money left in an existing grant be used to complete a much more involved public input and involvement project that would hopefully better define and attempt to resolve conflicts that divided many stakeholders affected by the condition of Big Chetac, Birch, and Little Birch lakes and the management actions aimed at making improvements to them.

In July 2016, Lake Education and Planning Services (LEAPS) was contracted with and led a nearly two-year public involvement campaign culminating in this document, considered an update of the 2010 LMP, and a plan for implementing it.

This updated version referred to as "Comp Plan", focuses on all three lakes in the system. Additional water quality and aquatic plant data was collected on Birch Lake in 2017; new aquatic plant data was collected on Big Chetac Lake; water quality monitoring and aquatic plant survey results since 2010 have been reviewed; and various surveys and reports completed by the BCABLA, WDNR and other stakeholders have been reviewed. In addition, representatives from a majority of the stakeholder groups have been heavily involved in the discussion leading to this updated plan, and several opportunities were provided for the general public to provide input and review.

The 2010 LMP was and continues to be a good resource for understanding how a lake works and identifying those things impacting Big Chetac and to a lesser degree, Birch and Little Birch lakes, both good and bad. This new Comp Plan updates existing information, adds new information, and then sticks to the nuts and bolts of management planning and implementation for all three lakes through at least 2024.

Portions of this Comp Plan will focus on the following: 1) public input gathered related to past, present, and future management recommendations; 2) past management planning and implementation; 3) watershed and lake characteristics; 4) updated water quality and aquatic plant data; 5) fisheries survey results; 6) Shoreland Habitat Assessment; 7) aquatic invasive species; 8) aquatic plant management; 9) whole lake management; 10) goals, objectives, and actions in this plan; and 11) a review of WDNR grant funding opportunities.

PUBLIC PARTICIPATION AND STAKEHOLDER INPUT

PUBLIC INVOLVEMENT

In July 2016 LEAPS began a public input campaign that included interviews with government officials in the Town of Edgewater, Town of Birchwood, and Village of Birchwood in an attempt to find out the source of their opposition to previous and current CLP management plans and other lake improvement actions being implemented or considered by the BCABLA. In addition to the government officials, resort owners on the lakes were contacted and asked if they would participate in similar interviews. Those that responded were interviewed by LEAPS. Resort input was considered necessary to get a better understanding of how one large group of identifiable lake users felt about the lakes and their satisfaction with many aspects of them including fishing and water quality. Resort owners who were in favor of and resort owners who were in opposition to what the BCABLA had been doing since 2013 were interviewed.

Throughout the implementation of the 2010 LMP the BCABLA was providing information to the public about its management planning and implementation, and had been working closely with the WDNR. Nearly every document created through 2015 and related to the implementation of the 2010 LMP was posted on the BCABLA webpage. Public meetings were held and paper surveys seeking input were distributed.

GOVERNMENT AND RESORT OWNER INTERVIEWS

All board members (3 each) and Town Clerks of the Towns of Edgewater and Birchwood were initially contacted by mail requesting a one-on-one interview. The Village of Birchwood President, four trustees, and the Village Clerk were also contacted by mail. A total of 10 resorts on the lakes were initially contacted by email, making a total of 24 requests for interviews. Follow up calls and emails led to all three Town of Edgewater Board Members being interviewed; two Town of Birchwood Board Members being interviewed; and the Village of Birchwood President, Clerk, and one Trustee being interviewed. Eight of the 10 resorts contacted completed full interviews. The owner of Red Cedar Spring Resort on the north end of Big Chetac Lake did not complete a full interview, but spent about 30 minutes in person discussing his thoughts about the lake and the three years of CLP management that essentially took place right outside his doorway. A total of 18 interviews were completed between late July and early September 2016. Half were done in person and the other half over the phone.

Interviews averaged about 90 minutes in length and were conducted by LEAPS using a set of questions developed by LEAPS covering the following six topic areas: 1) Lake Use, 2) Fisheries and Wildlife, 3) Aquatic Plant and Aquatic Plant Management, 4) Water Quality and Water Quality Management, 5) Information and Monitoring, and 6) Stakeholder Involvement and Discussion.

STAKEHOLDERS COMMITTEE

At the conclusion of the government and resort owner interviews it was clear that a mechanism was needed to insure appropriate stakeholder involvement in management planning discussion for Big Chetac, Birch, and Little Birch lakes. One stakeholder group in particular, including Birch and Little Birch lakes property owners, Village of Birchwood, and the Town of Birchwood indicated they felt underrepresented in the development of the 2010 LMP and the BCABLA's implementation of it through 2015.

In December 2016, a group of stakeholders determined by LEAPS based on its interviews were invited to meet and discuss the formation of a Stakeholders Committee and an application for a WDNR Lake Management Planning Grant to collect data from Birch, Little Birch, and Big Chetac lakes. The purpose of the Stakeholders Committee, if supported, would be to increase the level of public involvement and to provide a non-confrontational atmosphere for discussion among stakeholders to take place. During the December 2016 meeting, it was agreed by participants that a formal Stakeholders Committee should be formed and the following stakeholder groups included: three representatives from the BCABLA including two from Big Chetac Lake and one from Birch Lake; one representative each from the Towns of Edgewater and Birchwood and the Village of Birchwood; two resort owners - one from Big Chetac Lake and one from Birch Lake; and one representative from the Red Cedar River Watershed and TMDL Coalition. The Committee would be facilitated by LEAPS, with a representative from the WDNR also participating. Neither LEAPS nor the WDNR were considered voting members of the Committee. Committee meetings would be held on a regular schedule (monthly as long as it was the conclusion of members that it was still needed).

LAKE MANAGEMENT PLANNING GRANT PROJECT

During the December 2016 discussion, LEAPS and the BCABLA, proposed the preparation and application of a WDNR large-scale lake management planning grant to support activities in 2017 and 2018 that would address some of the concerns brought forth during the government and resort owners' interviews. The project included in the grant had several goals and objectives:

- Collect water quality data from the Deep Hole in Birch Lake;
- Collect water quality data from the inlet to Birch Lake from Big Chetac Lake and the outlet of Birch Lake to downstream waters;
- Cold and warm water whole-lake, point-intercept, aquatic plant surveys in Birch and Little Birch lakes (never done before);
- Repeat a warm water whole-lake, point-intercept, aquatic plant survey in Big Chetac Lake (last survey done in 2014);
- Complete a Shoreland Habitat Assessment survey on all three lakes;
- Design and implement a Resort Owners Fishing Success Survey;
- And, provide additional financial support for the Big Chetac, Birch, and Little Birch lakes management planning project.

Participants in attendance at the December 2016 meeting agreed that the project defined in the grant application would provide support needed to further management planning efforts. The grant application was submitted to the WDNR by the BCABLA in December 2016 and was awarded in April 2017.

STAKEHOLDER COMMITTEE MEETINGS

Stakeholder Committee meetings officially began in January 2017. Agendas and minutes were assembled by LEAPS and posted on the BCABLA webpage. A total of eight Stakeholder Committee meetings were held in 2017, all at the Birchwood Senior Center. Dates of the meetings and the topics discussed were as follows:

- (Jan. 24, 2017) 2010 Lake Management Plan
- (Mar. 2, 2017) Aquatic Plant and Aquatic Plant Management
- (Mar. 30, 2017) CLP Management in Other Lakes/Water Quality
- (Apr. 24, 2017) Changes in Stakeholders Committee Makeup/Initial Goal Setting

- (Jun. 19, 2017) Review of May Public Meeting/Goal Setting
- (Jul. 24, 2017) Goal Setting
- (Aug. 14, 2017) Goal Setting
- (Sep. 25, 2017) Review of August Public Meeting/Setting Management Objectives

Minutes and agendas for all of these meetings are available on the BCABLA webpage at www.bcabla.com.

PUBLIC MEETINGS

Three public meetings were held in 2017 specifically to share what the Stakeholders Committee had been discussing and to seek input from the general public. The first meeting was held on May 20, 2017 in the Birchwood School

Commons and focused on the results of the government and resort owners interviews; formation of the Stakeholders Committee; preparation and award of a WDNR Lake Management Planning Grant; details about the first four Stakeholder Committee meetings; and an exercise involving attendees at the meeting in a goal setting activity.

The second meeting was held in the small gym of the Birchwood Schools on August 29, 2017 and focused on initial lake management goals that had been developed by the Stakeholder Committee. This initial set of goals covered several areas of concern including water quality in both lakes; the fishery; aquatic plants; best management practices for reducing sediment and nutrient loading into the lakes; tracking, monitoring, and management strategy; balanced lake uses (fishing and other forms of recreation); invasive species; lake stewardship; communication and collaboration within the BCABLA and community; and implementation of a new plan. Public input and feedback was solicited through a participatory activity whereby people at the meeting could share their views and opinions.

After a review of the outcomes from the October meeting, the Stakeholders Committee revised the initial goals and added objectives and actions to help meet the goals. A third public meeting was held on October 28, 2018 at the Birchwood School Commons. All goals, objectives, and actions were placed on tables in large print format. At least one Stakeholders Committee member was stationed at each goal ready to answer questions and take comments. In addition to the public being asked to comment, they were given the opportunity to write on the table displays in any way to get their points/questions/comments/changes across. The results of this activity were then used to put together the goals, objectives, and actions that are included in this document.

In addition to the three public meetings, two additional meetings were held, one in May and one in October, with the Birchwood Area Chamber of Commerce.

BIG CHETAC AND BIRCH LAKES ASSOCIATION

The Big Chetac and Birch Lakes Association has four officer positions (President, Vice President, Treasurer, and Secretary), three at-large directors, and the past president. As of June 2017 it had approximately 138 members of which about 20% were Birch Lake property owners. As of June 2017, only the President, past president, and two at-large director positions on the board were filled. One of the at-large directors term was to end in 2018, and the past-president position dropped off in 2018. One of the goals for the BCABLA moving forward is to rebuild its membership and to fill the vacant board positions.

The stated purpose of the BCABLA is to "preserve, protect, and improve the quality of the lakes resources and its surroundings for the collective interests of its members." Membership in the association is open to any individual that owns real estate (or resides for at least one month each year) on or within one mile of the lake. Membership is voluntary and current dues are $35.00 for an individual and $45.00 for a family.

The BCABLA functions by committee with the following standing committees:

- **Membership** – Shall initiate a plan to recruit new members and offer suggestions to the board on retention of members.
- **Hospitality** – shall provide refreshments at the annual meeting and, after receiving board approval, shall organize and publicize other social events to be sponsored by the Association.
- **Finance** – Shall recommend fund-raising activities to the board and after receiving board approval, shall organize such activities. The Finance Committee shall also annually audit the financial records of the Association.
- **Land Use** – May represent the Association at local public hearings and informational meetings relating to zoning, sanitation codes, subdivision ordinances, pollution sources, and changes in land use which might affect water quality. The Committee shall offer proposals to the board regarding land use issues.
- **Boating** – May represent the Association at local public hearings and informational meetings relating to water safety patrols, lake use ordinances, and obstacles to navigation. The Committee shall offer proposals to

the board regarding water use issues.

- **Fishing, Water Quality, Weed and Algae** – May represent the Association at WDNR hearings and a local meetings relating to in-lake water quality, fish, and wildlife habitat, water levels, control of nuisance plants, and to the protection of desirable vegetation. The Committee shall offer proposals to the board regarding water quality monitoring, ecological management of the fishery, and a vegetation management plan.
- **Lake Management Plan Committee** – Represented the Association in the development and approval of a Comprehensive Lake Management Plan in 2010 and again in 2015.

With a limited number of current and active board members, the functionality of the Committees is reduced. As this new Lake Management Plan is implemented, the existing committees will be evaluated, modified if necessary, and new committees and committee structures (including goals) established.

The BCABLA maintains a webpage at www.bcabla.com, and a Facebook page at Big Chetac and Birch Lakes. Both the BCABLA webpage and Facebook page are in need of updating. The BCABLA also publishes at least one comprehensive newsletter each year, and submits occasional news items through the Birchwood News (Birchwood Schools).

During the June 2018 Annual Meeting, Mark Robinson, current president of the BCABLA, put forth the following draft list of priorities for the organization over the short-term:

- Complete and publish the five-year lake management plan based on stakeholder committee and public inputs.
- Form a Fisheries committee and begin work on a comprehensive Fisheries Management Plan with the WDNR.
- Identify candidates for BCABLA leadership positions and plan for a summer/fall election.
- Request volunteer "media specialists" to help rebuild and improve the organization's website at www.bcabla.com (urgent).
- Form additional BCABLA committees as volunteers and leadership allow (Bylaws stipulate Membership, Hospitality, Finance, Land use, Boating safety, Fishing - water quality – weed and algae, committees.)
- Identify potential projects for 2018 (and forward) by member input.

PAST MANAGEMENT PLANNING AND IMPLEMENTATION IN BIG CHETAC, BIRCH, AND LITTLE BIRCH LAKES

PAST MANAGEMENT PLANNING AND IMPLEMENTATION

As was previously mentioned, the original LMP for Big Chetac Lake was approved by the WDNR and BCABLA in 2010. Reducing the amount of CLP, a non-native aquatic invasive plant species, in Big Chetac Lake was one of the goals in the 2010 LMP. By doing so, it was thought that more beneficial native aquatic vegetation would return to the lake, water quality may improve, and some navigation and nuisance vegetation issues would be reduced. Between 2010 and 2013 the BCABLA Lake Management Plan Committee, made up of several BCABLA board members, gathered the necessary information to submit an Aquatic Invasive Species Control of an Established Infestation (ACEI) grant application to cover three years (2013-2015) of CLP chemical control in a 90-acre test plot in the north end of Big Chetac Lake. The grant also provided funding for aquatic plant survey work before and after chemical treatment, native plant re-planting, aquatic invasive species (AIS) education and monitoring, and monitoring of several measures to identify if management succeeded in its goal of reducing the amount of CLP in the lake. The overall goal of the project was to determine if control of established beds of CLP could increase the diversity, distribution and density of native vegetation, without causing harm to other aspects of a healthy lake.

In addition to the ACEI grant that was applied for and awarded, the BCABLA also applied for a WDNR lake management planning grant in 2013 to complete an Alum Dosage and Modeling Study (James, 2013). This study was also a recommendation made in the 2010 LMP. Aluminum sulfate (alum) is one of the substances that can chemically bond with phosphorus (a nutrient in excess in the lake) removing it from the water and locking it up in a manner that cannot negatively impact the lake.

CLP MANAGEMENT IN THE NORTH BAY OF BIG CHETAC LAKE

The ACEI grant that was awarded in early 2013 provided funding for three years of CLP management in the North basin of Big Chetac Lake. There was vocal and written opposition from local municipalities (Town of Edgewater, Town of Birchwood, and Village of Birchwood) to using chemical herbicides to manage CLP, however, the criteria required by the WDNR in order to be eligible and receive grant funding for the project was met by the BCABLA and management planning was deemed satisfactory to move forward with the proposed treatment area in the North basin.

In 2013, 90.8 acres in the North basin of Big Chetac Lake (Figure 1) were treated with Aquathol K at a concentration of 1.5-ppm. With the results of the treatment, there was no doubt that the application of Aquathol K could reduce the amount of CLP in the treated areas. While it did very effectively control CLP in the treated area, it affected CLP control far outside the boundaries of the treated area (nearly three times as much area), and negatively impacted several native aquatic plant species (Figure 1). The following is an excerpt from the 2013 Post-treatment Point-intercept Aquatic Plant Survey Report (Berg M. , 2013).

"Following the May 28th application of Aquathol K at a concentration of 1.5ppm, we returned to the lake on June 17-18, 2013 to assess the effectiveness of the treatment. CLP showed a highly significant reduction in the north bay for all rake fullness values as well as overall as it was nearly completely eliminated. We found it at only two of the 416 survey points (0.5%), and each rake was represented by a single CLP plant. We also noted evidence of residual control of CLP throughout the north basin at a distance of up to two miles downstream of the treatment area. Small pondweed (Potamogeton pusillus) and Coontail (Ceratophyllum demersum), the most common native plants in the north bay prior to treatment demonstrated highly significant declines; and Flat-stem pondweed (Potamogeton zosteriformis) exhibited a moderately significant decline. Conversely, Forked duckweed (Lemna trisulca) showed a highly significant increase, and filamentous algae a moderately significant increase."

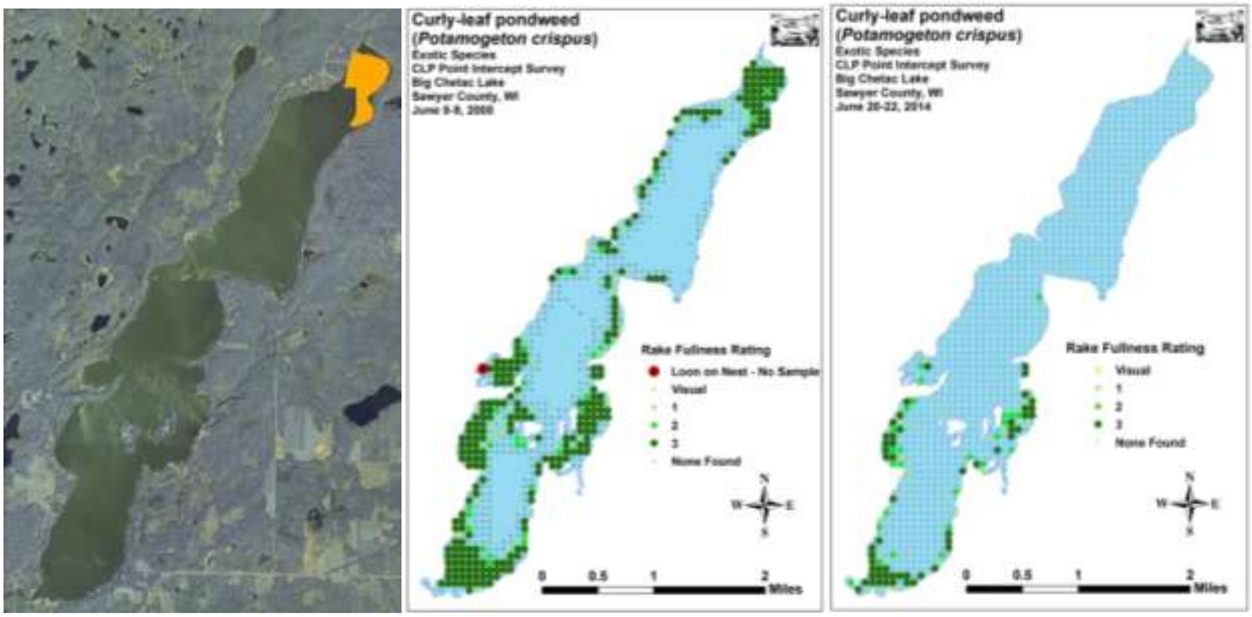


Figure 1: Original 2013 90.8 acre CLP treatment area; 2008 CLP distribution; and 2014 CLP distribution

In 2014, the same 90-acre area was treated again but only at a concentration of 1.0-ppm. In 2015, only 55 acres of the original area was chemically treated at a reduced concentration of 1.0-ppm. In the several years following the 2013 treatment CLP density and distribution remained low in the treated area. However native aquatic vegetation was slow to recover. Based on results from the 2017 whole-lake, summer, aquatic plant point-intercept survey, most of the native aquatic plants that had suffered significant declines after 2013 had started to come back, but were still not at the levels they were in 2008 prior to chemical treatment. Despite management results that negatively impacted a few native aquatic plant species, overall native aquatic plant species richness (diversity) in the lake stayed high throughout the treatment years with most of the plant diversity occurring in the inlets near the numerous creeks entering the lake. The overall density of aquatic vegetation decreased after treatment and has remained lower when comparing 2017 survey results with 2008 survey results.

Prior to the first CLP treatment in June 2013, the frequency of occurrence of CLP in the proposed treatment area was 88.5%. After three years of herbicide application (2013-15), the frequency of occurrence of CLP was 13.0%. In 2016 only one year after the last treatment, it was back up to 71.5%. 2017 is the last year that CLP mapping was completed in Big Chetac Lake.

In two control areas set up prior to actual treatment, and where no herbicide was applied, the frequency of occurrence for CLP remained high from 2013 to 2017.

During this time frame, no management planning or implementation (for CLP, aquatic plants, or water quality) was completed on Birch or Little Birch lakes.

BIG CHETAC AND BIRCH LAKES WATERSHED CHARACTERISTICS

The Big Chetac, Birch, and Little Birch lakes watershed is a sub-watershed of the larger Red Cedar Lake Watershed, an area that includes the headwaters of the Red Cedar River. The Red Cedar Lake Watershed covers the adjoining corners of Barron, Rusk, Sawyer, and Washburn counties (Figure 2). A small portion of the Lac Courte Oreilles Indian Reservation lies within the Red Cedar Lake Watershed north and west of Lake Chetac. Much of this watershed is forested, with county forest land a large component of the watershed. The north central portion of the watershed consists of glacial pitted outwash and contains numerous small to large lakes. Big Chetac and Birch Lake are located in this area. The area is mostly forested, but some agricultural land exists northwest and southeast of Birch Lake. The southeastern part of the watershed is in the rocky, hilly area known as the Blue Hills. The area consists of glacial end moraines and ground moraine. It is underlain by quartzite bedrock and is steep-sloped and forested. There are few lakes present in this area. The western portion of the watershed consists of end moraines and also contains a substantial number of lakes, the largest of which are Red Cedar, Hemlock, and Balsam. Most of the area is forested, though significant agricultural areas exist northeast and east of Red Cedar Lake, and southeast of Hemlock Lake.

Figure 2: Red Cedar Lake watershed - LC11, (WDNR)

LAND USE

The Big Chetac, Birch, and Little Birch lakes sub-watershed covers approximately 39,476 acres, the vast majority of which (73.4%) is covered by forest land (Figure 3). No other land cover type, with the exception of the 10.1% of open water, covers more than 7% of the area (Table 1). The shores of Big Chetac and Birch Lakes are well developed, with concentrated development in Edgewater on the NW shore, in the Village of Birchwood along the southwestern tip of the watershed boundary, and near resorts.

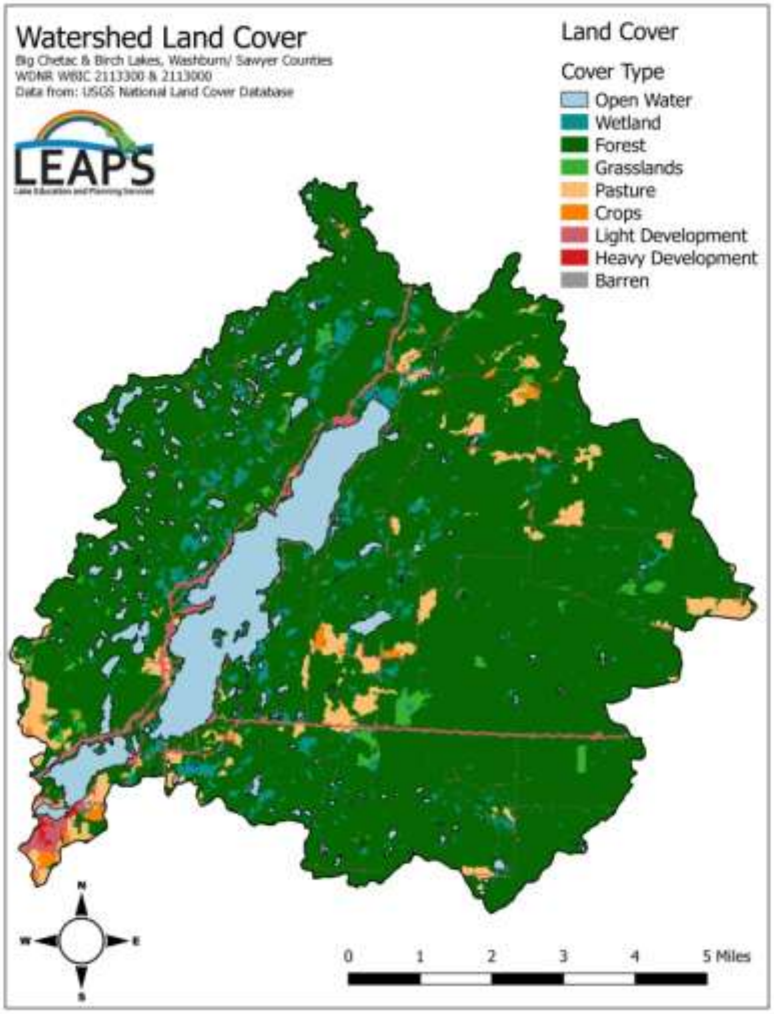


Figure 3: Big Chetac, Birch, and Little Birch lakes watershed

Table 1: Land use in the Big Chetac, Birch, and Little Birch lakes watershed

Cover Type	Total area (Acres)	% of Watershed
Open Water	3,996.7	10.1%
Wetlands	2,464.3	6.2%
Forest Land	28,984.2	73.4%
Grassland	589.3	1.5%
Pasture	1,684.9	4.3%
Crops	225.3	0.6%
Light Development	1,488.0	3.8%
Heavy Development	43.1	0.1%
Barren	1.1	0.0%

SOILS

Soils are classified into four main hydrologic soil groups (A, B, C, and D) to indicate their potential for producing runoff based off of the rate of infiltration. Group A soils have a high infiltration rate which makes the potential amount of runoff very low. These soils are generally very sandy and allow water to pass through unimpeded. Conversely, group D soils have a very low infiltration rate making their runoff potential fairly high. Group D soils are generally very dense with high amounts of organic material. This causes water to move slowly through group D soils often resulting in standing water on flat surfaces and flowing water over sloped surfaces. Group D soils are generally found within wetland areas, but they can be problematic in areas that lack the hydrophitic vegetation found within those areas.

There are also three sub groups (A/D, B/D, and C/D) these indicated the infiltration rate of the soils with respect to the water table. If the water table is high and blocking infiltration, these soils are considered to have a high runoff potential and placed into group D, but when the water table is lower, these soils are similar to the first grouping (A, B, or C). Almost half of the soils within the Big Chetac and Birch Lakes Watershed fall into either group C or C/D while the rest are almost evenly split between A or A/D and B or B/D (Table 2).

Table 2: Soil groups in the Big Chetac and Birch Lakes watershed

Soil Group	Percentage of Watershed	Infiltration Rate
A	15.8	High
B	14.9	Moderate
C	31.3	Slow
D	0	Very Slow
A/D	6.7	High when drained, very slow when undrained
B/D	3.4	Moderate when drained, very slow when undrained
C/D	18.4	Slow when drained, very slow when undrained
Water	9.5	N/A

Over half of the area above water is considered to be poorly drained soils that fall into either group C or C/D. These soils often are comprised of high amounts of organic material and/ or clay which makes precipitation more likely to run off into a lake or stream than it would be to infiltrate the ground. However, the soils surrounding Big Chetac and Birch Lakes tend to fall into groups A, A/D, B, and B/D which all drain fairly well (Figure 4). This can reduce the amount of runoff that directly flows into the lakes.

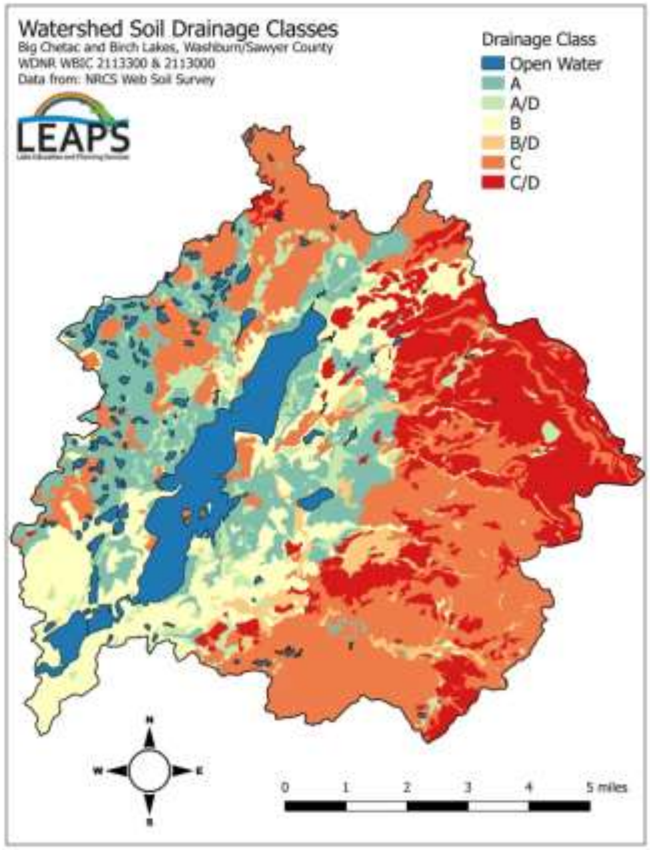


Figure 4: Soil drainage classes in the Big Chetac, Birch, and Little Birch lakes watershed

WETLANDS

A wetland is an area where water is at, near or above the land surface long enough to be capable of supporting aquatic or hydrophytic vegetation and which has soils indicative of wet conditions. Wetlands have many functions which benefit the ecosystem surrounding Big Chetac and Birch Lakes. Wetlands with a higher floral diversity of native species support a greater variety of native plants and are more likely to support regionally scarce plants and plant communities. Wetlands provide fish and wildlife habitat for feeding, breeding, resting, nesting, escape cover, travel corridors, spawning grounds for fish, and nurseries for mammals and waterfowl.

Wetlands also provide flood protection within the landscape. Due to the dense vegetation and location within the landscape, wetlands are important for retaining stormwater from rain and melting snow moving towards surface waters and retaining floodwater from rising streams. This flood protection minimizes impacts to downstream areas. Wetlands provide water quality protection because wetland plants and soils have the capacity to store and filter pollutants ranging from pesticides to animal wastes.

Wetlands also provide shoreline protection to Big Chetac and Birch Lakes because shoreline wetlands act as buffers between land and water. They protect against erosion by absorbing the force of waves and currents and by anchoring sediments. This shoreline protection is important in waterways where boat traffic, water current, and wave action cause substantial damage to the shore. Wetlands also provide groundwater recharge and discharge by allowing the surface water to move into and out of the groundwater system. The filtering capacity of wetland plants and substrates help protect groundwater quality. Wetlands can also stabilize and maintain stream flows, especially during dry months. Aesthetics, recreation, education and science are also all services wetlands provide. Wetlands contain a unique combination of terrestrial and aquatic life and physical and chemical processes.

There is a good amount of wetland area within the Big Chetac and Birch Lakes Watershed (Figure 5). The highest concentrations of wetland areas can be found fairly close to Big Chetac and Birch Lakes These areas help trap nutrients and sediments from making their way into the lakes.

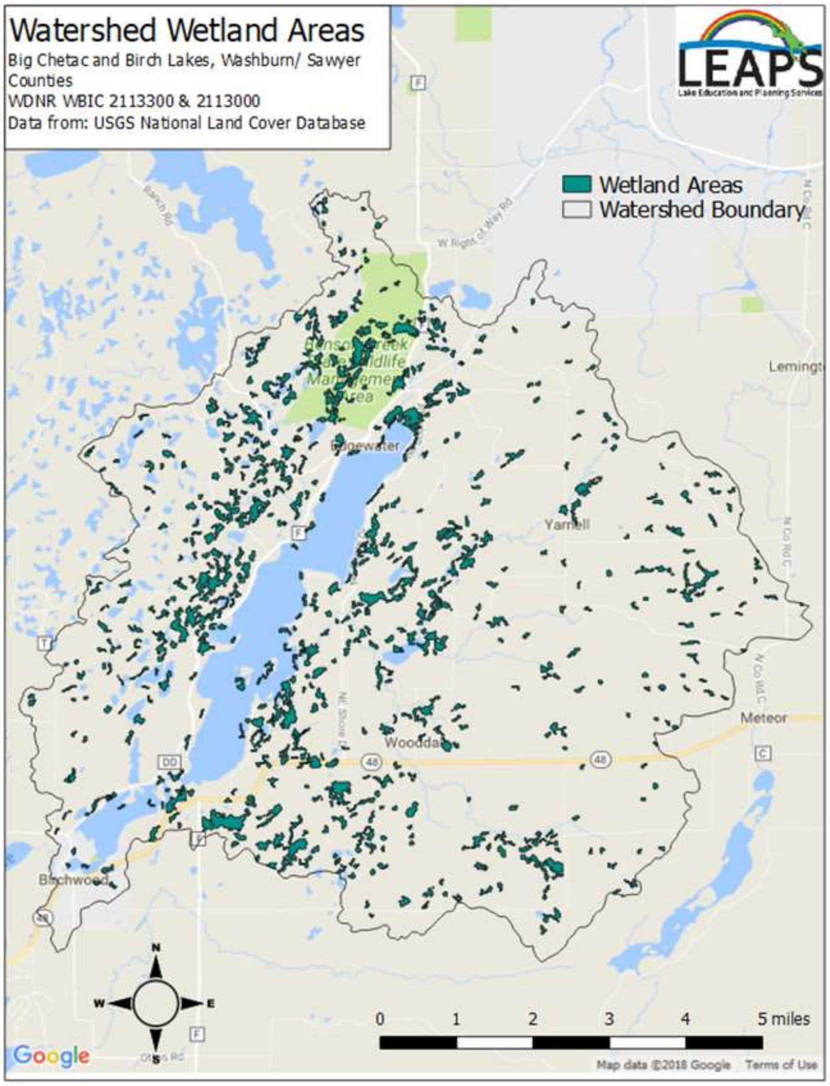


Figure 5: Wetlands in the Big Chetac, Birch, and Little Birch lakes watershed

FORESTRY

Through an extensive review of land management impacts on water quality in North America, research complied by the EPA it was determined that there is the potential for forestry operations to adversely affect water quality if best management practices (BMPs) are poorly implemented. Sediment concentrations can increase due to accelerated erosion; water temperatures can increase due to removal of over story riparian shade; slash and other organic debris can accumulate in water bodies, depleting dissolved oxygen; and organic and inorganic chemical concentrations can increase due to harvesting and fertilizer and pesticide applications. These potential increases in contaminants are usually proportional to the severity of site disturbance. Impacts of silvicultural nonpoint-source pollution depend on site characteristics, climatic conditions, and the forest practices employed (Fulton & West, 2002).

However, in general, if BMPs are properly designed and implemented, the adverse effects of forestry activities on hydrologic response, sediment delivery, stream temperature, dissolved oxygen, and concentrations of nutrients and pesticides can be minimized. The following specific management measures should be considered by all forest managers as they develop comprehensive forest management plans. Planning of the timber harvest to ensure water-quality protection will minimize nonpoint-source pollution and increase operational efficiency. Streamside management areas of sufficient width and extent are crucial because they can greatly reduce pollutant delivery. Identification and avoidance of high hazard areas can greatly reduce the risk of landslides and mass erosion. Careful planning of roads and skid trails will reduce the amount of land disturbed by them, thereby reducing erosion and sedimentation. Proper design of drainage systems and stream crossings can prevent system destruction by storms, thereby preventing severe erosion, sedimentation, and channel scouring. Road system planning is a critical part of pre-harvest planning. Good road location and design can greatly reduce the sources and transport of sediment. Road systems should generally be designed to minimize the number of road miles per acre, the size and number of landings, the number of skid trail miles, and the number of watercourse crossings, especially in sensitive watersheds. Timing operations to take advantage of favorable seasons or conditions and avoiding wet seasons prone to severe erosion or spawning periods for fish reduce impacts to water quality and aquatic organisms. Drainage problems can be minimized when locating roads by avoiding clay beds, seeps, springs, concave slopes, ravines, draws, and stream bottoms.

As previously mentioned, more than 75% of the watershed draining to the Big Chetac and Birch Lakes is forested, which likely means some level of timber harvest and other forestry practices are occurring. According to Data USA, in 2017 Sawyer County forestry and agriculture made up 3.43% of the industry in the county with 1.65% of the workforce in the county (Data USA, 2017). Numbers are similar for Washburn County. Forest land owned by both private parties and the counties are present in the watershed (Figure 6).

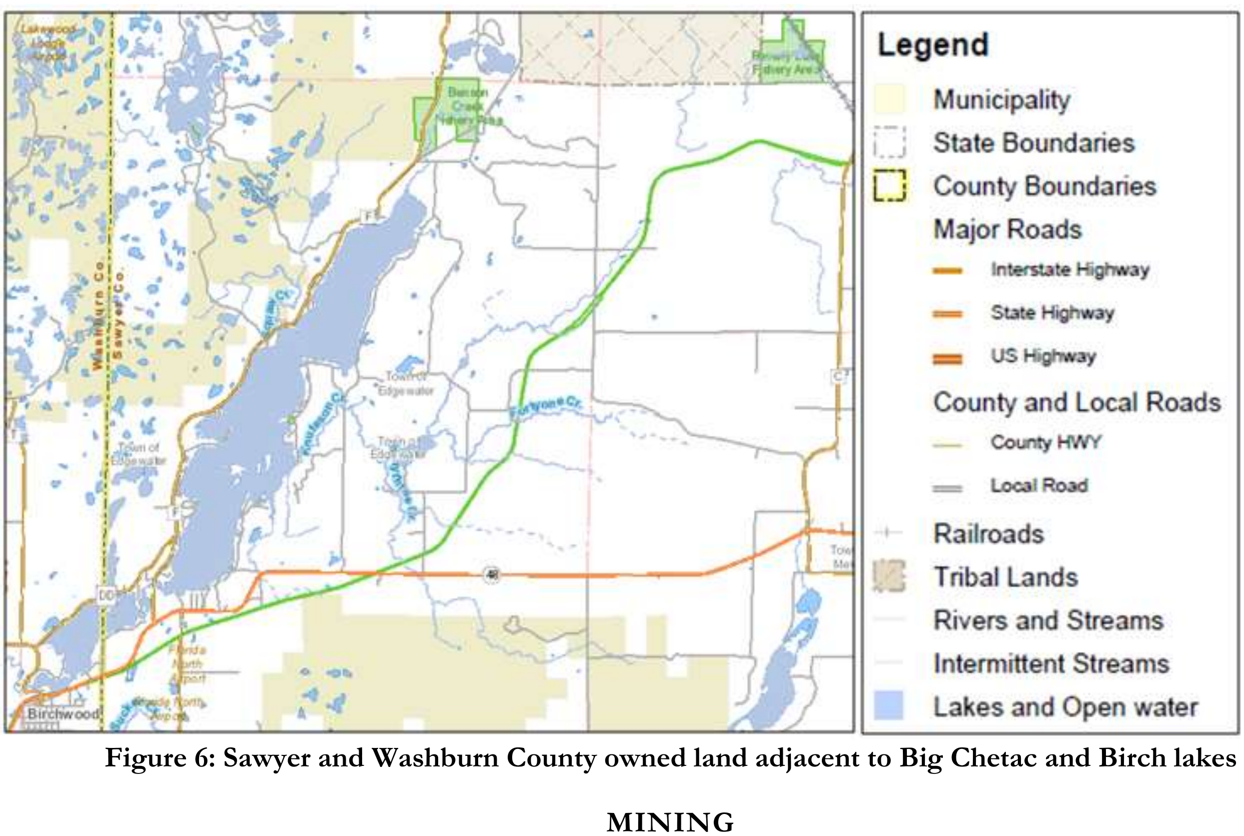


Figure 6: Sawyer and Washburn County owned land adjacent to Big Chetac and Birch lakes

MINING

Metallic mining has been of minor importance in Sawyer County over the past century. Currently there are no active metallic mineral mines in Sawyer County. Non-metallic mineral resources include sand, gravel and aggregate deposits.

Minerals extracted from Sawyer County are primarily used for construction purposes. Based on non-metallic mining permits in Sawyer County circa 2010, a total of 49 non-metallic mines are active, all of which produce sand and gravel or stone products. Only one is listed as being in the Town of Edgewater (Sawyer County Comprehensive Plan, 2010).

NATURAL HERITAGE INVENTORY

The Natural Heritage Inventory (NHI) is a dynamic database of species and natural communities that are of concern around the State of Wisconsin. The Wisconsin natural heritage working list contains species known or suspected to be rare in the state along with natural communities native to Wisconsin. This list was last updated on July 18th, 2017. It includes species legally designated as "endangered" or "threatened" as well as species in the advisory "special concern" category. Species that fall under the “threatened” or “endangered” category are afforded special protections within the State while those that are considered “special concern” category carry no legal protections but are being monitored because of the potential need for legal protection. In Washburn and Sawyer Counties, which contain the entire Big Chetac and Birch Lakes Watershed, there are one endangered and three threatened mammal species, two endangered and four threatened bird species, five threatened fish species, one threatened reptile species, one endangered mussel, and one endangered insect species (Table 3). In addition to these species that have legal protections there are also 27 animal species of special concern.

Table 3: NHI animal list

Scientific Name	Common Name	WI status	Group
Cochlicopa morseana	Appalachian Pillar	SC/N	Rare Aquatic and Terrestrial Snails
Agabetes acuductus	A Water Scavenger Beetle	SC/N	Rare Beetles
Helophorus latipenis	A Water Scavenger Beetle	SC/N	Rare Beetles
Cicindela patruela patruela	Northern Barrens Tiger Beetle	SC/N	Rare Beetles
Botaurus lentiginosus	American Bittern	SC/M	Rare Birds
Chlidonias niger	Black Tern	END	Rare Birds
Setophaga cerulea	Cerulean Warbler	THR	Rare Birds
Bucephala clangula	Common Goldeneye	SC/M	Rare Birds
Chordeiles minor	Common Nighthawk	SC/M	Rare Birds
Oporornis agilis	Connecticut Warbler	SC/M	Rare Birds
Setophaga kirtlandii	Kirtland's Warbler	END	Rare Birds
Ammodramus leconteii	Le Conte's Sparrow	SC/M	Rare Birds
Accipiter gentilis	Northern Goshawk	SC/M	Rare Birds
Contopus cooperi	Olive-sided Flycatcher	SC/M	Rare Birds
Buteo lineatus	Red-shouldered Hawk	THR	Rare Birds
Falcipennis canadensis	Spruce Grouse	THR	Rare Birds
Catharus ustulatus	Swainson's Thrush	SC/M	Rare Birds
Coturnicops noveboracensis	Yellow Rail	THR	Rare Birds
Lycaena dione	Gray Copper	SC/N	Rare Butterflies and Moths
Ophiogomphus anomalus	Extra-striped Snaketail	END	Rare Dragonflies and Damselflies
Aeshna clepsydra	Mottled Darner	SC/N	Rare Dragonflies and Damselflies
Gomphus graslinellus	Pronghorn Clubtail	SC/N	Rare Dragonflies and Damselflies
Ophiogomphus smithi	Sioux (Sand) Snaketail	SC/N	Rare Dragonflies and Damselflies
Percina evides	Gilt Darter	THR	Rare Fishes
Erimyzon sucetta	Lake Chubsucker	SC/N	Rare Fishes
Acipenser fulvescens	Lake Sturgeon	SC/H	Rare Fishes
Etheostoma microperca	Least Darter	SC/N	Rare Fishes
Lepomis megalotis	Longear Sunfish	THR	Rare Fishes
Notropis nubilus	Ozark Minnow	THR	Rare Fishes
Notropis anogenus	Pugnose Shiner	THR	Rare Fishes
Moxostoma carinatum	River Redhorse	THR	Rare Fishes
Martes americana	American Marten	END	Rare Mammals
Eptesicus fuscus	Big Brown Bat	THR	Rare Mammals
Poliocitellus franklinii	Franklin's Ground Squirrel	SC/N	Rare Mammals
Canis lupus	Gray Wolf	SC/FL	Rare Mammals
Myotis lucifugus	Little Brown Bat	THR	Rare Mammals
Glaucomys sabrinus	Northern Flying Squirrel	SC/P	Rare Mammals
Myotis septentrionalis	Northern Long-eared Bat	THR	Rare Mammals
Sorex palustris	Water Shrew	SC/N	Rare Mammals
Napaeozapus insignis	Woodland Jumping Mouse	SC/N	Rare Mammals
Alasmidonta marginata	Elktoe	SC/P	Rare Mussels and Clams
Cyclonaias tuberculata	Purple Wartyback	END	Rare Mussels and Clams
Emydoidea blandingii	Blanding's Turtle	SC/P	Rare Reptiles
Plestiodon septentrionalis	Prairie Skink	SC/H	Rare Reptiles
Glyptemys insculpta	Wood Turtle	THR	Rare Reptiles
Endangered	Threatened	Special Concern	

Within Washburn and Sawyer Counties there are four endangered and six threatened plant species as well as 22 plant species of special concern (Table 4).

Table 4: NHI plant list

Scientific Name	Common Name	WI status	Group
Littorella uniflora	American Shoreweed	SC	Rare Plants
Crotalaria sagittalis	Arrow-headed Rattle-box	SC	Rare Plants
Callitriche hermaphroditica	Autumnal Water-starwort	SC	Rare Plants
Sceptridium oneidense	Blunt-lobe Grape-fern	SC	Rare Plants
Calypso bulbosa	Calypso Orchid	THR	Rare Plants
Adlumia fungosa	Climbing Fumitory	SC	Rare Plants
Sparganium glomeratum	Clustered Bur-reed	THR	Rare Plants
Botrychium lunaria	Common Moonwort	END	Rare Plants
Epilobium strictum	Downy Willow-herb	SC	Rare Plants
Artemisia dracunculus	Dragon Wormwood	SC	Rare Plants
Asclepias ovalifolia	Dwarf Milkweed	THR	Rare Plants
Platanthera hookeri	Hooker's Orchid	SC	Rare Plants
Leucophysalis grandiflora	Large-flowered Ground-cherry	SC	Rare Plants
Botrychium mormo	Little Goblin Moonwort	END	Rare Plants
Elatine triandra	Longstem Water-wort	SC	Rare Plants
Tephroseris palustris	Marsh Ragwort	SC	Rare Plants
Botrychium minganense	Mingan's Moonwort	SC	Rare Plants
Boechera missouriensis	Missouri Rock-cress	SC	Rare Plants
Vaccinium vitis-idaea	Mountain Cranberry	END	Rare Plants
Utricularia resupinata	Northeastern Bladderwort	SC	Rare Plants
Platanthera flava var. herbiola	Pale Green Orchid	THR	Rare Plants
Artemisia frigida	Prairie Sagebrush	SC	Rare Plants
Aplectrum hyemale	Putty Root	SC	Rare Plants
Cypripedium arietinum	Ram's-head Lady's-slipper	THR	Rare Plants
Eleocharis robbinsii	Robbins' Spike-rush	SC	Rare Plants
Amerorchis rotundifolia	Round-leaved Orchis	THR	Rare Plants
Potamogeton bicupulatus	Snail-seed Pondweed	SC	Rare Plants
Potamogeton pulcher	Spotted Pondweed	END	Rare Plants
Galium brevipes	Swamp Bedstraw	SC	Rare Plants
Schoenoplectus torreyi	Torrey's Bulrush	SC	Rare Plants
Potamogeton vaseyi	Vasey's Pondweed	SC	Rare Plants
Potamogeton diversifolius	Water-thread Pondweed	SC	Rare Plants
Endangered	Threatened	Special Concern	

In order to effectively make management recommendations it is necessary to fully evaluate the conditions within the area of concern. While this plan generally focuses on issues at the scale of the entire watershed, it is still important to take stock of the baseline conditions of each lake, in order to be able to estimate how management could positively or negatively impact them. For the purposes of establishing a lake inventory, Big Chetac Lake will be considered one lake, and Birch and Little Birch lakes will be considered one lake.

PHYSICAL CHARACTERISTICS – BIG CHETAC LAKE

Big Chetac Lake is a 2,400-ac drainage lake in southwestern Sawyer County. The average depth is 14-ft with a deepest point of 26-ft (Figure 7). Water inputs for Big Chetac Lake come from several small, local tributaries, groundwater, and precipitation. At the southern end of the lake, the water drains into Birch Lake forming the headwaters of the Red Cedar River. In the most recent aquatic plant point-intercept survey on Big Chetac, the bottom substrate was documented at 533 of the 897 survey points. Figure 6 shows that the majority of substrate was muck (71.3%) with the remaining areas covered in sand (21.6%) and rock (7.1%).

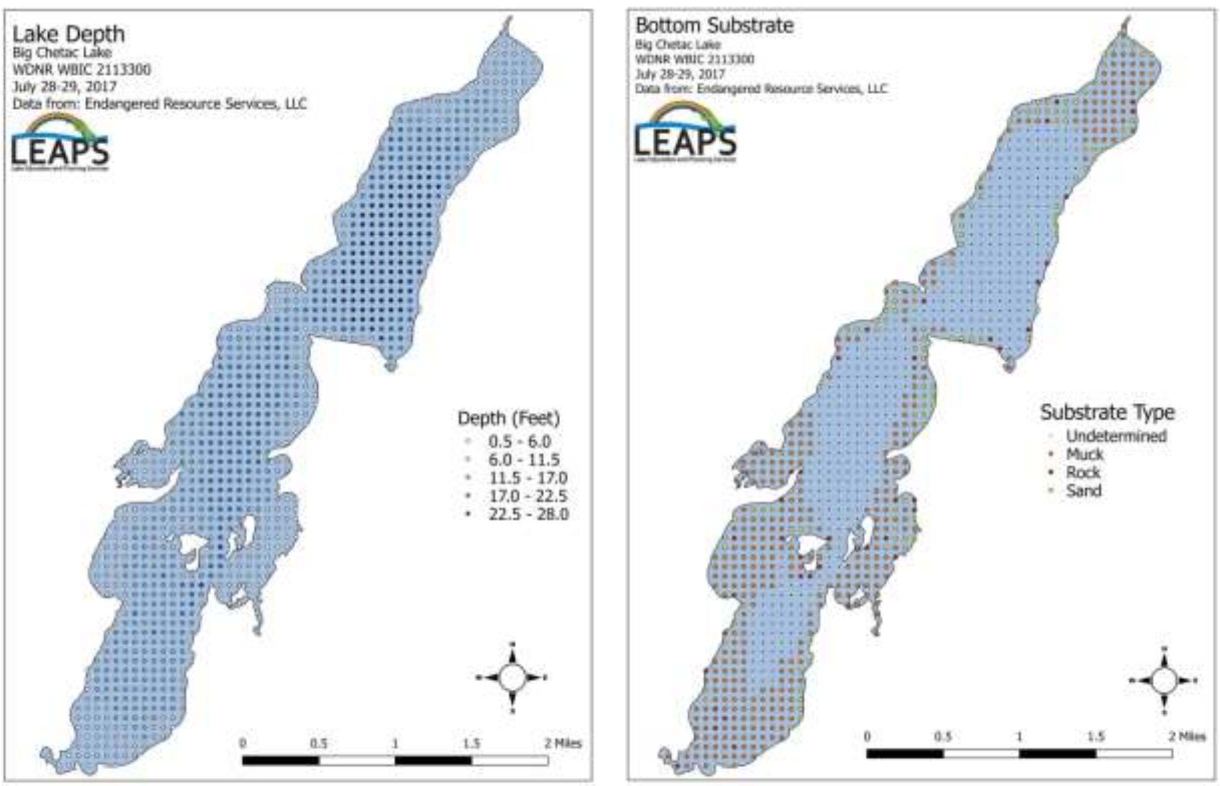


Figure 7: Big Chetac Lake depth and bottom substrate

PHYSICAL CHARACTERISTICS – BIRCH AND LITTLE BIRCH LAKES

Birch and Little Birch Lakes are drainage lakes downstream of Big Chetac Lake with a surface area of 368 acres. The dam that holds back water for Big Chetac, Birch, and Little Birch lakes is on Little Birch Lake. A maximum depth of 73-ft is reached in Birch Lake with Little Birch maxing out at about 18-ft. The average depth between the two lakes is 24-ft (Figure 8). In the 2017 aquatic plant point-intercept survey on Birch and Little Birch lakes, the bottom substrate within the littoral (plant growing) zone of the lake was mostly muck in the bays, followed by sand and rock along the shore (Figure 9).

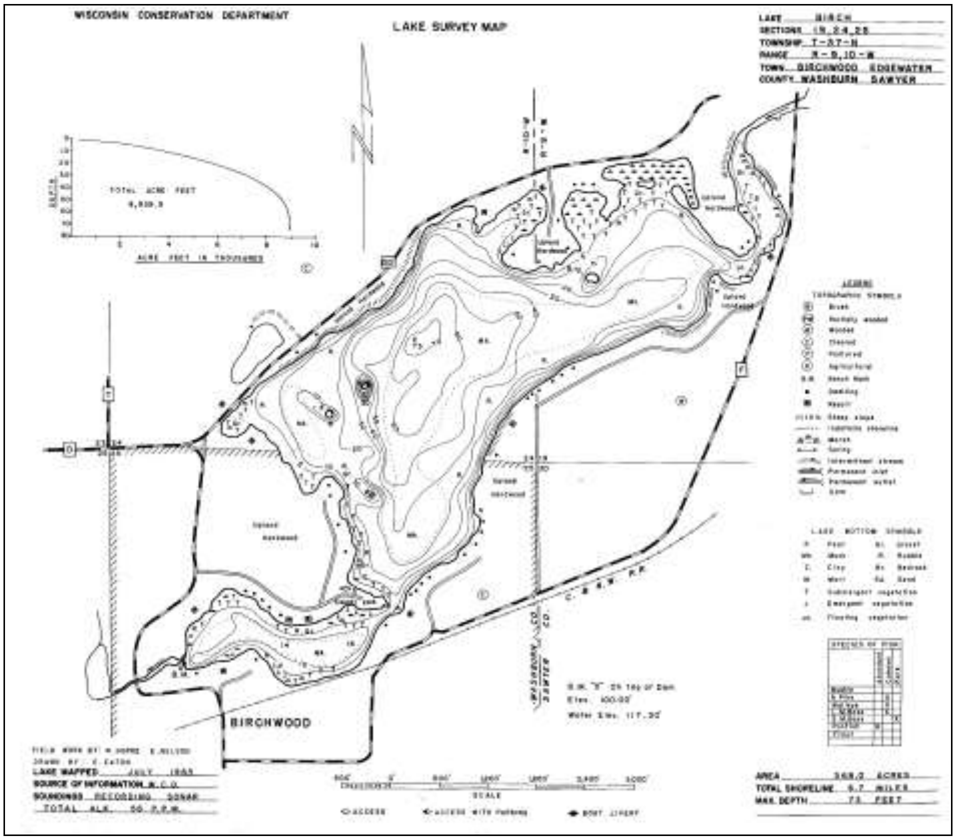


Figure 8: Birch and Little Birch Lake map

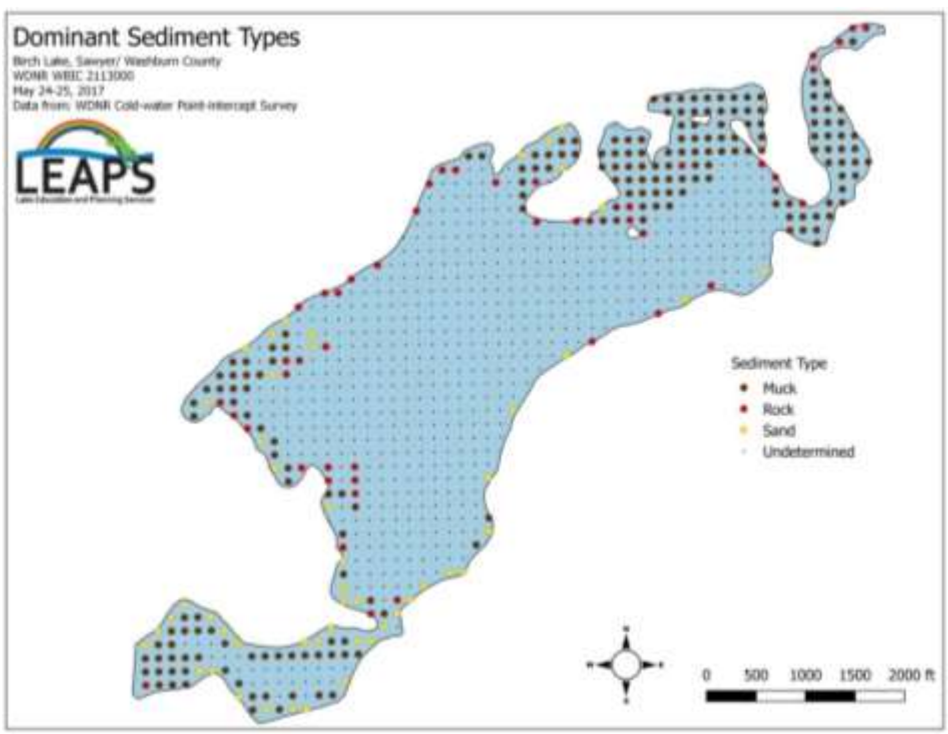


Figure 9: Bottom substrate in Birch and Little Birch lakes

WATER QUALITY – BIG CHETAC LAKE

2008 PALEO-ECOLOGICAL SEDIMENT CORE STUDY

In 2008, a paleo-ecological sediment core study was conducted on Big Chetac Lake. The purpose of sediment core studies is to gain insight to what kinds of conditions existed within the lake prior to European development. Because the sediments in the deeper portions of lakes remain relatively untouched by both people and natural factors, they can be analyzed in terms of what kinds of plant and algal remains are found at various depths. This provides insight into what types of nutrients and conditions were dominant at any given time up to roughly 300 years back. On Big Chetac Lake, a 93-cm sediment core was taken from 25-ft of water in the North Basin. A complete diagnostic of the core was completed (Garrison & LaLiberte, 2010). The core was dated to estimate historical dates and sedimentation rates, the diatom (one of the most common, and ancient varieties of algae) community was analyzed to assess changes in nutrient levels, and geochemical elements were examined to determine the causes of changes in water quality. This study came up with the following conclusions:

- The mean sedimentation rate for the last 150 years in Lake Chetac was near the median measured in 52 Wisconsin lakes. This was partially because it is a moderately hard water lake and relatively shallow.
- There were two episodic peaks in the sedimentation rate, around 1910 and 1940. The first peak was likely the result the increased water level from the dam flooding land along the lake shore. It is unclear what watershed disturbance contributed to the 1940 peak.
- Other than the short lived peaks around 1910 and 1940, the sedimentation rate for the last 150 years has largely been unchanged.
- Phosphorus was the only element that exhibited significant changes in the last 150 years. Phosphorus deposition rates have increased in the last 2 decades probably as a result of internal loading of phosphorus from the sediments. Soil erosion and commercial fertilizers do not appear to be a significant source of the elevated phosphorus deposition.
- The diatom and blue-green algal communities indicate that phosphorus levels are naturally high in Lake Chetac. Before the arrival of Europeans in the mid-1800s, algal blooms were common. Historical phosphorus concentrations were 55-60μg/L.
- Phosphorus levels were at their highest levels in the period 1910 to 1980 although it is likely that internal loading has resulted in higher summer phosphorus concentrations in recent years that is not reflected in either the diatom or bluegreen algal fossils.

MODERN WATER QUALITY

Water quality data has been collected, sporadically, on Big Chetac Lake since as early as 1995, but there is not very consistent data until 2007. In 2007, volunteers began to collect water clarity (Secchi depth) measurements in the Central and South basins of Big Chetac and water chemistry data in only the Central basin through the Citizen Lake Monitoring Network (CLMN). In 2014, the North basin was added to the CLMN data for both Secchi depth and water chemistry data collection.

Both the South and Central basins have similar water clarity with summer averages (July and August) of 2.84-ft and 2.95-ft respectively based on multiple years of CLMN data. The North basin has only been regularly sampled since 2014, but has a summer water clarity average of 2.80-ft similar to the other two basins. All of these values are well below average for the Central Georegion which was 9.6 feet in 2017. In addition to being well below average, both the

Central and South basins show similar downward trends for water clarity since 2007 (Figure 10). There is not enough data to determine a trend for the North basin.

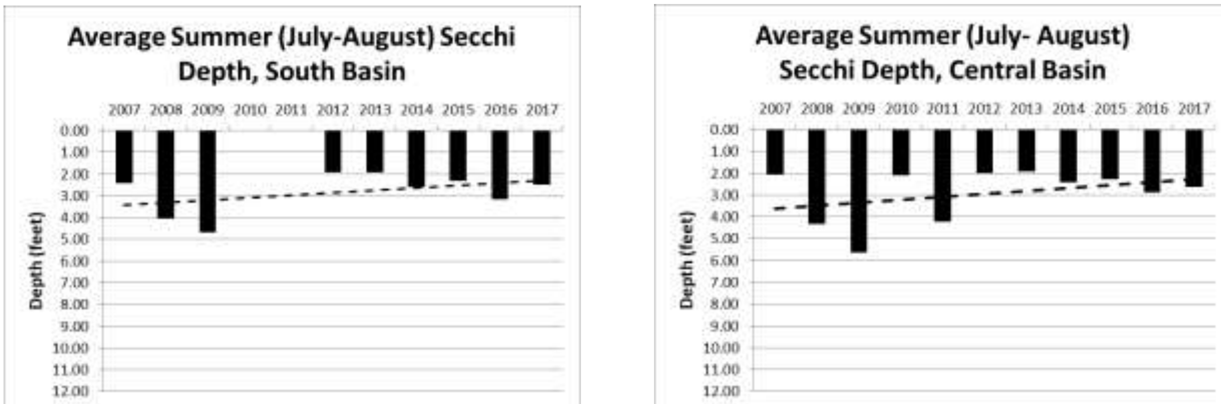


Figure 10: Average summer Secchi depth in the Central and South basins, 2007-2017 (two or more readings in July and August)

Water chemistry data has been collected in the Central basin since 2007 and in the North basin since 2014. In the Central basin, the trend for total phosphorus (TP) appears to be decreasing at a very slow pace. The same is not true of the chlorophyll-A levels which appear to be increasing (Figure 11). While the TP levels are decreasing, the average seasonal amount found within the lake falls well above the 40µg/L threshold for a stratified reservoir to be considered impaired. Even the best year in the last ten, 2009, showed average seasonal TP levels that were high at 48.25µg/L. In the worst year of the last ten, 2012, TP levels during the summer were 101.25µg/L, over five times the state threshold for impaired waters. From 2007 to 2017 the average seasonal TP was 70.02µg/L. Historical water quality data from the sediment core study has shown Big Chetac to be a naturally eutrophic system with historic phosphorus concentrations likely in the 55-60µg/L range (Garrison & LaLiberte, 2010). If the average annual phosphorus could be brought back to this level consistently, it is likely that water quality issues would be less prevalent.

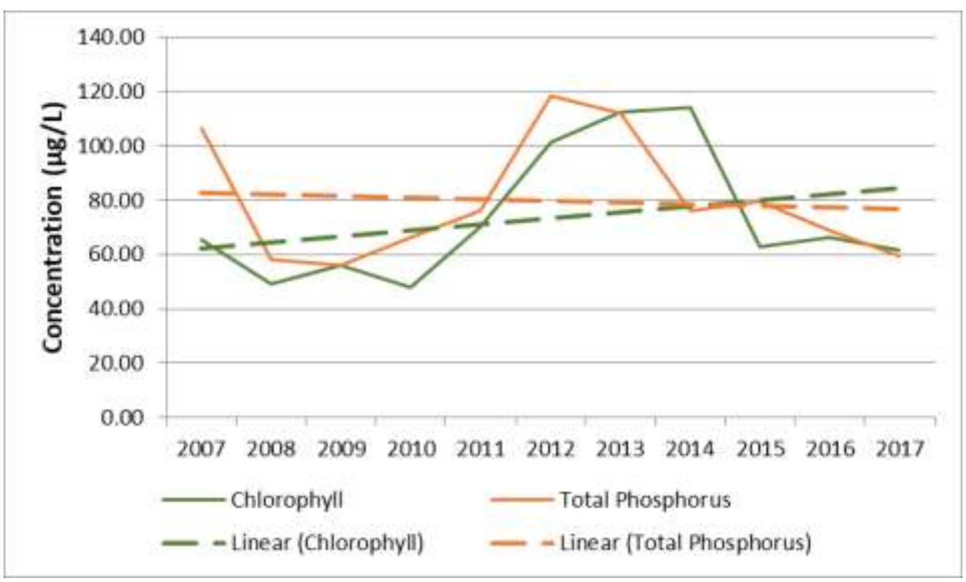


Figure 11: Chlorophyll-a and total phosphorus annual averages in the Central basin using WisCALM parameters, 2007-2017

WATER QUALITY – BIRCH LAKE

While the extent of water clarity and water quality data for Birch Lake is limited, there is volunteer data from the CLMN program from 1996-2000, 2004, 2017, & 2018. Through the lake management planning grant awarded in 2017, additional water quality was collected from the Deep Hole in Birch Lake. The monthly average for all of the Secchi Disk water clarity data is shown in Figure 12.

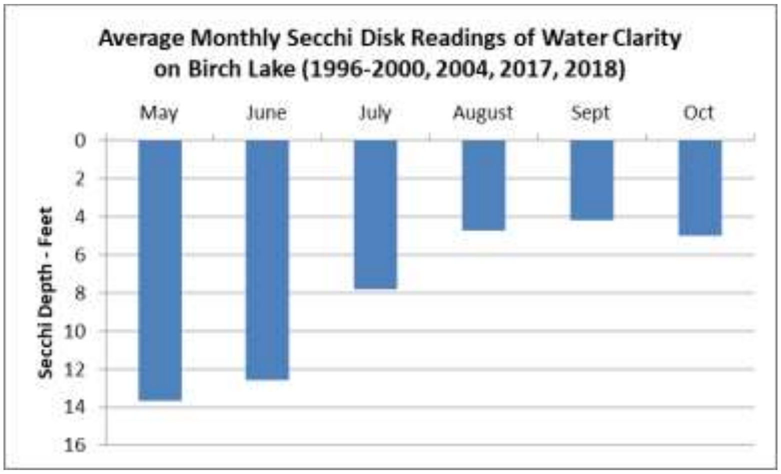


Figure 12: Average monthly Secchi disk reading of water clarity from the Deep Hole in Birch Lake

Total phosphorus (TP) and chlorophyll-a (ChlA) are measures that can be used to estimate water quality in the lake. Data is limited (Table 5), but with that data, a quick comparison can be made between Big Chetac and Birch lakes. Table 6 indicates that averages for TP and ChlA are less in Birch Lake than they are in the Central basin of Big Chetac Lake. Also included in Table 6 are the limits for TP and ChlA for waters that are considered impaired by the State of WI (TP) and the World Health Organization (ChlA). Birch Lake does not exceed the impaired waters limit for chlorophyll-a, only Big Chetac does.

Given that Birch Lake is a deep (73-ft) stratified lake, it is expected that a strong thermocline would develop separating the surface waters (epilimnion) from the bottom waters (hypolimnion). When this happens, the hypolimnion usually goes anoxic (becomes devoid of dissolved oxygen) often times right up to the thermocline. In Birch Lake stratification begins in early June and lasts through most of the summer and fall. As a result, there is the potential for significant internal loading of phosphorus from the bottom sediments into the water column. Figure 13 demonstrates the extent of stratification and the effects it has on temperature and dissolved oxygen (DO) in Birch Lake.

Table 5: Total Phosphorus and Chlorophyll-a Data from the Deep Hole in Birch Lake

Birch Lake Water Quality Data - Total Phosphorus (TP), Chlorophyl a, and Bottom Waters Iron & TP				
Parameter	**MG/L**	**Date**	**Location**	**Storet #**
PHOSPHORUS TOTAL	0.018	5/18/2004 9:00	BIRCH LAKE - DEEP HOLE	583094
PHOSPHORUS TOTAL	0.023	8/3/2004 13:00	BIRCH LAKE - DEEP HOLE	583094
PHOSPHORUS TOTAL	0.0518	7/30/2017 9:30	BIRCH LAKE - DEEP HOLE	583094
PHOSPHORUS TOTAL	0.047	8/24/2017 11:00	BIRCH LAKE - DEEP HOLE	583094
PHOSPHORUS TOTAL	0.0416	9/17/2017 9:30	BIRCH LAKE - DEEP HOLE	583094
CHLOROPHYLL A	51.54	8/3/2004 13:00	BIRCH LAKE - DEEP HOLE	583094
CHLOROPHYLL A	49.1	7/30/2017 9:30	BIRCH LAKE - DEEP HOLE	583094
CHLOROPHYLL A	29.7	8/24/2017 11:00	BIRCH LAKE - DEEP HOLE	583094
CHLOROPHYLL A	7.89	9/17/2017 9:30	BIRCH LAKE - DEEP HOLE	583094
IRON TOTAL RECOVERABLE	4.81	7/30/2017 10:00	BIRCH LAKE - DEEP HOLE - BOTTOM	583094
IRON TOTAL RECOVERABLE	1.25	8/24/2017 11:30	BIRCH LAKE - DEEP HOLE - BOTTOM	583094
IRON TOTAL RECOVERABLE	3.6	9/17/2017 10:00	BIRCH LAKE - DEEP HOLE - BOTTOM	583094
PHOSPHORUS TOTAL	0.371	7/30/2017 10:00	BIRCH LAKE - DEEP HOLE - BOTTOM	583094
PHOSPHORUS TOTAL	0.14	8/24/2017 11:30	BIRCH LAKE - DEEP HOLE - BOTTOM	583094
PHOSPHORUS TOTAL	0.318	9/17/2017 10:00	BIRCH LAKE - DEEP HOLE - BOTTOM	583094

Table 6: Comparison of Total Phosphorus and Chlorophyll-a for both Big Chetac and Birch lakes with recognized standards for impaired waters

TP (6/15-9/15); ChlA (7/15-9/15)	TP (ppb)	Chlorophyll A (ppb)
Big Chetac Lake - Central Basin (2007-2017)	79.79	73.45
Birch Lake - Deep Hole (2017)	46.8	28.9
WI State Standard - Impaired Waters	30	NA
Worlkd Heatlth Organization	NA	30

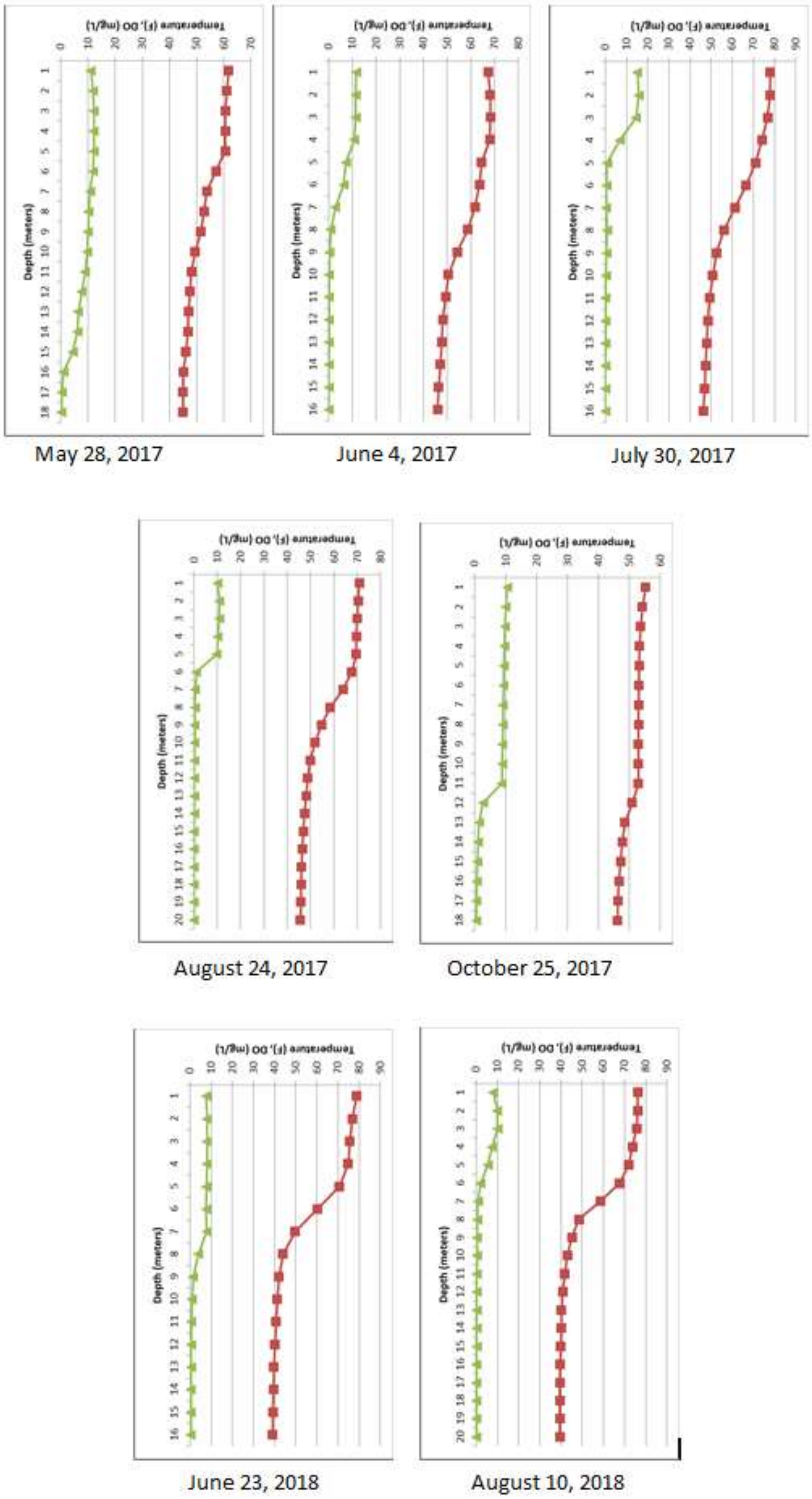


Figure 13: Temperature (red line) and DO (green line) profiles from Birch Lake (2017 & 2018)

TEMPERATURE AND DISSOLVED OXYGEN

TEMPERATURE

Water temperature is an important measurement of lake health. It exerts a major influence on biological activity and growth. Generally, the higher the water temperature is, the greater the biological activity there is in that water. Fish, insects, zooplankton, phytoplankton, and other aquatic species all have a preferred temperature range. As temperatures get too far above or below a preferred range, the number of individuals of a given species will decline, and/or the species makeup of the water waterbody will change. Within the watershed of Big Chetac and Birch lakes different streams are classified as cold or warm water. Several cold water streams in the watershed are listed as Class 1 trout waters. Brook trout, native to WI, require the cold water in these streams to survive. Different land uses around and along these streams influence the temperature of the water.

Temperature is also important because of its influence on water chemistry. The rate of chemical reactions generally increases at higher temperature. Water, particularly groundwater, with higher temperatures can dissolve more minerals from the rocks it is in and will therefore have a higher electrical conductivity. It is the opposite when considering a gas, such as oxygen, dissolved in the water. Warm water holds less dissolved oxygen than cool water, and may not contain enough dissolved oxygen for the survival of different species of aquatic life. Some compounds are also more toxic to aquatic life at higher temperatures.

The temperature of water is influenced by many things. The most obvious is seasonal changes in air temperature. Water temperatures will be cooler in the spring and late fall than in the summer and early fall. Daily variations may also occur, especially in the surface layers of the lake which are typically warmer during the day when the sun is shining than they are at night. In deep lakes, significant temperature differences from the surface to the bottom may cause the water to separate into distinctly different layers, a process termed thermal stratification (Figure 14). During the open water season of lakes, energy from the sun warms the surface waters, but may not be able to penetrate far into the depths of the lake to warm bottom waters. Cold water is more dense than warm water, and as a result will sink to the bottom of a lake during the warm water season. However, water has a unique chemical property. Instead of continuing to get more dense as it gets colder, once it reaches the freezing point, ice forms which is less dense and floats at the surface. It is this property that maintains life in lakes even in the coldest winters, assuming the water is deep enough not to freeze all the way from the surface to the bottom.

Once thermal stratification occurs, it tends to persist until the air temperature cools again in fall. Because the layers don't mix, they develop different physical and chemical characteristics. For example, dissolved oxygen concentration, pH, nutrient concentrations, and species of aquatic life in the upper layer can be quite different from those in the lower layer. Thermal stratification can be disturbed by storm events, boat use, and extended periods of cold or warm air temperatures. Shallow lakes may not stratify at all. Deep lakes will often stay in a stratified state well into the colder seasons of late fall and winter when surface water temperatures may be cooled to the point they are the same as the bottom waters and the whole system gets mixed up again. This process is called overturn, and happens both in the fall before ice forms and soon after the ice melts in the spring.

Because light penetration and the energy associated with it deceases with depth in the water column, the sun can heat a greater proportion of the water in a shallow lake than in a deep lake and so a shallow lake can warm up faster and to a higher temperature. Lake temperature also is affected by the size and temperature of inflows (e.g., a stream during snowmelt, or springs or a lowland creek) and by how quickly water flushes through the lake. Even a shallow lake may remain cool if fed by a comparatively large, cold stream (Lake Access, 2018).

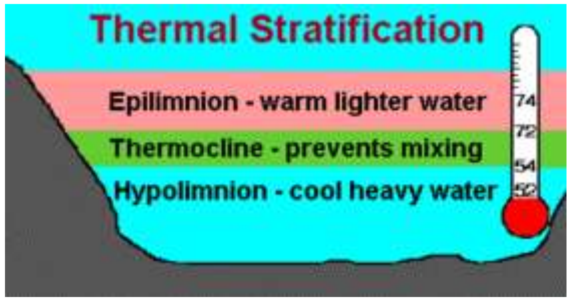


Figure 14: Summer thermal stratification

DISSOLVED OXYGEN

A commonly measured lake or stream water parameter is DO. The amount of DO in the water can tell a lot about water quality, and is crucial for the organisms and creatures living in it. Like terrestrial animals, fish and other aquatic organisms need oxygen to live. As water moves past their gills (or other breathing apparatus), microscopic bubbles of oxygen gas in the water are transferred from the water to their blood. Chemical processes dictate that this transfer is efficient only above certain concentrations. In other words, oxygen can be present in the water, but at too low a concentration to sustain aquatic life. Most freshwater fish species, for example require a concentration of at least 3-4 parts per million (ppm) of oxygen in the water to survive. Oxygen also is needed by the many chemical reactions that are important to lake functioning.

Oxygen is produced during photosynthesis (where plants covert carbon dioxide in the air and water to oxygen) and consumed during respiration (breathing of living aquatic species) and decomposition (when dead plants and other things break down and decay). Because it requires light, photosynthesis occurs only during daylight hours. Respiration and decomposition, on the other hand, occur 24 hours a day. This difference alone can account for large daily variations in DO concentrations. During the night, when photosynthesis cannot counterbalance the loss of oxygen through respiration and decomposition, DO concentrations may steadily decline. It is lowest just before dawn, when photosynthesis resumes.

Other sources of oxygen include the air and inflowing streams. Oxygen concentrations are much higher in air, which is about 21% oxygen, than in water, which is a tiny fraction of 1 percent oxygen. Where the air and water meet, this tremendous difference in concentration causes oxygen molecules in the air to dissolve into the water. More oxygen dissolves into water when wind stirs the water; as the waves create more surface area, where more diffusion can occur. As previously mentioned, cold water can hold more oxygen than warmer water. Warmer water becomes "saturated" more easily with oxygen. As water becomes warmer it can hold less and less DO. So, during the summer months in the warmer top portion of a lake, the total amount of oxygen present may be limited by temperature.

In natural environments, temperature and DO are not too much of a concern for aquatic life, since the animals and plants in the water have evolved to best survive in that environment. It is when the temperature of a water body changes, either by a natural event or by a human-induced event, that negative impacts may be caused. Just downstream of the Big Chetac and Birch Lake system, both Balsam and Red Cedar lakes are listed as two-story fisheries, meaning the water in the deeper parts of the lakes is cold enough, and in the past, contained enough oxygen to support cold water fish species like trout and whitefish. Birch Lake is 73-ft deep and has plenty of cold water, but water below 12-15 feet is basically devoid of oxygen from early June through the end of the open water season, eliminating any ability to support a cold water fishery (Figure 13). The two-story fishery in both Balsam and Red Cedar lakes are suffering similar fates (cold water but not enough oxygen), enough so that in Red Cedar Lake, the destruction of the cold water fishery is one reason the lake is listed as impaired.

CAUSES OF INCREASED TEMPERATURE IN LAKES

Parking lots and roads are examples of impervious surfaces that may be adjacent to a water body. Water runs off of these surfaces into local lakes and streams instead of soaking into the ground as in natural environments. These and similar surfaces act as "fast lanes" for rainfall to make its way into lakes and streams. Rain that falls on a parking lot that has been baking in the sun all day during summer gets super-heated and then runs off into waterbodies. This heated water may cause immediate adverse conditions that can be a shock to aquatic life, or just contribute to the slow warming of the water. Along with the heat, runoff from impervious surfaces adjacent to lakes and streams can contain pollutants, such as sediment, leaking motor oil, hydrocarbons from exhaust, leftover fertilizer, and normal trash. In northern climates where winter snow and ice often require the use of road salt, elevated chloride levels in the water can negatively impact plant growth and harm aquatic organisms (Hunt, Herron, & Green, 2012).

In lakes, the direct measurement of thermal pollution is not common. However, in running waters, like those streams that bring water into the Chetac Chain of Lakes, the elevated temperature of water entering them can be a serious problem for populations of cool or cold-water fish already stressed from the other contaminants. Water temperature fluctuations in streams may be further worsened by cutting down trees, which provide shade, and by absorbing more heat from sunlight due to increased water turbidity. The same can be said for removing trees from the shoreline of a lake during development.

WATER BUDGET AND NUTRIENT LOADING – BIG CHETAC AND BIRCH LAKES

In order to determine where the nutrients within a lake are coming from, it is necessary to determine a water budget for that lake. This involves determining how much is entering the lake versus how much is exiting it. Once a water budget has been developed, the source of nutrients, most importantly phosphorus and nitrogen, can be determined. During the "Getting Rid of the Green" lake study project that started in 2007, several studies were conducted to determine the main sources of phosphorus within Big Chetac Lake. During this study, water inputs to Big Chetac Lake included local tributaries, precipitation, and groundwater flow. Water going out included that which goes out through Birch Lake and over the dam, ground water exiting the lake, and evaporation. Residence time is a measure of how long water coming into a lake remains before going out again. Residence time for Big Chetac Lake is estimated to be about four years. Residence time differs from lake to lake based on volume and flow through, and changes with rainfall and drought conditions. Generally, longer lake residence times mean a higher build-up of nutrients due to less flushing (moving water through). More water flushing through a lake system may have a cleansing effect on the given lake. With this data, it was estimated that about 9,624-lbs of phosphorus were in Big Chetac

These studies have not been conducted on Birch Lake. However, between 2017 and 2019 total phosphorus data was collected at the inlet (Co. F Bridge), outlet (Co. D Culvert), and at the Deep Hole in the lake. Sampling at the deep hole included surface water samples, bottom water samples, and water column samples. Flow data was also collected from the inlet and outlet of Birch Lake. Based on this information, the estimated amount of phosphorus entering Birch Lake from Big Chetac Lake is approximately 1,260-lbs annually. Over the same time period, 773-lbs of phosphorus are leaving Birch Lake. The total phosphorus load in Birch Lake was calculated to be around 3,973-lbs indicating that Birch Lake acts as a sink for phosphorus coming into the lake. Internal loading in Birch Lake has not been quantified. While the main source of water into Birch Lake is the inlet from Big Chetac Lake, it cannot be assumed that this is the main source of the nutrient loading into Birch Lake. There are many other variables that need to be considered before a complete nutrient budget for Birch Lake can be calculated.

NUTRIENT LOADING IN BIG CHETAC LAKE

During the 2008-10 Getting Rid of the Green study, phosphorous loading from the following sources were quantified; atmospheric deposition, groundwater flow, tributary loading, near shore contributions, septic systems, curly-leaf pondweed decay, and internal recycling. Figure 15 shows the breakdown for phosphorous loading from these sources. These numbers need to be updated but provide at least a place to start in determining what needs to be done to maintain a desired level of water quality. In total, the amount of phosphorus entering the lake was estimated at approximately 11,748-lbs.

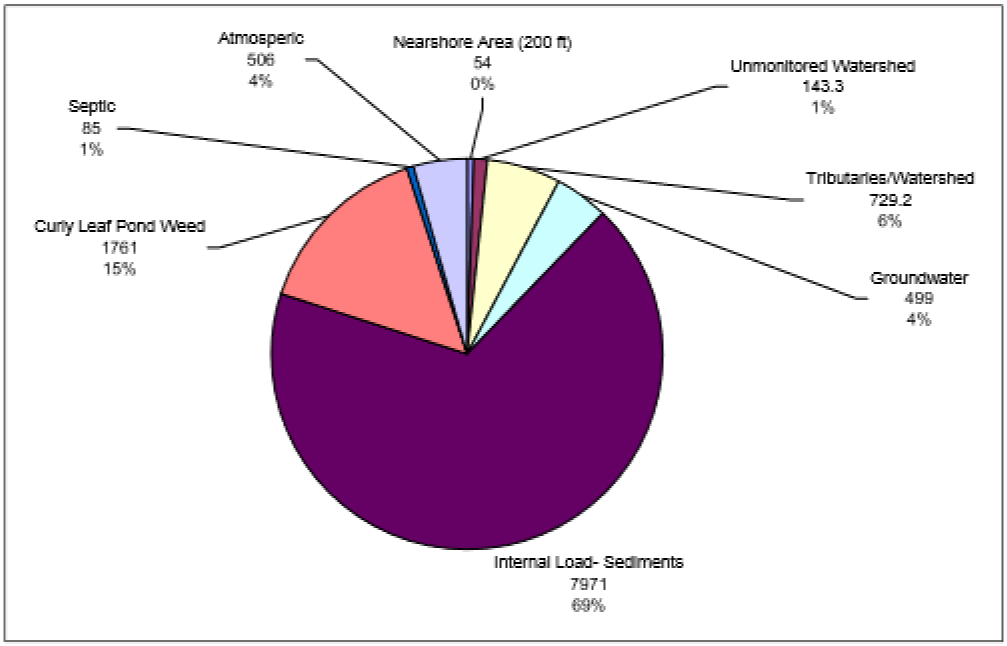


Figure 15: Total Phosphorus Loading into Big Chetac Lake

Recycling of existing phosphorous from the sediments at the bottom of the lake accounts for approximately 69% of the total phosphorous loading to the lake. A lack of oxygen caused by decaying plant and animal material in the bottom of the lake and high pH levels in the water column lead to an internal release of phosphorous stored in the bottom sediments. A long lake residence time (3 to 4 years for Big Chetac Lake) increases the amount of phosphorous that settles into the bottom sediments instead of being flushed from the system. The phosphorus from the sediment is then distributed or re-suspended throughout the lake by natural processes including turnover, chemical reactions facilitated by a lack of oxygen, and high pH values, and waves caused by the wind; and human induced disturbances including waves and disturbances to the bottom by boat traffic. Phosphorous release rates from the sediments calculated in 2007 by the US Army Corp of Engineers were as high as 19.1 mg/m^2/day under high pH and anoxic conditions. Total days without oxygen in the bottom waters ranged from 5 days a year in the south basin to as much as 90 days a year in the north basin.

The next largest source of phosphorous to Big Chetac Lake is the annual senescence of CLP at 15% (based on 2008 CLP abundance). According to data reported on in the 2008 Paleoecology sediment core, since the 1980's phosphorous is the most significant element that has increased in deposition (Garrison & LaLiberte, 2010). In this same time period, organic matter and calcium have also increased but not as dramatically. IT has been suggested that this could be from increased internal recycling of phosphorous existing in the sediments (Garrison & LaLiberte, 2010). What caused greater levels of phosphorous in the sediments to be re-introduced into the lake during this time frame is not completely known, but could be related to the introduction and subsequent takeover of the early season plant community by CLP. While it is not known what level of CLP was in the lake in the 1980's and levels in 2008 exceeded 600 acres or approximately 25% of the entire lake surface. Increased levels of CLP since the 1980's could also explain the increased levels of calcium and organic matter noted in the paleo-ecological report. CLP will often have $CaCO_3$ encrustations on it. Waisel, Oerteli, & Stahel (1990) reported encrustations reaching up to 80% of the total CLP leaf dry weight. These encrustations were also reported to contain large amounts of phosphorous (Allenby, 1981). CLP completes its life cycle and begins senescence in the early summer at the same time that bottom waters in Big Chetac Lake start becoming anoxic. Whether this new decay causes the rapid decline in oxygen, or merely aggravates it is unclear. As was stated before, 15% or more of the total annual phosphorous load in Big Chetac Lake could be coming from CLP.

LAKE SYSTEM FLUSHING AND WATER QUALITY

As was indicated in the 2010 LMP for Big Chetac Lake, increasing the flushing rate of the lake can make improvements in water quality. The flushing rate of a lake is related to its retention time. The longer water stays in a system, the more opportunity there is for the phosphorous in that water to settle out into the bottom sediments or to be utilized for growing algae. One researcher suggested that blue-green algal dominance is never observed in lakes where hydraulic retention time is shorter than five days, even though such lakes can have very high nutrient concentrations (Scheffer, 1998). Flushing a lake with relatively clean water can decrease nutrient levels and even wash out certain slow- growing algal groups. Often there is a noticeable reduction in algae following a large rain event as the retention time in the lake is shortened by the added runoff.

As also indicated in the 2010 LMP, there were no good ways to increase the flushing of the system except to hope significant rain events would happen frequently enough to provide some benefit. Water quality in the system has been better in the last few years then it was in previous years as indicated CLMN water quality data collected by volunteers. One of the objectives during the development of this new plan was to determine a reasonable water quality goal to aim for when implementing the actions in the plan. Preliminary goals were first solicited from the constituency during in-person or phone interviews, and through stakeholder group discussion. What came from that discussion was that if the water quality in the lakes could be what it was in 2016 and 2017 (even 2015) then many folks would be satisfied. Back in 2007, when the initial "Getting Rid of the Green" study was initiated, water quality in the Big Chetac Chain was much worse than it is now.

To come up with a value to have as a goal, water quality data from 2007 to 2017 was looked at to determine the best and worst years (Table 7). As expected two of the best years for water quality as measured by the amount of phosphorus, were 2016 & 2017. When looking for an explanation as to why these two years were considered the best years out of ten, one only needed to look at the seasonal rainfall records for the Birchwood area. From 2011 to 2014, total seasonal rainfall (March – October) averaged 13.65 inches as recorded at the Rice Lake Regional Airport (https://www.wunderground.com/history/month , last accessed 8/6/2018). These years in turn were some of the worst in the last ten for water quality. From 2015 to 2017 total seasonal rainfall averaged 26.41 inches (Table 8), nearly doubling the amount of rainfall flushing out the Big Chetac and Birch lakes system which was reflected in these years being some of the best years in the last ten. It seems safe to assume that if seasonal rainfall stays high (>20 inches), it will only benefit the entire system. If seasonal rainfall drops back to <20 inches water quality in the system will again suffer.

The average phosphorus concentration in Big Chetac Lake during the wet years, which were also the best years for water quality, was approximately 55-ppb. The average phosphorus concentration during the dry years was about 83-ppb. If the constituency was satisfied with water quality in the lake during the wet years, then the goal in the dry years should be to get to that level. Improving conditions in the dry years will likely improve water quality in the wet years as well. The difference between the wet and dry year phosphorus concentrations is 28-ppb. This concentration equates to approximately 2,109-lbs of phosphorus in the lake, or about 18% of the total load (11,748-lbs).

With this data, a goal of 55-ppb of phosphorus was set for Big Chetac Lake. What follows is a discussion of how to reach that goal.

Table 7: TP values for the Central basin in Big Chetac Lake, 2007-2017 (five best years are tinted)

Big Chetac Total Phosphorus (ppb) Central Basin									
Year	Average	Min	Max	Range (max-min)	Best Year (Ave)	Best Year (Range)	Best Year (High)	Ave Ranking	Ranking
2017	50.75	25	81.9	56.9	2	2	1	1.67	1
2016	58.8	28.2	88.5	60.3	4	3	3	3.33	3
2015	71.35	40.7	117	76.3	8	5	6	6.33	6
2014	69.82	32.4	130	97.6	7	7	7	7.00	7
2013	96.95	45.1	155	110.0	10	9	9	9.33	9
2012	101.25	50	184	134	11	10	11	10.67	11
2011	66	35	136	101	6	8	8	7.33	8
2010	60.5	30	85	55	5	1	2	2.67	2
2009	48.25	21	98	77	1	6	5	4.00	5
2008	53.75	30	94	64	3	4	4	3.67	4
2007	92.75	33	175	142	9	11	10	10.00	10

Table 8: Monthly rainfall 2008, 2011-2017

Monthly Rainfall (Inches) Rice Lake Regional Airport - Weather Underground										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average
March	0.34	Data Not Available	Data Not Available	0.74	0.7	0.88	0.61	0.25	1.84	0.73	0.76
April	2.74			2.05	1.97	2.68	2.88	1.48	1.8	2.26	2.23
May	1.59			1.9	3.32	3.41	4.81	3.96	4.62	5.99	3.70
June	5.02			0.15	1.73	2.66	1.94	2.67	3.95	4.2	2.79
July	2.35			1.99	2.29	0.22	0.68	5.73	4.17	2.1	2.44
August	0.92			3.36	1.24	0.05	1.72	3.78	5.08	6.52	2.83
September	2.91			1.13	0.56	1.98	0.04	5.17	3.55	1.63	2.12
October	1.25			0.39	1.65	4.31	0.56	2.51	1.75	3.5	1.99
Total	17.12			11.71	13.46	16.19	13.24	25.55	26.76	26.93	18.87

CONTROLLING OR REDUCING EXTERNAL NUTRIENT INPUTS

External inputs of phosphorous to the Big Chetac and Birch lakes include sources that can and cannot be readily managed. From the 2010 LMP, only 16% of the total phosphorous in Big Chetac Lake is coming from external sources, the rest is coming from internal loading and from CLP as it decays in the system. External sources measured include the atmosphere, groundwater, nearshore contributions (including septic systems), and contributions through surface water runoff from the larger watershed. Little can be done to reduce the amount of phosphorous carried in by groundwater or blown over and carried into the lake by wind and precipitation, but phosphorus loading from the nearshore area and larger watershed can be reduced.

BEST MANAGEMENT PRACTICES (BMP'S) IN THE WATERSHED THAT REDUCE PHOSPHOROUS LOADING

The watershed of Big Chetac and Birch lakes is mostly in a natural state. A little more than 81% of the watershed is made up of forests, wetlands, and grasslands. Agriculture (pasture and row crops) make up and additional 5%. Agricultural practices in a watershed are often a significant source for phosphorous in a lake. STEPL modeling was used to estimate a percent of decrease if certain BMPs were implemented. The total amount of phosphorus contributed by the agricultural land was calculated to be about 2,250-lbs. If 100% of the cropland was converted to conservation tillage, cover crops planted, and/or retired; and 25% of the pasture was converted to grassed buffers, phosphorus loading could be reduced by 28% (630-lbs). If only 50% of the cropland was converted the reduction in phosphorus would be about 19% (427-lbs). Additional practices including livestock feeding and manure management strategies could further reduce phosphorous loading.

More than 73% of the watershed is still in a forested state, some of this is Sawyer County Forestry land. A conscious effort should be made to preserve, protect, and enhance these properties and to preserve additional property through conservation easements, environmental land trusts, and the Wisconsin Stewardship Program. When logging is done in the watershed, the BCABLA and their partners should be actively working to insure logging practices minimize disturbance and protect near shore buffers along lakes and streams.

BMP'S IN THE DEVELOPED NEAR SHORE AREA THAT REDUCE PHOSPHOROUS LOADING

The total phosphorus input from the nearshore area of Big Chetac and Birch lakes is estimated at less than 5% of the total load. Septic systems at most contribute another 2.0%. When compared to the other sources of phosphorous to the lakes, these values are very low. However, using a different scale for measurement, the amount of phosphorous per acre contributed by the nearshore area is about 0.38-lbs, more than twice what is contributed by the larger watershed per acre at 0.15-lbs. This, plus the idea that nearly every property owner on the lake could do something to help reduce phosphorous loading likely at little cost, make it worth doing.

Recent land use digitizing of a 300-ft zone around both Big Chetac and Birch lakes identified more than 153-ac of lawn and 63-ac of impervious surfaces. Using the WDNR WiLMS modeling suite these areas contributed 152.3-lbs or 75% of phosphorus loading attributed to the nearshore area. If half of the lawn was converted to a natural state, phosphorus loading could be reduced by 18.5%. Additional phosphorus loading from the nearshore area comes from the septic system or onsite wastewater systems. Results from a septic system survey completed by Sawyer County in 2008 indicated that about 108-lbs of phosphorus were contributed to the lake annually. Currently, about 11% (99 out of 880) of the individual landowner parcels on the lakes are undeveloped. Minimizing further development of these areas would prevent additional phosphorus from being added to the lake.

Together, phosphorus reductions gained by implementing BMPs in the nearshore area and the larger watershed may seem of little value. At most, these changes could generate a little more than 20% of the required reduction in phosphorus loading needed to reach the designated goal. However, many of the issues that cause an increase in phosphorus loading from the nearshore area and watershed can be addressed by property owners and users of the land. By restoring disturbed shorelines, leaving "no mow" or more substantial buffer strips along lake and stream edges, using no fertilizer or phosphorous free fertilizers, diverting runoff form hard surfaces and rooftops, preventing shoreland erosion, and maintaining septic systems in properly working order, the total phosphorous per acre of the nearshore area can be reduced. By incorporating no till and other conservation tillage practices, installing grassed waterways, maintaining buffers along lakes, streams and wetlands, planning cover crops to augment nutrient needs, following appropriate manure spreading guidelines, and making improvements to feed lots and barnyards, and other agricultural BMPs the load from these lands can be reduced. Most of these activities can easily be implemented by property owners and users of the land at relatively low costs. Making sure all septic systems are functioning properly will also minimize phosphorus loading to the lake. Protecting undeveloped portions of the nearshore area would prevent loading from this area from increasing in the future.

CONTRIBUTIONS OF TOTAL PHOSPHORUS FROM CURLY-LEAF PONDWEED IN BIG CHETAC AND BIRCH LAKES

In the spring and early summer 2008 CLP was present across more than 25% of the surface area and more than 66% of the littoral zone of Big Chetac Lake (Berg M. , 2008). CLP grows early and quickly often being well-established even before the winter ice goes out of the lake. It has dense growth patterns that create large masses of vegetation that can interfere with lake recreational uses and shade out other plant growth. However, the life cycle of this plant typically concludes in late June or early July. The large masses of vegetation die and senesce quickly and then often disappear from the water column in a very short period of time.

Decaying CLP and other vegetation releases phosphorous into the lake water. The phosphorous content of the CLP from Big Chetac Lake in 2007 was measured at 0.26% by the WDNR (Roesler, 2008) based on plant samples from 10 different sites. The median CLP biomass was calculated to be 245 g/m2. Based on an area of CLP covering 620 acres

(Berg M. , 2008) the total phosphorous mass potentially released from CLP in Big Chetac Lake is estimated at 3,522-lbs or 30% of the total phosphorous load.

The total phosphorous mass value contributed by CLP from the previous paragraph assumes that 100% of the phosphorous contained in the CLP will go directly into the water column. This is probably not the case. Naturally senescing CLP generally settles to the lake bottom where a substantial portion of the decomposition occurs. This would likely result in some of the phosphorous released by CLP being immediately captured in the sediment. Filamentous algae present in the area where CLP is decaying and periphyton on the remaining plant community would likely use up some of the phosphorous released from the CLP as well (Roesler, 2008). Conditions in Big Chetac Lake would seem to support this assumption. The 2008 Big Chetac Lake CLP Survey completed in June and late July of 2008 (Berg M. , 2008) indicated that a large amount of living CLP was still visible in late July, and that rake samples taken from the bottom still contained a lot of CLP detritus. A better value to consider for Big Chetac Lake might be 50% of the potential phosphorous released from the CLP making it to the water column. If this is the case, then CLP contributed around 1761-lbs or 15% of the total phosphorous load based on 2008 CLP coverage in the lake.

This value is based on 620 acres of CLP, so if the amount of surface matting CLP is less than 620 acres in any given year, the amount of phosphorous released into the water column from decaying CLP will also be less. If there were only 465 acres of CLP in the lake – a reduction of 25% then it is also reasonable to assume that the amount of phosphorus released will also be reduced by 25%. If the total phosphorus contributed by CLP was 1,761-lbs with 620 acres of CLP, it would be only 1,320-lbs with 310 acres, a difference of 441-lbs. Added to the 630-lbs from agricultural BMPs and 28-lbs from the nearshore area, a 52% reduction in phosphorus loading has occurred. If additional CLP were harvested (or chemically treated with stakeholder approval) that would reduce phosphorus loading even more.

During a 2017 cold-water, point-intercept aquatic plant survey completed by the WDNR, about 63 additional acres of CLP were identified in Birch Lake which would add another 179-lbs of phosphorus using the calculation from Big Chetac Lake. A 50% reduction in CLP in Birch Lake would reduce the load by another 90-lb.

INTERNAL LOADING IN BIG CHETAC AND BIRCH LAKES

Algae growth in Big Chetac and Birch Lakes is fueled by excess phosphorus. The 2010 LMP indicated that internal loading of phosphorus (that portion of the total phosphorus load already in the sediments at the bottom of the lake) was the main source (67%) of available phosphorus for algae growth in Big Chetac Lake. Big Chetac Lake is a large and shallow lake with a long maximum fetch (the area of a lake's surface over which the wind blows in an essentially constant direction, thus generating waves) along a south-south-west to north-north-east axis makes it highly susceptible to mixing (James, 2013). This particular characteristic of the lake contributes a great deal to the amount of internal loading that occurs in the lake. Mixing in a lake occurs when phosphorus rich waters at the bottom of the lake (hypolimnion) get mixed into waters near the surface of the lake (epilimnion). The movement of this phosphorus from the hypolimnion to the epilimnion is termed "vertical P transport". In 1988, researchers proposed the Osgood Index as a means to estimate the probability of partial or complete mixing of lakes during summer storms (Osgood, 1988). The Osgood Index itself is a ratio of the mean depth over the square root of the surface area. Researchers who proposed the Osgood Index suggested that lakes with an Osgood Index <6 would be polymictic lakes (lakes that mix several times during the season) or have surface waters (epilimnia) strongly influenced by the bottom waters (hypolimnia). Lakes with large surface areas relative to their depths may be more susceptible to vertical P transport.

The Osgood Index for Big Chetac Lake is only 1.5 (James, 2013), and it has been shown that Big Chetac has multiple mixing events in a given year. Collected data in the North, Central and South basins of the lake indicate periods of hypolimnetic anoxia (low or no dissolved oxygen in the bottom waters) due to stratification. Stratification is when lake water develops warmer, oxygen-rich water near the surface and colder oxygen poor waters near the bottom separated by a thermometric barrier known as the thermocline. Periods of stratification were generally longest in the North basin beginning in early June and lasting through September except during periods of vertical P transport. Stratification occurred much more sporadically in the Central and South basins of Big Chetac, usually not starting until late June. The longer these periods of stratification last, the more phosphorus builds up in the bottom waters. If stratification is disturbed due to wind and waves or by heavy boat use, vertical P transport increases introducing more of the bottom waters to surface waters where the phosphorus is rapidly used to grow more algae.

Although the studies completed back in the late 2000's did not specifically look at stratification in Birch Lake, more recent data suggests the Birch Lake stratifies very early in the season and at 73-ft deep remains stratified all the way into September when water temperature begins to cool. Dissolved oxygen profiles at the deep hole in Birch Lake (Figure 6) indicated anoxic (no oxygen) in waters greater than 9-meters in the month of June and anoxic conditions below 4-meters July-September.

According to Nurnberg (2009), there are indicators that internal loading may be a significant source of phosphorus in both polymictic (mixes frequently) shallow lakes like Big Chetac, and in stratified dimictic (only mixes during spring and fall turnover) deep lakes like Birch. Polymictic lakes that show increasing total phosphorus (TP) and dissolved reactive phosphorus (DRP) throughout the summer even in upper waters; have turnover or mixing events during the summer leading to algae blooms and increased turbidity; have a thin oxygenated sediment layer, occasional anoxia in weed beds and in the open water during quiescent conditions (early morning); and occasional iron, manganese or reduced gas development during quiescent conditions; all may indicate a lake heavily impacted by internal loading (Nurnberg, 2009). Many of these conditions, if not all have been documented in past research for Big Chetac Lake.

Stratified lakes like Birch may be impacted by internal loading if there is severe hypolimnion anoxia; increasing TP and DRP with depth profiles; increasing hypolimnetic TP and DRP throughout the summer; concomitant iron, manganese or reduced gas development; and fall turnover the leads to blooms and increased turbidity (Nurnberg, 2009). At least some of these conditions have been documented in Birch Lake however more data is needed to confirm that they are happening.

Dissolved oxygen profiling in Birch Lake in 2017 showed anoxic conditions below 4-meters of depth from July through September. Historic Secchi disk readings of water clarity show the average water clarity in July and August to be 6.22-ft. In September and October the average water clarity is nearly 2-ft less at 4.29-ft suggesting fall algal blooms, perhaps associated with fall turnover. Water sampling in 2017 at the surface and at the bottom of the Birch Lake at the deep hole found that surface water concentrations of TP decreased from late July to mid-September. TP in the bottom waters was 5 to 7 times higher than TP in the surface waters, but showed a significant decline from July to August, then back up again in September. Iron in the bottom waters was also measured in 2017 with iron concentrations near the bottom being 9 to 13 times greater than TP concentrations in the surface waters. Iron was also significantly less in August than it was in July or September. Full water column profiles (top to bottom) for phosphorus and iron were completed in 2019 and were used to help estimate the total phosphorus load in Birch Lake previously in this document.

USING ALUM TO REDUCE INTERNAL LOADING

One method for reducing internal loading in lakes is to chemically seal the sediment in the bottom of the lake so less phosphorus can be released. To do this requires applying a compound that will chemically bind with the available phosphorus keeping it in a permanent state where it cannot be released back into the water column. In the presence of oxygen, iron is an excellent and natural binding agent for phosphorus. Unfortunately in the absence of oxygen, the chemical bond between iron and phosphorus breaks. In lakes like Big Chetac and Birch where the hypolimnion of the lake goes anoxic for much of the season, internal loading can be significant.

One nontoxic material that has been used with some success is aluminum sulfate or "alum". On contact with water, aluminum sulfate is broken down into another chemical compound that forms a fluffy precipitate called "floc". As the floc slowly settles it removes phosphorous from the water and collects suspended particles in the water and carries them down to the bottom of the lake. Once on the bottom the floc forms a layer that acts as a phosphorous barrier by combining with the phosphorous as it is released from the sediment. Once bound by aluminum sulfate, the phosphorus cannot be returned to the water column even under anoxic conditions.

During the discussion phase of the development of this Comp Plan, a lot of concern was expressed related to the impacts of aluminum sulfate on aquatic biota including fish and invertebrates. In a review of literature conducted by (Gensemer & Playle, 1999) they conclude that aquatic invertebrates are not very sensitive to aluminum. Field studies have generally demonstrated the hardiness of aquatic invertebrates to aluminum, but they may be indirectly affected if their predators (e.g., fish) are influenced by aluminum. Aquatic invertebrates do not biomagnify aluminum. Aluminum is a gill toxicant to adult fish causing respiratory effects, depending on the acidity of the water and the concentration of aluminum they are exposed to. Respiratory effects predominate at low pH (approx. 5-6) and with exposures to aluminum concentrations above 50µg/L. These values pertain to the amount of free aluminum that may persist in the water, not the aluminum that is bound up in the floc or bottom blanket (aluminum hydroxide) that is formed. Free aluminum may persist at pH less than 6 or other hydroxides may form at pH greater than 9; although toxicity may occur at pH > 8 in some conditions. Both forms may be toxic to aquatic life. As a practical matter, the use of buffered alum has mitigated this concern by controlling the pH to acceptable ranges. Indeed, there has been only one reported case in the United States in recent years where toxicity has been a problem (NALMS, 2004). Under proper use guidelines, alum has not been shown to cause any long-term negative impacts to aquatic life.

The biggest problem is determining how much alum to use, and trying to establish how long the alum treatment may be effective. Multiple factors can positively (or negatively) affect longevity of improved water quality after Al addition to reduce internal P cycling. Water residence time, water column stability, and the relative magnitude of internal to external P loads can all affect the perceived effectiveness of internal P loading management (Huser, et al., 2015). In order to determine factors related to longevity of water quality improvement in Al-treated lakes, Huser et al. examined 114 lakes previously treated with Al to reduce internal P loading from the sediment. Their research indicated that the most important factors affecting the longevity of an alum treatment explaining 82% of the variation, included the amount of alum used (appropriate dosage), the watershed area to lake area ratio (the size of the land draining to a lake verses the size of the lake itself), and lake morphology (size, shape, depth, etc.). Moderate to high densities of bottom feeding fish negatively affected longevity. Their research indicated that longevity in shallow lakes was less, but the depth of the lake only explained about 3% of the variation. For all of the lakes they looked at, treatment longevity based on declines in epilimnetic (surface water) TP averaged 11 years. Significant differences in treatment longevity between deeper, stratified lakes (mean 21 years) and shallow polymictic lakes (mean 5.7 years) were detected (Huser, et al., 2015). There was not enough data in any of the lakes included in this study to determine the impact of disturbance of the sediment caused by boats on the longevity of an alum treatment.

BIG CHETAC LAKE ALUM STUDY

In 2013, Bill James and the University of Wisconsin – Stout Discovery Center completed phosphorus budget analysis and alum dosage estimation for Big Chetac Lake. The resulting report concluded that internal loading is indeed a significant source of phosphorus to the lake, and overall, the North basin represented the greatest internal P loading contribution in conjunction with the highest anoxic factor and a longest period of stratification and bottom water anoxia. By contrast, the Central and South basin internal P loading contributions were much lower, coinciding with more intermittent stratification, lower anoxic factor values, and much shorter periods of bottom water anoxia. Despite the higher amounts of phosphorus being released in the North basin, the summer mean concentrations of phosphorus were similar in each basin suggesting a great deal of water mixing and exchange between the three basins (James, 2013).

The report also concluded that an application of alum could significantly reduce internal loading if applied to water in the North basin, and by doing so relatively uniform reductions in surface water TP, a potential 60% decline in mean summer chlorophyll concentrations (a measure of the amount of algae in the water), and an increase in water clarity as measured by a Secchi disk, to near 1-meter. It should be noted, that the average summer (July & August) water clarity lakewide as recorded by volunteers through the CLMN is 3.06-ft. An increase to 1-meter would only add about a quarter foot or 3 inches to the average summer water clarity. While this does not sound like much, it is also expected that severe algae blooms which occur about 73% of the time during the summer would be reduced to approximately 18% of the time (James, 2013).

An Al dosage of 135g/m2 was chosen for treatment for the North basin of Big Chetac Lake. This amount equates to about 19.77g/m3, which is higher than the maximum allowable concentration in Big Chetac Lake of 10.0-12.5g/m3. Maximum concentration is defined as that dose which reduces pH to 6, a pH favorable for forming insoluble aluminum hydroxide and for assuring that the dissolved (free) aluminum remains below potentially toxic concentrations (Cooke & Kennedy, 1981). To account for this the alum would be applied over the course of 2 or 3 years likely with a buffer added to make sure pH remained at or above 6. Sediment areas located at depths >20-ft and an additional sediment area encompassing depths >15-ft (Figure 16) were recommended for treatment. These areas, totaling about 462 acres in the north basin were chosen because they were exposed to anoxia and, thus, had a high potential for anaerobic P release from sediments. The total estimated cost, including a generic setup fee, for an application of Al was ~$1,720,000.00 (James, 2013).

Figure 16: Location of the proposed aluminum sulfate treatment area in the North basin of Big Chetac Lake

ALUM IN BIRCH LAKE

The nutrient budget and alum dosage study completed in 2013 only included Big Chetac Lake. The general assumption has been that if improvements were made in Big Chetac Lake that these improvements would trickle down to Birch and Little Birch Lakes. However, if Birch Lake is suffering from its own internal loading, which more recent data seems to suggest, then this assumption may be incorrect, or at least only part of the picture that is impacting Birch Lake. More needs to be done to determine how water movement from Big Chetac into Birch Lake impacts Birch Lake's water quality.

Some initial water quality data collected in 2017, indicated that phosphorus levels in water coming from Big Chetac into Birch Lake was higher than the surface water phosphorus levels in Birch Lake itself. Furthermore, the phosphorus levels in water going out over the dam was even less suggesting that Birch Lake is acting as a phosphorus sink, pulling phosphorus from the water coming from Big Chetac. This may be occurring during fall turnover when the surface and bottom waters in Birch Lake begin to mix. Iron and phosphorus data collected from the bottom waters of Birch Lake between late July and mid-September 2017 showed a ratio of iron to phosphorus between 9 and 13 to 1. During fall turnover when oxygen is present, iron is available in the water column that can bind with phosphorus. The question is, is there enough iron to bind with the Birch Lake's own internal load of phosphorus and with additional phosphorus coming in from Big Chetac.

One of the criterion that is used to determine the possible longevity of an alum treatment done to improve water quality is external sources of P to the lake. In the case of Birch Lake, there appears to be significant phosphorus coming into and staying in the lake from Big Chetac. But it also appears that internal loading could be significantly impacting Birch Lake, so a combined approach to curb external sources of P into Birch Lake and control of the internal load of P may be needed to make improvements. Meaning that Birch Lake needs to be considered its own management entity rather than just assuming that what happens in Big Chetac will make Birch better.

CONSTITUENT REACTION TO APPLICATION OF ALUM

While research indicates that the application of alum could help maintain or improve Big Chetac Lake, and if additional research were to indicate application in Birch Lake could also help, there is a great deal of undecidedness and some opposition to its use. Probably most of the controversy is over the cost of implementing an alum application. In Big Chetac Lake alone, the estimated cost of application exceeds $1.7 million. Even if the application was spaced out over two or more years, the cost would still be over $500,000.00 annually. There are lake protection grants available from the WDNR that could cover up to $200,000.00 annually, but these still fall far short of the estimated cost.

The general constituency still has a lot of questions related to the application of alum to the North basin of Big Chetac Lake or any other part of the lake system. How long would it last? What impact would it have on Birch, Little Birch, and other downstream waters? What impact would it have on the fishery? How clear would the water get? Would the increase in water clarity create better conditions to support aquatic plant growth? In order to answer these and other questions, the BCABLA needs to spend more time researching them and then taking its findings to the public for input. It is clear that there would have to be buy-in from many local stakeholders including the BCABLA constituency, local towns, Village of Birchwood, local sporting and fishing clubs, and the businesses that benefit from the lake system in order to make this type of management action happen.

AQUATIC PLANTS IN BIG CHETAC, BIRCH, AND LITTLE BIRCH LAKES

BIG CHETAC LAKE

When the "Getting Rid of the Green" project started in 2007, one of the first lake characteristics to be looked at was the aquatic plant community. Aquatic plants are the foundation of a healthy lake system. Because of this, plants are one of the best measures of a lake's overall health. It was well known at the time that that there was a lot of CLP in the system, but not much was known about other native aquatic plants. In 2008 a whole-lake, point-intercept, aquatic plant survey of Big Chetac Lake was completed using a 970 point grid created by the WDNR. This grid was used in 2008 to establish a baseline of aquatic vegetation and in 2014, to compare changes being brought about by the use of aquatic herbicides to control CLP. Again in 2017, it was used to see how native aquatic plants were recovering in the lake.

In 2014, the aquatic plant survey of the entire lake was in response to CLP chemical treatment in 2013 and 2014 that left fewer aquatic plants than expected in Big Chetac Lake, particularly in the Central and North basins. Plant survey results from 2014, showed a decline in native aquatic vegetation, but this was not entirely due to chemical treatment of 90 acres of CLP in the North basin. Ice out in the spring of 2014 was very late, with most lakes holding onto their ice until after the Wisconsin fishing opener the first weekend in May. The spring of 2014 was cool and lasted a long time, further slowing the growth of native aquatic plants in Big Chetac Lake.

At the time of the 2017 survey, Secchi disc readings were in the 2-3ft range. This very poor water clarity produced a littoral zone that extended to 11.5ft and included 352 survey points of which 201 had vegetation (20.7% of the lake bottom and 57.1% of the littoral zone). Although this was a highly significant decline from 2014 when plants were found growing to 14.5ft (493 littoral points), it represented a moderately significant increase from the 148 points with vegetation found during that survey (15.3% of the lake bottom and 30.0% of the littoral zone). The 2017 values also represented a near return to vegetation levels seen in 2008 when plants were found growing at 269 points within the then 12.5ft littoral zone (27.7% of the bottom/68.6% of the littoral zone). In addition to the recovery in points with vegetation, it was found that the mean and median depth of plant growth also increased from 5.4ft/5.0ft in 2014 to 5.9ft/ 6.0ft in 2017. This relatively uniform growth in the depth/colonization of the plant community was nearly identical to what was first observed in 2008 when the mean/median was also 5.9ft/6.0ft.

Table 9 is a brief comparison of the statistics from each of the whole-lake point-intercept surveys completed in Big Chetac Lake.

Table 9: Comparison of 2008, 2014, and 2017 point-intercept aquatic plant survey data

Summary Statistics:	2008	2014	2017
Total number of points sampled	970	970	970
Total number of sites with vegetation	269	148	201
Total number of sites shallower than the maximum depth of plants	392	493	352
Frequency of occurrence at sites shallower than maximum depth of plants	68.6	30.0	57.1
Simpson Diversity Index	0.90	0.93	0.93
Maximum depth of plants (ft)	12.5	14.5	11.5
Mean depth of plants (ft)	5.9	5.4	5.9
Median depth of plants (ft)	6.0	5.0	6.0
Average number of all species per site (shallower than max depth)	1.88	0.80	1.54
Average number of all species per site (veg. sites only)	2.74	2.68	2.70
Average number of native species per site (shallower than max depth)	1.55	0.69	1.50
Average number of native species per site (sites with native veg. only)	2.49	2.71	2.69
Species richness	35	39	39
Species richness (including visuals)	40	42	45
Species richness (including visuals and boat survey)	46	48	52
Mean total rake fullness (veg. sites only)	2.02	1.84	1.74

Overall diversity in Big Chetac Lake was again exceptionally high and almost unchanged from the previous surveys. In 2008, the Simpson Index value was 0.90; ticked up to 0.93 in 2014; and remained there in 2017. Overall richness was moderate and also little changed as 35 species were found in the rake in 2008, 39 in 2014, and 39 in 2017. When including visuals and the boat survey, these numbers jumped to 46/48/52 respectively. Localized richness, after increasing from 2.49 native species/site with native vegetation in 2008 to 2.71/site in 2014, experienced a non-significant decline to 2.69/site in 2017 (Figure 17). As in previous surveys, the bulk of the lake's species occurred near the creek inlets, in the herbicide control bay west of the main public boat landing, and in the Bullpen (Figure 18). While there is no specific water clarity data to support, the reason for more aquatic plant diversity in these areas is thought to be better water clarity at the inlet of Benson, Heron, Knuteson, and Malviney creeks. The west bay is also one of the largest, shallow-water bays in the entire lake, providing greater habitat for aquatic plant growth.

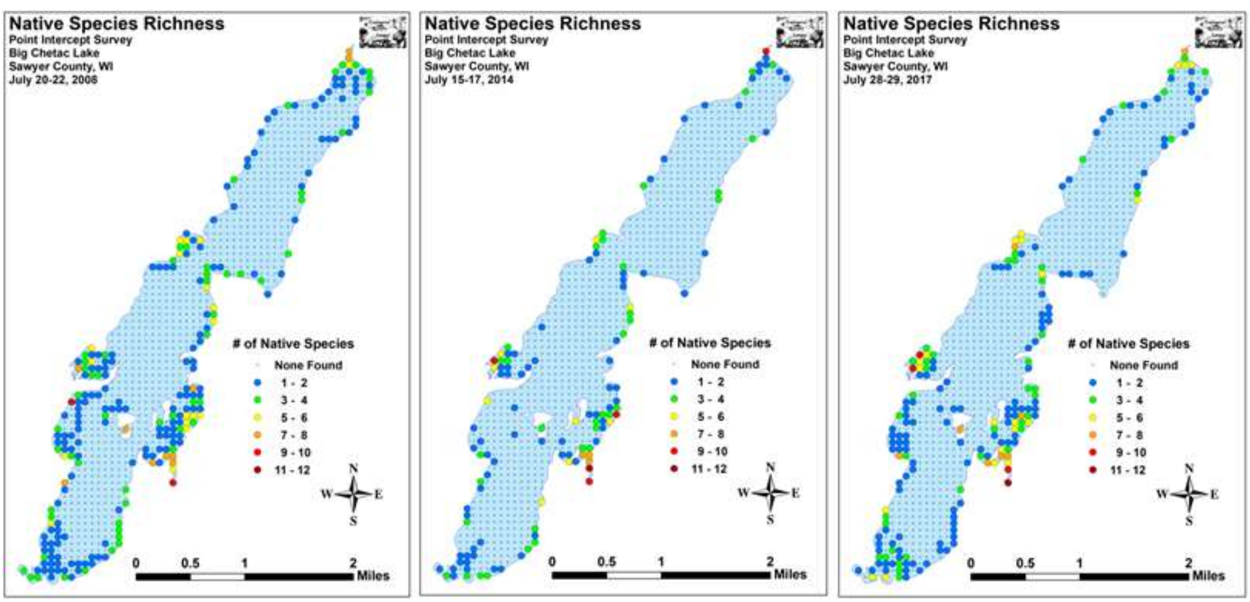


Figure 17: **Native species richness (diversity) in Big Chetac Lake, 2008, 2014, & 2017**

Figure 18: **Locations in Big Chetac Lake**

The estimated 2008 baseline mean rake fullness at sites with vegetation was a moderate 2.02. It fell to a low/moderate 1.84 in 2014 and to 1.74 in 2017. This further decline wasn't significant and it likely reflects the increase in low density deep water points as plants reestablish in these areas. Figure 19 is a visual representation of rake fullness as it changed from 2008 to 2017. The rake fullness value is a measure of plant density based on a 1-3 scale related to how much vegetation is pulled from the lake at each sample point (Figure 20).

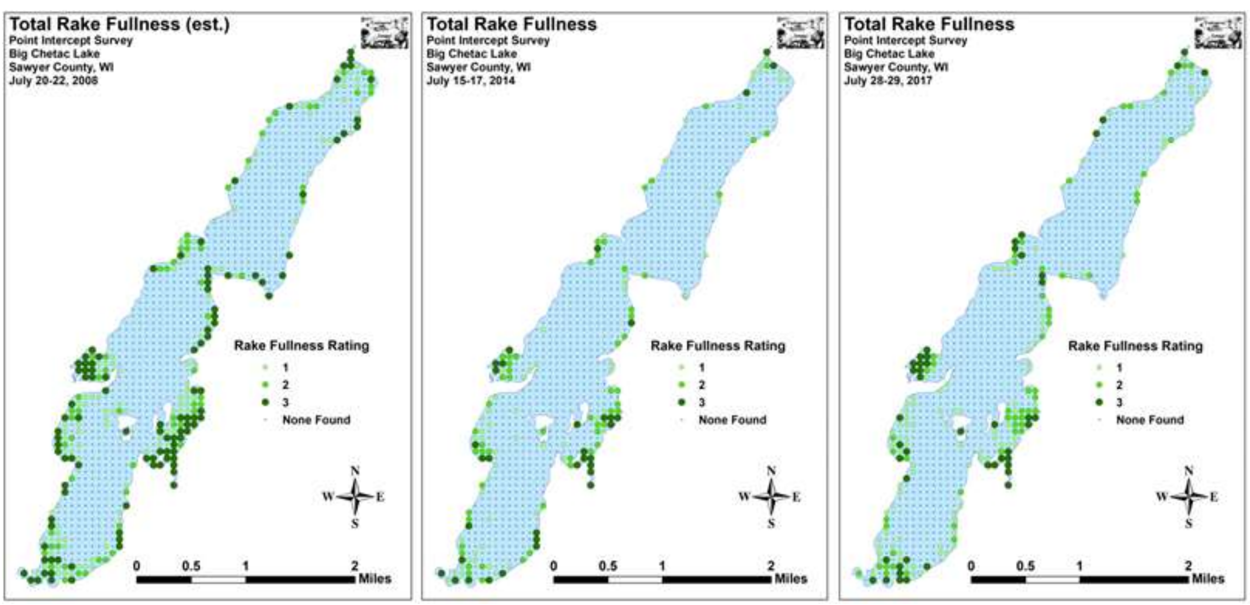


Figure 19: **Total rake fullness (density) in Big Chetac Lake, 2008, 2014, and 2017**

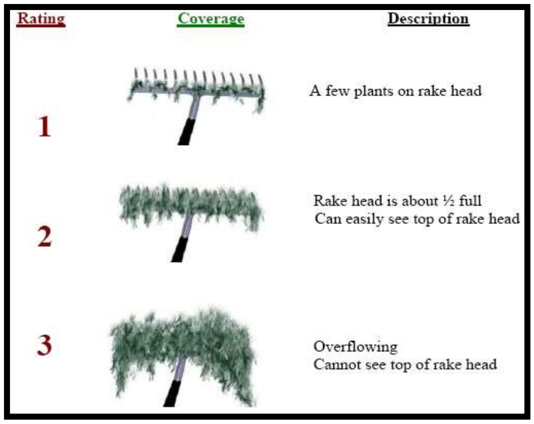


Figure 20: **Visualization of rake fullness values from the whole-lake, point-intercept aquatic plant survey**

From 2008 to 2014, ten species and filamentous algae experienced significant changes in distribution all of which were declines. Specifically, curly-leaf pondweed, small pondweed, coontail, filamentous algae, flat-stem pondweed, forked duckweed, and Fries' pondweed suffered highly significant declines; fern pondweed saw a moderately significant decline; and small duckweed, large duckweed, and white water crowfoot experienced significant declines. At the time it was noted that most of the species that experienced the biggest contractions in range were either species that start growing early in the spring prior to herbicide application (curly-leaf pondweed, small pondweed, flat-stem pondweed, and Fries' pondweed) or ones that overwinter as vegetation (coontail and fern pondweed). Conversely, species that primarily use seeds, spores, rhizomes, or tubers (slender naiad, wild celery, white-water lily, nitella, sago pondweed, spatterdock, and clasping-leaf pondweed) tended to be almost unchanged in their distribution.

By 2017, many species that had shown dramatic declines in 2014 were beginning to recover. Twelve species and filamentous algae saw significant changes, and all but one of those was an increase. Filamentous algae, flat-stem pondweed, nitella, forked duckweed, northern water-milfoil, common waterweed, and muskgrass populations all benefited from highly significant increases in distribution; small pondweed and white water crowfoot enjoyed moderately significant increases; and coontail, Fries' pondweed, and water star-grass had significant increases.

Small pondweed was one of the plant species most impacted by the 2013 and 2014 chemical treatment of CLP. In 2008, it was the most widely distributed native species found at 130 sites with a mean rake of 1.41. Although the 2014 survey found it suffering a highly significant decline in range to 37 points, its mean rake fullness of 1.46 was nearly unchanged. In 2017, a moderately significant increase in distribution was documented. However, it also suffered a highly significant decline in mean rake fullness to 1.08. This may be because most rake samples in the northern half of the lake that contained this species had one or two individual stems. Visual analysis of the maps showed this species also declined in the southern half of the lake (Figure 21).

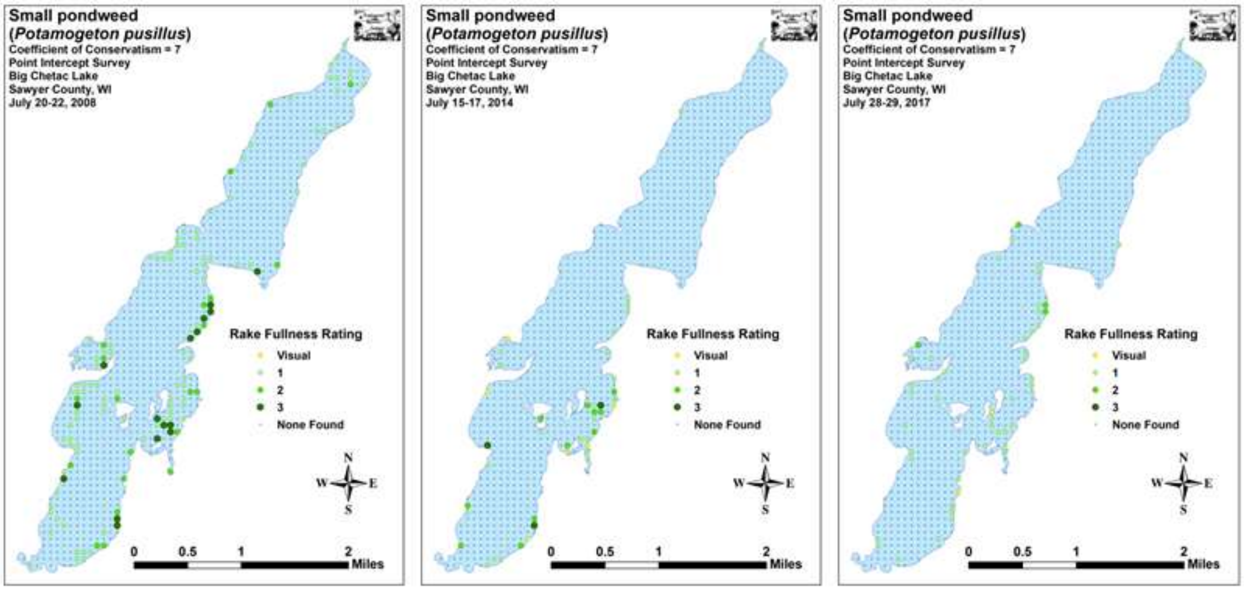


Figure 21: Distribution and density of small pondweed in Big Chetac Lake

The Floristic Quality Index (FQI) measures the impact of human development on a lake's aquatic plants. The 124 species in the index are assigned a Coefficient of Conservatism (C) which ranges from 1-10. The higher the value assigned, the more likely the plant is to be negatively impacted by human activities relating to water quality or habitat modifications. Plants with low values are tolerant of human habitat modifications, and they often exploit these changes to the point where they may crowd out other species. The FQI is calculated by averaging the conservatism value for each native index species found in the lake during the point-intercept survey, and multiplying it by the square root of the total number of plant species (N) in the lake. Statistically speaking, the higher the index value, the healthier the lake's aquatic plant community is assumed to be. (Nichols, 1999) identified four eco-regions in Wisconsin: Northern Lakes and Forests, North Central Hardwood Forests, Driftless Area and Southeastern Wisconsin Till Plain. He recommended making comparisons of lakes within ecoregions to determine the target lake's relative diversity and health. Big Chetac Lake is in the Northern Lakes and Forests Ecoregion.

In 2008, 34 native index species were identified on the rake during the point-intercept survey. They produced a mean Coefficient of Conservatism (C) of 6.0 and a Floristic Quality Index (FQI) of 34.8. The 2014 survey found 37 native index plants on the rake during the point- intercept survey. They produced a mean C of 5.9 and a FQI of 35.8 – both of these values were nearly identical to the 2008 survey. During the 2017 survey, a total of 39 native index species were identified in the rake. They produced a mean C of 6.0 and a FQI of 37.3. Each of these values represented an increase over the 2014 survey again suggesting the aquatic plant community in Big Chetac Lake is recovering.

WILD RICE

Wild rice, a plant of significant wildlife and cultural value, is present in scattered patches along the creek inlets in the Bullpen (Figure 22). Most areas support only low to moderate density plants, and no areas have ever been mapped that were big enough or dense enough that they would offer profitable human harvest. Outside of this area, wild rice has never been observed growing anywhere else in the system.

The 2008 survey found a bed of rice in the nearly inaccessible bay south of the Malviney Creek inlet that was moderate to high density. The only two survey points in the lake with rice occurred here, and each had a rake fullness of 3. This shallow bay still had rice in 2014 and 2017, but the area has largely been taken over by water lilies and cattails (Figure 23). In 2014 and 2017, wild rice was found at three points, but each sample consisted of a single plant so the mean rake fullness was 1.00 for each survey (Figure 24).

Figure 22: Panorama of northern wild rice in Malviney Creek inlet facing northwest into the Bullpen – 7/28/17 (Berg M. S., 2017a)

Figure 23: Rice remnants in bays southwest of Malviney Creek inlet – 7/28/17 (Berg M. S., 2017a)

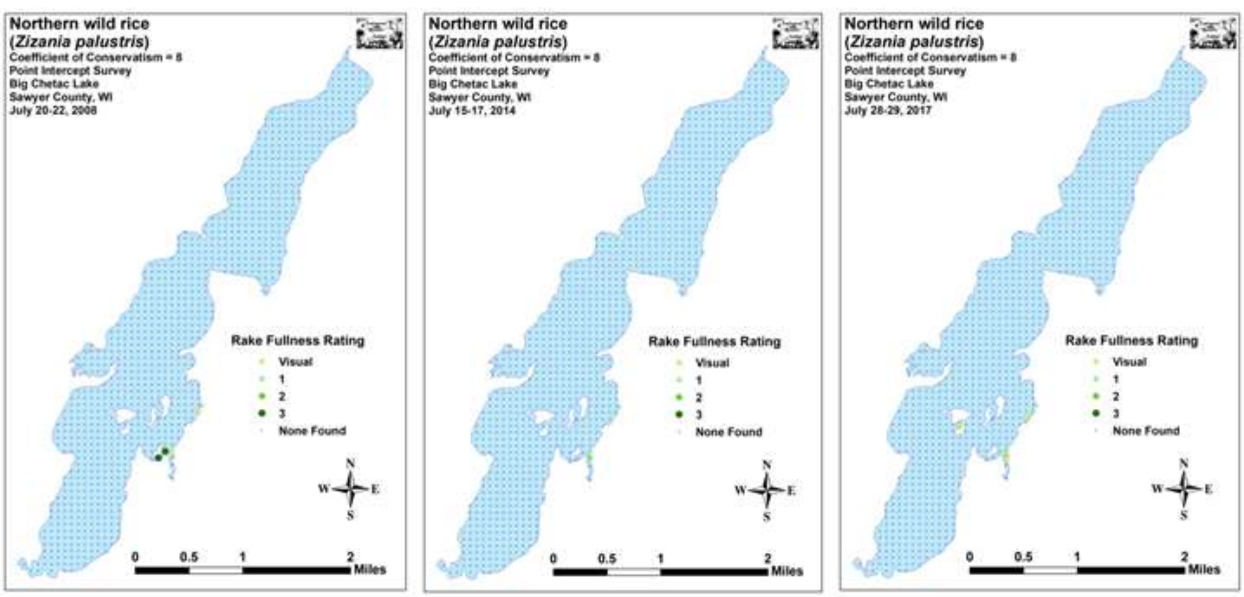


Figure 24: 2008, 2014, and 2017 northern wild rice density and distribution

Given the limited amount of wild rice in the system, it is likely that it will never increase to a harvestable amount. However, seeding of wild rice could be discussed with GLIFWC and St. Croix Tribal Resources. The implication of wild rice on management of other aquatic plants in the system is simply one of not being able to chemically treat in areas where wild rice is present and possible restrictions on harvesting in the area as well, if harvesting becomes a regular management activity.

More information about the 2017 aquatic plant survey in Big Chetac Lake can be found in the final aquatic plant management survey report completed by Endangered Resource Services (Berg M. S., 2017a).

BIRCH LAKE

During the "Getting Rid of the Green" project, aquatic plants in Birch and Little Birch lakes were not surveyed. In 2017, as a part of a lake management planning grant awarded to the BCABLA, the WDNR completed a survey of both CLP (early season) and native aquatic plants (late summer) using a survey grid containing 871 points at 43-meter intervals. This is the only whole-lake aquatic plant survey data that is available, so it serves as a baseline for future comparisons. Of the points created only 293 (33.6%, 123 acres) were considered to be in the littoral zone in the early season. This number dropped to 264 (30.3%, 111 acres) during the summer survey. During the two surveys the number of points with vegetation in the littoral zone was 150 (51.5% frequency of occurrence) in the spring and 151 (61.9% frequency of occurrence) in the summer.

During the spring or cold-water survey, 151 of 293 points had vegetation, but that vegetation was exclusively CLP. An additional 31 points listed CLP as a visual (Figure 25).

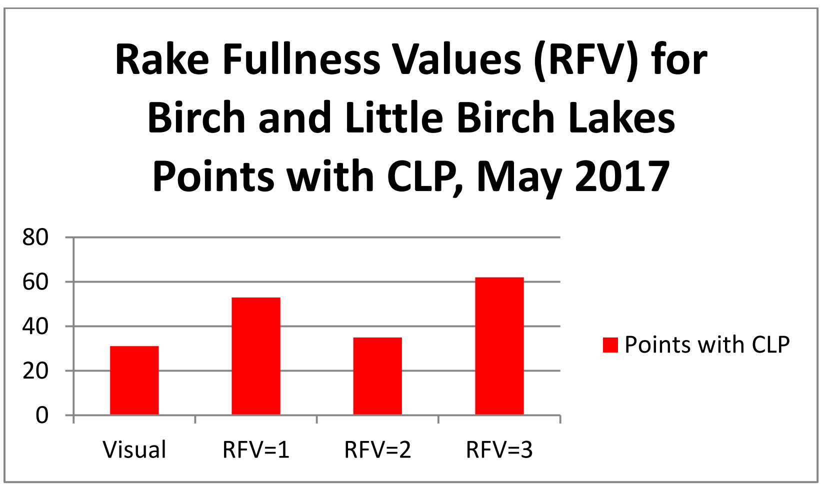


Figure 25: Rake Fullness Values (density) of points with CLP

It is unknown if the amount of CLP in Birch and Little Birch lakes is indicative of an average year for CLP or if the CLP exploded in 2017, like it did in many other area lakes. The cold water survey showed that CLP was present in most of the areas of the lakes where the habitat is suitable (mostly over muck bottom) (Figure 24). Overall, the CLP in Birch Lake was fairly dense with most of the points having a rake fullness value of either 2 or 3 (Figure 26). This is especially true in the channel that flows in from Big Chetac Lake where almost all of the points sampled showed very dense CLP.

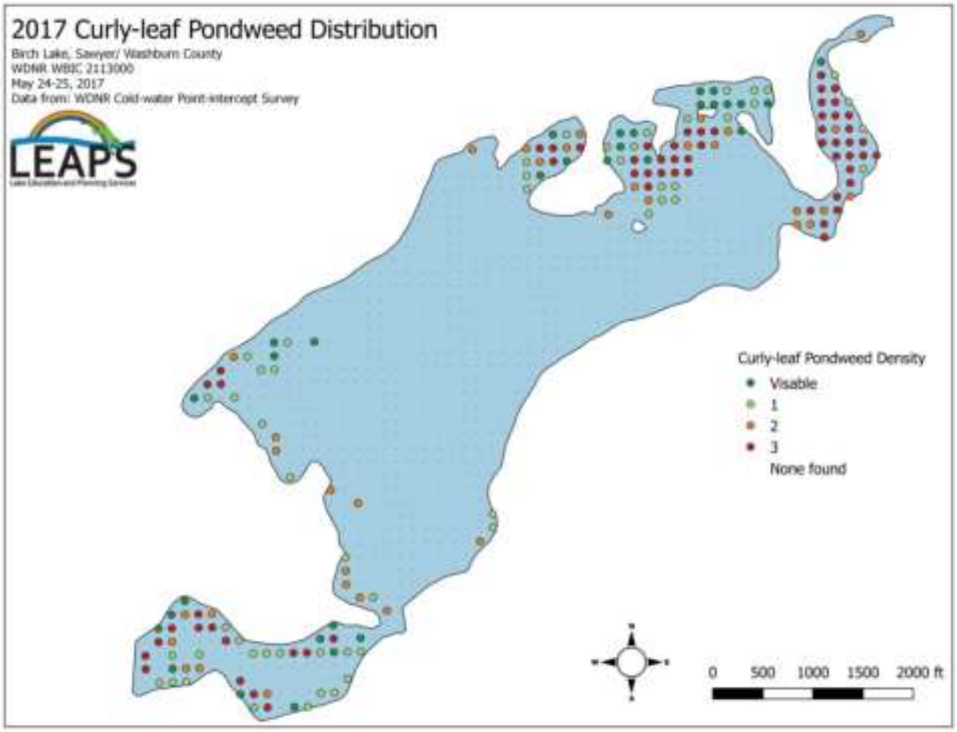


Figure 26: CLP density in Birch and Little Birch lakes

The native plant community is not extremely diverse, likely due to the small littoral zone and the dense growth CLP early in the season. The number of species growing in the lake is further hampered by algae growth which limits water clarity later in the season. And unlike Big Chetac, there are no creek inlets along the shores of Birch or Little Birch lakes to offer locations of greater water clarity.

One parameter used to determine the overall diversity of the aquatic plant community in a body of water is the Simpson's Diversity Index (SDI). The SDI allows the entire plant community at one location to be compared to the entire plant community at another location. It also allows the plant community at a single location to be compared over time thus allowing a measure of community degradation or restoration at that site. With Simpson's Diversity Index, the index value represents the probability that two individual plants (randomly selected) will be different species. The index values range from 0 -1 where 0 indicates that all the plants sampled are the same species to 1 where none of the plants sampled are the same species. The greater the index value, the higher the diversity in a given location. Although many natural variables like lake size, depth, dissolved minerals, water clarity, mean temperature, etc. can affect diversity, in general, a more diverse lake indicates a healthier ecosystem. Perhaps most importantly, plant communities with high diversity also tend to be more resistant to invasion by exotic species.

The SDI for Birch Lake is 0.85, pretty low when compared to the SDI of the Big Chetac Lake plant community in 2017 (0.93); and when compared to FQI's in the downstream Red Cedar Lakes in 2018: Balsam – 0.92, Mud – 0.91, Red Cedar – 0.93, and Hemlock – 0.93.

The Floristic Quality Index (FQI) measures the impact of human development on a lake's aquatic plants. The 124 species in the index are assigned a Coefficient of Conservatism (C) which ranges from 1-10. The higher the value assigned, the more likely the plant is to be negatively impacted by human activities relating to water quality or habitat modifications. Plants with low values are tolerant of human habitat modifications, and they often exploit these changes to the point where they may crowd out other species. The FQI is calculated by averaging the conservatism value for each native index species found in the lake during the point-intercept survey, and multiplying it by the square root of the total number of plant species (N) in the lake. Statistically speaking, the higher the index value, the healthier the lake's aquatic plant community is assumed to be. (Nichols, 1999) identified four eco-regions in Wisconsin: Northern Lakes and Forests, North Central Hardwood Forests, Driftless Area and Southeastern Wisconsin Till Plain. He recommended making comparisons of lakes within ecoregions to determine the target lake's relative diversity and health. Big Chetac Lake is in the Northern Lakes and Forests Ecoregion.

In 2017, a total of 20 native index species were identified on the rake during the point-intercept survey. They produced a mean C of 5.9 and a FQI of 26.4. Nichols (1999) reported an average mean C for the Northern Lakes and Forest Region of 6.7 putting Birch Lake below average, in 2017, for this part of the state. The FQI was, however, very near the mean FQI of 24.3 for the Northern Lakes and Forest Region (Nichols, 1999).

During the 2017 summer plant survey, the maximum depth at which aquatic plants were found was 11.5-ft. Where plants were found, they were generally very dense with most of these areas having rake fullness ratings of 3. In the large bay on the northern shoreline, the vegetation was so thick that WDNR surveyors were unable to reach a large portion of it (Figure 27). Despite the highly dense plant growth, most of the areas that could be reached only contained one or two species (Figure 28).

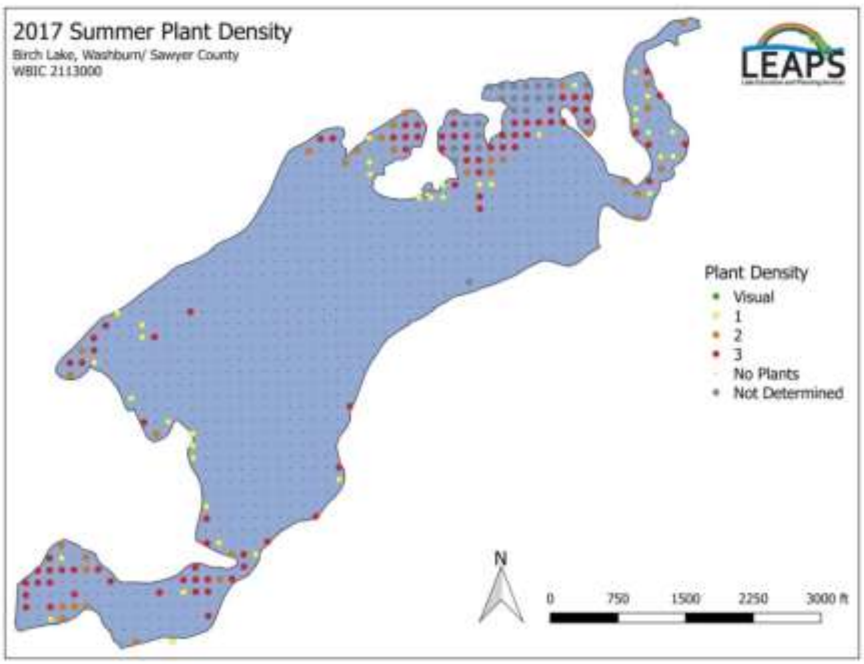


Figure 27: 2017 Summer plant density in Birch and Little Birch lakes.

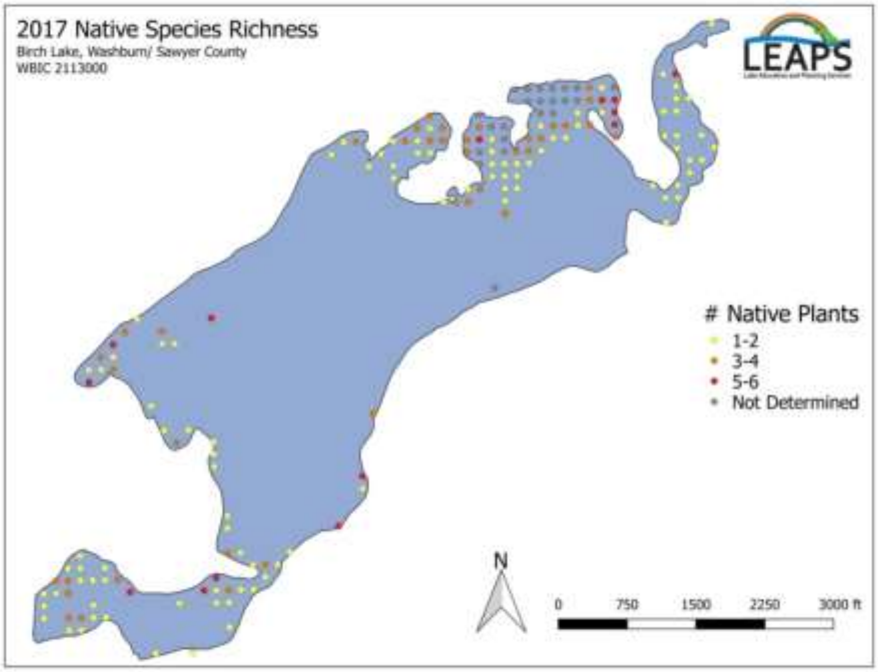


Figure 28: Localize native species richness in Birch and Little Birch lakes

During the 2017 summer survey coontail was the most common aquatic plant species found at 95 pts (Frequency of Occurrence (FO) within vegetated sites = 62.91%). Fern-leaf pondweed, the second most common species was found at 71 pts (FO=47.02%). Flat-stem pondweed and wild celery were the third most common species at 44 points each (FO=29.14%). Common waterweed, White waterlily, and Clasping-leaf pondweed were the 4th, 5th, and 6th most common species at 26, 22, and 20 points (FO=17.22, 14.57, 13.25) respectively. No other species exceeded a FO >10% although Northern watermilfoil was close at 7.95% (12 pts) (Figures 29 & 30).

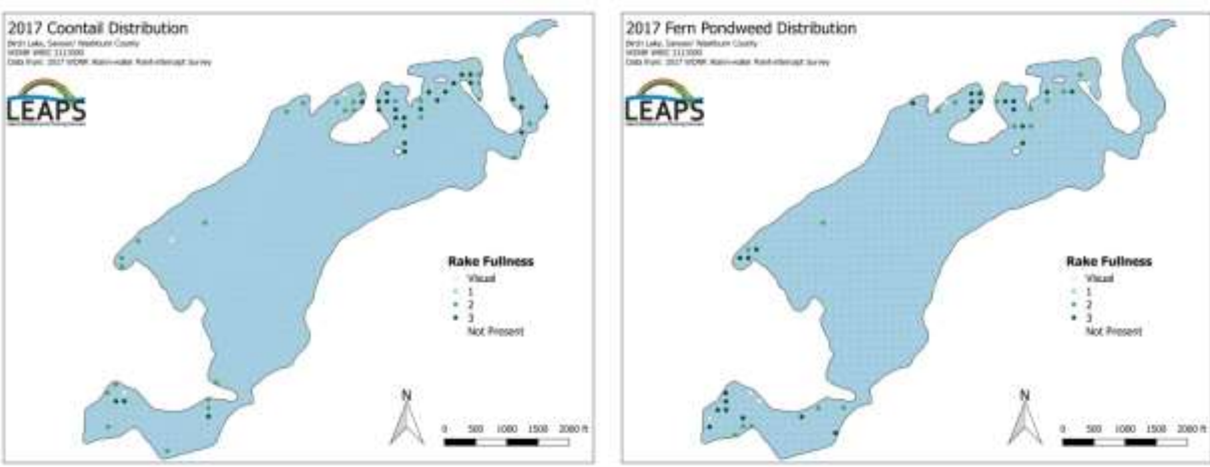


Figure 29: Distribution and density of coontail and fern-leaf pondweed in Birch and Little Birch lakes

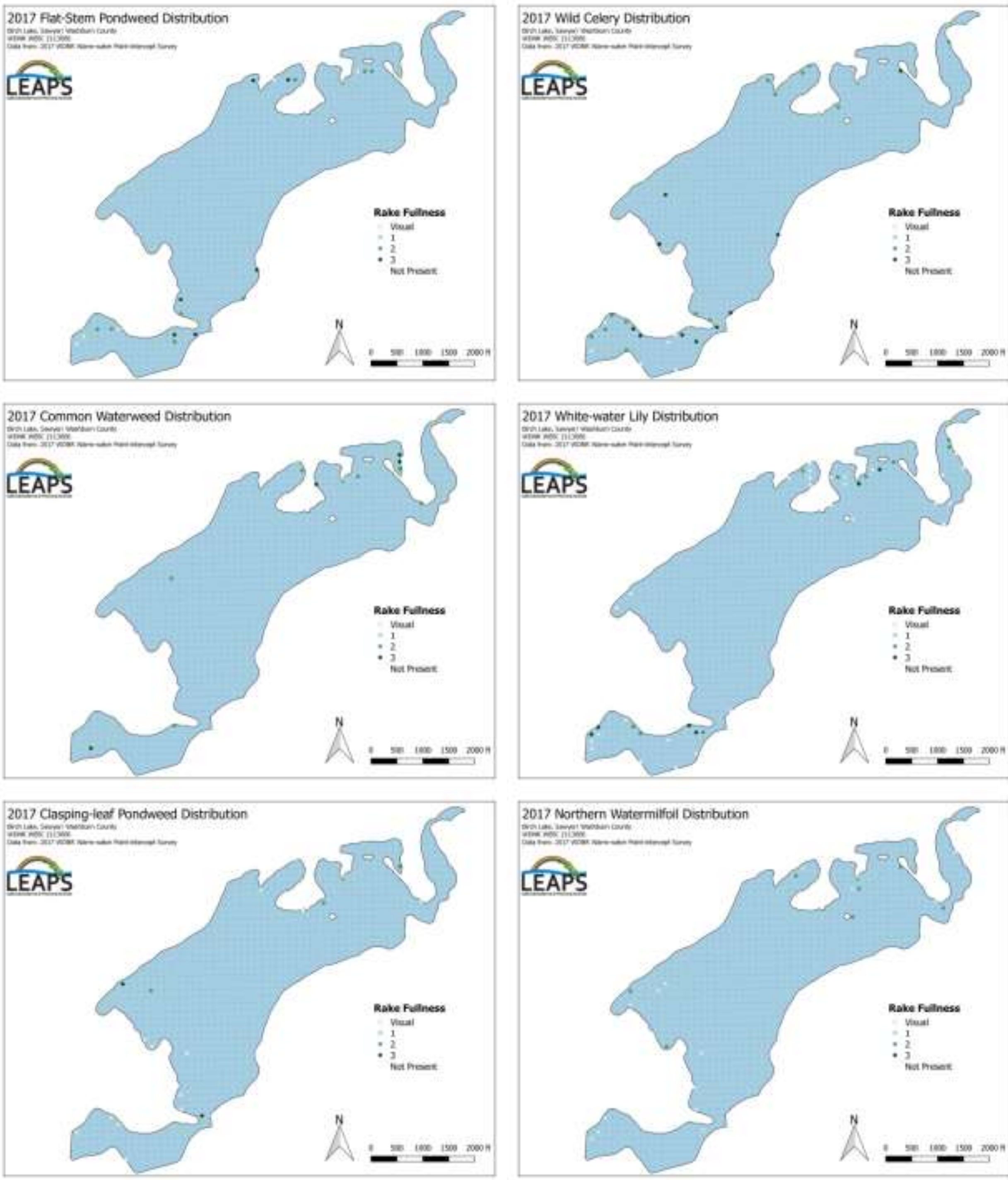


Figure 30: Distribution and density of the most abundant plant species in Birch and Little Birch lakes

BIRCH AND LITTLE BIRCH LAKES PLANT COMMUNITY

The Birch and Little Birch lakes ecosystem is home to a diverse plant community that is typical of high nutrient lakes. This community can be subdivided into four distinct zones (emergent, shallow submergent, floating-leaf, and deep submergent) with each zone having its own characteristic functions in the aquatic ecosystem. Depending on the local bottom type (sand, rock, sandy muck or nutrient rich organic muck), these zones often had somewhat different species present.

In shallow areas, beds of emergent plants prevent erosion by stabilizing the lakeshore, break up wave action, provide a nursery for baitfish and juvenile gamefish, offer shelter for amphibians, and give waterfowl and predatory wading birds like herons a place to hunt. These areas also provide important habitat for invertebrates like dragonflies and mayflies. On sand and gravel bars arrowhead was present.

Common arrowhead (Young 2008)

Just beyond the emergents, in sheltered muck-bottomed areas the floating-leaf species Spatterdock and White-water lily were relatively common throughout the lake. A few high value native pondweeds with floating leaves like Large-leaf pondweed were found. The canopy cover they provide is often utilized by panfish and bass for protection.

Spatterdock (CBG 2014)

White water lily (Falkner 2009)

Large-leaf pondweed (Fewless 2010)

Growing amongst these floating-leaf species, we also noted the submergent species Coontail, and Common waterweed. In addition to these rooted plants, a large number of "duckweeds" were found floating among both the lily pads and the emergents.

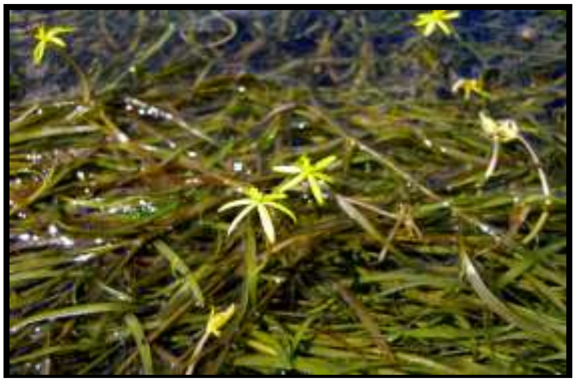
Forked duckweed (Curtis 2010) Large duckweed (Thomas2014)

Small duckweed and Common watermeal (Kieron 2010) Common waterweed (Fischer 2008)

Sand and sandy muck bottomed habitats supported few floating-leaf species. In pure sand areas the plant community was made up of generally finer leaved submergent plants like Slender naiad and White water crowfoot. These species tend to form a carpet that stabilizes the bottom.

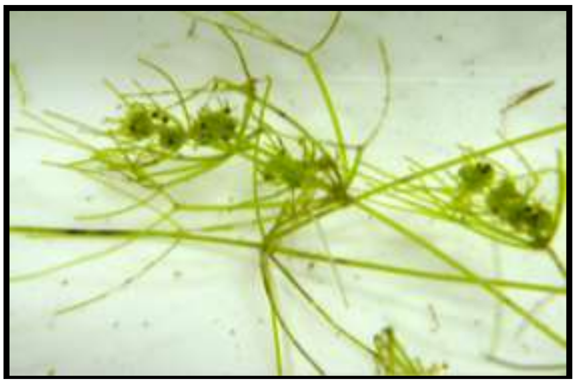
Slender naiad (Apipp 2009) White water crowfoot (Wasser 2014)

Shallow sandy muck areas tended to support slightly broader-leaved species like Water star-grass, Northern watermilfoil, Nitella (*Nitella* sp.), Clasping-leaf pondweed, and Wild celery. The roots, shoots, and seeds of these species are heavily utilized by both resident and migratory waterfowl for food. They also provide important habitat for the lake's fish throughout their lifecycles, as well as a myriad of invertebrates like scuds, dragonfly and mayfly nymphs, and snails.



Water star-grass (Mueller 2010)

Northern water-milfoil (Berg 2008)



Nitella (Green 2002)

Clasping-leaf pondweed (Cameron 2014)

Wild celery (Dalvi 2009)

Deeper areas from 5-11.5ft were dominated by Coontail and Fern-leaf pondweed. Curly-leaf pondweed, White-stem pondweed, and Flat-stem pondweed were present. Predatory fish like the lake's northern pike are often found along the edges of these beds waiting in ambush.

Coontail

(Hassler 2011) Fern-leaf pondweed (Apipp 2011)

White-stem pondweed (Fewless 2005) Flat-stem pondweed (Fewless 2004)

To date, no Eurasian watermilfoil has been found in Big Chetac, Birch, or Little Birch Lakes.

WATER CLARITY, ALGAE, AND AQUATIC PLANT GROWTH IN BIG CHETAC AND BIRCH LAKES

In a paper discussing the factors in lakes that affect the maximum depth of colonization of submersed aquatic plant growth, Caffrey et al, 2007 documented many studies that showed that the distribution and abundance of aquatic plants in lakes are affected by many forces including but not limited to pressure, substrate characteristics, lake morphology, water column nutrient concentration, waterfowl grazing, and light availability (Caffrey, Hoyer, & Canfield, 2007). Given the high attenuation of irradiance through the water column (light quickly dissipating/losing it intensity as it moves through the water), and because plants require light to photosynthesize, light availability is often considered one of the most important factors that regulate abundance and distribution of aquatic plants (Zimmerman, Pasini, & Alberte, 1994). Several other studies quoted by Caffrey et al have shown that the maximum depth at which aquatic plants colonize is linearly related to transparency of the water.

As previously discussed water clarity is most commonly measured by a Secchi disk (Figure 31). The Secchi disk is lowered into the water column until it can no longer be seen. The depth at which it disappears from view is considered the Secchi depth. Though not a direct measurement of the amount of light passing through the water column at any given depth, it is a reliable substitute if a light meter measuring light irradiance is not available. Caffrey et al found that measuring actual light attenuation with a meter did not predict maximum depth of plant colonization any better than the Secchi disk.

Figure 31: Secchi Disk

Water clarity or Secchi depth measurements can help scientists estimate the depth at which underwater aquatic macrophytes will be expected to survive. A general rule of thumb is that aquatic macrophytes can grow to a depth of about 1.5 times the Secchi depth measurement. For example, if a Secchi depth measurement is 3-ft, the depth at which aquatic macrophytes can grow is limited to about 4.5 feet (Florida LAKEWATCH, 2001). Differences in water clarity are primarily caused by the presence (or lack) of dissolved substances and/or suspended particles (particulates) in the water.

Dissolved organic substances or compounds can come from many types of terrestrial and aquatic plants, and can color the water reddish or brown, sometimes even to the point of appearing black. When there is an abundance of dissolved organic compounds in the water, scientists often refer to the water as being "colored" or sometimes they'll refer to the waterbody as being a "dark" lake. There are two types of color that are measured in waterbodies: apparent color is the color of a water sample that has not had particulates filtered out of the water; and true color is the color of a water sample that has had all particulates filtered out of the water. The measurement of true color is the one most commonly used by scientists. Organic compounds dissolved in the water (color) are important because they absorb sunlight as the light passes through the water, Secchi depth values decrease as the amount of color in the water increases (Florida LAKEWATCH, 2001).

Particulates include free-floating algae, called phytoplankton, as well as other solids suspended in the water. These include sand, clay, or organic particles stirred up from the bottom, washed in from the shoreline, washed in from the surrounding land, or brought in by the wind and rain. Because particulates absorb and scatter sunlight as the light passes through the water, Secchi depth (water clarity) values decrease as the amount of particulates in the water increases. While all particles are known to affect water clarity, studies throughout the world have shown that free-floating algae are the dominant particles influencing water clarity in most lakes (Florida LAKEWATCH, 2001). Scientists often estimate the amount of free-floating algae in a lake by measuring the amount of chlorophyll-a in a water sample, measured in units of micrograms per liter (µg/L). Chlorophyll-a is what makes plants and algae look green.

A strong relationship exists between chlorophyll-a and Secchi depth measurements of water quality, with maximum chlorophyll-a values correlating with minimum Secchi depth measurements (Stadelmann, Brezonik, & Kloiber, 2001). Both Big Chetac and Birch lakes have high chlorophyll-a concentrations throughout the summer and fall season (Figures 24 & 25). The concentrations measured are indicative of a high abundance of algae in the surface water of both lakes. This algae, along with other suspended particulates, reduces light penetration needed to grow aquatic plants. In Birch Lake, this issue is compounded by the fact that only 30% of the lake's surface is considered to be in the littoral zone, or where enough light can penetrate to grow plants. This number is not much higher for Big Chetac Lake at 36%.

Algae are aquatic plants. The amount of algae in a lake can be an indicator of a lakes productivity, or capacity to support aquatic life. Algae are typically the main food source for small critters (called zooplankton) in a lake which graze on it like cows on grass. Zooplankton is fed on by larger lake creatures, which in turn are fed on by even larger ones, and so on. Larger aquatic plants (called macrophytes) are another indicator of a lake's productivity. If there are only small amounts of aquatic plants and algae, a lake is generally considered unproductive. Whereas, if a lake has clear water, due to low chlorophyll-a concentrations, but has a lot of larger aquatic plants, it can be stated that the lake is a biologically productive system (Florida LAKEWATCH, 2001).

The abundance of macrophytes can affect water clarity, making it better by using up available nutrients to grow. If available nutrients are used by algae in the absence of macrophytes, where by excess algae reduces light penetration, the reverse is also true; water clarity can further reduce the amount of rooted aquatic plant growth. When lake water is turbid (because of free-floating algae or perhaps suspended sediment), sunlight can't penetrate as far into the water, limiting the maximum depth at which larger aquatic plants can grow. This inverse relationship between water clarity and aquatic plants suggests that the biological productivity of a lake can shift between being a lake dominated with phytoplankton (algae) to a lake dominated by rooted aquatic plants (Florida LAKEWATCH, 2001). In the case of both Big Chetac and Birch lakes, a shift has already occurred to a more algae-dominated system. The aquatic plants that are most abundant in both lakes are those that can survive with less light penetration.

It has been observed that if the amount of rooted aquatic plant coverage is less than 30% of the bottom area of a waterbody, the presence of plants does not greatly influence the amount of free-floating algae in open-water. However, lakes with aquatic plant coverage over 50% or more of the bottom area typically have reduced chlorophyll concentrations and clearer water. In Birch Lake, rooted aquatic plants only covered 17.3% of the lake bottom in 2017. Rooted aquatic plants only covered 20.7% of the Big Chetac Lake bottom. Neither value is enough to have a positive impact on water clarity.

SHORELANDS

How the shoreline of a lake is managed can have big impacts on the water quality and health of that lake. Natural shorelines prevent polluted runoff from entering lakes, help control flooding and erosion, provide fish and wildlife habitat, may make it harder for AIS to establish themselves, muffle noise from watercraft, and preserve privacy and natural scenic beauty. Many of the values lake front property owners appreciate and enjoy about their properties - natural scenic beauty, tranquility, privacy, relaxation - are enhanced and preserved with good shoreland management. And healthy lakes with good water quality translate into healthy lake front property values.

Shorelands may look peaceful, but they are actually the hotbed of activity on a lake. At least 90% of all living things found in lakes - from fish, to frogs, turtles, insects, birds, and other wildlife - are found along the shallow margins and shores. Many species rely on shorelands for all or part of their life cycles as a source for food, a place to sleep, cover from predators, and to raise their young. Shorelands and shallows are the spawning grounds for fish, nesting sites for birds, and where turtles lay their eggs. There can be as much as 500% more species diversity at the water's edge compared to adjoining uplands.

Lakes are buffered by shorelands that extend into and away from the lake. These shoreland buffers include shallow waters with submerged plants (like coontail and pondweeds), the water's edge where fallen trees and emergent plants like rushes might be found, and upward onto the land where different layers of plants (low ground cover, shrubs, trees) may lead to the lake. A lake's littoral zone is a term used to describe the shallow water area where aquatic plants can grow because sunlight can penetrate to the lake bottom. Shallow lakes might be composed entirely of a littoral zone. In deeper lakes, plants are limited where they can grow by how deeply light can penetrate the water.

Shorelands are critical to a lake’s health. Activities such as replacing natural vegetation with lawns, clearing brush and trees, importing sand to make artificial beaches, and installing structures such as piers, can cause water quality decline and change what species can survive in the lake.

PROTECTING WATER QUALITY

Shoreland buffers slow down rain and snow melt (runoff). Runoff can add nutrients, sediments, and other pollutants into lakes, causing water quality declines. Slowing down runoff provides more time for water to soak (infiltrate) into the ground. Water that soaks into the ground is less likely to damage lake quality and recharges the groundwater that supplies water to lakes. Slowing down runoff water also reduces flooding, and stabilizes stream flows and lake levels.

Shoreland wetlands act like natural sponges trapping nutrients where nutrient-rich wetland sediments and soils support insects, frogs, and other small animals eaten by fish and wildlife.

Shoreland forests act as filters, retainers, and suppliers of nutrients and organic material to lakes. The tree canopy, young trees, shrubs, and forest understory all intercept precipitation, slowing runoff, and contributing to water infiltration by keeping the soil's organic surface layer well-aerated and moist. Forests also slow down water flowing overland, often capturing its sediment load before it can enter a lake or stream. In watersheds with a significant proportion of forest cover, the erosive force of spring snow melts is reduced as snow in forests melts later than snow on open land, and melt water flowing into streams is more evenly distributed. Shoreland trees grow, mature, and eventually fall into lakes where they protect shorelines from erosion, and are an important source of nutrients, minerals and wildlife habitat.

PROTECTING AGAINST INVASION OF INVASIVE SPECIES

In addition to removing essential habitat for fish and wildlife, clearing native plants from shorelines and shallow waters can open up opportunities for invasive species to take over. Like tilling a home garden to prepare it for seeding, clearing shoreland plants exposes bare earth and removes the existing competition (the cleared shoreland plants) from the area. Nature fills a vacuum. While the same native shoreland plants may recover and reclaim their old space, many invasive species possess "weedy" traits that enable them to quickly take advantage of new territory and out-compete natives.

The act of weeding creates continual disturbance, which in turn benefits plants that behave like weeds. The modern day practice of mowing lawns is an example of keeping an ecosystem in a constant state of disturbance to the benefit of invasive species like turf grass, dandelions, and clover, all native to Europe. Keeping shoreline intact is a good way to minimize disturbance and minimize opportunities for invasive species to gain a foothold.

THREATS TO SHORELANDS

When a landowner develops a waterfront lot, many changes may take place including the addition of driveways, houses, boat houses, decks, garages, sheds, piers, rafts and other structures, wells, septic systems, lawns, sandy beaches and more. Many of these changes result in the compaction of soil and the removal of trees and native plants, as well as the addition of impervious (hard) surfaces, all of which alter the path that precipitation takes to the water.

Building too close to the water, removing shoreland plants, and covering too much of a lake shore lot with hard surfaces (such as roofs and driveways) can harm important habitat for fish and wildlife, send more nutrient and sediment runoff into the lake, and cause water quality decline (Figure 32).

Figure 32: New lakeside development, same site (2016-left); (2018-right)

Changing one waterfront lot in this fashion may not result in a measurable change in the quality of the lake or stream. But cumulative effects when several or many lots are developed in a similar way can be enormous. A lake's response to stress depends on what condition the system is in to begin with, but bit by bit, the cumulative effects of tens of thousands of waterfront property owners "cleaning up" their shorelines, are destroying the shorelands that protect their lakes. Increasing shoreline development and development throughout the lake's watershed can have undesired cumulative effects.

SHORELAND PRESERVATION AND RESTORATION

If a native buffer of shoreland plants exists on a given property, it can be preserved and care taken to minimize impacts when future lake property projects are contemplated. If a shoreline has been altered, it can be restored. Shoreline restoration involves recreating buffer zones of natural plants and trees. Not only do quality wild shorelines create higher property values, but they bring many other values too. Some of these are aesthetic in nature, while others are essential to a healthy ecosystem. Healthy shorelines mean healthy fish populations, varied plant life, and the existence of the insects, invertebrates and amphibians which feed fish, birds, and other creatures. Figure 33 shows the difference between a natural and unnatural shoreline adjacent to a lake home. More information about healthy shorelines can be found at the following website: http://wisconsinlakes.org/index.php/shorelands-a-shallows (last accessed 1-12-2017).

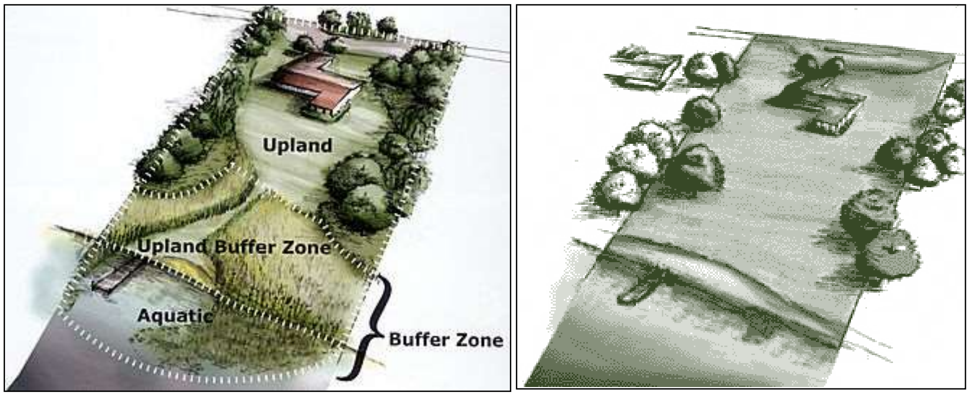


Figure 33: Healthy, AIS resistant shoreland (left) vs. shoreland in poor condition (right)

Much of the shoreline of Big Chetac, Birch, and Little Birch is natural however where development is greater, improvements to the shoreline would help maintain water quality in the lake. Turf grass, mowed lawns to the edge of the lake, exposed earth, and rip rap increase the amount of runoff from roof tops, driveways, lawns and pathways to the lake. The WDNR encourages the installation of relatively simple best management practices including rain gardens, native plantings, and runoff diversion projects through its Healthy Lakes Initiative. The BCABLA could sponsor some of these projects for individual property owners who are interested in improving their shorelines.

2017 SHORELAND HABITAT ASSESSMENT

As a part of the 2017-18 lake management planning project, a shoreland habitat assessment was completed on all three lakes. The protocol used in this survey was developed by the WDNR as a way to evaluate shoreline habitat. This survey is intended to provide management recommendations to individual property owners based on the evaluation of their property. This protocol involves photographing each parcel from the lake which is then matched to land use information about the riparian zone. For this survey, the riparian zone is defined as the strip of land, along the shore, from the high water level back 35 feet. The information collected includes ground cover which includes lawn, impervious surfaces, and native plants. Additional land use information includes the number of human structures in the riparian zone and various other runoff concerns.

During the assessment each property was given a priority ranking in terms of the projects that could be done and the benefits to the lake they could provide. The priority rankings that accompany each parcel evaluation were developed based on the parameters that were most prevalent on the lake. They help to determine the needs of the lake, and the individual properties assessed. The parameters used to determine priority were those that would contribute most significantly to stormwater runoff into the lake. This includes percentage of canopy cover; the percentage of undisturbed vegetation; a summed percentage of ground covered by manicured lawn, impervious surfaces, and easily eroded surfaces; the number of buildings present in the riparian zone; the presence or absence of trails to the lake; and lawns that sloped directly to the lake. For each factor that was considered, there are value ranges assigned to each parameter which determine the color to be assigned (red, yellow, or white). The value ranges can be seen in Table 10. Values that fall within the red range are worth 2 points, values in the yellow range are worth 1 point, and values in the white range are not given any points. The points are then summed and the properties prioritized based on the point range for the entire lake.

Table 10: Parameters used in the 2017 Big Chetac, Birch, and Little Birch lakes Shoreland Habitat Assessment

Parameter	Red range (2 points)	Yellow Range (1 Point)	White (No points)
Percent canopy cover	0-33%	34-66%	>66%
Percent shrub and herbaceous (undisturbed)	0-33%	34-66%	>66%
Percent lawn, impervious, and other surfaces	>66%	34-66%	0-33%
Number of buildings and other human structures	>1	1	0
Presence/ Absence of lawn mowed to shore	N/A	1 (Present)	0 (Absent)
Presence/Absence of bare soil or sand deposits	1 (Present)	N/A	0 (Absent)

LAKE-WIDE SUMMARY OF RESULTS

To establish priority rankings for each portion of the lakes, it was important to consider the entire lake. The maximum possible score was 11 points, and the highest scoring parcel came close with 10 points. From here, four levels of concern were established: red, orange, yellow, and white. These colors correspond to the priority of concern red properties are of high concern, orange are moderate, yellow is low, and white parcels are of almost no concern. Tables 11, 12, & 13 summarize the survey results for the northern section of Big Chetac Lake, southern section of Big Chetac Lake, and Birch and Little Birch Lakes.

Table 11: Score ranges and priority rankings for the 215 parcels surrounding the northern section of Big Chetac Lake

Color	Overall Score	Priority	Number of Parcels
Red	7-11 Points	High	18
Orange	5-6 Points	Moderate	13
Yellow	3-4 Points	Low	32
White	0-2 Points	No Concern	152

Table 12: Score ranges and priority rankings for the 216 parcels surrounding the southern section of Big Chetac Lake

Color	Overall Score	Priority	Number of Parcels
Red	7-11 Points	High	17
Orange	5-6 Points	Moderate	25
Yellow	3-4 Points	Low	16
White	0-2 Points	No Concern	158

Table 13: Score ranges and priority rankings for the 194 parcels surrounding Birch and Little Birch Lakes

Color	Overall Score	Priority	Number of Parcels
Red	7-11 Points	High	27
Orange	5-6 Points	Moderate	32
Yellow	3-4 Points	Low	18
White	0-2 Points	No Concern	117

PRIORITY RANKINGS BY PARCEL

Figures 34, 35, & 36 provide a broad overview of the parcel rankings for each section of the lakes. Included in the document that details the results of the Shoreland Habitat Assessment are the numbers used to determine the overall score for each individual parcel, as well as a photograph (where available) and management recommendations for each parcel. Photos are intended to provide reference for individual property owners. These have been matched to the correct properties as best as possible. It is important to note that while ranking each parcel ONLY the 35-ft along the shoreline was considered. The photos were not used to assess properties and can be misleading for certain parameters, particularly canopy cover. For example, some parcels appear mostly shaded, but only have 15% canopy cover. This is likely because the assessment only considered 35-ft back and the canopy cover started beyond that mark. Additionally, there are other considerations such as camera angle, time of day, etc. All evaluations were done in the field to prevent any misdirection that would have been caused by using photos to assess the properties.

In the Shoreland Habitat Assessment Project Report, management recommendations for each parcel are explained in more detail in the section following the ranking. Generally speaking, there are very few recommendations for properties scoring under 3 points, so these have been marked with no priority ranking. Many of the low priority parcels would benefit from native plantings along the shore to act as a buffer zone. The high and moderate priorities would do well with rain gardens, rock infiltrations near structures, as well as native plantings. These are all general patterns, but it is important to note that there is a good amount of variation between each parcel. To account for this, there are specific management recommendations for each parcel. The recommendations for each parcel are meant to give property owners an idea of some of inexpensive small scale projects that would best suit the needs of their property. The projects suggested come primarily from the WDNR's Healthy Lakes Initiative which means most of them are eligible for grant funding through the WDNR.

The protocol used in this survey only involves that area of shore for each parcel that is within 35-ft of the water's edge. It does not evaluate the condition of the entire lot. However, land use in a wider band around the lake was evaluated in 2019 and used to estimate runoff and nutrient loading from a larger "nearshore" area.

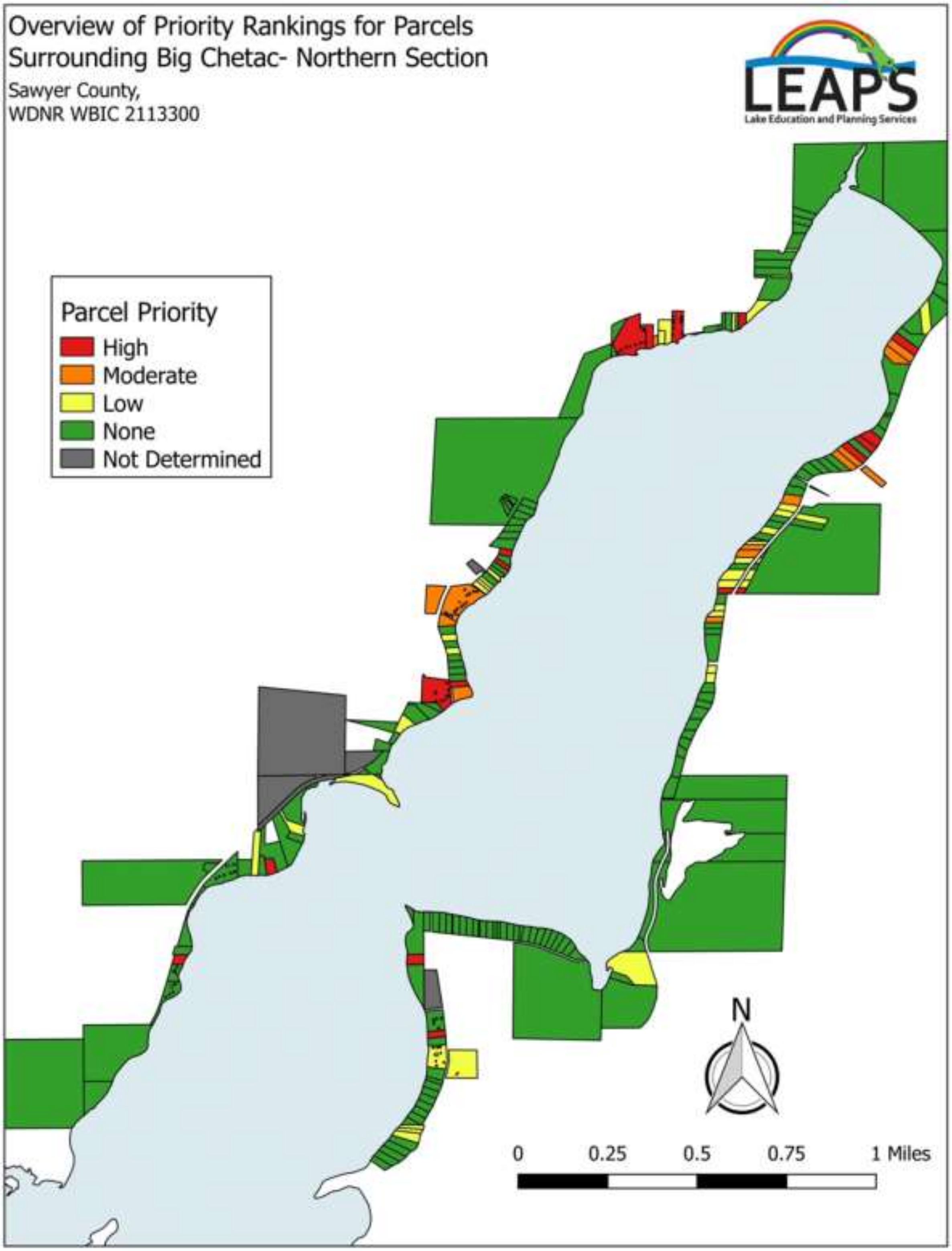


Figure 34: Parcel priority around the north half of Big Chetac Lake

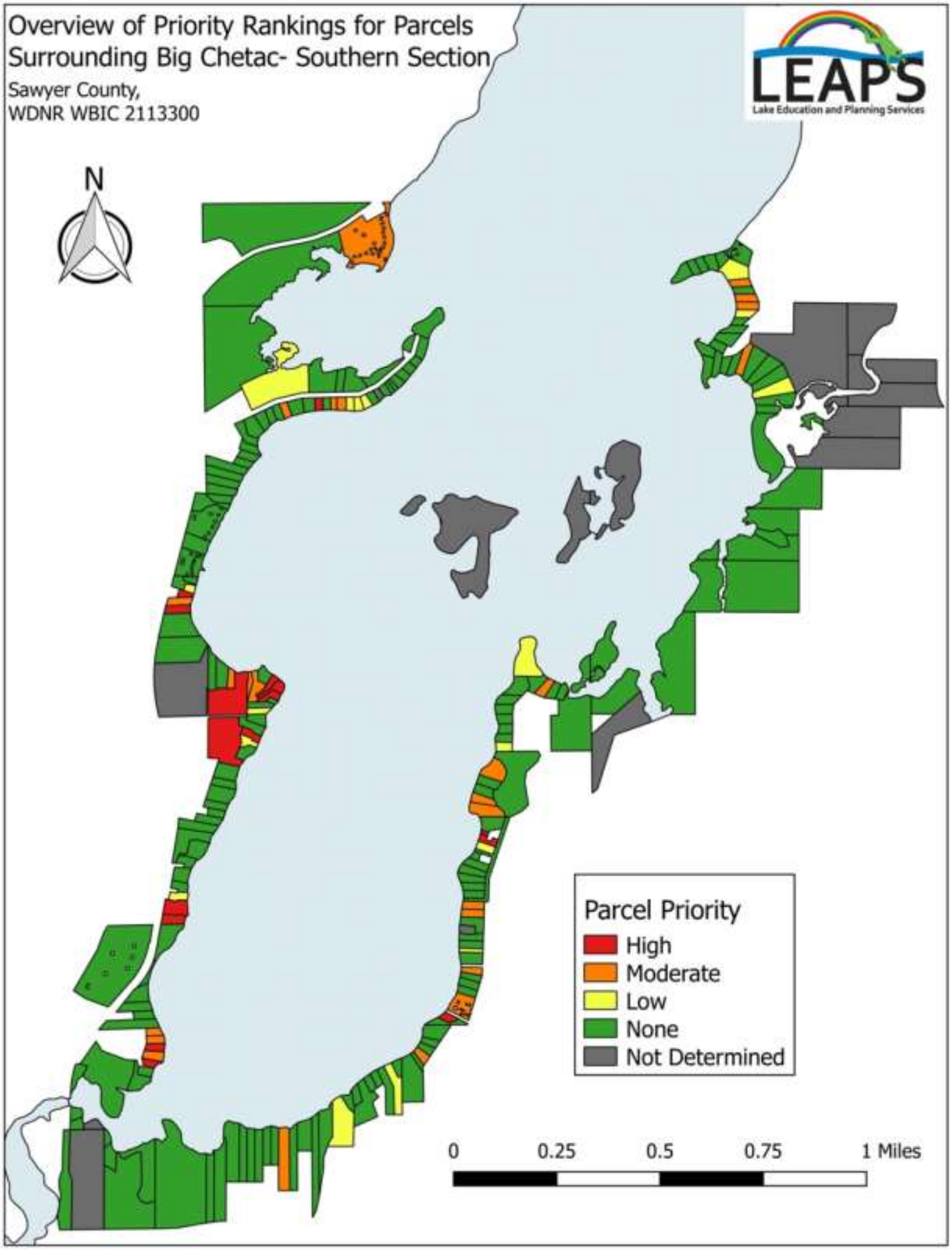


Figure 35: Parcel priority around the south half of Big Chetac Lake

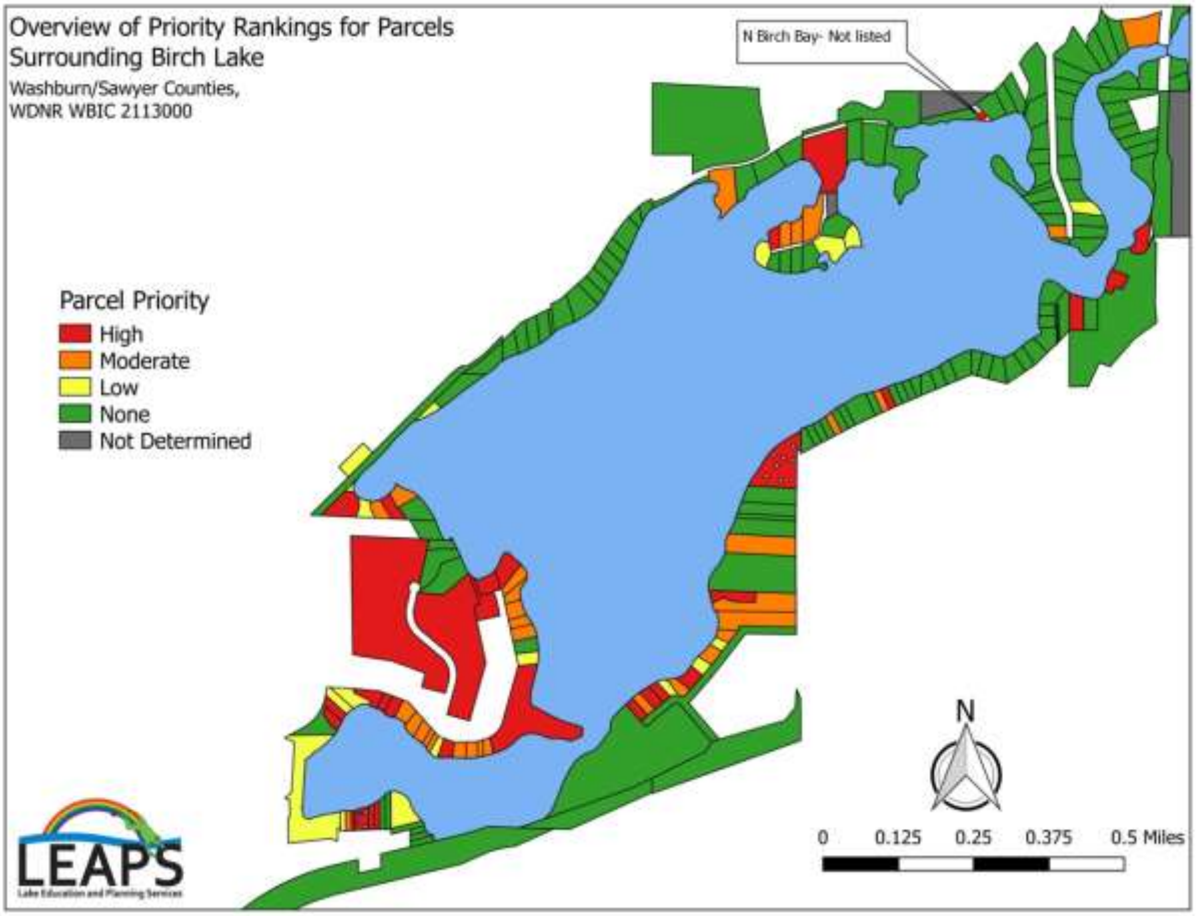


Figure 36: Parcel priority around Birch and Little Birch lakes

COARSE WOODY HABITAT IN BIG CHETAC, BIRCH, AND LITTLE BIRCH LAKES

Coarse woody habitat (CWH) in lakes is classified as trees, limbs, branches, roots, and wood fragments at least 4 inches in diameter that enter a lake by natural (beaver activity, toppling from ice, wind, or wave scouring) or human means (logging, intentional habitat improvement, flooding following dam construction). CWH in the littoral or near-shore zone serves many functions within a lake ecosystem including erosion control, as a carbon source, and as a surface for algal growth which is an important food base for aquatic macro invertebrates. Presence of CWH has also been shown to prevent suspension of sediments, thereby improving water clarity (Sass, 2009). CWH serves as important refuge, foraging, and spawning habitat for fish, aquatic invertebrates, turtles, birds, and other animals. The amount of littoral CWH occurring naturally in lakes is related to characteristics of riparian forests and likelihood of toppling. However, humans have also had a large impact on amounts of littoral CWH present in lakes through time. During the 1800's the amount of CWH in northern lakes was increased beyond natural levels as a result of logging practices (Sass, 2009). But time changes in the logging industry and forest composition along with increasing shoreline development have led to reductions in CWH present in many northern Wisconsin lakes.

CWH is often removed by shoreline residents to improve aesthetics or select recreational opportunities (swimming and boating). Jennings et al. (2003) found a negative relationship between lakeshore development and the amount of CWH in northern Wisconsin lakes. Similarly, Christensen et al. (1996) found a negative correlation between density of cabins and CWH present in Wisconsin and Michigan lakes. While it is difficult to make precise determinations of natural densities of CWH in lakes it is believed that the value is likely on the scale of hundreds of logs per mile. The positive impact of CWH on fish communities have been well documented by researchers, making the loss of these habitats a critical concern (Wolter, 2012).

The Shoreland Habitat Assessment referred to earlier also assessed the amount of CWH present in the lake. However this is done for the entire lake instead of for each individual parcel. For shoreland habitat assessment purposes, CWH is defined as wood (trees, stumps, logs, and brush) in no deeper than 2 feet of water that is at least 4 inches in diameter, at the widest point, and at least 5 feet long. CWH in the water provides habitat for fish, birds, and numerous other types of wildlife in addition to protecting from banks from erosion. Figure 37 shows all the locations in Big Chetac, Birch, and Little Birch lakes where CWH was identified. Birch and Little Birch Lakes had 54 points with CWH or approximately 7.5 points per mile of shoreline. Big Chetac (not including the islands) had 87 points with CWH or approximately 4.1 points per mile of shoreline, far from the estimates of 100's of locations per mile of shoreland in natural, undisturbed lakes.

While many points with CWH were identified during the survey, much of this consisted of a log or branch in the water (simple CWH) versus a whole tree with many branches and larger stumps or logs all intertwined (complex CWH). The greater the complexity of the CWH the more habitat it can provide for fish and other inhabitants of the lake. Larger trees can last for several hundred years in the water providing habitat for many creatures (Sass, 2009). WDNR Fisheries Managers have expressed their support for the construction of "Fishsticks" projects along the shores of the lakes. Fishsticks are fish structure created from whole trees cut and stacked on top of each other (Figure 38). Fishsticks are typically installed in the winter, anchored to the shore, and often weighted down to help woody material sink to the bottom during spring ice melt.

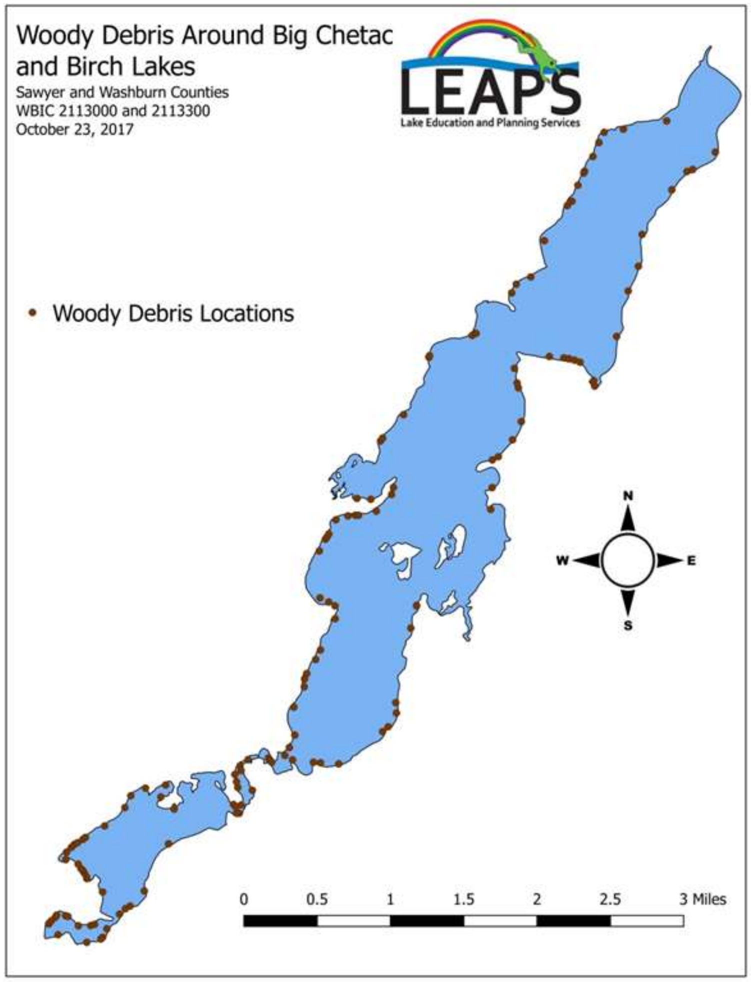


Figure 37: Woody habitat around Big Chetac, Birch and Little Birch lakes

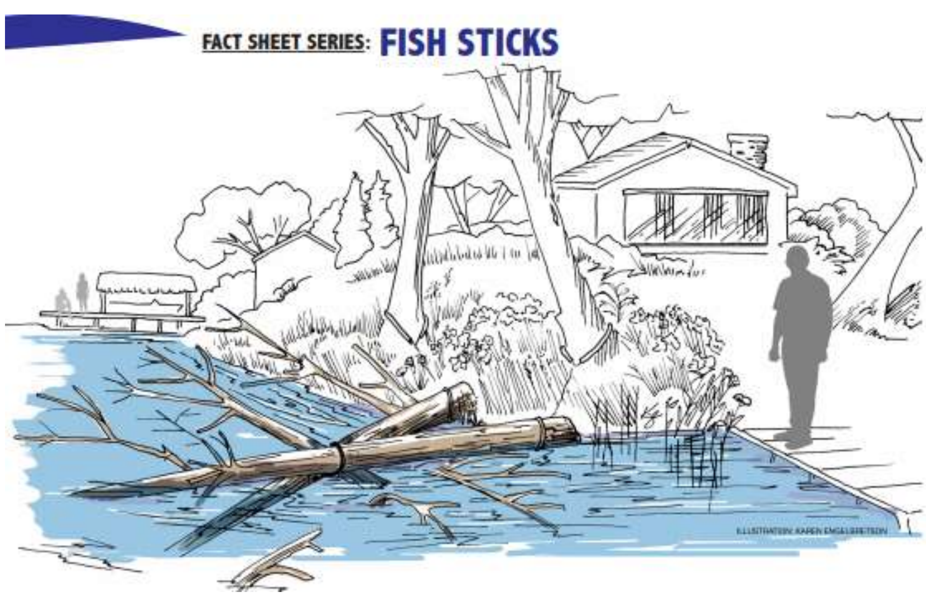


Figure 38: Healthy Lakes Fact Sheet Series: Fishsticks. WDNR/Wisconsin Lakes Partnership

FISHERIES (EXCERPTS FROM THE 2017 SURVEY REPORT BY MAX WOLTER, WDNR)

BIG CHETAC LAKE

The DNR's 2017 fish survey efforts on Big Chetac focused on walleye, but provided useful information on most other fish species as well. Both netting and electrofishing efforts included in this survey were well timed to capture target species. The results of this survey provide a lot of reasons to be optimistic about the future of the Lake Chetac fishery.

The WDNR conducted a fyke netting survey on Big Chetac in early April 2017 (immediately after ice out) to assess the adult walleye, northern pike, yellow perch and black crappie populations in the lake. Up to twelve nets were set overnight for five total nights which resulted in 56 total net-nights of effort. An electrofishing survey was conducted on June 6, 2017 documented the status of bluegill, smallmouth bass, largemouth bass, and non-game species and provided information on juvenile walleye. Six miles of shoreline were shocked.

Adult walleye appeared to be moderately abundant based on the netting portion of this survey. About one in five adult walleye are over the minimum length limit (18 inches). There is currently a very large year class of walleye between 12-15 inches. The best indication is that these are stocked fish from 2014 based on previous age and growth analysis of Big Chetac walleye. The electrofishing portion of the survey captured many walleye in the 12-15 inch range, but also many walleye between 6-9 inches. This smaller group of walleye is likely made up of fish from the fall 2016 stocking event. Both spring and fall surveys have demonstrated good early life survival of stocked fish in Lake Chetac relative to other lakes in the area. The prolonged lack of natural reproduction is still problematic and will hinder efforts to create a more dynamic walleye fishery, but stocking does appear to be a relatively effective tool for Big Chetac.

Northern pike were captured at a relatively low rate but demonstrated above average size compared to other lakes in the area. Big Chetac has been known as a big pike destination.

Abundance of largemouth bass declined slightly since the last survey in 2013 but size structure has improved slightly including a higher proportion now being over 14 inches. This was the desired outcome when the minimum length limit was removed in 2014. Smallmouth bass were more abundant in the 2017 survey than in past electrofishing surveys, though most smallmouth captured were less than 10 inches in length. The somewhat sudden increase in smallmouth abundance is of interest, but is not concerning.

Big Chetac is known as a panfish lake first and foremost and the 2017 survey contained good news for that group of fish. Bluegill abundance decreased since 2013, but size improved dramatically. In 2014, only 1.4% of bluegill in Big Chetac were over 8 inches. In 2017, 23% of bluegill were over 8 inches. The presence of many small walleye may be keeping bluegill abundance suppressed to some extent which could allow faster growth and better overall size.

Two distinct year classes of crappie appear to be present in Big Chetac, one around 9-11 inches and one around 5-6 inches. Few crappie were captured in between these two year classes. This kind of sporadic crappie recruitment, where big year classes pop up periodically and almost no crappie recruitment happens in between, is common.

Few yellow perch were captured as a part of the 2017 survey despite extremely high catch rates in the 2013 fish survey. This result leaves questions about whether timing of the 2017 survey was suitable for capturing a representative sample of the Big Chetac perch population.

Bowfin are a native species to Big Chetac and other lakes at the headwaters of the Red Cedar River drainage. Most bowfin in Big Chetac are between 20-30 inches long. Bowfin are looked upon negatively by many anglers, but their poor reputation is likely not deserved. While bowfin are not considered good table fare, they put up an excellent fight and are a unique component of the fishery in Lake Chetac. Few other lakes in the Hayward area have bowfin populations.

BIRCH LAKE

Currently, there is very little fisheries data available for Birch Lake. However, a WDNR electrofishing survey for gamefish and panfish is scheduled for the 2019 season. A walleye population estimate and a creel survey are planned in the near future. Since 1982, Birch Lake has been regularly stocked with walleye fingerlings, but this stocking ended in 2012. Given there is not much data available, it is however currently speculated that Birch Lake likely has more bass and panfish than Big Chetac which has more walleye (Personal Communication with Max Wolter, WDNR Fisheries Biologist, February 19, 2018).

FISHERIES CONTROVERSY

Birchwood, WI which is the closest community to the Big Chetac, Birch, and Little Birch Lakes system, is known as the Bluegill Capital of Wisconsin, primarily because of what has been and still is considered to be a strong panfish fishery. A few years back, a 10 bluegill limit was put in place on the system. The number of crappies, pumpkinseed, and perch that can be caught on the system all follow regular fishing regulations (25 fish, but only 10 can be bluegills) (Figure 34). Limiting bluegill was an effort to preserve and improve that fishery in the lake, and according to WDNR fisheries survey results presented previously in this document, the population is in good shape, although the number of smaller fish is less than previous surveys. WDNR fisheries biologists point to the number of walleye in the system as one of the major contributing factors to the lower bluegill numbers, but also maintain that this is good for the population as it creates better growth rates and bigger fish.

In recent years, it has been the contention of many that the Big Chetac, Birch, and Little Birch lakes is being managed to promote a healthy walleye population. As mentioned, fisheries biologists contend that a healthy walleye population also promotes a healthy panfish population. Unfortunately, bass fishermen on the lakes contend that managing for walleyes hurts the bass population, and therefore management should be focused on bass. Since 2014, there has been no minimum size limit for either species of bass – largemouth or smallmouth, although a daily bag limit of 5 fish is in place (Figure 39).

In addition to the concerns related to which fish species the Big Chetac, Birch, and Little Birch lakes should be managed for, some people believe that the system is being managed solely for recreational activities other than fishing, mainly activities that involve full body immersion like swimming, skiing, and tubing, without regard to impacts on the fishery.

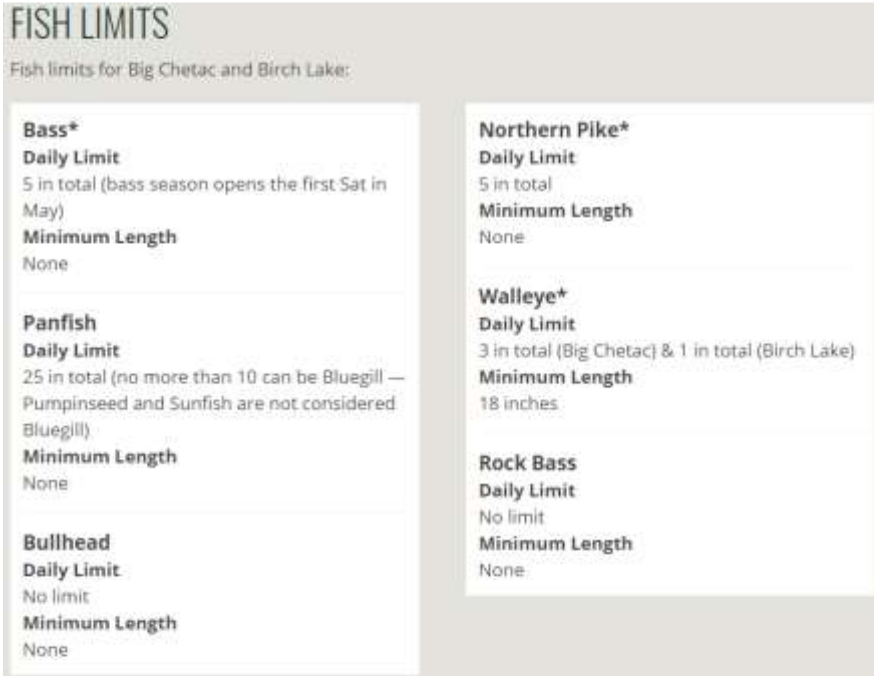


Figure 39: Fishing limits on Big Chetac and Birch lakes (Fred Thomas Resort)

In addition to the strife among different fish species enthusiasts, Big Chetac, Birch, and Little Birch lakes are regularly a part of Tribal walleye spearing. The average annual number of walleyes taken from the system through spearing over the last 22 years is 419 (Tribal spearing data provided by WDNR Fisheries Biologist Max Wolter).

A great deal of time was spent in trying to come up with a management recommendation for the fishery in Big Chetac, Birch, and Little Birch lakes. However, in the end it was decided that this lake management plan was not the place for what should be a separate "fisheries management" plan determined by stakeholders representing all the different fisheries expectations for the lakes. As such it is recommended that a Fisheries Committee be created by the BCABLA, to be made up of fishing enthusiasts from all species. The Fisheries Committee should work closely with WDNR and Tribal Resources to come up with a plan that considers many constituencies.

2017 LAKE USE AND FISHING SUCCESS SURVEY

The lake management planning grant awarded by the State to the BCABLA provided support for a Lake Use and Fishing Success Survey administered by several resorts around the lakes. The purpose of the survey was to collect data directly from clientele staying at the resorts. The survey asked resort clientele to provide certain details about their fishing experience while on the lake. Details included time spent on the water both fishing and doing non-fishing activities; identifying where on the lake participants spent their time fishing; the number of fish caught; the number of fish that were kept; and measuring the size of all fish kept. The survey asked anglers to identify the fish being caught and kept. It tracked bluegill, pumpkinseed, perch, crappie, largemouth and smallmouth bass, walleyes, and northern pike. Anglers were also asked to rate their time fishing and their success as excellent, good, average, poor, or terrible. Resort clientele were encouraged to file a daily report regardless of having a good or bad day of fishing.

The survey was a response to concerns that even though fisheries studies conducted by the WDNR suggest that fishing in the Big Chetac, Birch, and Little Birch lakes is in good shape, what people on the water are experiencing may not support that. During the survey which started with the 2017 May fishing opener and ended after Labor Day Weekend, nine different resorts participated in distributing and collecting surveys from their clientele. Fish Identification Cards were given to participants so they could tell the difference between bluegills and pumpkinseed/sunfish. Incentives including a pocket tape measure and WDNR yellow stick-on tape measure were offered to participants. While the numbers of surveys collected were not high, they do give a snapshot as to what people on the water were actually experiencing in 2017.

During the survey, 411 paper surveys were collected (Table 14). These 411 surveys represented 1,092 fishermen and nearly 2,500 fishing hours. Overall, 35% of respondents felt the fishing experience was good or excellent. Those having an average experience equaled 23%, leaving 42% with a poor or terrible fishing experience. Not everyone was fishing – 25% of respondents listed their primary use of the lake was doing something other than fishing. Of course that means 75% were fishing supporting ascertains that Big Chetac, Birch, and Little Birch lakes are still a major destination for fishermen.

Table 14: 2017 Fishing Success Survey results

Overall Lake Use 2017 Season		
What was your primary lake use?	Watersports	32
	Fishing	387
	Swimming	95
	Other	4
Hours Spent on water (Not fishing)		312.25
Marked map zones where activities took place	A	137
	B	239
	C	79
	D	123
Total People in Fishing Parties		1092
Hours of Fishing Time		2446.75
Average Fishing hours per Person		2.24
Contacted by WDNR Creel Agent		15
Quality of fishing Experience	Excellent	27
	Good	96
	Average	83
	Poor	105
	Terrible	47
Surveys collected		411

A lot of fish were recorded during the survey. The number of fish and their size structure that was recorded during the survey are reflected in Tables 15 & 16. Both panfish and gamefish numbers were recorded.

Table 15: Fish caught and recorded during the 2017 Fishing Success Survey

Fisheries Data 2017 Season	
Panfish Totals	
Total Caught- Bluegills	3000
Total Kept	1249
Total Caught-Pumpkinseed	308
Total Kept	135
Total Caught- Perch	1343
Total Kept	439
Total Caught- Crappie	4607
Total Kept	2892
Gamefish Totals	
Total Caught- LM Bass	246
Total Kept	54
Total Caught- SM Bass	196
Total Kept	16
Total Caught- Walleyes	323
Total Kept	11
Total Caught- Northern	72
Total Kept	19

Table 16: Catch totals and sizes from the 2017 Fishing Success Survey

	Bluegills	Crappies	Perch
Total Caught	3000	4607	1343
Total Kept	1249	2892	439
Total Measured	1547	3389	743
>8 inches	31.40%		60.40%
>10 inches		31.50%	

	Walleyes	Northern	LM Bass
Total Caught	323	72	246
Total Kept	11	19	54
Total Measured	165	32	122
>12 inches			46.70%
>18 inches	10.90%		
>24 inches		9.40%	

This informal survey reflected some of what has been heard from local fishermen. There are walleyes present, but they are not very big; there are not enough northerns; and bass populations are changing. What the survey did not seem to corroborate is that there are no panfish in the lakes. 2017 was one of the best years for crappie fishing according to many of the resorts on the lake. Many of the bluegills caught by anglers participating in this survey were decent in size, but fishermen would like to catch more. Most fishing occurred in the Central Basin of Big Chetac Lake, followed by the North Basin, then Birch Lake, and then the South Basin of Big Chetac Lake (Figure 40).

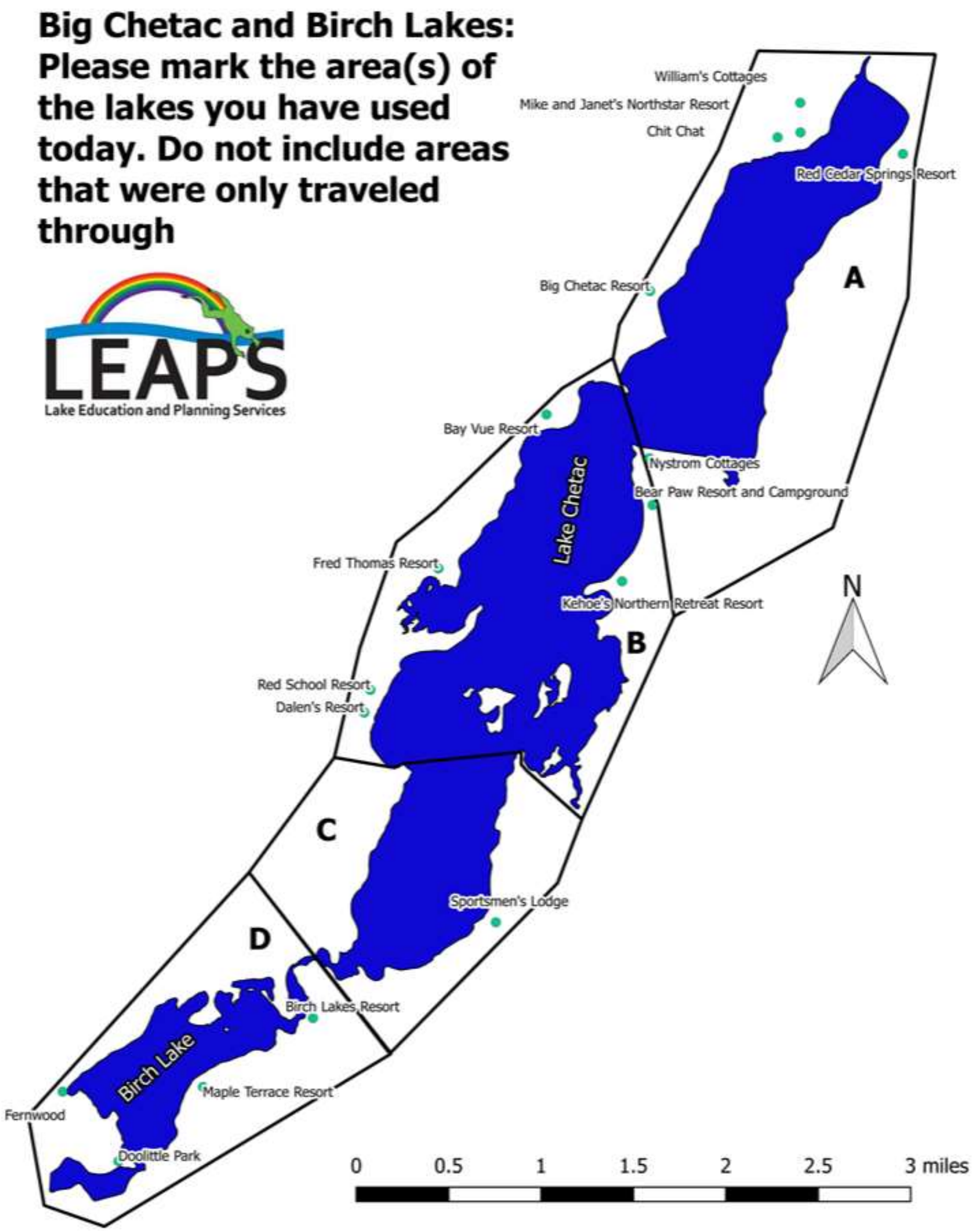


Figure 40: Fishing Success Survey basin map

2017-18 WDNR CREEL SURVEY

The WDNR completed a more formal Creel Survey on Big Chetac Lake (not including Birch) through the 2017-18 fishing season. A general creel survey synopsis is reflected in Table 17 from the Openwater and Ice Creel Report (Provided by Max Wolter, WDNR Fisheries Biologist August 2018).

Table 17: 2017 creel survey synopsis

OPENWATER AND ICE CREEL
2017-2018

CREEL SURVEY SYNOPSIS

MWBC: 2113300
LAKE: Lake Chetac
COUNTY: Sawyer
ACRES: 1,920

PROJECTED PRESSURE: 131,601 HOURS

HOURS/ACRE: 68.5

Species	Directed Effort (Hours)	(%)	Catch	Specific Catch Rate (Fish/Hour)	Harvest	Specific Harvest Rate (Fish/Hour)	Mean Length (inches)
Walleye	16,156	7.0%	8,398	0.3061	435	0.0179	19.7
Northern Pike	16,226	7.1%	3,407	0.1570	1,057	0.0567	25.4
Largemouth Bass	14,241	6.2%	6,871	0.2923	941	0.0360	13.8
Smallmouth Bass	9,148	4.0%	4,196	0.1604	585	0.0339	11.7
Bluegill	56,297	24.5%	84,650	1.3371	35,076	0.5684	7.9
Pumpkinseed	454	0.2%	640	0.1020	431	0.1020	6.9
Black Crappie	83,237	36.2%	102,938	1.2020	72,154	0.8440	9.8
Yellow Perch	34,159	14.9%	95,725	1.8425	34,482	0.7407	9.3
Rock Bass	*	0.0%	1,625	*	563	*	8.8
Black Bullhead	*	0.0%	87	*	19	*	13.8
Bowfin	*	0.0%	117	*	0	*	*
Brook Trout	*	0.0%	21	*	0	*	*

Due to a difference in methodology, a direct comparison of the catch and harvest numbers from the WDNR Creel Survey (DNR) and similar numbers from the Resort Owners Fishing Success Survey (LPL) cannot be made, however, it appears that results reflect similar outcomes (Table 18).

Table 18: Similar survey numbers from the WDNR Creel Survey and 2017 Fishing Success Survey

Fish Species	Survey	Total Caught	Total Kept	% Kept	Average Size (inches)
Walleye	DNR	8398	435	5.2	19.7
	LPL	323	11	3.4	>18" = 10.9%
Northern	DNR	3407	1057	31.0	25.4
	LPL	72	19	26.4	>24" = 9.4%
L. Bass	DNR	6871	941	13.7	13.8
	LPL	246	54	22.0	>12" = 46.7%
S. Bass	DNR	4196	585	13.9	11.7
	LPL	196	16	8.2	
Bluegill	DNR	84650	35076	41.4	7.9
	LPL	3000	1249	41.6	>8" = 31.4%
Pumpkinseed	DNR	640	431	67.3	6.9
	LPL	308	135	43.8	
Crappie	DNR	102938	72154	70.1	9.8
	LPL	4607	2892	62.8	>10" = 31.5%
Perch	DNR	95725	34482	36.0	9.3
	LPL	1343	439	32.7	>8" = 60.4%

WAVES AND WATERCRAFT

WAKE BOATS

Low-speed boating is a relatively new phenomenon on Wisconsin lakes. It involves watercraft specifically designed to be driven at slow speeds and to create large wakes for skiing, boarding, and surfing. Specialized "wake boats" are designed to increase wave height in the wake in a number of different ways. These specialized boats are often built with a hull shaped to achieve maximum wake, may have a hydrofoil device that lowers the stern of the boat when under power, and may have built in ballast tanks to increase weight in the back of the boat causing more water to be displaced and larger waves created. Not every boat has all of these features, but there are some that do.

The problem with increased wake height is related to the adverse effects that go along with large waves. The larger the wave, the deeper it can churn sediment in shallow water. The larger the wave, the more energy it delivers when it crashes against the shore exacerbating erosion along both natural and disturbed shorelines. The boats themselves are designed such that the propeller driving the boat is lower in the water, and often larger than on a normal boat, creating turbulence that can reach the bottom in as much as 10-ft of water again disturbing the lake bed and churning up sediments.

Whether it is propeller-induced or the result of boat-induced waves, sediment and nutrients can become re-suspended in the water column of the lake. Depending on how fine the sediment is, it could take up to 24-hrs. for sediment stirred up to settle back to the bottom of the lake. Sediment in suspension means nutrients like nitrogen and phosphorus can re-enter the lake ecosystem able to interact with the biotic community in the water column. The sediment itself can reduce water clarity, limited sunlight penetration which is vital for aquatic plant growth. Often times phosphorus re-suspended and now available in the water column can fuel rapid algae growth (blooms) which can contribute to further water clarity and quality issues.

The deeper the propeller, or if a boat is operating in shallow water, it can uproot or fragment aquatic vegetation, leading to the destruction of desirable aquatic plants or the spread of non-native invasive species like Eurasian watermilfoil (EWM) if present. Ballast tanks on some of these boats that help create the large wakes, are generally filled with lake water and the process of filling and emptying them into a lake or at the boat landing of another lake can spread other aquatic invasive species like zebra mussel larvae that may live in the water (Keller, 2017).

MOTORIZED BOATING IN GENERAL

It is not just the "relatively new" phenomenon that is wake boats that can cause problems in lakes, motor boat use in general cause the same impacts. Large or small, fishing or other recreation, if driven in the wrong place.in the wrong way, or at the wrong time, drivers can cause lake issues with their watercraft. In a review of existing studies related to boats and how they affect lakes, (Apslund, 2000) concludes that boats in general have been shown to affect water clarity and can be a source of nutrients and algal growth in aquatic ecosystems, and that shallow lakes, and shallows parts of lakes and rivers, and channels connecting lakes are the most susceptible to impacts. In another part of the review, he concludes that waves or wakes produced by boats can influence shoreland erosion. River systems, channels connecting lakes, and small lakes are the most impacted. The type of shoreline also impacts how much these waves erode, with loosely consolidated, steep, un-vegetated banks being the most susceptible.

Apslund, 2000 further identifies some other impacts of boating, but these in general are less studied, and not as conclusive. Boats impact aquatic plants by direct cutting, scouring of sediments in shallow areas preventing aquatic plant growth, uprooting of plants, and increased wave activity. The effects of boating on the fishery is less studied and basically centers around disturbing fish from spawning nests, or in changing fish habitat (water clarity, sediment, aquatic plant beds, etc). Effects on wildlife are also little studied, but include temporary disturbance (waterfowl, birds of prey) and in some cases more permanent disturbance (loons and loon nesting).

In another part of the Apslund, 2000 study, personal watercraft (PWC) or jetskis are discussed. The conclusions drawn suggest that the issues caused by PWC are similar to those caused by boats in general. Noise and emissions, and how PWC are used by their riders are of generally more concern than the impacts on the ecosystem.

IMPACTS ON BIG CHETAC, BIRCH, AND LITTLE BIRCH LAKES

Both Big Chetac and Birch Lakes have characteristics that make the use of large wake boats (and other boats) somewhat problematic. Birch Lake is deep, with little shallow water, but is also quite small, so the wakes kicked up by these boats have more impact on the shorelines. Big Chetac Lake is much larger, so waves likely have less impact, but it is also much shallower with roughly 30% of the lakes surface area 10-ft or less in depth, so disturbances to the bottom sediments are much more common. In addition to the two lakes, there is the extended channel between Big Chetac and Birch Lakes, and a smaller channel from Birch Lake through Little Birch Lake to the public access and dam.

Related to this issue is what some lake constituents see as an increase in the amount of non-fishing recreational activities involving motorboats. These activities include but are not limited to wake boating, water-skiing, tubing, pontoon cruising, speed boating, and use of PWC.

Negative Impacts caused by boating in general (not just wake boats) can be minimized through education. Continuous boater reminders of the "no wake" areas of the lakes: channels between Big Chetac and Birch and between Birch and Little Birch; within 100-ft of the shore for boats and within 200-ft for PWC should be made. Regulating boat use is a much more complicated and controversial management issues and is not recommended in this management plan. However, voluntary limits placed on this type of boating activity should be encouraged.

Currently, there is a Town of Edgewater Ordinance that restricts water-skiing on Big Chetac Lake to between 11:00am and 5:00pm. The ordinance was put in place to create a "quiet time" on the lake that would be more conducive to fishing. It is recommended in this plan that this ordinance be reviewed and modified to included other recreational motor sports like wake boating and tubing, and to expand it to all three lakes and adopted by all three government organizations: Town of Edgewater, Town of Birchwood, and Village of Birchwood. It is further recommended that efforts to enforce the ordinance, or at least to make lake users aware of it, be reviewed and modified if a more effective awareness campaign can be developed. One idea would be to hire a Lake Educator to spend time on the lake in an educational, not authoritative role.

There currently exists two officially recognized (by Town ordinance) no wake areas on the lakes, other than the normal state regulations of no wake within in 100-ft of shore for boats, and 200-ft of shore for personal watercraft. These areas are the channel between the outlet of Big Chetac Lake and the inlet of Birch Lake; and in the narrows off the point between Birch and Little Birch lakes. In additional, there is at least one officially recognized hazard buoy in place on Birch Lake. Enforcement in these no wake areas can be implemented by the WDNR, Sawyer County Sheriff's Department, or the Birchwood Police Department.

Other than expanding the water-skiing ordinance to the entire lake system and clarifying what activities are included in the waterski ordinance, no other ordinances are recommended in this plan.

The main non-native aquatic plant species of most concern in Big Chetac, Birch, and Little Birch lakes is CLP. In 2008, dense growth CLP covered nearly 25% of the 2400-acre lake, contributing what in 2009 determined to approximately 15% of the total phosphorus load to the lakes when it decayed, second only to the large amount of internal loading going on in the lake. Chinese Mystery Snails and Purple Loosestrife are likely present in the system but no management beyond physical removal is planned for them. Eurasian watermilfoil (EWM) has not been identified in the system.

NON-NATIVE, AQUATIC INVASIVE PLANT SPECIES

CURLY-LEAF PONDWEED

CLP is an invasive aquatic perennial that is native to Eurasia, Africa, and Australia (Figure 38). It was accidentally introduced to United States waters in the mid-1880s by hobbyists who used it as an aquarium plant. The leaves are reddish-green, oblong, and about 3 inches long, with distinct wavy edges that are finely toothed. The stem of the plant is flat, reddish-brown and grows from 1 to 3 feet long. CLP is commonly found in alkaline and high nutrient waters, preferring soft substrate and shallow water depths. It tolerates low light and low water temperatures. It has been reported in all of the lower 48 states.

CLP spreads through burr-like winter buds (turions) (Figure 41), which are moved among waterways. These plants can also reproduce by seed, but this plays a relatively small role compared to the vegetative reproduction through turions. New plants form under the ice in winter, making curly-leaf pondweed one of the first nuisance aquatic plants to emerge in the spring. It becomes invasive in some areas because of its tolerance for low light and low water temperatures. These tolerances allow it to get a head start on and out-compete native plants in the spring. In mid-summer, when most aquatic plants are growing, CLP plants are dying off. Plant die-offs may result in a critical loss of dissolved oxygen. Furthermore, the decaying plants can increase nutrients which contribute to algal blooms, as well as create unpleasant stinking messes on beaches. CLP forms surface mats that interfere with aquatic recreation.

Figure 41: CLP Plants and Turions

EURASIAN WATERMILFOIL

EWM is a submersed aquatic plant native to Europe, Asia, and northern Africa (Figure 42). It is the only non-native milfoil in Wisconsin. Like the native milfoils, EWM has slender stems whorled by submersed feathery leaves and tiny flowers produced above the water surface. The flowers are located in the axils of the floral bracts, and are either four-petaled or without petals. The leaves are threadlike, typically uniform in diameter, and aggregated into a submersed terminal spike. The stem thickens below the inflorescence and doubles its width further down, often curving to lie parallel with the water surface. The fruits are four-jointed nut-like bodies. Without flowers or fruits, EWM is difficult to distinguish from Northern water milfoil. EWM has 9-21 pairs of leaflets per leaf, while Northern milfoil typically has 7-11 pairs of leaflets. Coontail is often mistaken for the milfoils, but does not have individual leaflets.

EWM grows best in fertile, fine-textured, inorganic sediments. In less productive lakes, it is restricted to areas of nutrient-rich sediments. It has a history of becoming dominant in eutrophic, nutrient-rich lakes, although this pattern is not universal. It is an opportunistic species that prefers highly disturbed lake beds, lakes receiving nitrogen and phosphorous-laden runoff, and heavily used lakes. Optimal growth occurs in alkaline systems with a high concentration of dissolved inorganic carbon. High water temperatures promote multiple periods of flowering and fragmentation.

Unlike many other plants, EWM does not rely on seed for reproduction. Its seeds germinate poorly under natural conditions. It reproduces by fragmentation, allowing it to disperse over long distances. The plant produces fragments after fruiting once or twice during the summer. These shoots may then be carried downstream by water currents or inadvertently picked up by boaters. EWM is readily dispersed by boats, motors, trailers, bilges, live wells, and bait buckets. It can stay alive for weeks if kept moist.

Once established in an aquatic community, milfoil reproduces from shoot fragments and stolons (runners that creep along the lake bed). As an opportunistic species, EWM is adapted for rapid growth early in spring. Stolons, lower stems, and roots persist over winter and store the carbohydrates that help milfoil claim the water column early in spring, photosynthesize, divide, and form a dense leaf canopy that shades out native aquatic plants. Its ability to spread rapidly by fragmentation and effectively block out sunlight needed for native plant growth often results in monotypic stands. Monotypic stands of EWM provide only a single habitat, and threaten the integrity of aquatic communities in a number of ways; for example, dense stands disrupt predator-prey relationships by fencing out larger fish, and reducing the number of nutrient-rich native plants available for waterfowl.

Dense stands of EWM also inhibit recreational uses like swimming, boating, and fishing. Some stands have been dense enough to obstruct industrial and power generation water intakes. The visual impact that greets the lake user on milfoil-dominated lakes is the flat yellow-green of matted vegetation, often prompting the perception that the lake is "infested" or "dead". Cycling of nutrients from sediments to the water column by EWM may lead to deteriorating water quality and algae blooms in infested lakes.

Figure 42: EWM

PURPLE LOOSESTRIFE

Purple loosestrife (Figure 43) is a perennial herb 3-7 feet tall with a dense bushy growth of 1-50 stems. The stems, which range from green to purple, die back each year. Showy flowers that vary from purple to magenta possess 5-6 petals aggregated into numerous long spikes, and bloom from August to September. Leaves are opposite, nearly linear, and attached to four-sided stems without stalks. It has a large, woody taproot with fibrous rhizomes that form a dense mat. By law, purple loosestrife is a nuisance species in Wisconsin. It is illegal to sell, distribute, or cultivate the plants or seeds, including any of its cultivars.

Purple loosestrife is a wetland herb that was introduced as a garden perennial from Europe during the 1800's. It is still promoted by some horticulturists for its beauty as a landscape plant, and by beekeepers for its nectar-producing capability. Currently, more than 20 states, including Wisconsin have laws prohibiting its importation or distribution because of its aggressively invasive characteristics. It has since extended its range to include most temperate parts of the United States and Canada. The plant's reproductive success across North America can be attributed to its wide tolerance of physical and chemical conditions characteristic of disturbed habitats, and its ability to reproduce prolifically by both seed dispersal and vegetative propagation. The absence of natural predators, like European species of herbivorous beetles that feed on the plant's roots and leaves, also contributes to its proliferation in North America.

Purple loosestrife was first detected in Wisconsin in the early 1930's, but remained uncommon until the 1970's. It is now widely dispersed in the state, and has been recorded in 70 of Wisconsin's 72 counties. Low densities in most areas of the state suggest that the plant is still in the pioneering stage of establishment. Areas of heaviest infestation are sections of the Wisconsin River, the extreme southeastern part of the state, and the Wolf and Fox River drainage systems.

This plant's optimal habitat includes marshes, stream margins, alluvial flood plains, sedge meadows, and wet prairies. It is tolerant of moist soil and shallow water sites such as pastures and meadows, although established plants can tolerate drier conditions. Purple loosestrife has also been planted in lawns and gardens, which is often how it has been introduced to many of our wetlands, lakes, and rivers.

Purple loosestrife can germinate successfully on substrates with a wide range of pH. Optimum substrates for growth are moist soils of neutral to slightly acidic pH, but it can exist in a wide range of soil types. Most seedling establishment occurs in late spring and early summer when temperatures are high.

Purple loosestrife spreads mainly by seed, but it can also spread vegetatively from root or stem segments. A single stalk can produce from 100,000 to 300,000 seeds per year. Seed survival is up to 60-70%, resulting in an extensive seed bank. Mature plants with up to 50 shoots grow over 2 meters high and produce more than two million seeds a year. Germination is restricted to open, wet soils and requires high temperatures, but seeds remain viable in the soil for many years. Even seeds submerged in water can live for approximately 20 months. Most of the seeds fall near the parent plant, but water, animals, boats, and humans can transport the seeds long distances. Vegetative spread through local perturbation is also characteristic of loosestrife; clipped, trampled, or buried stems of established plants may produce shoots and roots. Plants may be quite large and several years old before they begin flowering. It is often very difficult to locate non-flowering plants, so monitoring for new invasions should be done at the beginning of the flowering period in mid-summer.

Any sunny or partly shaded wetland is susceptible to purple loosestrife invasion. Vegetative disturbances such as water drawdown or exposed soil accelerate the process by providing ideal conditions for seed germination. Invasion usually begins with a few pioneering plants that build up a large seed bank in the soil for several years. When the right disturbance occurs, loosestrife can spread rapidly, eventually taking over the entire wetland. The plant can also make morphological adjustments to accommodate changes in the immediate environment; for example, a decrease in light level will trigger a change in leaf morphology. The plant's ability to adjust to a wide range of environmental conditions gives it a competitive advantage; coupled with its reproductive strategy, purple loosestrife tends to create monotypic stands that reduce biotic diversity.

Purple loosestrife displaces native wetland vegetation and degrades wildlife habitat. As native vegetation is displaced, rare plants are often the first species to disappear. Eventually, purple loosestrife can overrun wetlands thousands of acres in size, and almost entirely eliminate the open water habitat. The plant can also be detrimental to recreation by choking waterways.

Purple loosestrife may exist along the shores of or in ditches and wetlands around the system.

Figure 43: Purple Loosestrife

REED CANARY GRASS

Reed canary grass (Figure 44) is a large, coarse grass that reaches 2 to 9 feet in height. It has an erect, hairless stem with gradually tapering leaf blades 3 1/2 to 10 inches long and 1/4 to 3/4 inch in width. Blades are flat and have a rough texture on both surfaces. The lead ligule is membranous and long. The compact panicles are erect or slightly spreading (depending on the plant's reproductive stage), and range from 3 to 16 inches long with branches 2 to 12 inches in length. Single flowers occur in dense clusters in May to mid-June. They are green to purple at first and change to beige over time. This grass is one of the first to sprout in spring, and forms a thick rhizome system that dominates the subsurface soil. Seeds are shiny brown in color.

Both Eurasian and native ecotypes of reed canary grass are thought to exist in the U.S. The Eurasian variety is considered more aggressive, but no reliable method exists to tell the ecotypes apart. It is believed that the vast majority of our reed canary grass is derived from the Eurasian ecotype. Agricultural cultivars of the grass are widely planted.

Reed canary grass is a cool-season, sod-forming, perennial wetland grass native to temperate regions of Europe, Asia, and North America. The Eurasian ecotype has been selected for its vigor and has been planted throughout the U.S. since the 1800's for forage and erosion control. It has become naturalized in much of the northern half of the U.S., and is still being planted on steep slopes and banks of ponds and created wetlands.

Reed canary grass can grow on dry soils in upland habitats and in the partial shade of oak woodlands, but does best on fertile, moist organic soils in full sun. This species can invade most types of wetlands, including marshes, wet prairies, sedge meadows, fens, stream banks, and seasonally wet areas; it also grows in disturbed areas such as bergs and spoil piles.

Reed canary grass reproduces by seed or creeping rhizomes. It spreads aggressively. The plant produces leaves and flower stalks for 5 to 7 weeks after germination in early spring and then spreads laterally. Growth peaks in mid-June and declines in mid-August. A second growth spurt occurs in the fall. The shoots collapse in mid to late summer, forming a dense, impenetrable mat of stems and leaves. The seeds ripen in late June and shatter when ripe. Seeds may be dispersed from one wetland to another by waterways, animals, humans, or machines.

This species prefers disturbed areas, but can easily move into native wetlands. Reed canary grass can invade a disturbed wetland in just a few years. Invasion is associated with disturbances including ditching of wetlands, stream channelization, and deforestation of swamp forests, sedimentation, and intentional planting. The difficulty of selective control makes reed canary grass invasion of particular concern. Over time, it forms large, monotypic stands that harbor few other plant species and are subsequently of little use to wildlife. Once established, reed canary grass dominates an area by building up a tremendous seed bank that can eventually erupt, germinate, and recolonize treated sites.

Despite only being recorded during the boat survey on Big Chetac Lake, Reed canary grass was often a dominant plant just beyond the lakeshore in adjacent wetlands and next to mowed or otherwise disturbed shoreline areas.

Figure 44: Reed Canary Grass

NON-NATIVE AQUATIC INVASIVE ANIMAL SPECIES

CHINESE MYSTERY SNAILS

The Chinese mystery snails and the banded mystery snails (Figure 45) are non-native snails that have been found in a number of Wisconsin lakes. There is not a lot yet known about these species, however, it appears that they have a negative effect on native snail populations. The mystery snail's large size and hard operculum (a trap door cover which protects the soft flesh inside), and their thick hard shell make them less edible by predators.

The female mystery snail gives birth to live crawling young. This may be an important factor in their spread as it only takes one impregnated snail to start a new population. Mystery snails thrive in silt and mud areas although they can be found in lesser numbers in areas with sand or rock substrates. They are found in lakes, ponds, irrigation ditches, and slower portions of streams and rivers. They are tolerant of pollution and often thrive in stagnant water areas. Mystery snails can be found in water depths of 0.5 to 5 meters (1.5 to 15 feet). They tend to reach their maximum population densities around 1-2 meters (3-6 feet) of water depth. Mystery snails do not eat plants. Instead, they feed on detritus and in lesser amounts on algae and phytoplankton. Thus removal of plants along the shoreline area will not reduce the abundance of mystery snails.

Lakes with high densities of mystery snails often see large die-offs of the snails. These die-offs are related to the lake's warming coupled with low oxygen (related to algal blooms). Mystery snails cannot tolerate low oxygen levels. High temperatures by themselves seem insufficient to kill the snails as the snails could move into deeper water.

One concern often voiced by lake residents is whether or not Chinese mystery snails are carriers of the swimmer's itch parasite. In theory they are potential carriers. However, because they are an introduced species and did not evolve as part of the lake ecosystem, they are less likely to harbor the swimmer's itch parasites.

Chinese mystery snails are present within the Big Chetac, Birch, and Little Birch lakes.

Figure 45: Chinese Mystery Snails

RUSTY CRAYFISH

Rusty crayfish (Figure 46) live in lakes, ponds and streams, preferring areas with rocks, logs and other debris in water bodies with clay, silt, sand or rocky bottoms. They typically inhabit permanent pools and fast moving streams of fresh, nutrient-rich water. Adults reach a maximum length of 4 inches. Males are larger than females upon maturity and both sexes have larger, heartier, claws than most native crayfish. Dark "rusty" spots are usually apparent on either side of the carapace, but are not always present in all populations. Claws are generally smooth, with grayish-green to reddish-brown coloration. Adults are opportunistic feeders, feeding upon aquatic plants, benthic invertebrates, detritus, juvenile fish and fish eggs.

The native range of the rusty crayfish includes Ohio, Tennessee, Kentucky, Indiana, Illinois and the entire Ohio River basin. However, this species may now be found in Michigan, Massachusetts, Missouri, Iowa, Minnesota, New York, New Jersey, Pennsylvania, Wisconsin, New Mexico and the entire New England state area (except Rhode Island). The Rusty crayfish has been a reported invader since at least the 1930's. Its further spread is of great concern since the prior areas of invasion have led to severe impacts on native flora and fauna. It is thought to have spread by means of released game fish bait and/or from aquarium release. Rusty crayfish are also raised for commercial and biological harvest.

Rusty crayfish reduce the amount and types of aquatic plants, invertebrate populations, and some fish populations--especially bluegill, smallmouth and largemouth bass, lake trout and walleye. They deprive native fish of their prey and cover and out-compete native crayfish. Rusty crayfish will also attack the feet of swimmers. On the positive side, rusty crayfish can be a food source for larger game fish and are commercially harvested for human consumption.

Rusty crayfish may be controlled by restoring predators like bass and sunfish populations. Preventing further introduction is important and may be accomplished by educating anglers, trappers, bait dealers and science teachers of their hazards. Use of chemical pesticides is an option, but does not target this species and will kill other aquatic organisms.

It is illegal to possess both live crayfish and angling equipment simultaneously on any inland Wisconsin water (except the Mississippi River). It is also illegal to release crayfish into a water of the state without a permit.

Rusty crayfish are known to be in the Red Cedar Chain of Lakes and in the Red Cedar River so could be in Big Chetac, Birch, and Little Birch lakes although they have not been documented.

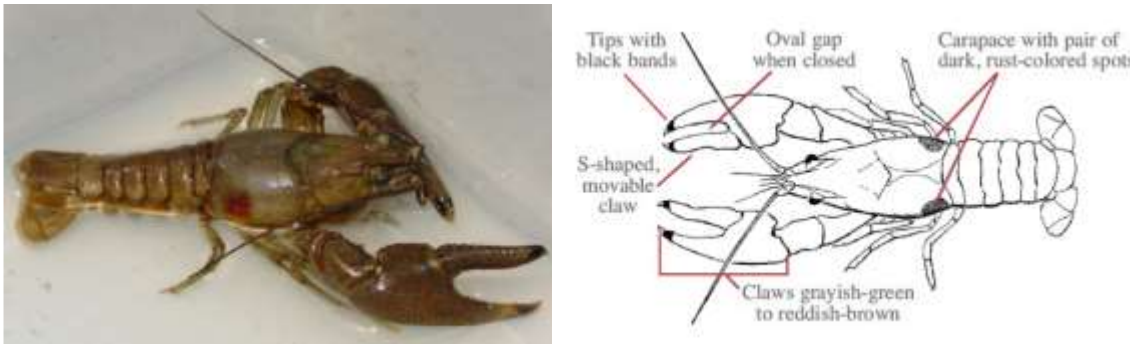


Figure 46: Rusty Crayfish and identifying characteristics

ZEBRA MUSSELS

Zebra mussels (Figure 47) are an invasive species that have inhabited Wisconsin waters and are displacing native species, disrupting ecosystems, and affecting citizens' livelihoods and quality of life. They hamper boating, swimming, fishing, hunting, hiking, and other recreation, and take an economic toll on commercial, agricultural, forestry, and aquacultural resources. The zebra mussel is a tiny (1/8-inch to 2-inch) bottom-dwelling clam native to Europe and Asia. Zebra mussels were introduced into the Great Lakes in 1985 or 1986, and have been spreading throughout them since that time. They were most likely brought to North America as larvae in ballast water of ships that traveled from fresh-water Eurasian ports to the Great Lakes. Zebra mussels look like small clams with a yellowish or brownish D-shaped shell, usually with alternating dark- and light-colored stripes. They can be up to two inches long, but most are under an inch. Zebra mussels usually grow in clusters containing numerous individuals.

Zebra mussels feed by drawing water into their bodies and filtering out most of the suspended microscopic plants, animals and debris for food. This process can lead to increased water clarity and a depleted food supply for other aquatic organisms, including fish. The higher light penetration fosters growth of rooted aquatic plants which creates more habitats for small fish, but may inhibit the larger, predatory fish from finding their food. This thicker plant growth can also interfere with boaters, anglers and swimmers. Zebra mussel infestations may also promote the growth of blue-green algae, since they avoid consuming this type of algae but not others.

Zebra mussels attach to the shells of native mussels in great masses, effectively smothering them. A survey by the Army Corps of Engineers in the East Channel of the Mississippi River at Prairie du Chien revealed a substantial reduction in the diversity and density of native mussels due to Zebra Mussel infestations. The East Channel provides habitat for one of the best mussel beds in the Upper Mississippi River. Future efforts are being considered to relocate such native mussel beds to waters that are less likely to be impacted by zebra mussels.

Once zebra mussels are established in a water body, very little can be done to control them. It is therefore crucial to take all possible measures to prevent their introduction in the first place. Some of the preventative and physical control measures include physical removal, industrial vacuums, and back flushing.

Chemical applications include solutions of chlorine, bromine, potassium permanganate and even oxygen deprivation. An ozonation process is under investigation (patented by Bollyky Associates Inc.) which involves the pumping of high concentrations of dissolved ozone into the intake of raw water pipes. This method only works in controlling veligers, and supposedly has little negative impacts on the ecosystem. Further research on effective industrial control measures that minimize negative impacts on ecosystem health is needed.

In the fall of 2016, zebra mussels were found in a northwest Wisconsin lake for the first time. With this discovery, it increases the likelihood that zebra mussels will spread faster throughout northwest Wisconsin. This could increase the risk to the Big Chetac, Birch, and Little Birch lakes if appropriate preventative measures are not taken. Lake user education, watercraft inspection, and AIS monitoring should continue to be done at the boat landings, both public (by the BCABLA) and private (in cooperation with the Resorts); and with lake property owners, lake users, and visitors to the lakes.

Figure 47: Zebra Mussels

AIS PREVENTION STRATEGY

CLP is currently the only AIS causing issues in Big Chetac, Birch, and Little Birch lakes. However there are many more that could be introduced to the lake, two of the most problematic would be Eurasian watermilfoil or the hybrid form of EWM (found in Rice Lake in June 2018) and zebra mussels. The BCABLA should continue to do watercraft inspection and have appropriate AIS signage at the access points. Both of these programs should follow UW-Extension Lakes and WDNR protocol through the Clean Boats, Clean Waters program and the Citizen Lake Monitoring Network AIS Monitoring program.

Additionally, educating and informing lake residents is the best way to keep non-native AIS at bay in the lakes. To foster this, the BCABLA could host and/or sponsor lake community events including AIS identification and management workshops, and distribute education and information materials to lake property owners and lake users through the newsletter, webpage, and general mailings.

WISCONSIN'S AQUATIC PLANT MANAGEMENT STRATEGY

The waters of Wisconsin belong to all people. Their management becomes a balancing act between the rights and demands of the public and those who own property on the water's edge. This legal tradition called the Public Trust Doctrine dates back hundreds of years in North America and thousands of years in Europe. Its basic philosophy with respect to the ownership of waters was adopted by the American colonies. The US Supreme Court has found that the people of each state hold the right to all their navigable waters for their common use, such as fishing, hunting, boating and the enjoyment of natural scenic beauty.

The Public Trust Doctrine is the driving force behind all management in Wisconsin lakes. Protecting and maintaining that resource for all of Wisconsin's people are at the top of the list in determining what is done and where. In addition to the Public Trust Doctrine, two other forces have converged that reflect Wisconsin's changing attitudes toward aquatic plants. One is a growing realization of the importance of a strong, diverse community of aquatic plants in a healthy lake ecosystem. The other is a growing concern over the spread of AIS, such as EWM. These two forces have been behind more recent changes in Wisconsin's aquatic plant management laws and the evolution of stronger support for the control of invasive plants.

The impacts of humans on Wisconsin's waters over the past five decades have caused public resource professionals in Wisconsin to evolve a certain philosophy toward aquatic plant management. This philosophy stems from the recognition that aquatic plants have value in the ecosystem, as well as from the awareness that, sometimes, excessive growth of aquatic plants can lessen our recreational opportunities and our aesthetic enjoyment of lakes. In balancing these, sometimes competing objectives, the Public Trust Doctrine requires that the State's public resource professionals be responsible for the management of fish and wildlife resources and their sustainable use to benefit all Wisconsin citizens. Aquatic plants are recognized as a natural resource to protect, manage, and use wisely.

Aquatic plant protection begins with human beings. We need to work to maintain good water quality and healthy native aquatic plant communities. The first step is to limit the amount of nutrients and sediment that enter the lake. There are other important ways to safeguard a lake's native aquatic plant community. They may include developing motor boat ordinances that prevent the destruction of native plant beds and reduce shoreline erosion and sediment disturbance caused by boat wakes, limiting aquatic plant removal activities, designating certain plant beds as critical habitat sites and preventing the spread of non-native, invasive plants, such as EWM.

If plant management is needed, it is usually in lakes that humans have significantly altered. If we discover how to live on lakes in harmony with natural environments and how to use aquatic plant management techniques that blend with natural processes rather than resist them, the forecast for healthy lake ecosystems looks bright. To assure no harm is done to the lake ecology, it is important that plant management is undertaken as part of a long range and holistic plan.

In many cases, the development of long-term, integrated aquatic plant management strategies to identify important plant communities and manage nuisance aquatic plants in lakes, ponds or rivers is required by the State of Wisconsin. To promote the long-term sustainability of our lakes, the State of Wisconsin endorses the development of APMPs and supports that work through various grant programs.

There are many techniques for the management of aquatic plants in Wisconsin. Often management may mean protecting desirable aquatic plants by selectively hand pulling the undesirable ones. Sometimes more intensive management may be needed such as using harvesting equipment, herbicides or biological control agents. These methods require permits and extensive planning. Often using an Integrated Pest Management (IPM) strategy that incorporates multiple management actions/alternatives works the best.

While limited management on individual properties is generally permitted, it is widely accepted that a lake will be much better off if plants are considered on a whole-lake scale. This is routinely accomplished by lake organizations or units of government charged with the stewardship of individual lakes.

AQUATIC PLANT MANAGEMENT ALTERNATIVES

Because CLP is still a large issue in Big Chetac, Birch, and Little Birch lakes, management of this species should still be considered, except perhaps not in the same ways it was managed in the past. There are also issues with nuisance native aquatic plants and mats of filamentous algae in some areas of the lakes that can be managed in a variety of ways in Wisconsin. The best management strategy will be different for each lake and will depend on which plant species needs to be controlled, how widespread the problem is, and the other plants and wildlife in the lake. In many cases, an integrated pest management (IPM) approach to aquatic plant management that utilizes a number of control methods is necessary. The eradication of non-native aquatic invasive plant species like CLP or EWM is generally not feasible, but preventing them from becoming a more significant problem is an attainable goal. It is important to remember however, that regardless of the plant species targeted for control, sometimes no manipulation of the aquatic plant community is the best management option. Plant management activities can be disruptive to a lake ecosystem and should not be done unless it can be shown they will be beneficial and occur with minimal negative ecological impacts.

Management alternatives for nuisance aquatic plants can be grouped into four broad categories: manual and mechanical removal, chemical application, biological control, and physical habitat alteration. Manual and mechanical removal methods include pulling, cutting, raking, harvesting, suction harvesting, and other means of removing the physical plant from the water and in most cases will require a WDNR permit. Chemical application is typified by the use of herbicides that kill or impede the growth of the aquatic plant and always requires a WDNR permit. Biological control methods include organisms that use the plant for a food source or parasitic organisms that use the plant as a host, killing or weakening it. Biological control may also include the use of species that compete successfully with the nuisance species for available resources. This activity may require a WDNR permit. Physical habitat alteration includes dredging, installing lake-bottom covers, manipulating light penetration, flooding, and drawdown. These activities may require permits under the WDNR waterways and wetlands program. It may also include making changes to or in the watershed of a body of water to reduce nutrients going in.

Each of the above control categories are regulated by the WDNR and most activities require a permit from the WDNR to implement. Mechanical harvesting of aquatic plants and under certain circumstances, physical removal of aquatic plants, is regulated under Wisconsin Administrative Rule NR 109. The use of chemicals and biological controls are regulated under Administrative Rule NR 107. Certain habitat-altering techniques like the installation of bottom covers and dredging require a Chapter 30/31 waterway protection permit. In addition, anytime wild rice is involved one or more of these permits will be required.

Informed decision-making on aquatic plant management implementation requires an understanding of plant management alternatives and how appropriate and acceptable each alternative is for a given lake. The following sections list scientifically recognized and approved alternatives for controlling aquatic vegetation.

NO MANAGEMENT

When evaluating the various management techniques, the assumption is erroneously made that doing nothing is environmentally neutral. In dealing with nonnative species like EWM, the environmental consequences of doing nothing may be high, possibly even higher than any of the effects of management techniques. Unmanaged, these species can have severe negative effects on water quality, native plant distribution, abundance and diversity, and the abundance and diversity of aquatic insects and fish (Madsen, 1997). Nonindigenous aquatic plants are the problem, and the management techniques are the collective solution. Nonnative plants are a biological pollutant that increases geometrically, a pollutant with a very long residence time and the potential to "biomagnify" in lakes, rivers, and wetlands (Madsen, 2000).

Foregoing any management of CLP in the Big Chetac, Birch, and Little Birch lakes is supported by a few, but in general some form of limited management is desired.

HAND-PULLING/MANUAL REMOVAL

Manual or physical removal of aquatic plants by means of a hand-held rake or cutting implement; or by pulling the plants from the lake bottom by hand is allowed by the WDNR without a permit per NR 109.06 Waivers under the following conditions:

- Removal of native plants is limited to a single area with a maximum width of no more than 30 feet measured along the shoreline provided that any piers, boatlifts, swim rafts and other recreational and water use devices are located within that 30-foot wide zone and may not be in a new area or additional to an area where plants are controlled by another method (Figure 48)
- Removal of nonnative or invasive aquatic plants as designated under s. NR 109.07 is performed in a manner that does not harm the native aquatic plant community
- Removal of dislodged aquatic plants that drift on-shore and accumulate along the waterfront is completed.
- The area of removal is not located in a sensitive area as defined by the department under s. NR 107.05 (3) (i) 1, or in an area known to contain threatened or endangered resources or floating bogs
- Removal does not interfere with the rights of other riparian owners
- If wild rice is involved, the procedures of s. NR 19.09 (1)) are followed.

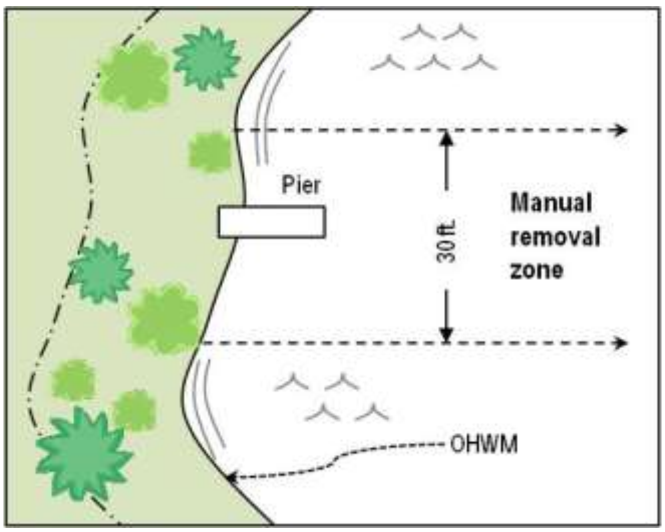


Figure 48: Aquatic vegetation manual removal zone

Although up to 30 feet of aquatic vegetation can be removed, removal should only be done to the extent necessary. There is no limit as to how far out into the lake the 30-ft zone can extend, however clearing large swaths of aquatic plants not only disrupts lake habitats, it also creates open areas for non-native species to establish. Physical removal of aquatic plants requires a permit if the removal area is located in a "sensitive" or critical habitat area previously designated by the WDNR. Manual or physical removal can be effective at controlling individual plants or small areas of plant growth. It limits disturbance to the lake bottom, is inexpensive, and can be practiced by many lake residents. In shallow, hard bottom areas of a lake, or where impacts to fish spawning habitat need to be minimized, this is the best form of control. If water clarity in a body of water is such that aquatic plants can be seen in deeper water, pulling AIS while snorkeling or scuba diving is also allowable without a permit according to the conditions in NR 106.06(2) and can be effective at slowing the spread of a new infestation (perhaps EWM) within a lake when done properly.

Larger-scale hand or diver removal projects have had positive impacts in temporarily reducing or controlling AIS. Typically hand or diver removal is used when AIS has been newly identified and still exists as single plants or isolated small beds. This does not pertain to the existing CLP population, but could be considered if a different aquatic invasive plant species were to be found in the lake.

DIVER ASSISTED SUCTION HARVESTING

Diver assisted suction harvesting or DASH, as it is often called, is a fairly recent aquatic plant removal technique. It is called "harvesting" rather than "dredging" because, although a specialized small-scale dredge is used, bottom sediment is not removed from the system. The operation involves hand-pulling of the target plants from the lake bed and inserting them into an underwater vacuum system that sucks up plants and their root systems taking them to the surface. It requires water pumps on the surface (generally on a pontoon system) to move a large volume of water to maintain adequate suction of materials that the divers are processing (Figure 49). Only clean water goes through the pump. The material placed by the divers into the suction hose along with the water is deposited into mesh bags on the surface with the water leaving through the holes in the bag. The bags have a large enough 'mesh' size so that silts, clay, leaves and other plant material being collected do not immediately clog them and block water movement. If a fish or other living marine life is sucked into the suction hose it comes out the discharge unharmed and is returned to the body of water. It can have some negative impacts to other nearby non-target plants if not done carefully, particularly those plants that are perennials and expand their populations by sub-sediment runners (Eichler, Bombard, Sutherland, & Boylen, 1993).

Figure 49: DASH Diver Assisted Suction Harvest (Aquacleaner Environmental, http://www.aquacleaner.com/index.html); Many Waters, LLC)

DASH is best suited for small beds of EWM that are relatively dense in order to minimize the by-catch. Since at present, EWM has not been found in the Big Chetac, Birch, and Little Birch lakes, and given the amount of CLP in the system, this management method is not recommended.

MECHANICAL REMOVAL

Mechanical management involves the use of devices not solely powered by human means to aid removal. This includes gas and electric motors, ATV's, boats, tractors, etc. Using these instruments to pull, cut, grind, or rotovate aquatic plants is illegal in Wisconsin without a permit. DASH is also considered mechanical removal. To implement mechanical removal of aquatic plants a Mechanical/Manual Aquatic Plant Control Application is required annually. The application is reviewed by the WDNR and other entities and a permit awarded if required criteria are met. Using repeated mechanical disturbance such as bottom rollers or sweepers can be effective at control in small areas, but in Wisconsin these devices are illegal and generally not permitted.

MECHANICAL HARVESTING

Mechanical harvesting is more traditionally used for control of CLP, but can be an effective way to reduce EWM biomass in a water body. It is typically used to open up channels through existing beds of EWM to improve access for both human related activities like boating, and natural activities like fish distribution and mobility on lakes in maintenance mode where EWM is well-established and restoration efforts have been discontinued.

Aquatic plant harvesters are floating machines that cut and remove vegetation from the water (Figure 50). The size and harvesting capabilities of these machines vary greatly. As they move, harvesters cut a swath of aquatic plants that is between 4 and 20 feet wide, and can be up to 10 feet deep. The on-board storage capacity of a harvester ranges from 100 to 1,000 cubic feet (by volume) or 1 to 8 tons (by weight). Most harvesters can cut between 2 and 8 acres of aquatic vegetation per day, and the average lifetime of a mechanical harvester is 10 years.

Figure 50: Aquatic Plant Harvester on Rice Lake, WI

Mechanical harvesting of aquatic plants presents both positive and negative consequences to any lake. Its results - open water and accessible boat lanes - are immediate, and can be enjoyed without the restrictions on lake use which follow herbicide treatments. In addition to the human use benefits, the clearing of thick aquatic plant beds may also increase the growth and survival of some fish. By eliminating the upper canopy, harvesting reduces the shading caused by aquatic plants. The nutrients stored in the plants are also removed from the lake, and the sedimentation that would normally occur as a result of the decay of this plant matter is prevented. Additionally, repeated harvesting may result in thinner, more scattered growth.

Aside from the obvious effort and expense of harvesting aquatic plants, there are many environmentally-detrimental consequences to consider. The removal of aquatic species during harvesting is non-selective. Native and invasive species alike are removed from the target area. This loss of plants results in a subsequent loss of the functions they perform, including sediment stabilization and wave absorption. Shoreline erosion may therefore increase. Other organisms such as fish, reptiles, and insects are often displaced or removed from the lake in the harvesting process. This may have adverse effects on the population of these organisms as well as the lake ecosystem as a whole.

Much like mowing a lawn, harvesting must be conducted numerous times throughout the growing season. Although the harvester collects most of the plants that it cuts, some plant fragments inevitably persist in the water. This may allow the invasive plant species to propagate and colonize in new, previously unaffected areas of the lake. Harvesting may also result in re-suspension of contaminated sediments and the excess nutrients they contain.

Disposal sites are a key component when considering the mechanical harvesting of aquatic plants. The sites must be on shore and upland to make sure the plants and their reproductive structures don't make their way back into the lake or to other lakes. The number of available disposal sites and their distance from the targeted harvesting areas will determine the efficiency of the operation, in terms of time as well as cost.

Timing is also important. The ideal time to harvest, in order to maximize the efficiency of the harvester, is just before the aquatic plants break the surface of the lake. For CLP, it should also be before the plants form turions (reproductive structures) to avoid spreading the turions within the lake. If the harvesting work is contracted, the equipment should be inspected before and after it enters the lake. Since these machines travel from lake to lake, they may carry plant fragments with them, and facilitate the spread of AIS from one body of water to another. There is at least one harvesting contractor available in northern Wisconsin, making this a definite management action to consider.

Using mechanical harvesting to open up areas in the lakes that often have navigation issues related to CLP early and dense growth native aquatic vegetation and algae later in the season is recommended for the Big Chetac, Birch, and Little Birch lakes. Should EWM ever be found in the lakes, this method of management should be re-evaluated because its use would likely do more to spread EWM around the lakes than effect control.

SMALL-SCALE CUTTING WITH REMOVAL

There are a wide range of small-scale mechanical harvesting techniques, most of which involve the use of boat mounted rakes, scythes, and electric cutters. As with all mechanical harvesting, removing the cut plants is required. Commercial rakes and cutters range in prices from $200 for rakes to around $3000 for electric cutters with a wide range of sizes and capacities. Cutters that are not entirely human powered require a permit for use.

Using a weed rake or cutter that is run by human power is allowed without a permit provided the cut material is taken out of the lake. If cutting or raking includes the use of any device that operates via motor, gas or electric, would require a permit. Dragging a bed spring or bar behind a boat, tractor or any other motorized vehicle to remove vegetation is also illegal without a permit. Although not truly considered mechanical management, incidental plant disruption by normal boat traffic is a legal method of management. Active use of an area is often one of the best ways for riparian owners to gain navigation relief near their docks. Most aquatic plants won't grow well in an area frequently disturbed for boating and swimming. It should be noted that purposefully navigating a boat to clear large areas is not only potentially illegal it can also re-suspend sediments, encourage AIS growth, and cause ecological disruptions, all things that are bad for a lake.

While small-scale cutting with or without the help of mechanical means can be done in Big Chetac, Birch, and Little Birch lakes, it would likely be at a very small level. If done according to the guidelines in physical removal, no permit is needed. If it is done with non-human powered mechanical assistance, a permit from the WDNR is required.

BOTTOM BARRIERS AND SHADING

Physical barriers, fabric or other, placed on the bottom of the lake to reduce aquatic plant growth would be more effective if there were only small areas of concern. Bottom barriers placed on the bottom of Big Chetac or Birch lake would provide only limited if any relief. If aquatic vegetation was an issue at the beach on Birch Lake a bottom barrier could help. Adding dye to the water with the purpose of shading out aquatic plant growth would not be effective due to the size of the lakes.

As the water gets greener in the summer months, shading is already causing a reduction in beneficial aquatic plant growth. Bottom barriers and shading are not recommended management actions for Big Chetac, Birch, and Little Birch lakes.

DREDGING

Dredging is the removal of bottom sediment from a lake. Its success is based on altering the target plant's environment. It is not usually performed solely for aquatic plant management but rather to restore lakes that have been filled in with sediment, have excess nutrients, inadequate pelagic and hypolimnetic zones, need deepening, or require removal of toxic substances (Peterson, 1982). In shallow lakes with excess plant growth, dredging can make areas of the lake too deep for plant growth. It can also remove significant plant root structures, seeds/turions, rhizomes, tubers, etc. In Collins Lake, New York the biomass of curly-leaf pondweed remained significantly lower than pre-dredging levels 10-yrs after dredging (Tobiessen, Swart, & Benjamin, 1992). Dredging is very expensive, requires disposal of sediments, and has major environmental impacts. It is not a selective procedure so it can't be used to target any one particular species with great success except under extenuating circumstances. Dredging at any level must be permitted by the WDNR if it is done through mechanical means. Manual dredging of up to 100 cubic feet for may be done without a permit by property owners if all criteria found in the WDNR's exemption checklist are met. It should not be performed for aquatic plant management alone. It is best used as a multipurpose lake remediation technique (Madsen, 2000).

Dredging is not a recommended management action for Big Chetac, Birch, or Little Birch lakes.

DRAWDOWN

Drawdown, like dredging, alters the plant environment by removing all water in a water body to a certain depth, exposing bottom sediments to seasonal changes including temperature and precipitation. A winter drawdown is a low cost and effective management tool for the long-term control of certain susceptible species of nuisance aquatic plants. Winter drawdown has been shown to be an effective control measure for EWM, but typically only provides 2-3 years of relief before EWM levels return to pre-drawdown levels. A winter drawdown controls susceptible aquatic plants by dewatering a portion of the lake bottom over the winter, and subsequently exposing vascular plants to the combined effect of freezing and desiccation (drying). The effectiveness of drawdown to control plants hinges on the combined effect of the freezing and drying. If freezing and dry conditions are not sustained for 4-6 weeks, the effectiveness of the drawdown may be diminished.

A huge amount of water would need to be drawn out of the system to affect any aquatic invasive species control, so is not recommended as a management action.

BIOLOGICAL CONTROL

Biological control involves using one plant, animal, or pathogen as a means to control a target species in the same environment. The goal of biological control is to weaken, reduce the spread, or eliminate the unwanted population so that native or more desirable populations can make a comeback. Care must be taken however, to insure that the control species does not become as big a problem as the one that is being controlled. A special permit is required in Wisconsin before any biological control measure can be introduced into a new area.

GALERUCELLA BEETLES

Two species of Galerucella beetles are currently approved for the control of purple loosestrife in Wisconsin (Figure 51). The entire lifecycle of Galerucella beetles is dependent on purple loosestrife. In the spring, adults emerge from the leaf litter below old loosestrife plants. The adults then begin to feed on the plant for several days until they begin to reproduce. Females lay their eggs on loosestrife leaves and stems. When the larvae emerge from these eggs they begin feeding on the leaves and developing shoots. When water levels are high these larvae will burrow into the loosestrife stems to pupate into adult beetles. These new adults emerge and begin feeding on the loosestrife again (Sebolt, 1998). Galerucella beetles do not forage on any plants other than purple loosestrife. Because of this the populations, once established, are self-regulating. When the purple loosestrife population drops off, the beetle population also declines. When the loosestrife returns, the beetle numbers will usually increase.

Figure 51: Galerucella Beetle

These beetles will not eradicate purple loosestrife entirely. This is true of almost all forms of biological control. Galerucella beetles will help regulate loosestrife which will allow native plants to also become established.

Beetles can be obtained from the WDNR or many of the public wetlands around Wisconsin. Because rearing these beetles requires the cultivation of a restricted species, a permit is necessary. Beetle rearing and release is only recommended for the Big Chetac, Birch, and Little Birch lakes if larger areas of purple loosestrife are identified on or around the system.

EWM WEEVILS

While many biological controls have been studied, only one has proven to be effective at controlling EWM under the right circumstances. Euhrychiopsis lecontei is an aquatic weevil native to Wisconsin that feeds on aquatic milfoils (Figure 52). Their host plant is typically northern watermilfoil; however they seem to prefer EWM when it is available. Milfoil weevils are typically present in low numbers wherever northern or Eurasian water milfoil is found. They often produce several generations in a given year and over winter in undisturbed shorelines around the lake. All aspects of the weevil's life cycle can affect the plant. Adults feed on the plant and lay their eggs. The eggs hatch and the larva feed on the plant. As the larva mature they eventually burrow into the stem of the plant. When they emerge as adults later, the hole left in the stem reduces buoyancy often causing the stem to collapse. The resulting interruption in the flow of carbohydrates to the root crowns reduces the plant's ability to store carbohydrates for over wintering reducing the health and vigor (Newman, Holmberg, Biesboer, & Penner, 1996).

Figure 52: EWM Weevil

The weevil is not a silver bullet. They do not work in all situations. The extent to which weevils exist naturally in a lake, adequate shore land over wintering habitat, the population of bluegills and sunfish in a system, and water quality characteristics are all factors that have been shown to affect the success rate of the weevil.

As there has been no EWM currently documented in the Big Chetac, Birch, and Little Birch lakes, the use of weevils is not recommended in this management plan.

OTHER BIOLOGICAL CONTROLS

There are other forms of biological control being used or researched. It was thought at one time that the introduction of plant eating carp could be successful. It has since been shown that these carp have a preference list for certain aquatic plants. EWM is very low on this preference list (Pine & Anderson, 1991). Use of "grass carp" as they are referred to in Wisconsin is illegal as there are many other environmental concerns including what happens once the target species is destroyed, removal of the carp from the system, impacts to other fish and aquatic plants, and preventing escapees into other lakes and rivers. Several pathogens or fungi are currently being researched that when introduced by themselves or in combination with herbicide application can effectively control EWM and lower the concentration of chemical used or the time of exposure necessary to kill the plant (Sorsa, Nordheim, & Andrews, 1988). None of these have currently been approved for use in Wisconsin and are not recommended for use in the Big Chetac, Birch, and Little Birch lakes.

CHEMICAL CONTROL

Aquatic herbicides are granules or liquid chemicals specifically formulated for use in water to kill plants or retard plant growth. Herbicides approved for aquatic use by the U.S. Environmental Protection Agency (EPA) are considered compatible with the aquatic environment when used according to label directions. Some individual states, including Wisconsin, also impose additional constraints on herbicide use.

The WDNR evaluates the benefits of using a particular chemical at a specific site vs. the risk to non-target organisms, including threatened or endangered species, and may stop or limit treatments to protect them. The WDNR frequently places conditions on a permit to require that a minimal amount of herbicide is needed and to reduce potential non-target effects, in accordance with best management practices for the species being controlled. For example, certain herbicide treatments are required by permit conditions to be in spring because they are more effective, require less herbicide and reduce harm to native plant species. Spring treatments also means that, in most cases, the herbicide will be degraded by the time peak recreation on the water starts.

The WDNR encourages minimal herbicide use by requiring a strategic Aquatic Plant Management (APM) Plan for management projects over 10 acres or 10% of the water body or any projects receiving state grants. WDNR also requires consideration of alternative management strategies and integrated management strategies on permit applications and in developing an APM plan, when funding invasive species prevention efforts, and by encouraging the use of best management practices when issuing a permit. The WDNR frequently supervises treatments; requires that adjacent landowners be notified of a treatment and given an opportunity to request a public meeting; requires that the water body is posted to notify the public of treatment and usage restrictions; and requires reporting after treatment occurs.

The advantages of using chemical herbicides for control of aquatic plant growth are the speed, ease and convenience of application; the relatively low cost; and the ability to somewhat selectively control particular plant types with certain herbicides. Disadvantages of using chemical herbicides include possible toxicity to aquatic animals or humans; oxygen depletion after plants die and decompose which can cause fishkills; a risk of increased algal blooms as nutrients are released into the water by the decaying plants; adverse effects on desirable aquatic plants; loss of fish habitat and food sources; water use restrictions; and a need to repeat treatments due to existing seed/turion banks and plant fragments. Chemical herbicide use can also create conditions favorable for non-native AIS to outcompete native plants (for example, areas of stressed native plants or devoid of plants).

When properly applied, the possible negative impacts of chemical herbicide use can be minimized. Early spring to early summer applications are preferred because exotic species are actively growing and many native plants are dormant, thus limiting the loss of desirable plant species; plant biomass is relatively low minimizing the impacts of de-oxygenation and contribution of organic matter to the sediments; fish spawning has ceased; and recreational use is generally low limiting human contact. The concentration and amount of herbicides can be reduced because colder water temperatures enhance the herbicidal effects. Selectivity of herbicides can be increased with careful selection of application rates and seasonal timing. Lake hydro-dynamics must also be considered; steep drop-offs, inflowing waters, lake currents and wind can dilute chemical herbicides or increase herbicide drift and off-target injury. This is an especially important consideration when using herbicides near environmentally sensitive areas or where there may be conflicts with other water uses in the treatment vicinity.

Although done less frequently, herbicides can be applied in the late fall when most native plants have begun to die on their own, or have already gone dormant for the season. Typically invasive plant species like EWM will continue to grow well into the fall. Timing of a fall application of herbicides can be such that few native plants are expected to be killed. In some bodies of water, particularly those where wild rice is present, it may be possible to treat later in the fall, having no effect on wild rice. Wild rice in the seedling stage below the surface of the water is very susceptible to herbicides including 2, 4-D, endothall, and others. In most cases, herbicides are not used where wild rice is present. But in some cases, where the presence of EWM is actually causing harm to the wild rice, fall treatments have been completed.

In some lakes, poor water clarity in the summer months may limit the growth of EWM. Later in the fall when the water begins to clear, EWM may get more of the light it needs to begin accelerated growth. The herbicide applied in the fall may be the same herbicide as applied in the spring and may be applied at the same concentration. One drawback is that the results of a fall treatment cannot be quantified until the next season.

HOW CHEMICAL CONTROL WORKS

Aquatic herbicides are sprayed directly onto floating or emergent aquatic plants or are applied to the water in either a liquid or granular form. Herbicides affect plants through either systemic or direct contact action. Systemic herbicides are capable of killing the entire plant. Contact herbicides cause the parts of the plant in contact with the herbicide to die back, leaving the roots alive and able to re-grow.

Herbicides can be classified as broad-spectrum (kill or injure a wide variety of plant species) or selective (effective on only certain species). Non-selective, broad spectrum herbicides will generally affect all plants that they come in contact with. Selective herbicides will affect only some plants. Often dicots, like Eurasian watermilfoil, will be affected by selective herbicides whereas monocots, such as common waterweed will not be affected. The selectivity of a particular herbicide can be influenced by the method, timing, formulation, and concentration used.

Sonar® whose active ingredient is fluridone, is a broad spectrum herbicide that interferes with the necessary processes in a plant that create the chlorophyll needed to turn sunlight into plant food through a process called photo-synthesis. Rodeo® whose active ingredient is glyphosate is another broad spectrum herbicide that prevents an aquatic plant from making the protein it needs to grow. As a result the treated plant stops growing and eventually dies.

2, 4-D and triclopyr are active ingredients in several selective herbicides including Navigate®, DMA 4®, and Renovate®. These herbicides stimulate plant cell growth causing them to rupture, but primarily in dicots. These herbicides are considered selective as they have little to no effect on monocots in treated areas. Fluridone, 2, 4-D, and triclopyr are all considered systemic. When applied to the treatment area, plants draw the herbicide in through the leaves, stems, and roots killing all of the plant, not just the part that comes in contact with the herbicide.

Research done with triclopyr in 2014 (Vassios, Nissen, Koschnick, & Heilman, 2014) suggests that there is a difference between how the target plant is affected when using liquid or granular formulations of triclopyr. In short, liquid applications of triclopyr tend to build up quicker in the meristem or growing tip of EWM, while granular applications tend to build up more in the root crown of EWM. The indication was that perhaps treating a body of water with both the granular and liquid formulation of the herbicide would affect a greater area of the plant providing better results than either formulation alone. This research was only completed using triclopyr, but it may have some application with 2,4-D as well, given that both herbicides affect the target plant in a similar way.

Aquathol® whose active ingredient is endothall; Reward® whose active ingredient is diquat; and Cutrine® whose active ingredient is a form of copper are considered broad spectrum contact herbicides. They destroy the outer cell membrane of the material they come in contact with and therefore kill a plant very quickly. None of these three are considered selective and have the potential to kill all of the plant material that they come in contact with regardless of the species. As such, great care should be taken when using these products. Certain plant species like curly-leaf pondweed begin growing very early in the spring, even under the ice, and are often the only growing plant present at that time. This is a good time to use a contact herbicide like Aquathol, as few other plants would be impacted. Using these products later in the season, will kill all vegetation in contact with the herbicide and can provide substantial nuisance relief from a variety of aquatic plants.

It is possible to apply more than one herbicide at a time when trying to establish control of unwanted aquatic vegetation. An example would be controlling EWM and CLP at the same time with an early season application, and controlling aquatic plants and algae at the same time during a mid-season nuisance relief application. Applying systemic and contact herbicides together has a synergistic effect leading to increased selectivity and control. Single applications of the two could result in reduced environmental loading of herbicides and monetary savings via a reduction in the overall amount of herbicide used and of the manpower and number of application periods required to complete the treatment.

EFFICACY OF AQUATIC HERBICIDES

The efficacy of aquatic herbicides is dependent on both application concentration and exposure time, and these factors are influenced by two separate but interconnected processes - dissipation and degradation. Dissipation is the physical movement of the active herbicide within the water column both vertically and horizontally. Dissipation rates are affected by wind, water flow, treatment area relative to untreated area, and water depths. Degradation is the physical breakdown of the herbicide into inert components. Depending on the herbicide utilized, degradation occurs over time either through microbial or photolytic processes.

MICRO AND SMALL-SCALE HERBICIDE APPLICATION

The determining factor in designating chemical treatments as micro or small-scale is the size of the area being treated. Small-scale herbicide application involves treating areas less than 10 acres in size. The dividing line between small-scale and micro treatments is not clearly defined, but is generally considered to be less than 3 acres. Small-scale chemical application is usually completed in the early season (April through May). Micro treatments are as well, but may be used as follow-up spot treatments after an early season application, or in instances where a new infestation has been identified in a lake with EWM already or a in a completely new lake. Recent research related to micro and small-scale herbicide application generally shows that these types of treatment are less effective than larger scale treatments due to rapid dilution and dispersion of the herbicide applied.

Some suggested ways to increase the effectiveness of this management strategy are to increase the concentration of herbicide used, use a contact herbicide like diquat that does not require as long a contact time to be effective, or in some manner contain the herbicide in the treated area by artificial means.

Pre- and post-treatment aquatic plant surveys and testing for herbicide residuals are not required by the WDNR for small-scale treatments. Nor is an approved APMP if the organization sponsoring the application is not using grant funding to help defer the costs. Even though not required by the WDNR, participating in these activities is recommended as it helps to gain a better understanding of the impact and fate of the chemical used.

LARGE-SCALE HERBICIDE APPLICATION

Large-scale herbicide application involves treating areas more than 10 acres in size. Like small-scale applications, this is usually completed in the early-season (April through May) for control of non-native invasive species like EWM and CLP while minimizing impacts on native species. It is generally accepted that lower concentration of herbicide can be used in large-scale applications as the likelihood of the herbicide staying in contact with the target plant for a longer time is greater. If the volume of water treated is more than 10% of the volume of the lake, or the treatment area is ≥160 acres, or 50% of the lakes littoral zone, effects can be expected at a whole-lake scale. Large-scale herbicide application can be extended in some lakes to include whole bay or even whole lake treatments. The size of the treatment area, the more contained the treatment area, and the depth of the water in the treatment area, are factors that impact how whole bay or whole lake treatments are implemented.

Pre- and post-treatment aquatic plant surveying and having an approved APMP are required by the WDNR when completing large-scale chemical treatments. Residual testing is not required by the WDNR, but highly recommended to gain a better understanding of the impact and fate of the chemical used.

PRE AND POST TREATMENT AQUATIC PLANT SURVEYING

When introducing new chemical treatments to lakes where the treatment size is greater than ten acres or greater than 10% of the lake littoral area and more than 150-ft from shore, the WDNR requires pre and post chemical application aquatic plant surveying. The protocol for pre and post treatment survey is applicable for chemical treatment of CLP and EWM.

The WDNR protocol assumes that an Aquatic Plant Management Plan has identified specific goals for non-native invasive species and native plants species. Such goals could include reducing coverage by a certain percent, reducing treatments to below large-scale application designations, and/or reducing density from one level to a lower level. A native plant goal might be to see no significant negative change in native plant diversity, distribution, or density. Results from pre and post treatment surveying are used to improve consistency in analysis and reporting, and in making the next season's management recommendations.

The number of pre and post treatment sampling points required is based on the size of the treatment area. Ten to twenty acres generally requires at least 100 sample points. Thirty to forty acres requires at least 120 to 160 sampling points. Areas larger than 40 acres may require as many as 200 to 400 sampling points. Regardless of the number of points, each designated point is sampled by rake, recording depth, substrate type, and the identity and density of each plant pulled out, native or invasive.

In the year prior to an actual treatment, the area to be treated must have a mid-season/summer/warm water point intercept survey completed that identifies the target plant and other plant species that are present. A pre-treatment aquatic plant survey is done in the year the herbicide is to be applied, prior to application to confirm the presence and level of growth of the target species. A post-treatment survey should be scheduled when native plants are well established, generally mid-July through mid-August. For the post-treatment survey, repeat the PI for all species in the treatment polygons, as was done the previous summer. For whole-lake scale treatments, a full lake-wide PI survey should be conducted.

CHEMICAL CONCENTRATION TESTING

Chemical concentration testing is often done in conjunction with treatment to track the fate of the chemical herbicide used. Testing is completed to determine if target concentrations are met, to see if the chemical moved outside its expected zone, and to determine if the chemical breaks down in the system as expected. Monitoring sites are located both within and outside of the treatment area, particularly in areas that may be sensitive to the herbicide used, where chemical drift may have adverse impacts, where movement of water or some other characteristic may impact the effect of the chemical, and where there may be impacts to drinking and irrigation water. Water samples are collected prior to treatment and for a period of hours and/or days following chemical application.

In some lakes, rhodamine dye is added to the herbicide at the time of application in amounts equal to the expected concentration of the herbicide and a fluorimeter is used to sample the dye as it moves around the system. Both systems for tracking the movement of the herbicide, concentration attained, and contact time maintained can be used effectively to help better current and future planning.

HERBICIDE USE IN THE BIG CHETAC, BIRCH, AND LITTLE BIRCH LAKES

The Big Chetac, Birch, and Little Birch lakes has an aquatic plant community that has been impacted by areas of dense growth CLP which have tended to shade out more desirable native aquatic plants later in the year. It was expressed in the 2010 LMP that control of large areas of CLP might increase the amount of beneficial native vegetation in the system via two mechanisms: 1) reducing competition between CLP and later growing native vegetation, and 2) improved water clarity due to nutrient reduction caused by less CLP biomass decaying in the bottom of the lake. It was expected that early season, cold-water CLP treatments would kill CLP before it created a large amount of biomass, in contrast to a huge biomass of CLP decaying in late June and early July after natural senescence. Three years of CLP treatment in the North Basin did show that competition with CLP could be reduced, however there was not enough native vegetation remaining in those areas previously dominated by CLP to provide much growth. Furthermore, water clarity and quality still quickly deteriorated after treatment, suggesting that until and unless other management actions to improve water clarity and water quality are done, the benefits to native aquatic vegetation from large-scale CLP control will be minimal.

For this reason, the use of aquatic herbicides, except in very limited areas where other forms of aquatic plant management cannot be implemented effectively, is not recommended in this five year plan. Should a new AIS like EWM be found in the Big Chetac, Birch, and Little Birch lakes, the use of aquatic herbicides in the system should be re-evaluated.

MANAGEMENT DISCUSSION

There is no question that some form of management is needed in Big Chetac, Birch, and Little Birch lakes. Water quality is still an issue for all three lakes; CLP is still abundant in the entire system; and the native aquatic plant community is still suffering from competition with dense growth CLP early in the season and a lack of water clarity later in the season. In the last three years (2015-2017), an increase in seasonal rainfall has done its part to flush out the system leaving better water quality in its wake, but depending on rain to improve water quality by itself is probably folly, particularly when dry summer drought conditions return, which at some point they will.

Although both Big Chetac and Birch Lake are connected drainage lakes that form the headwaters of the Red Cedar River, they are different types of lakes. Birch Lake is considered a Deep Lowland lake under the state's Natural Community Determinations. It has a maximum depth of 73-ft and a mean depth of 24-ft. Birch Lake is not listed as a Wisconsin impaired water (last reviewed in 2018), but receives almost all of its surface water input from Big Chetac Lake which is impaired.

Big Chetac Lake is considered a Shallow Lowland lake. It has a maximum depth of 28-ft and a mean depth of 14-ft. Big Chetac Lake was listed as an impaired water for total phosphorus in 2014. The 2018 assessments showed continued impairment by phosphorus with new total phosphorus and chlorophyll-a sample data exceeding the 2018 WisCALM listing thresholds for the Recreation use and Fish and Aquatic Life use.

Management planning began in the system in 2007 with the "Getting Rid of the Green" project sponsored by the BCABLA and funded by several WDNR lake management planning grants. At that time, nearly all data collection and analysis; management planning, and management implementation was focused on Big Chetac Lake, with little consideration given to Birch Lake. The thought at the time was that any management implemented with the goal of improving Big Chetac Lake, if successful, would trickle down and make improvements to Birch and Little Birch Lakes as well. At least from 2013-2015 when CLP management was occurring in Big Chetac Lake, this was not the case. No other significant management actions for aquatic plants or water quality have been implemented since 2015 in either lake.

BIRCH LAKE MANAGEMENT DISCUSSION

There is a surprising lack of information about Birch Lake. Until 2017, the aquatic plant community had not been evaluated. There continues to be an absence of water quality data simply because there is no regular volunteer working through the Citizen Lake Monitoring Network; and little is known about the water or nutrient budgets for the lake. What little data exists suggest that Birch Lake is acting as a phosphorus sink for large amounts of phosphorus coming into the lake from Big Chetac Lake. What isn't known is how much of the phosphorus in the lake is from Big Chetac and how much is from sources within (internal loading) and sources immediately adjacent to the lake (external). Dissolved Oxygen and Temperature profiles collected in 2017 indicate the lake is strongly stratified with no oxygen below about 4-meters (13-ft) from early July through fall turnover. Sampling of bottom waters in the deep hole of Birch Lake in July, August, and September 2017 showed high concentrations of TP and concomitant iron, but it is not known if there is enough available iron to rebind with phosphorus from within Birch Lake, much less with all the additional phosphorus brought in from Big Chetac Lake.

From 2013-2015 CLP was managed in the North basin of Big Chetac Lake, but nothing was done to manage CLP in Birch Lake. While the actual littoral (plant growing zone) in Birch and Little Birch Lakes is fairly small, it is mostly dominated by CLP early, and then has areas of dense growth native aquatic plants later in the season that interfere with riparian owner access to open water. Certain management goals, objectives, and actions in this plan do focus on Birch Lake, but it would be beneficial at some point to develop a water quality management plan just for Birch and Little Birch lakes based on more complete Birch and Little Birch lakes data. But until this is done, recognizing that Birch and Little Birch lakes are not just an extension of Big Chetac Lake and modifying management planning and implementation to accommodate their differences is a positive step.

BIG CHETAC LAKE MANAGEMENT DISCUSSION

Since Big Chetac Lake is where all management actions since 2010 (2013) were implemented, that is where most of the concerns related to past and future management impacts were focused. There are still those who believe that what was done from 2013-2015 to control CLP will forever change the makeup of Big Chetac Lake, despite evidence showing that Big Chetac is recovering. There is no question that previous management, particularly in 2013, had a greater impact than what was expected, and for that reason alone it should not be repeated without significant review and modification. Had the 2013 CLP management project done what it was supposed to do, or even failed to do much of anything, there would likely not be the backlash that accompanied management action both proposed and implemented, in the years that have followed. Many constituents, even those who benefitted from the management results from 2013-2015, still have concerns about future management. Many would like to see management continue, provided there is greater assurance that what is planned accomplishes what is expected, and that those expectations are clearly defined for the constituency.

With that underlying thought, any large-scale management action like large-scale chemical treatment of CLP or the application of alum to the system is not wholly recommended in this plan, unless stakeholders and constituents are at least in understanding of what is to be done and the expected impacts even if they do not entirely agree with it. What management planning and implementation in this plan aims to eliminate, is the vehement opposition to whatever is proposed.

Big Chetac Lake still has a great deal of early season CLP growth, and there are places where management to open up navigation lanes through dense growth CLP could benefit both lake users and property owners. Figures 53 & 54 reflect the spring/early summer CLP density in the three lakes. For Big Chetac Lake, the 2008 CLP map is used because it likely represents CLP at its most abundant. Spring/early summer CLP has only been mapped once (2017) in Birch and Little Birch lakes from 2017. Larger scale harvesting of CLP could, in part, make up the difference between wet and dry year phosphorus levels in both Big Chetac and Birch lakes. The red circles represent the areas of greatest CLP density that could be considered for future navigation lanes and/or nuisance relief harvesting. However, actual management planning would be based on property owner and lake user input and on-lake survey work prior to actual implementation of management actions.

Later in the season, limited harvesting could be used to open up navigation lanes through dense growth native aquatic vegetation in both lakes assuming it is causing navigation and access to open water issues for property owners and lake users, and are not areas of special interest due to wild rice. Figures 55 & 56 reflect the most recent whole-lake, summer PI data for both lakes. The red circles represent areas of greatest summer vegetation that could be considered for future management.

There is more support for harvesting operations to remove CLP and dense growth native aquatic vegetation than there is for the application of aquatic herbicides. Contracted harvesting is now readily available in NW Wisconsin, making it possible to implement harvesting even without the BCABLA owning harvesting equipment. Actual management proposals would be based on annual input from property owners on Big Chetac, Birch, and Little Birch lakes, and confirmation of nuisance and navigation issues via on-lake survey work prior to actual implementation would be completed.

No large-scale (>10-ac) CLP or native aquatic plant management using aquatic herbicides is recommended in this plan. However, small-scale (<10-ac) management using aquatic herbicides will be considered in areas that are not conducive to harvesting – meaning that there is some aspect of the proposed area that makes harvesting difficult or impossible (like the present of stumps and other underwater obstacles). If the use of aquatic herbicides is proposed, approval of property owners adjacent to the proposed treatment areas will be gained prior to submittal of a chemical application permit.

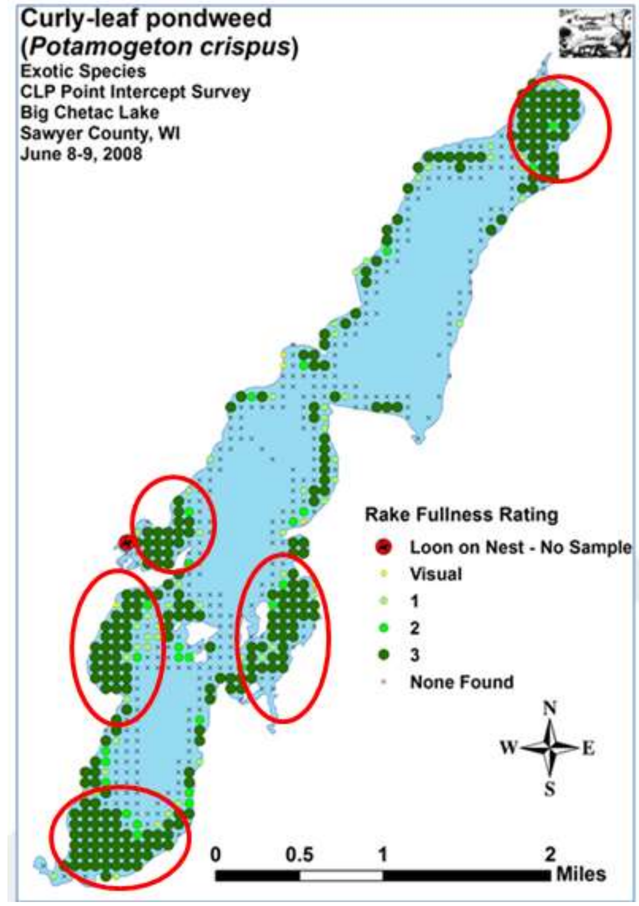


Figure 53: 2008 Spring CLP density in Big Chetac Lake

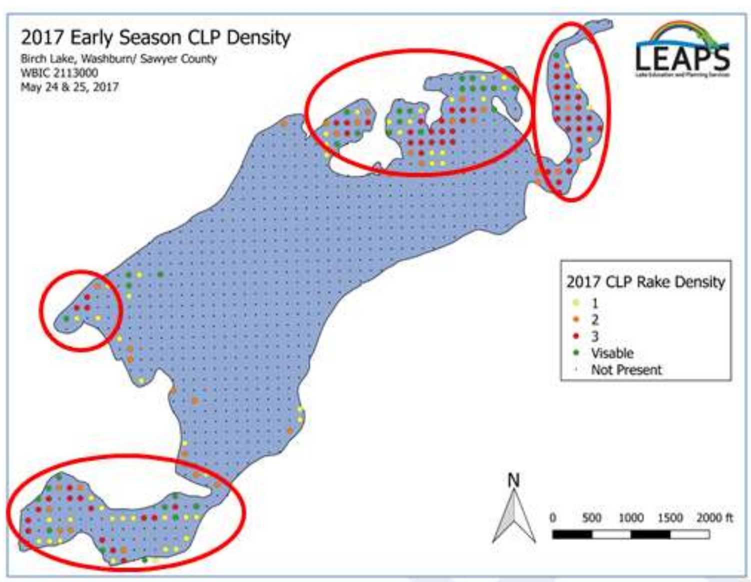


Figure 54: 2017 Spring CLP density in Birch and Little Birch Lakes

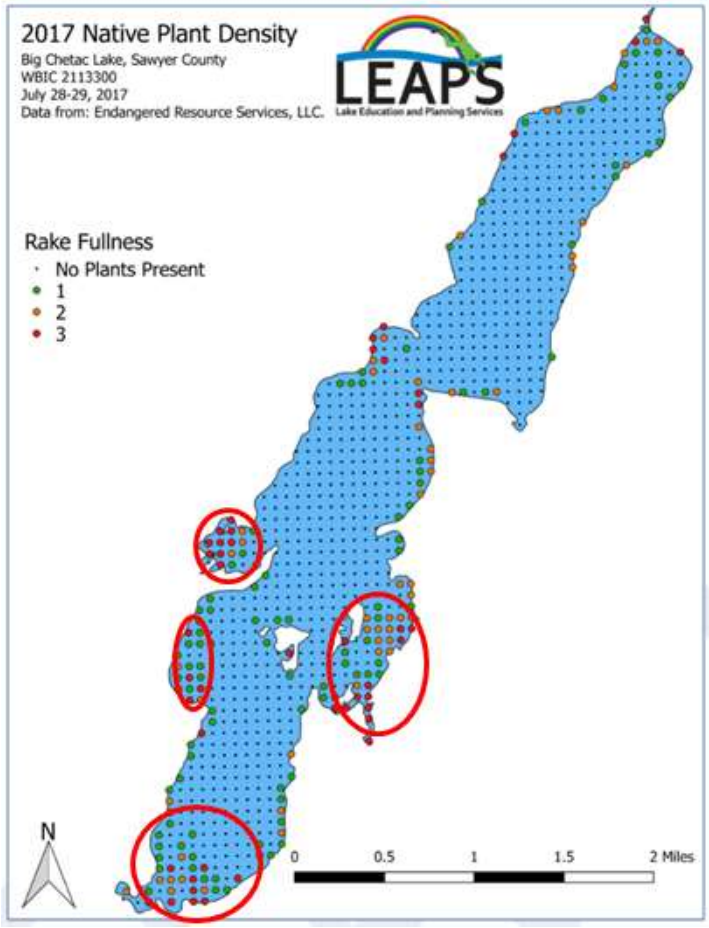


Figure 55: 2017 Summer aquatic plant density – Big Chetac Lake

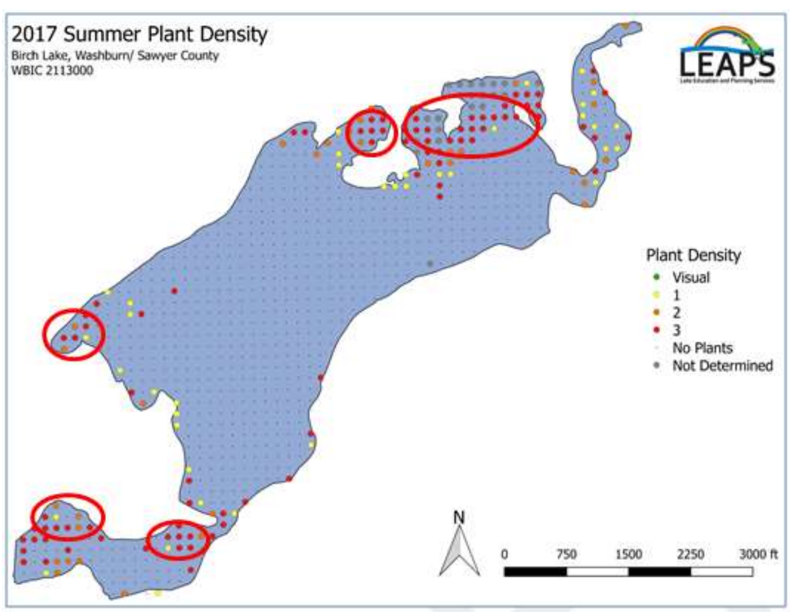


Figure 56: 2017 summer aquatic plant density – Birch and Little Birch Lakes

Water quality goals in this plan are generally centered on making the lakes more aesthetically appealing, but not changing the lakes into something they aren't. It is the opinion of some that improving water quality/water clarity by reducing external nutrient inputs and by implementing actions that could reduce the amount of internal nutrients impacting the lake will negatively impact the fishery in the lakes. As such any management actions need to balance making improvements while at the same time showing that the fishery is either not affected or is improved.

Since about 2015, water quality in the entire system has been more satisfactory (reflected in comments made during the interviews and in Stakeholder Committee discussions) due in large part to the amount of rainfall experienced in each year after and including 2015. Average seasonal (March-October) rainfall generally exceeded 25 inches in each year after and including 2015. In the four years prior to 2015, seasonal rainfall averaged just 13.65 inches. With this in mind, and taking into account measured parameters including total phosphorus and chlorophyll-a from the five best years out of the last ten (2007-2017), a target value for TP was determined to be 55-µg/L in Big Chetac Lake. This value is based on the average TP readings from each of those five years. If TP levels in the worst years can be brought down to this level, it will be even better during best years. The target value for Birch Lake is slightly lower at 47-µg/L.

WHOLE SYSTEM MANAGEMENT DISCUSSION

NEARSHORE AND WATERSHED BEST MANAGEMENT PRACTICES

The 2010 LMP's recommendations for best management practices along the shore and in the watershed were made as a means to involve more people in management actions to improve the lakes. While it is recognized that contributions to external nutrient loading from the nearshore area and larger watershed are minimal, it is still important to incorporate these management actions in the new plan. Changes in land use can be made in the nearshore area and in the larger watershed that will help reduce the overall phosphorus loading into the lakes.

One way to encourage property owners adjacent to the lakes to make changes in how their property affects the lake is to work through the WDNR Healthy Lakes Initiative to implement small projects including natives plantings adjacent to the lakes, rain gardens, runoff diversions, and infiltration trenches in the upland area, and Fishsticks fisheries improvement projects in the water near the shore. The Shoreland Habitat Assessment project completed in 2017 provides more in-depth information about how smaller projects can be implemented with or without grant assistance to make improvements in shoreland habitat and fisheries habitat. At the same time, native plant restoration projects adjacent to the lake, rain gardens in more upland areas, diversions of runoff from impervious surface away from the lake, and infiltration trenches can be used to reduce the amount of lawn and impervious surfaces further reducing runoff into the lakes that carry phosphorus and other pollutants. It would literally take hundreds of these smaller projects to affect any significant change, however every little bit helps, and it is a way to keep property owners involved in the protection of the lakes.

In the larger watershed, agricultural BMPs to reduce runoff can be implemented. Forestry practices can be monitored to ensure their minimal impact on water quality. Preserving and protecting undeveloped land and retiring active farmland will provide longer term benefits.

These practices by themselves will not necessarily meet all water quality goals, but the will reduce the extent of larger projects like CLP management and application of alum that may be considered long-term.

AQUATIC INVASIVE SPECIES

To date, problematic AIS including EWM and zebra mussels have not been identified in the Big Chetac, Birch, and Little Birch lakes. Implementing management actions to continue watercraft inspection through the Clean Boats Clean Waters program; to monitor the littoral (plant growing) zone and nearshore area for new AIS; and to provide education and information for constituents and lake users is important. Since 2016, zebra mussels have been found for the first time in a NW WI lake (Big McKenzie Lake, Washburn/Burnett Counties), and hybrid watermilfoil (similar to EWM) was found in Rice Lake downstream on the Red Cedar River. EWM is present in many lakes in NW

WI, including 9 lakes in Barron County, 13 lakes in Sawyer County, 5 lakes in Washburn County, and 5 lakes in Rusk County (WDNR AIS Lists, August 2018). Big Chetac, Birch, and Little Birch lakes are all at high risk of a new AIS being introduced.

LAKE USE

While not boiling to the surface, there is an undercurrent of concern related to recreational uses of the Big Chetac, Birch, and Little Birch lakes. Many believe that Big Chetac, Birch, and Little Birch lakes should primarily be fishing lakes and managed accordingly. Some of these people believe that efforts to improve water quality in the lakes is solely being done to make the lakes more appealing to activities like swimming, waterskiing, tubing, and more recently wake boarding that require full body immersion. During the interviews with resort owners, a question was asked about how clientele of the resorts use the lakes. All of the resort owners interviewed felt that fishing was the main use of lake, but they also felt that recreational uses including tubing, skiing, and swimming were increasing. Several also stated that quiet water sports like sight-seeing and kayaking remain important. There is a waterskiing ordinance in place on the lake that says waterskiing should only take place between 11:00am and 5:00pm. However, it was generally felt during the interviews that this ordinance has not been adequately enforced and should be expanded to include other recreational uses.

There is a general feeling that other state, county, and town rules and ordinances including no wake zones, power loading, overfishing, and AIS prevention rules including disposal of live bait and the "illegal to transport" rule are not being followed. Furthermore, adequate enforcement of these rules and ordinances is not being done. It is recommended that the BCABLA review and evaluate existing ordinances; and then make recommendations to the appropriate municipality for modifying existing ordinances, or making new ordinances if existing ordinances are inadequate, and consider hiring an annual lake educator or constable to work directly with lake users to promote practices that are good for the lake.

FISHERIES MANAGEMENT

As was previously mentioned in this plan, management recommendations regarding the fishery in the lakes are extremely difficult to determine. Other than the fact that most people do not want to see changes in the fishery that could be considered negative, there is no clear consensus yet established. There is great discussion still related to what kind of a fishery should be promoted and managed for in the lakes. Some want panfish (bluegills, pumpkinseed, crappie, and perch), some want walleye, some want bass, and still others want bigger and more numerous northern pike. If any fisheries management recommendations are to be made, they need to be made by representatives of the many facets of the fishing community including the WDNR after thoughtful deliberation and discussion. It is recommended that a Fisheries Committee be created by the BCABLA and that committee be given the responsibility of coming up with an official fisheries management plan for the lakes.

Another recommendation that is being made is to work with property owners around all three lakes to install Fishsticks aquatic fishery habitat projects that can be funded by Healthy Lakes grants.

MONITORING, MODIFICATION, SURVEY, AND TRACKING

Due to past management results, there will be increased scrutiny of any proposed or implemented management action related to the Big Chetac, Birch, and Little Birch lakes. As such, it will be to the benefit of the BCABLA to do what it can to document actions taken and the results of those actions. In the past, the BCABLA has done a good job documenting plant management results and impacts to both target and non-target aquatic plant species. If CLP management were to be implemented CLP bed-mapping, PI surveys, and turion density surveys should be continued. In the North and Central basin where management from 2013-2015 impacted native species, native aquatic plant PI surveys should be continued at least for a few more years to continue documenting the recovery of native plant species and resurgence of CLP.

At the present time, there is an active volunteer collecting monthly water quality data including water clarity (Secchi disk), TP, and Chlorophyll A, and temperature profiling according to the guidelines in the CLMN program from the three basins in Big Chetac Lake. At the present time there is not an active volunteer collecting the same data from Birch Lake.

CLMN data only includes the parameters of TP and ChlA. TP is collected in the spring and then June-August. ChlA is only collected June-August. It would be beneficial to add TP and ChlA through October in all three basins of Big Chetac Lake and in Birch Lake particularly since one indicator of internal loading is higher levels of both TP and ChlA in the late summer and fall. It may be beneficial to add water column sampling for both phosphorus and iron monitoring in at least the North basin of Big Chetac Lake and in Birch Lake for at least a couple of years in a row. Dissolved oxygen (DO) profiles should be added to temperature profiles.

An Alum Study was completed for Big Chetac Lake back in 2013, and once a more formal documentation of water and nutrients budgets for Birch Lake have been completed, it might be beneficial to do the same for Birch Lake.

UPPER RED CEDAR RIVER WATERSHED WATER AND NUTRIENT BUDGETING

One of the big questions that remain as it pertains to the entire Red Cedar River Headwaters watershed above the Mikana Dam on Red Cedar Lake is just how much water and nutrients move into and out of each lake in the system (Big Chetac, Birch, Little Birch, Balsam, Hemlock, and Red Cedar). This essentially unanswered question is an important one given that change in one of more of the lakes is expected to have impacts on some or all of the remaining lakes. Water and nutrient budgets including groundwater, were calculated for Big Chetac Lake during the "Getting Rid of the Green" project back in 2007 and 2008, but should be repeated. The "Getting Rid of the Green" project stopped at the outlet of Big Chetac Lake to Birch Lake, except to measure what was likely going over the dam and downstream into Balsam Lake. There was no data collected to determine water and nutrient budgets for Birch Lake independent from Big Chetac. Some data, including an attempt to quantify how much water was coming into Birch Lake from Big Chetac, phosphorus and iron totals in the bottom waters of Birch Lake, and water going out over the dam, was collected in 2017 but the limited scope of that project only scratched the surface of what should be done.

Water and nutrient budgets were last established for the Red Cedar lakes (Balsam, Red Cedar, and Hemlock) back in 2003 based on 2001 data. During that study completed by the USGS and based on only one year of data, 36% of the water and 39% of the nutrients entering Red Cedar Lake through Balsam Lake came from Birch Lake. It has long been wondered by the Red Cedar Lakes Association how quickly improvements made to Big Chetac and Birch Lakes would translate to improvements in Balsam Lake and then Red Cedar Lake.

Another aspect of the water and nutrient budget in all of the lakes is the large wetland complex that exists between Birch Lake and Balsam Lake. It may be that this is the one single feature in the watershed that has protected Balsam and Red Cedar lakes from more rapid deterioration due to upstream phosphorus inputs (Figure 60).

Figure 57: Wetland Complex between Birch and Balsam Lakes (Google Earth)

GOALS, OBJECTIVES, AND ACTIONS

Much of the Stakeholders Committee discussion and two of the three Public Meetings were focused on coming up with goals, objectives, and actions that would maintain or improve conditions in the Big Chetac, Birch, and Little Birch lakes. Arguably, one of the most involved discussions both during the Stakeholder Committee meetings and in the Public meetings was one involving the order of importance of said goals. There were some who believed that water quality was the most important goal as it affected everything else. There were some who felt a fisheries management goal was most important because without the fishery one of the main reasons for people to come to and use the Big Chetac, Birch, and Little Birch lakes would be gone. There were still others who felt keeping new AIS (like EWM) out of the lakes should be most important. In the end, a goal structure was created that put all goals on the same plane, with no single goal garnering a different level of "suggested" or "unsuggested" importance (Figure 61).

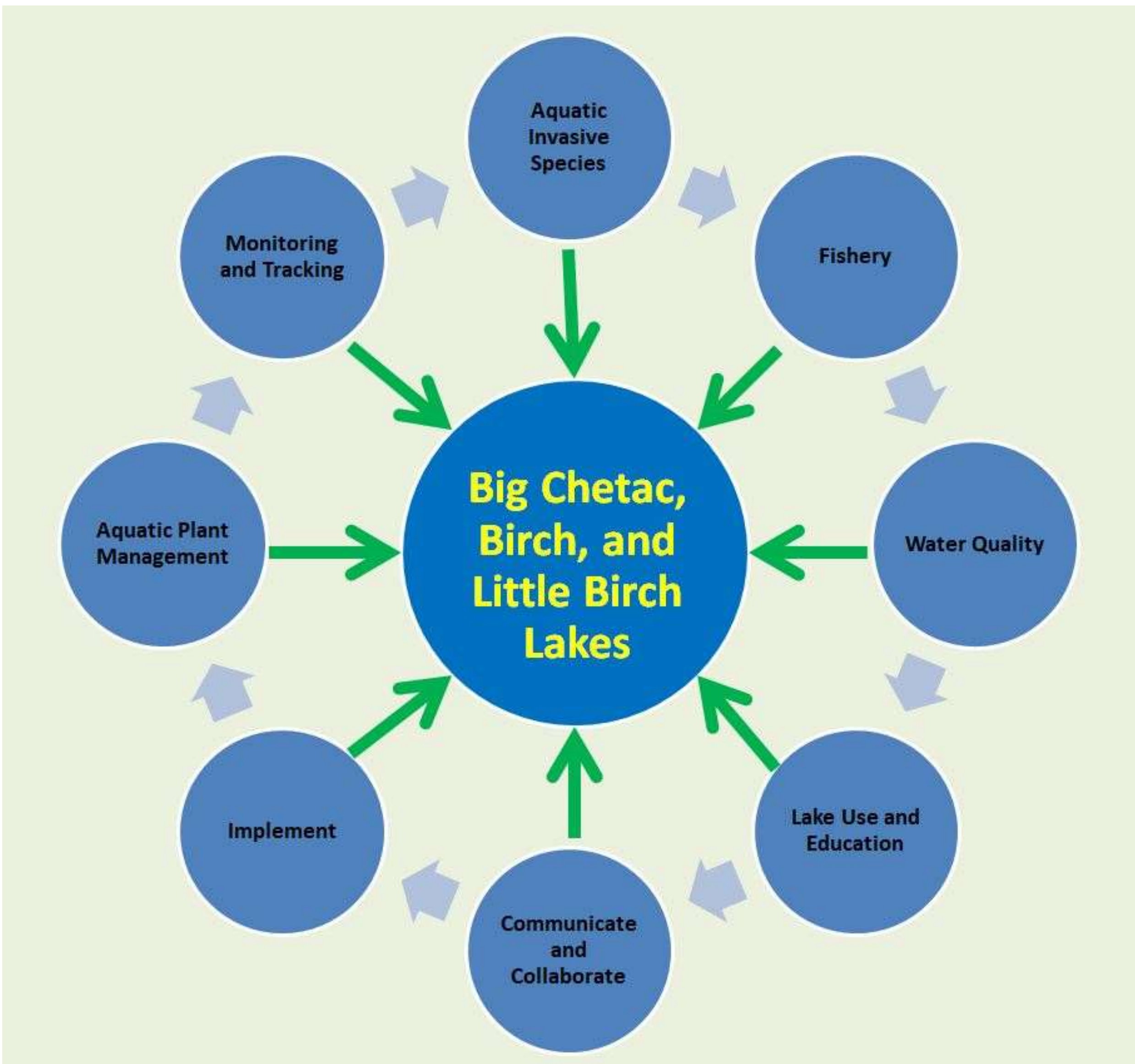


Figure 58: Goals for Big Chetac, Birch, and Little Birch Lakes (LEAPS, 2019)

Each of these goals are important to maintain or make improvements to the lakes in the system. In the figure above, the main goals circle around the three lakes and are all connected. Such is the function of the goals, objectives, and actions in this document. They are all meant to be implemented in concert with each other, rather than selecting only one or two that, depending on the perspective, may or may not be more important. Appendix A lays out each of the goals that have been reached through this planning process, the objectives included in each goal, and the actions that will be implemented to help reach those objectives. Appendix B is an implementation matrix that will help guide who is to do what and when and how a given action might be funded if funding is needed.

WDNR AIS GRANT PROGRAMS

There are several different WDNR grant programs that may be applicable to and/or support the goals, objectives, and actions in this Management Plan.

LAKE MANAGEMENT PLANNING GRANTS

Lake management planning grants are intended to provide financial assistance to eligible applicants for the collection, analysis, and communication of information needed to conduct studies and develop management plans to protect and restore lakes and their watersheds. Projects funded under this subprogram often become the basis for implementation projects funded with Lake Protection grants. There are two categories of lake management planning grants: small-scale and large-scale.

SMALL SCALE LAKE MANAGEMENT PROJECTS

Small-scale projects are intended to address the planning needs of lakes where education, enhancing lake organizational capacity, and obtaining information on specific lake conditions are the primary project objectives. These grants are well suited for beginning the planning process, conducting minor plan updates, or developing plans and specification for implementing a management recommendation.

LARGE SCALE LAKE MANAGEMENT PROJECTS

Large-scale projects are intended to address the needs of larger lakes and lakes with complex and technical planning challenges. The result will be a lake management plan; more than one grant may be needed to complete the plan. Currently these grants require that 33% of a total projects cost be covered by the sponsor through volunteer time, donated services and/or equipment, and/or cash. The application due date is December 10.

LAKE PROTECTION GRANTS

Lake protection and classification grants assist eligible applicants with implementation of lake protection and restoration projects that protect or improve water quality, habitat or the elements of lake ecosystems. There are four basic Lake Protection subprograms: a) Fee simple or Easement Land Acquisition b) Wetland and Shoreline Habitat Restoration c) Lake Management Plan Implementation d) Healthy Lakes Projects. Lake Management Plan Implementation funds are the most likely to be used if approved by the WDNR, but land acquisition and wetland and shoreland habitat restoration funding could also be applicable if projects are identified by the BCABLA over the next five years. Healthy lakes project funding is more immediate and could be applied for and utilized in year one implementation of this plan.

HEALTHY LAKES PROJECTS

The Healthy Lakes grants are a sub-set of Plan Implementation Grants intended as a way to fund increased installation of select best management practices on waterfront properties without the burden of developing a complex lake management plan. Details on the select best practices can be found in the Wisconsin Healthy Lakes Implementation Plan and in best practices fact sheets available through the Healthy Lakes Initiative.

Eligible best practices with pre-set funding limits are defined in the Wisconsin Healthy Lakes Implementation Plan, which local sponsors can adopt by resolution and/or integrate into their own local planning efforts. By adopting the Wisconsin Healthy Lakes Implementation Plan, a lake organization is immediately eligible to implement the specified best practices. The intent of the Healthy Lakes grants is to fund shovel-ready projects that are relatively inexpensive and straight-forward. The Healthy Lakes grant category is not intended for large, complex projects, particularly those that may require engineering design. All Healthy Lake grants require a 25% sponsor match and have a standard 2-year timeline. Applications are due on February 1 each year.

AQUATIC INVASIVE SPECIES GRANTS

Aquatic Invasive Species grants can be used to support education, prevention, and planning projects, Clean Boats, Clean Waters programs, aquatic plant survey costs, plant management permitting costs, and many other actions. In some cased they can be used to support management implementation as well. Currently these grants require that 25% of a total projects cost be covered by the sponsor through volunteer time, donated services and/or equipment, and/or cash. Application due dates are December 10 and February 1.

For more information about these or any other lake related WDNR grant, visit the WDNR's Surface Water Grants page at https://dnr.wi.gov/aid/surfacewater.html.

GRANT FUNDS TO ASSIST IMPLEMENTATION OF THIS COMP PLAN

The BCABLA has already, and will continue to request funding for watercraft inspection. It has plans to request Healthy Lake funding in either 2020 or 2021. Lake management planning funding will likely be requested in 2020 to support a project in cooperation with the Red Cedar Lakes Association to determine current water and nutrient budgets for Big Chetac and Birch lakes.

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Appendix A – Goals, Objectives, and Actions

Appendix B – Implementation Matrix